DEVELOPING FRAMEWORK FOR CAPABILITIES RELATED TO SUPPORTING MANAGEMENT DISCIPLINE THAT CONTRIBUTES TO R&D IN PUBLIC ORGANIZATIONS OF PAKISTAN

ZEESHAN ASIM

DOCTOR OF PHILOSOPHY

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

DECLARATION OF THESIS AND COPYRIGHT

Author's Full Name : ZEESHAN ASIM

Date of Birth : 30 July 1983

Title : DEVELOPING FRAMEWORK FOR CAPABILITIES RELATED TO SUPPORTING MANAGEMENT DISCIPLINE THAT CONTRIBUTES TO R&D IN PUBLIC ORGANIZATIONS OF PAKISTAN

Academic Session : 2018/2019

I declare that this thesis is classified as:

- ☐ CONFIDENTIAL — (Contains confidential information under the Official Secret Act 1997)*
- ☐ RESTRICTED — (Contains restricted information as specified by the organization where research was done)*
- ☑ OPEN ACCESS — I agree that my thesis to be published as online open access (Full Text)

I acknowledge that Universiti Malaysia Pahang reserves the following rights:

1. The Thesis is the Property of Universiti Malaysia Pahang
2. The Library of Universiti Malaysia Pahang has the right to make copies of the thesis for the purpose of research only.
3. The Library has the right to make copies of the thesis for academic exchange.

Certified by:

(Student's Signature)	(Supervisor's Signature)
AQ1859313	Shahryar Sorooshian
New IC/Passport Number	Name of Supervisor
Date:	Date:

NOTE: * If the thesis is CONFIDENTIAL or RESTRICTED, please attach a thesis declaration letter.

*Pahang*withits copy attached to the thesis.

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Doctor of Philosophy.

____

(Supervisor's Signature)

Full Name : DR. SHAHRYAR SOROOSHIAN

Position : ASSOICATE PROFESSOR

Date:

STUDENT'S DECLARATION

I hereby declare that the work in this thesis is based on my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

____

(Student's Signature)

Full Name :ZEESHAN ASIM

ID Number : PPT16003

Date :

DEVELOPING FRAMEWORK FOR CAPABILITIES RELATED TO SUPPORTING MANAGEMENT DISCIPLINE THAT CONTRIBUTES TO R&D IN PUBLIC ORGANIZATIONS OF PAKISTAN

ZEESHAN ASIM

Thesis submitted in fulfillment of the requirements

for the award of the

DOCTOR OF PHILOSOPHY

Faculty of Industrial Management

UNIVERSITI MALAYSIA PAHANG

JULY 2019

ACKNOWLEDGEMENTS

I would like to express my deep and sincere gratitude to my main supervisor, Assco Prof. Dr Shahryar Sorooshian, for his personal guidance and support in my work for over four years during my study. His expertise, supervision, and mentoring have been of great value for me. I am, for his advice and encouragement in my study. Without support from both supervisors, this thesis would not have evolved as it has.

I wish to extend my gratitude to the members of staff and managers at a number of Nation Productivity organisations and Asian Science Consortium for taking part in the surveys and allowing me to conduct the field study in Pakistan. Their contributions, time, and the effort they spent in completing the questionnaires and in the interviews were of a great help for me to carry out the fieldwork, which made this study possible.

I wish I could give individual acknowledgment to all those who have contributed in my work. However, this is impossible, but I am truly grateful to all those who have significantly participated.

Finally, I would like to express my loving thanks to my family. Without their support and encouragement, this thesis would not have been completed. Thus, this thesis is dedicated to them all my family.

ABSTRAK

Penbangunan dan Penyelidiken (R & D) di bawah lingkungan skop pengurusan telah menjadi satu aspek penting bagi peringkat individu, organisasi dan global. R & D telah lama dianggap sebagai keutamaan bagi negara-negara yang sedang membangun. Walau bagaimanapun, R & D di seluruh negara-negara membangun menghadapi kekurangan penting dalam mengklasifikasikan keupayaan untuk menangani isu ketidakupayaan. Hasil daripada masalah tersebut, terdapat permintaan yang berpotensi dalam kalangan organisasi awam untuk mewujudkan model secara teori yang berkaitan R & D di peringkat organisasi. Objektif utama kajian ini adalah untuk menawarkan sebuah model metodologi yang menyokong dalam penstrukturan semula rangka kerja R & D berdasarkan keupayaan untuk menyokong pengurusan disiplin. Untuk mencapai matlamat utama, kajian ini terdiri daripada kajian teori dan empirikal: Kajian literatur umum; kajian literatur secara sistematik tentang keupayaan berkaitan dengan sokongan disiplin pengurusan yang terlibat di dalam R & D; perbincangan kumpulan fokus diaplikasikan untuk menapis keupayaan di bawah pandangan khusus negara; Menggunakan model yang dicadangkan dalam kes organisasi awam Pakistan untuk menyusun semula orientasi R&D untuk menghadapi cabaran pada masa hadapan. Kemajuan berdaya saing dalam mana-mana firma R & D mempunyai implikasi silang budaya khusus kepada negara di mana R & D berfungsi sejak kajian ini menarik kes R & D di dalam organisasi awam Pakistan. Oleh itu, teknik kumpulan Fokus disesuaikan dengan penapisan keupayaan yang berkaitan dengan inovasi pengetahuan dan pengurusan teknologi sebagai "menyokong disiplin pengurusan". Keupayaan ini dikumpulkan daripada kajian literatur yang sistematik (PRISMA and Co-word analysis). Pakar-pakar yang dinamakan terdiri daripada pelbagai pusat penyelidikan yang merangkumi universiti, organisasi awam. Tambahan pula, berdasarkan keputusan kumpulan fokus hasil hubungan dan keutamaan keupayaan dapat dirumuskan melalui teknik DANP Teknik. DANP (DEMATEL Berdasarkan ANP) teknik menggunakan pakar-pakar pelbagai disiplin yang membolehkan model umum pemasangan khusus untuk R & D dalam organisasi awam. Daripada kajian ini dapat dibuat satu kesimpulan, dengan mengisi jurang kekurangan potensi yang berlaku dalam bentuk kegagalan keupayaan. Kajian ini mempunyai konsep novelti pada infrastruktur, proses dan perspektif strategik yang berkaitan dengan keupayaan yang dimiliki oleh pengetahuan, inovasi dan pengurusan teknologi selari dengan tingkah laku sumber-sumber mereka yang secara tidak langsung mempengaruhi kepada R & D. Keupayaan perspektif sebagai pembuat keputusan kriteria yang membolehkan untuk menilai kekurangan dalam mengklasifikasikan keupayaan untuk menangani isu kegagalan keupayaan. Kajian ini membolehkan pembuat dasar membangunkan rangka kerja R & D yang mungkin berguna untuk negara-negara membangun yang tidak mempunyai hak keistimewaan lain di mana dinyatakan bahawa R & D model memainkan peranan penting dalam membangunkan polisi sains kebangsaan.

.

ABSTRACT

Research and development R&D under the boundaries of management scope has become a crucial aspect for individual, organizational and global level. R&D has long considered as a top priority for developing countries. However, R&D across developing countries confronts vital deficiencies in classifying capabilities to address capability failure issue. As result of such problem, there is potential demand among public organizations for creating theoretical model dealing R&D at organizational level. The prime objective of this research is to classify the capabilities related to supporting management discipline that adds their influence on R&D, To analyze the interrelationship among the capabilities related to supporting management discipline for R&D in Pakistan Public Organizations and To prioritize the capabilities that involve at R&D in public organizations based on their interdependency in case of Pakistan . To accomplish the primary objective, the research comprise on theoretical and empirical studies: General literature review; Systematic literature review gathering capabilities related to supporting management disciplines that involve in R&D; Focus group discussion applied for refining capabilities under country-specific view; Applying proposed model in case of Pakistan public organization to reconfigure R&D orientation to confront future challenges. Competitive progression in any R&D firm does have cross-cultural implication specific to country within which the R&D functioned since is this study draw the case of R&D in Pakistan public organization. Therefore, Focus group technique adapted to refining relevant capabilities related to knowledge innovation and technology management as “supporting management discipline”. These capabilities gathered from the systematic literature review (PRISMA and Co-word analysis). The experts nominated from various research centers that include universities, public organizations. Furthermore, based on focus group results the interrelationship and prioritization of capabilities can be formulate through DANP techniques. The DANP (DEMATEL Based ANP) technique utilizes multidisciplinary experts that allow general model fitting specifically to R&D’s in public organization. The study concluded, by filling the potential gap that occurs in shape of capability failure. Key finding of this study is to draws novel Framework on infrastructural, processes and strategic perspective related to capabilities that belongs to knowledge, innovation and technology management along with behavior of their resources that influence indirectly on R&D. The capabilities perspective as criteria’s allowing decision makers to assess the vital deficiencies in classifying capabilities to address capability failure issue. This research enables policymakers to developed R&D framework that might be useful for other low privilege developing countries where state driven R&D model plays a crucial role in developing national science policy.

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

α	Threshold Value
T '	Normalization of Total Matrix

LIST OF ABBREVIATIONS

K.M	Knowledge Management
I.M	Innovation Management
T.M	Technology management
PRISMA	Preferred Reporting Items for Systematic Reviews and Meta-Analyses
R&D	Research and Development
K.cre	Knowledge Creation
K.Acq	Knowledge Acquisition
Int Kno Port	Intellectual Knowledge Portfolio
K.shar	Knowledge Sharing
K.Imp	Knowledge Implementation
K.tran	Knowledge Transfer
Cult	Culture
Stru	Structure
Tech	Technology
Peop	People
Lead& Supp	Role of Leadership & Support
org. Lear	Organizational Learning
Succ. Rate	Success rate of R&D products
Code	Codification
Pers	Personalization
Ex.kn	External knowledge source
Int.Kn	Internal knowledge source
Tech .Tran	Technology Transfer
Dec.Mak	Decision Making Process
In. Op Inn	Open Innovation
Proj. mang	Project Management
Inn. com	Innovativeness Compability
Rate Int	Rate of Introduction New Product
Int & Ext Kno	Internal & External Knowledge Sharing
R&D.Corp	R&D cooperation

Ext Net	External Networking
Know .Inc	knowledge incentives
Rad Inn	Radical Innovation
Abso. Cap	Absorptive capacity
R&D Empo	R&D Employee
Tech Tren	Technology Trends
Inno. per	Innovative Performance
Inov Str& ini	Innovation strategies and initiatives
Org.Str	Organization strategy
Tech. Acq	Technology Acquisition
Tech. Expo	Technology Exploitation
Tech. Pro	Technology Protection
Tech. lear	Technology Learning
Tech. Sele	Technology Selection
Tech. Iden	Technology identification
Tech Deve	Technology development
Mang Cap	Management Capability
Fac	Facility and Equipment
Org. Capa	Organization Capability
Pers. Skil	Personal Skill
Str Tech	Strategic Technology Road Mapping
Corp Tech Stra	Corporate Technology Strategy
Corport Bus Strat	Corporate Business Strategy
Tech Alli	Technology Alliance Strategy
Desor. Cap	Desorptive Capacity
GII	Global Innovation Index
GCI	Global Competitive Index
TAI	Technology Achievement Index
IMF	International Monetary Fund
TMC	Technology Management capability
IMC	Innovation Management Capability
KMC	Knowledge Management Capability
NUST	National University of Science & Technology

UNESCO	United Nations Educational, Scientific and Cultural Organization
NCST	National Commission of science and technology
MOST	Ministry of Science and Technology

CHAPTER 1

INTRODUCTION

1.1 Introduction

The existing industrial environment has had a considerable impact on organizations across the globe (WEF, 2017). An uncertainty and risk-averse allow organizations emphases on short-term advantages, and obstructs any long term opportunities to highly uncertain assignments for Research and Development (R&D). Also, the industrial cutbacks may cause the reduction of various supporting management disciplines and human capital in shape of brain drain, including highly skilled experts which consider as driving factor for knowledge-based economies (Cetindamar et al., 2010; Pellens et al., 2016; Pilkington, 2008). However, it has been found that at current circumstances some of technically advance public and private organizations have not trivialize the role of supporting management disciplines related to R&D even during the worst financial crisis. Conversely, they take as an opportunity to raise their spending for R&D (Archibugi et al., 2013; Pellens et al., 2016). The vitality of these organizations forced towards rethink to manage their R&D as anti-catastrophic strategies. Few studies suggested that strong role of supporting management disciplines allow R&D to balance short-term and long-term sustainable growth (Cetindamar et al., 2010; Pilkington, 2008). Moreover, enabling more fundamental approach focusing on R&D at governmental level is significant for nurturing an environment to get long-term socio-economic benefits (Şener & Sarıdoğan, 2011). Conversely, the question of how and what degree that role supporting management discipline may contribute to manage R&D at what level that need to answer. Thus, it would be better to conduct empirical study which could offers strong argument for managing capabilities within organizations, which play significant role in utilizing R&D to enhance national competitiveness such as in R&D in public organizations

1.2 Research Background

R&D initially known as knowledge translating processes (Clark & Fujimoto, 1991b; Moenaert & Souder, 1990; Nowotny, 2003; Savory, 2009). Therefore, the transformation of information may rely from sources such as customer order, current market demand, technological development into product designs and manufacturing processes (Khodakarami & Chan, 2014; Rolstadås et al., 2012; Weerd-Nederhof & Drongelen., 1994)

Developing countries looking to contributes more on R&D in public organizations, because new capabilities were vital for national competitiveness (Bank, 2010). This is specifically factual for large developing countries, which have a significant mass of resources and proficiency to drive R&D with respect their local conditions (OECD, 2016). At least for minimum level, these developing countries require aggressive capabilities for R&D in order to align with global industrial demand (OECD, 2016). According to world bank public organizations confronting various issues during distribution of limited resources specifically deal with R&D due to policy deficiency (WDI, 2016). Therefore, better distribution of such resources should be the top priority, including the better understanding of what supporting management disciplines that the government should help to maintain the R&D effectiveness among pubic organizations (Kahn & McGourty, 2009). The second concern is about the active configuration of these resources, specifically their contribution to R&D in public organization (OECD, 2016). It is complicated to validate pure scientific research in developing countries due to severe socio-economic obligations, when more applied R&D can make a considerable footprint (Bank, 2010). Several developing countries are unsuccessful to measure effectiveness of R&D in public organizations or implement any transparent accountability mechanism. Those public institutions adds insufficient value to accomplish the desirable needs for national competitiveness (Bank, 2010). In this context, it makes sense for developing countries to classify the resources that drive capabilities belongs to supporting management discipline. It helps in dealing with R&D in public organization and need to sustain their managerial disciplines in which they already have a comparative edge (Gaillard, 2010). Not just sustain it, but it is also significant for them to expand more on resources related to supporting management discipline. (Dutta et al., 2017; Gaillard, 2010)

By 2015, almost $1,800 billion worth of dollars were spent on R&D around the world. Over the last two decade, the global resources for R&D has more than doubled (Aksnes et al., 2017). During same period, R&D share expends from 1.40 to 1.69 percent to the global GDP (Aksnes et al., 2017). From 1996 to 2014, there has been an apparent shift of global R&D resources from North America to Asia developing countries. It is specifically due to the rising industrial growth in china, South-Korea and Taiwan (Aksnes et al., 2017). In 1996, the balance of R&D resources contribution to world's R&D by developed countries is about 65% while, developing countries contributes 26 %. However, by 2015-2016, the proportion were 48 and 43 percent, respectively (Aksnes et al., 2017). It shows the clear trends regarding locating more R&D toward developing countries.

However, the majority of developing countries depend on R&D in public sector which has so far confronting various capabilities failure due to infrastructural weakness among supporting management discipline (Guimón & Agapitova, 2013). The recent study made by World Management survey (WMS) which has legitimatized a quantum leap in their comparative study regarding contribution of supporting management discipline with their implication on R&D competitiveness (Cirera et al., 2017). WMS illustrates various systematic failures occurs among public organizations due to capability deficiencies related to supporting management discipline, which emerges as a critical driver for R&D among several developing countries (Cirera et al., 2017). Addressing these deficiencies consider as stressful and engaging process for many developing economics to sustain their R&D competitiveness (Guimón & Agapitova, 2013)

Evidences suggested that despite the substantial R&D myopia that occurs among various developing countries in shape of capability failure, somehow effect the national innovation policy (Cirera et al., 2017). Such effect ultimately divert the focus of various researchers to emphasize more on the significance of boarder set of capabilities related to supporting management discipline at R&D frontier (Cirera et al., 2017)

Supporting management discipline is an under researched phenomenon (Mah, 2015). Majority of firms operating capabilities that belongs knowledge, innovation and technology management as supporting management discipline (Cetindamar et al., 2010; Pilkington, 2008). Researchers in the field of R&D have explored numerous aspects of this phenomenon. Earlier studies, were used to clarify the real boundaries among supporting management discipline (Cetindamar et al., 2010; Pilkington, 2008) for example Matthews (1996) and Cho and Mathews (2000), downplay R&D-focused paradigms and emphases on how latecomer Asian firms looking to acquired capabilities that propel supporting management discipline in order to accelerated organizational learning as supporting instrument. Huang et al. (2008), more emphases on comparing R&D progress on the bases of effective management practice related to technology and innovation among public and private organization. Chiesa et al. (2008a) characterized multiple R&D configurations on the bases of knowledge management as effective supporting management tool and allow their performance indicators to measure long-term national goal. Although these studies analyze the effective utilization of supporting management discipline and only been explore effective involvement of these management disciplines to clarify the real boundaries among them (Cetindamara et al., 2009; Pilkington, 2008; Pilkington & Teichert, 2006). These studies neglecting the range of capabilities belong to supporting management disciplines, which share the boundaries with R&D to avoid systematic and market failures among developing countries (Foxley & Stallings, 2016; Guimón & Agapitova, 2013) leaving room for further research on the same field.

Few recent studies have focused upon R&D in latecomer industrial countries (Huang et al., 2008; Meesapawong et al., 2010; Reddy, 2011). Some recommendations have been observed regarding the degree to which developing countries may comply for improving their capabilities related to supporting management discipline. Such improvement were based on existing strength among their government institutes (Anwar-ul-Hassan Gilani 2015; Babelyte-Labanauske & Nedzinskas, 2016). This was giving without specific analysis to address significance of capabilities related to supporting management discipline in order to improve R&D deficiencies (Foxley & Stallings, 2016; Guimón & Agapitova, 2013). Thus, it remains arguable among researchers to explore more to address on classification of capabilities related supporting management discipline that leads to the capability failure.

1.3 Problem Statement

The existing literature on R&D under the boundaries of management scope has become a crucial aspect among individual, organizational, and global level. R&D has long considered as a top priority for majority of developing countries (Polit & Beck, 2010a). These developing countries consider R&D as a central stream element for during the development their science and technology policies to counter economic and social challenges. On the other hand, developed countries consider R&D as for sustainable competitive tool (Guimón & Agapitova, 2013). There is no reservation regarding the significance of R&D among developing countries as a potential instrument to confront growing challenges due to exponential technological development at a large industrial scale (Wang et al., 2013). However, many developing countries still facing the technical barriers due to the slowing progress in their R&D (Mazurkiewicz & Poteralska, 2017). OECD (2016) shows the majority of governments policies among developing countries used to supports the potential resources for R&D in public organizations, but the outcome was remained fragmented and disarticulated, making them ineffective (Maloney, 2014). Majority of developing countries spending less 0.5 % of their GDP on R&D although the spending grow up over the period by the number of emerging economies the situation remains the same (WEF, 2017). According to global innovation index (GII), developing countries rely on spending may confront various deficiencies relate to supporting management discipline even though, majority of governments among these developing countries advocating the policies that were put an effort to enhance their R&D competitiveness at governmental institutions (Ali et al., 2009; Dutta et al., 2016b; Wamae, 2009). Similarly, innovation mechanism among several developing countries faces huge constraints of systematic interaction, that were largely absent and depleting processes for capability accumulation that effect largely to R&D (Egbetokun et al., 2017)

More than 50 % of public organizations among these developing countries has failed to recognized the knowledge, innovation and technology management as supporting management disciplines as significant contributors to R&D (Guimón & Agapitova, 2013; Račinskaja et al., 2017). Such issue frequently appeared in shape of market failure and systematic failure as outcome of R&D (Guimón & Agapitova, 2013; Unsal & Cetindamar, 2015). The prior research more concerning about to rectify market and systematic failure also illustrate the method to overcome these failures (Bounfour & Miyagawa, 2014; Guimón & Agapitova, 2013; Lundvall et al., 2011; Meuleman & Maeseneire, 2012; Trade & Development, 2003). The prior research unable to highlight any narrative on capabilities failures that were appeared during capability learning process among various public organizations that are fail to classify the capabilities related to supporting management disciplines (Karaveg et al., 2016; Račinskaja et al., 2017). Therefore, classifying capabilities related to supporting management discipline is essential to propel R&D competitiveness with significant impact on national innovation system (Anwar-ul-Hassan & Ansari, 2015)

In a long-term perspective, these capabilities barriers lead to inevitable consequences for example, transfer of resources as investment always a weak point for developing countries as from development and self-reliance perspective (Ramzi & Salah, 2018). Majority of the developing countries remain depended on commercially and technological on external sources (Ramzi & Salah, 2018). In fact, the R&D is still the unrevealed black box of the developing countries. Prior studies unable to portray enough evidences on classifying the capabilities related to supporting management discipline that influence the R&D among developing nations (Ramzi & Salah, 2018)

Since the majority R&D, related activities in developing countries has fall under the public organizations (Anwar-ul-Hassan & Ansari, 2015; Guimón & Agapitova, 2013). Therefore, the effectiveness of R&D is considers an essential tool for national innovation system (NIS), that may rely on capabilities related to supporting management discipline as a significant approach for developing adequate national innovation policies (Anwar-ul-Hassan Gilani 2015; Unsal & Cetindamar, 2015).. Besides, prior studies were more about the role of supporting management discipline (Karlsson et al., 2011). However, unable to draw any attention on relationship between capabilities related to supporting management discipline (Karlsson et al., 2011; Madeira et al., 2013). Thus, more studies are required to justify before any conclusions can be drawn. Since, prior studies were more focused on some assumptions without considering the differences between developing countries regarding their existing development level and their ability to attract R&D opportunity (Karlsson et al., 2011; Madeira et al., 2013).

In order to remain economical in global arena, Pakistan requires a persistent strategy to produce and establish new resources for socio-economic growth (Ali et al., 2018). This objective can be accomplished if Pakistan is competent enough to increase its existing R&D capacity in the use for socio-economic development. Such progress also enables comprehensive expansion in science and techno-innovation (STI) through aggressive R&D programmes (Ali et al., 2018). Since Pakistan is a middle income economy, where R&D can be as potential contributor to their economic growth and draw major impact on society in shape of community development, skill development, and generation of new knowledge, high education, health, environment and sustainability (OECD, 2017). According to OECD 2017 report, among developing countries R&D in public organization plays a significant role for long term soci-economic growth based on true value that relatively small difference in rate of actual economic growth contribution maintained over a sustainable period can have enormous implication for material living standards(OECD, 2017). Effective R&D practices enables socio-economic growth rate of output per person based on community development, skill development, and generation of new knowledge, high education, health, environment and sustainability upto average value of 2.5 % per year which double average living standards in 28 years (OECD, 2017). In case of Pakistan according to OECD recent revelation, the situation required major improvement in-case of encouraging R&D to enhance soci-economic at present situation the role of R&D on community development from year 2015 to 2019 the average value remain stagnant at around 1.5% while, the average contribution of R&D on skill development were close upto 1.7%. The role of R&D contribution in case of generation of new knowledge and High education the average value remain maintain upto 1.44% and 1.98% over five years. R&D practices at public sector has positive influence on health and environment at national which shows certain progress over five year period the average value has maintain upto 2.1% and 2% respectively while the impact on sustainability remain stagnant average value 2.08%. In case of Pakistan, the overall average value that R&D contributes on socio-economic growth for common people is 1.84% which less than recommend value of 2.5% as shown in Figure 1.1. Since, Pakistan is a developing country the policy makers need more to emphasis on effective R&D practice at public sector in order to elevate socio-economic growth for common peoples.

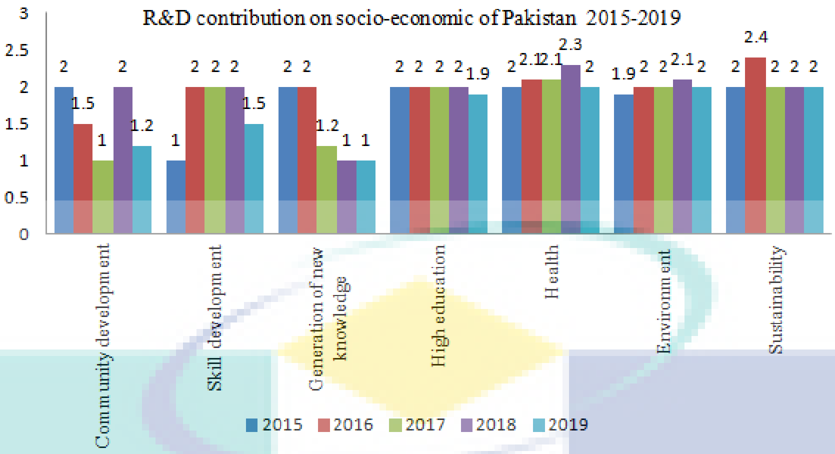

Figure 1.1 R&D Contribution on socio-economic Pakistan 2015-2019

Source: Ali et al.,(2018)

In this context Pakistan, is the case of interest for the analysis. According to Ministry of science and technology (MOST), Pakistan spend same as India on matters concerning to R&D nothing to smirk about since the figure stands below less than 1% of GDP (Gross Domestic Product). But the result is significantly hammered (Mannan, 2013). According to the recent report published by Pakistan Council of Science and Technology (PCST) reveals that depleting position of Pakistan among various indexes for instance: According to Global Innovation Index -2017, Pakistan rank 131th out of 141 countries (Dutta et al., 2017). Similarly, Technology Achievement Index (TAI-2015) shows more fragile position according to their measurement Pakistan rank at 127th out of 140 countries (Shahab, 2015). While, according to Global Competitive Index (GCI) Pakistan rank at 107th out of 140 countries which gives the clear picture about the significance of R&D in public organizations (Schwab, 2016a). From PCST recent prediction more than 75.25% research & development falls under the responsibility of governmental institutions (Muhammad & Bashir, 2014). Since, Ministry of science technology (MOST) has set the 2023 target to promote R&D according to UNESCO specification (Shahid, 2016). Therefore, heads of various scientific institutions including, Pakistan Engineering Council (PEC), National University of Science and Technology (NUST) and National Commission of Science and Technology (NCST) pitched the idea to boost R&D growth and prioritize the potentially weak capabilities that are involve as supporting management discipline to supplement R&D competitiveness specifically in public institutions (Shahid, 2015)

1.4 Objectives

The objectives for this research were three-fold

- RO_1: To classify the capabilities related to supporting management discipline that adds their influence on R&D
- RO_2: To develop framework based on interrelationship among the capabilities related to supporting management discipline for R&D in Pakistan Public Organizations
- RO_3: To prioritize the capabilities that involve at R&D in public organizations based on their interdependency in case of Pakistan

1.5 Research questions

With respect to research objectives, this PhD research looking to assess the following overarching question: In investigating such issue, three major research questions arises as follows

- RQ1. How to classify the capabilities related to supporting management discipline that shares the boundaries with R&D?

- RQ2. How to develop framework to draw if there is any relationship among the capabilities in case of R&D in Pakistan public organizations?

- RQ3. How to prioritize the capabilities that involve at R&D in public organizations based on their interdependency in case of Pakistan?

1.6 Scope of Study

This study limited to R&D in Pakistan Public Organizations. The study will more focus on classifying the capabilities related to supporting management discipline that contributes to R&D. This study will also, emphasized on determining relationship among the capabilities, and prioritizing them with respect to their interdependency in order to address capability failure issue that appear among majority of Public organizations of Pakistan. Key invited experts were from R&D in public organization with expertise and experience in knowledge management, innovation management and technology management. Upon researcher's consultation with National Productivity Organization (NPO), lists of related public organizations were presented with active R&D with organizational mission based on knowledge, innovation and technology management.

Addressing the multi-disciplinary R&D in public organizations, allow researcher to include all the studies based on relevant capabilities under a generic perspective as to oppose country-specific review. In this study, the systematic literature review (PRISMA) used as to screen out studies from Scopus Database. However, empirical studies allow researcher to rectify the gathered capabilities from on expert's consensus under country-specific domain. Furthermore, choosing study related to developing country instant of a developed country is motivates by the intensity of public R&D as compare to private R&D in developing countries

1.7 Research Motivation

On the research stream of supporting management disciplines, no exclusive model has been ultimately acknowledged. In the context of R&D in Public organizations, some conceptual models draw limited narratives on how to manage supporting management discipline. Some prior studies draw capabilities prospective related to knowledge, innovation and technology management as supporting management discipline that shares their boundaries with R&D under individual context. Significance of supporting management discipline on R&D has been long been striving to convene capability prospective among developing countries. However, prior studies have unable to explore the relationship among three set of capabilities all together which could guide R&D in public organization. The significance of supporting management discipline on R&D among public organizations draw number of challenges in shape of systematic and market failure. These challenges are further amplified in shaped of capability failure which appear during the capability learning process among majority of R&D in public organization across developing economics

From the researcher's 8–year work experience with a Pakistani public organization, 4 –years as industrial engineer and 4-years as senior researchers, witness to face many Pakistani public organizations have been confronting capabilities issues. Although, some R&D in public organizations start to respond the situation by assessing capabilities failure that appear during the capability learning process related to supporting management disciplines how every majority of public organizations unable to classifying the capabilities related to supporting management discipline and create interrelating influence among these capabilities on R&D. Furthermore, the prioritizing mechanism for ineffective capabilities already seems to be late and inadequate in dealing with the uncertain R&D in Public organization. Chiesa et al. (2008a) characterized multiple R&D configurations on the bases as capabilities related to supporting management tool and allow their performance indicators to measure long-term organizational among public sector. Although these studies analyze the effective utilization of supporting management discipline and only been explore effective involvement of these management disciplines to clarify the real boundaries among them. However, public R&D organisations need conceptual and applied frameworks which support the full spectrum of supporting management discipline, to delivering values to public organization specifically among developing countries.

In order the develop an framework related to R&D fit to the context of public organization, consensus based opinions from experts under country specific view required to rectify capabilities related to the knowledge, innovation, and technology management as supporting management discipline that were influencing R&D by merely emphasizing on a country-specific context. This is justified by the requirement that the rectified capabilities are somehow fit to the context of country. From the researcher's perspective, the guaranteed and unrestricted access to a R&D in public organizations is an essential factor to purse this research study. Hence, Pakistan is selected and Pakistani experts were invited to take part to the Focus Group study. Furthermore, Pakistan is a developing country striving to achieve R&D competitiveness. This is where R&D in Public organization should assist in delivering this vision. Therefore, conducting research on R&D in Public organization of Pakistan could bridge the large gap in developing sustainable competitiveness and could be constructive for other developing countries that exhibit similar characteristics

1.8 Significance of Research

This research adds to the body of knowledge by offering an integrated framework that enables the capabilities of three key disciplines to achieve effective R&D outcomes.

At first, this study employing knowledge management as a catalyst to R&D and argues sufficient criteria's for knowledge management capabilities for R&D. This study portrays theoretically relationship among criteria's for knowledge management capabilities that were necessary for decision makers and signifies that how knowledge management capabilities become core element during policy making to improve R&D

Secondly, this research adds to establish logical connectivity among processes, infrastructure, and strategies regarding capabilities related to technology management that considered previously as single sources toward retaining competitiveness. However previous studies were theoretically avoiding the potential criteria for technology management capabilities which were crucial for R&D. This study probably signifies technology management as the dimension that describes rules in the form of infrastructures, processes, and strategic capabilities and evaluates the relationship among these criteria's for developing appropriate policy to improve R&D.

Thirdly, this study theoretically contributes by portraying relationship among the dimensions and criteria's related to innovation management capabilities and their influence to R&D to draw a general guideline for effective policy-making for sustainable R&D.

This research produces some practical impact on R&D in public firm's in-shape of understanding the useful contribution of capabilities related to supporting management that uses as a supporting tool to assess the capability failure among R&D in public firms. Some studies formulate critical aspects of supporting management discipline, but there seems to an absolute lack of agreement among the researchers regarding the classification of these capabilities. Secondly, this research highlights justifies the argument that how the understandings of industrial experts towards capabilities related to supporting management discipline add as significant role during R&D configuration. Third, this research produces a retainable impact on national innovation mechanism as sustainable competitiveness for countries with low R&D expenditure. Fourthly, this research enables as capacity building for R&D in public organization through capabilities learning the process.

The finding of this research contributes to the national level (i.e., Pakistan) as a tool for developing a national innovation policy. Other than R&D in Public organizations can utilize focus group technique that may also adapt to design new network model that includes organizational-specific factors gathered by taking all dimensions of public R&D into account, refined by Pakistani experts

1.9 Limitation

This research posse's number of limitations. Since, it could be arguable that identification of criteria's and sub-criteria based on extensive systematic review with the bibliometric technique known as co-word analysis. The co-word analysis sketch the postulations on research article keywords comprise a sufficient narration of its content or the adequate associations that paper recognized between problems. But unable to draw complete characteristics of research which is based on comprehensive overview of abstract

It could be arguable that the implementation of the illustrative model may not country specific. That allows evaluating the significance of DANP-based Model in the cross-cultural setting; however, this research argues an in-depth analysis on adopting DANP- based network model specific to Pakistan that could provide enough interpretation

It could be argued that findings are based upon insufficient diverse data set. However, the research offers some of the standard dimensions for instance, the conceptual framework not only contributing to R&D research but also conceived as a generic adoption model. Also, the integrated approach is not new now. But the process through which they have been utilized to rectify the complication regarding multidisciplinary characteristic relate to R&D in public organization.

1.10 Operational Definition

This study comprises number key terms, which require being noticeably understood. These key terms are further in detailed with descriptive clarifications under the literature review.

Research and Development: Research, 'R' of R&D is an investigating ability that explores to recognize the universal principles (discovers new knowledge). While, development 'D' of R&D is the function of current scientific norms (knowledge), along with commercial and other compulsions, start from the layout of devices to the potential processes that accommodate the needs of humanity (Gibson, 1981)

Capability*:* The tool which enables a broad spectrum of fields, reflects the behavior which contributes to high performance (Ingrid Robeyns, 2003).

Innovation Management*:* Innovation Management is the ability to managing organization's innovation practices, starting at the initial stages of conceptualization, to its final stage of successful implementation. It comprises the decisions, activities, and procedure of devising and implementing an innovation strategy (Hargrave, 2006)

Knowledge Management: Knowledge management describe as practice to encourage knowledge growth, extensive sharing of knowledge among the function of the organization and the aim to preserve the knowledge resource within the organization domain (Steels, 1993)

Technology Management*:* Technology management is a set of management disciplines that allows organizations to manage their technological capabilities to create competitive advantage (Gaynor, 1996)

1.11 Summary

This chapter highlights an overview of research, its research background, 'Objectives', Research questions', 'Research scope', 'Research significance', 'Research motivation', 'Knowledge contribution'. This chapter aims is to provide readers a holistic picture before detailing on the research theme in the subsequent chapters

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The core purpose of this chapter is to present a careful review of existing literature related to supporting management discipline and its effectiveness on R&D. By re-examining the appropriate studies along with relevant research backgrounds, theoretical concepts, consistent interpretation on this phenomenon, with detailed references, where it is relevant to applied among developing countries. This chapter provides all the instruments for highlighting research gap and ignored issues. Due to the significant nature and high complexity of this research, this chapter is inherently specific and limited to the capability-based approach use to explore R&D effectiveness in multifaceted domains. Hence this chapters complies with all the relevant patterns of capabilities related to supporting management discipline specific to observe its effects on R&D

2.2 Overview on R&D

In recent time most of the public sector firms seek the opportunity to change their resource pattern according to the behavior of high market demand (Teece, 2009). The role of R&D remains highly encouraged among developing countries to sustain the high market demand in shape of developing new innovation and to survive in uncertain conditions (Hosni, 2010; Porter, 1985). Since the demand fluctuating due to dynamic market environment, where most of the public sector firm looking to updated their R&D resources with respect to the market demand (Hosni, 2010). The nature of capabilities related to supporting management disciplines have abilities to accommodate R&D within a complex environment depends on the aggressive innovation policy. Such policies allow public organizations to confront uncertain market behavior (Hosni, 2010). The evaluation of capabilities was necessary for any public organization that potentials rely on R&D in order to sustain the organizational competencies (Hosni, 2010). Furthermore, these evaluations help to predict future opportunities in order to map the maximum competitive advantage during the fluctuating business environment (Porter, 1985; Teece, 2009).

In majority of developing countries the public firms align their industrial strategy with respect to capabilities that support R&D at organizational level and allow firms to confront uncertain demands (Hosni, 2010). Such strategic alignment may facilitate organizational resource to understand the progressive technological advancement and technological shift (Hill & Rothaermel, 2003). Similarly, the supporting management discipline at capabilities level allows firms to enhance their R&D scope in order to understand current and future market trends (Einsehardt & Martin, 2000; Rothaermel & Hess, 2006; Unsal & Cetindamar, 2015; Zollo & Winter, 2002).

2.3 Generational Overview on R&D

Several scholars have highlighted R&D significance in the context of generational terms (Nobelius, 2004; Rogers, 1996). For instance, "it is understandable that firms with R&D function has encountered various management configurations and has widened its functional domains to adopt internal and external change" (Howells et al., 2008). Miller (1995a) suggested that continuous evolution of R&D as the function is necessary for overall organizational performance. Miller (1995a) represents the four-level "ladder" whose "rungs" increase from special reserve through a method of steady integration of various capabilities for strategic means.

Majority of industrial corporations observe these strategic mean related to various capabilities that were unable to pay substantial interest to their R&D function till the end of the nineteenth century (Ganguly, 1999). It is understandable that various new innovative products were an outcome of some individual efforts for instance: Edison, Wright, and Bell. However, because of the high complexity involve around the process of development during new product innovation. Somehow, these individual efforts numerous occasion were unsatisfactory to the market requirement (Ganguly, 1999). While, most advanced scientific break-through was a result of integrated efforts made by the multidisciplinary team's (Ganguly, 1999). As a result of such efforts, prominent industrial organizations initiating their in-house R&D practices, offering the best opportunities to scientist and technical consultants to accommodate their demands by spending huge budgets on development programs. During that period, various patterns were adopted to manage R&D function at each level. Many scholars' splits such transformation into generational context in order to assess the outcome of R&D over the period of the half-century.

Throughout at first generation of R&D (1950 to 1960), several new innovative products that were developed in the past become a part of new trends and consider as emerging industries. The involvement of technology was mainly seen as the cure for all the functional alignments (Pelz & Andrews, 1966; Rothwell, 1994a, 1994b). The first generation of R&D as functions undergoes to some of the postulation theories that initiate the process of evolution such as more products in; the more products came out. In brief, R&D was conceived as organizational function (Roussel, Saad, et al., 1991). In case of assessing R&D process, it was observed as a linear function to propel technological creativity towards downstream for end-user market (Quinn & Mueller, 1963).

Similarly, in first generation R&D majority of firms preferred knowledge practices and were relying on significant resources related capabilities belongs to knowledge management (Park & Kim, 2005b). First generation R&D covers some aspects that initiate innovation trends among emerging scientific corporations and allow them to invest more on science and technology (William, 2014). The technology was considered as a tangible asset to managed first generation R&D due to the emergence of information technology as computers reachable to few (Rogers, 1996).

In the second generation (starts mid of the 1960s till the end of 1970s), an equilibrium market demand were observed with more balance relationship between supply and demand. Escalating market competition allows firms to emphasis more on volumes and focuses on developing promotional strategies (Rothwell, 1994a). During that decade, more attention was made on short-term market demand, entirely avoiding to acquire long-term capability for R&D to fill market expectation (Rothwell, 1994a). In term of practice-wise, the significance of demand and processes were seen as opposite in contrast to the first generation. For instance, the creative idea could conceived from the market and rectify though systematic R&D processes (Hippel, 1975).

The main strength of second-generation R&D was predictability scenes towards the development of new product and starched capabilities to influence the external organizations in order to complement in-house R&D (William, 2014). During that generation, R&D more active to integrate with other business functions. This new configuration allow firms to predict the potential values that were necessary for successful product development at the project level (Miller, 2014). More efforts were made toward management strategies which comprised project cost-sharing within the organizational matrix. Technology support mechanisms were also introduced that allows primarily data-base for statistical data synthesis as a source of business advantage (Rogers, 1996).

The third generation of R&D can be recognized from the mid -1970s till end of 1980, where the world economy was fluctuating due to high inflation with demand saturation (Miller, 2014; Rothwell, 1994a). Marginalising cost to enhance profit became the name of game. Major R&D firms conceived waste reduction technique by reconfiguring current practices and modifying new technique to reduce internal cost (Miller & Morris, 1998). During that generation range of investment in R&D also influence various ways to balance market uncertainty (Cooper, 1983).

At the early stages, during third generation more emphases were made on capabilities that allow faster product development at lower expenditure rate (Miller, 2014). The new capabilities involve during the development process provides a progressive opportunity for cost reduction by integrating waste reduction techniques (Miller, 2014).

During that period, both individual and global R&D projects were the source of replicating the overall R&D strategy for the firms (Park & Kim, 2005b). Hence, it was essential for firms to carry out simultaneous processes to fill the individual and global requirement. These processes were basically rely on supporting management discipline (Park & Kim, 2005b). These disciplines allow firms to undergo aggressive decision making with respect to their competitor (Park & Kim, 2005b).

In case of fourth generation, it starts at the early of 1980s till the end 1990 during that period the economy recovered and various business leaders looking to rethink their business diversification significantly in favour to acknowledge their core capabilities. All laying within time-line competition paradigm, for instance: Japanese companies like Honda, Sony and Toyota (Rothwell, 1994a). In general, the automotive industry considers as an example that was functioned in the similar manner (Aoshima, 1994; Clark & Fujimoto, 1991a; Tushman & Reilly, 1999). During that generation, the focused was switched from manufacturing product to putting a product as an entity of total business value for example product volume in shape of product variety, product distribution, and product services (Miller & Morris, 1998). The new concepts of product development were introduced during that period with the comprehensive integration to other organizational units along with parallel activities, which allow firms speedy response to the market demand (Cooper & Kleinschmidt, 1995; Eldred & McGrath, 1997a, 1997b; Trygg, 1991). During this generation, R&D virtualizes as a process of synchronized learning and consider as the only solution to confront market dynamism. Most of the firms experimenting with IT as aggressive weapon in order to address "Productivity Paradox" (Rogers, 1996).

In fourth generation of R&D, add more supporting management discipline to enhance not only products, processes and services. But also improve business structures along with the existing industrial model (William, 2014). Such radical enhancement depends up internal functions capabilities such as R&D, production, engineering and manufacturing or services to manage innovation (Miller & Morris, 1998; William, 2014)

Similarly, In fifth generation it starts at the early of 1990s starches R&D boundaries of discussion from internal mechanism to external trends that includes firms R&D operations, R&D management, technological ability, and sharing the requirements of technology funds (Rothwell, 1994a). Therefore, R&D needs to integrate with the business atmosphere along with external factors for example: comprehensive understanding on competitors, complete know how about potential suppliers, distributors and market customers (Iansiti & West, 1997b). More emphases were made on understanding the inherent capabilities related to supporting management discipline to interface with the system of multiple stakeholders (MacCormack et al., 2001; Tushman & Reilly, 1999). Additionally, these capabilities not only boosting product development process but also manage overall operating acceleration promptly.

The generational classifications of R&D illustrates that the R&D consider as potential source to confront market dynamism (Iansiti & West, 1997a). To accommodate dynamic business circumstances such R&D can be a potential source for firms competitive advantages (Iansiti & West, 1997a). Therefore, majority firms realized that being competitive to market response requires reasonable understanding towards supporting management discipline that allows firms to adopt creative trend successfully as compared to their market competitors (Iansiti & West, 1997a)

2.4 Evolution of R&D Generations Across Pakistan Public organizations

Majority of R&D in public sector organization in Pakistan will unable to draw and sustain its competitive capacity to confront dynamic industrial trend if it continues to ignore investments on human capital and neglecting potential spending on technical (Qureshi, 2018). It is well-understood fact that more than part of the socio-economic growth among developed countries is based on technological capabilities (Qureshi, 2018). Pakistan requires to enables strong R&D policies that relates with existing R&D generation, which is not only synchronized with all other development policies but also established strong capacity building that belongs to education, health, industrial policy in order to confront dynamic industrial trend (Qureshi, 2018). Over the last, seven decade R&D trend in Pakistan public organization evolved with respect to the industrial demand (Qureshi, 2018)

In case of R&D evolution, the first generation at early of 1950s to the mid of 1960 the trend among majority of R&D in public organization of Pakistan were more towards technology push oriented (Bashir & Bashir, 2014). More emphases were made on scientific breakthrough and less focus were made on inter-organizational coordination. In case of second generation from mid of 1960s to early of 1970s a trend of market pull oriented approach were observed among major of public organizations (Bashir & Bashir, 2014) . Majority of R&D at governmental level were more emphasize on project driven strategies. Similarly, the third generation from mid of 1970 to 1980s most of R&D in public organization of Pakistan moving away from individual projects views and develop a strong association in between strategically balanced project portfolio and business strategy as corporate function (Bashir & Bashir, 2014). In case of Fourth generation which starts from 1980 to mid of 1990 a comprehensive transformation has observed among majority of R&D in public organizations more emphasize has made on customer based learning and strategic research alliance to manage internal and external knowledge (Bashir & Bashir, 2014). While, the fifth generation starts from mid of 1990s till upto present situation where majority of R&D in public organization of Pakistan were more focused on system integration within and beyond the organizational boundaries (Bashir & Bashir, 2014).The complete evolution of R&D generations across Pakistan Public organizations is shown in Table 2.1

Table 2.1 Current R&D generation adapted by Pakistan Public Organizations

Generation	**R&D Trends General characteristics**	**Specified R&D Characteristics**	**Public organization with respect to sectors**
First (1950s to the mid of 1960)	Incremental resource allocation	Science push strategy, More focus of breakthrough based on individual researchers	Agriculture, Medical, Engineering and Technology, Textile, Construction
Second (From mid of 1960s to early of 1970s)	Project quality	Based on Market pulled driven strategies, Project evaluation technique, Project quality,	Agriculture, Textile, Engineering, Defences, Medical, constructions

Table 2.1 Continued

Generation	R&D Trends General characteristics	Specified R&D Characteristics	Public organization with respect to sectors
Third (From mid of 1970 to 1980s)	Business integration Process	More emphasize on business alliance, and strategic partnership	Agriculture, Textile, Engineering, Defences, Medical, constructions, Minerals and Petroleum,
Fourth (From 1980 to mid of 1990)	Connecting External and internal Knowledge	Organization learning from Customer based perspective,	Agriculture, Textile, Engineering, Defences, Medical, constructions, Minerals and Petroleum, Telecommunication, IT and Finance sector
Five (From mid of 1990s till upto present situation)	System integration	Knowledge interaction within and beyond the organizational boundaries, Consistent collaboration with suppliers, customer, distributor, retailers	Agriculture, Textile, Engineering, Defences, Medical, constructions, Minerals and Petroleum, Telecommunication, IT and Finance sector, Marine, Bio medical, and Pharmaceutical

Source: Bashir & Bashir, (2014)

2.5 Theoretical impression on R&D

Many organizations enable R&D mechanism for the intention of discovering new product and processes, that effectively employ advance version of existing mechanism to enhance their productivity (OECD, 2016)

Research, 'R' of R&D is an investigating ability that explores to recognize the universal principles (discovers new knowledge). While, development 'D' of R&D is the function of current scientific norms (knowledge) along with commercial and other compulsions (Gibson, 1981). In simple words, 'R&D' considers as single phrase preferred by many companies to enhance their knowledge reserves (Niosi, 1999b). In case of discussing business aspect, the research argues the process of determining new knowledge that offers an infrastructure for innovative product development (Zedtwitz, 1999). In fact, managing operations related to R&D are the pillars of scientific efforts for various organizations subjected for facilitating the majority of their product discoveries. R&D contributes by enabling important scientific services for organizations sustainable in long run research practices (Bamfield, 2006).

R&D operations typically deal with three critical types of business domains: organizational laboratories, public research center (government funded) or private research centers, and university research laboratories (Niosi, 1999). In such perspective, Anil (2006) recognizes six different type of operational pattern related to R&D which basically comprises of; basic research, applied research, research based on the development of new product or processes, acquiring new product extension, product based engineering, and process-based engineering. Anil (2006) suggested starting two as general categories of 'research' and the last four consider as 'development.' An earlier studies, Gibson (1981) classifies R&D into two managing groups (managing research and managing development) and categories them as following:

- The basic research considers the systematic exploration of universal phenomena. In an attempt to classify more specific or to expand fundamental principles of nature in the scientific domain
- Managing applied research consider as resource rectification phenomena that carried out specifically within restricted scientific domain under the defined set of management rules. This allows firms to utilized the existing knowledge for the possible development of new application
- Managing exploratory expansion termed as that organization already to possess the scientific knowledge in order to develop the idea of new product or processes to achieve the future goal
- Managing advance growth as for expansion under exploratory research setting along with recognizable technological constraints, to generate an effective prototype product or process

- Managing engineering advancement under practical restrictions such as commercial constraints, manufacturing restrictions, and limitation involve during maintainability to the practical application. Managing engineering advancement phase allows processes or product organized for full-scale production. Amsden and Tschang (2003a) shed a reflection on new typology and categorization to manage R&D. They classify it into three categories 'managing pure science research domain, managing basic science research domain, and managing applied science research domain', that ease to identify management style used for R&D. Therefore, this seems to be quite similar to Gibson's typology only they insert pure science is the domain of research is shown in Table: 2.2

Table 2.2 Comprehensive Characteristics to Manage R&D

Characteristics	**Pure Sciences (a)**	**Basic Science (b)**	**Applied Science (c)**	**Exploratory Growth**	**Advance Growth**
Search	Fundamental knowledge	New knowledge to product for new Market	Characterized with respect to Product	Trial /prototype in as system	Prototype for production
Research Aim	Discovering new scientific Laws	Follows same as pure sciences but with application that are unfamiliar	Reapply known concepts for Specific Market	Implemented concepts as industrial system	Reduce operational cost, and uncertainty during production
Research outcome	Theoretical based IP	Product oriented IP	Differentiated product	Product Design	Manufacturing product
Performance	Intellectual Property	Product based IP	Niche product with IP	Market result (Time to reach to market)	Market result (no of rejects)
Generation (Time horizon)	Long term	Long term	Medium and short term	short term	Medium term
Methods	Experiments, trials, Mathematical techniques	Similar to (a)	Mathematical algorithm	Engineering Design, Engineering Tool and including simulation	Quality testing

Table 2.2 Continued

Characteristics	Pure Sciences (a)	Basic Science (b)	Applied Science (c)	Exploratory Growth	Advance Growth
Competent Skill among researcher	Doctor of Philosophy in Mathematics, Physics or Engineering	Similar to (a)	Bachelor, Masters, and PhD	PhD is not necessary	Same as (d) along with manageme nt skill
Size of Research	Depends upon the domain of study	Typically consumer oriented	Niche product market consumer	Depend up the size of system	Depend up production

Source: Amsden & Tschang, (2003a)

Amsden and Tschang (2003a) suggested these characteristics for R&D among middle-income countries materialize in between the extremes of managing basic research at one end to the advanced development at the other end. Amsden and Tschang (2003a) simplify the comprehensive categorization in shape of framework for middle and low income to locate their different type of management characteristics for R&D

In some of the previous studies more focus were made on the recognition of R&D management characteristics at international level for example: Medcof (1997) designate the types of management activities that are recognized internationally during distributed research cubical in context of 'R&D and support.'

- Managing research termed as the process of handling new scientific knowledge which has the probability to respond as the potential platform along with subsequent progress for economically feasible products and processes (Medcof, 1997). There is always a matter of managing uncertainty that the research outcome will have instantaneously commercial value (Medcof, 1997)
- Managing development is the process to facilitate innovating ability for new products and practices which possess commercial significance. These innovative abilities utilize existing platform for available scientific knowledge (Medcof, 1997). From such prospective 'Development' is not something that predetermined advance principle of sciences (Medcof, 1997)

- Support considered as factor that accommodates the existing product, or processes to specific circumstances (Medcof, 1997). In simple words, support does not aim to develop the basic principle of new products or processes (Medcof, 1997). The term ‘Support’ mainly preferred for modification of product and process for a specific to target consumer

These activities offers a necessary foundation for more adequate capabilities related to supporting management discipline which prevails R&D differences in between public and private firms (Amsden & Tschang, 2003a). To understand at what extent these capabilities influences R&D that involve in public sector organization. It is useful to categorize them on the bases of their complexity and with respect to their management discipline (Amsden & Tschang, 2003a). In such a context, Karlsson (2006) offers a comprehensive analysis on such management operations. According to him, number of public sector firms uses different processes for R&D that can be prioritized in the class of technical difficulty both in services and production sectors that is shown in Table: 2.3 which illustrates these levels complexity and capabilities appropriate for R&D

Table 2.3 Level of technical complexity used R&D in overlapping types

Difficulty	Manufacturing capability	Service capability
High Level	Advance R&D, “frontier innovation ”,& specified R&D services	
Mid –Level	Creating, plan and approval	High-end service (i.e. software expansion)
Basic Level	Basic Manufacturing	Low –end-services

Source: Karlsson, (2006)

In Table 2.2 there can be three hierarchical phases of organizational functions that used to distinguished management complexity at each level of R&D. Karlsson (2006), highlights the level of complexity in the shape of capabilities with value added sets of high skill.’

In normal circumstances, there are few value added resources which drives capabilities related to R&D. Firstly, in most organizations ‘R&D mode of operatic has been considering as the assurance of potential resources for new discoveries and innovation'(Audretsch et al., 2002). Secondly, managing these processes always consider instrumental for firms to elevate the degree of complexity. It involves higher time frames along with the greater extent of uncertainty (Medcof, 1997). Thirdly, 'R&D is highly recognized to be knowledge-intensive and unrestricted by its character' (Maskell et al., 2007). Effective improvisation of dynamic capabilities allow R&D to produce new knowledge (Brockhoff, 2003). Since knowledge has considered as the most vital ingredient in the world of business, therefore R&D knowledge is crucially considered as a core asset for organizational growth (Meyer, 1993a). Fourthly, they segregated by-line to represents R&D management by distinguishing capabilities related to the R&D process; it is easier to distinguish from there outcomes (Amsden & Tschang, 2003b). Fifthly, R&D becomes crucial aspects that influence speedy trend for technological development (Barry et al., 1991).

Sixthly, the capabilities that used by supporting management disciplines to manage processes generally compensated with high expending budgets with highly proficient skilled professionals (Iaccarino, 2004). R&D has become a dominated industry in the modern era which can replicate its significance for the development of any country economic growth (Iaccarino, 2004). Seventh, 'R&D by its characteristics represents the stable technological ability for the organization to remain competitive (Hauser & Zettelmeyer, 1996). Eighthly, the new creative technological growth specifically in IT and with the global competition provides a notion of managing business-driven R&D which has been highly recognizable as universal phenomena (Ganguly, 1999)'.

2.6 The Role of R&D in Economic Development

In case of progressive Economic development, the role of R&D has been regarded as one of the significant strategies to create knowledge based culture in case of developing technological potential (Bayarcelik & Tasal, 2012). In economic development context, Research and development (R&D) comprise of creative ability at national level that drive systematic foundation in order to enhance the stock of knowledge especially among developing countries. Such systematic ability enables knowledge culture in order to create new applications (Bayarcelik & Tasal, 2012). The potential spending on R&D may increase the possibility to accomplish high standard of technology at national and regional level, that allow policymaker at national level to introduces more advance product or process, resulting more value addition in shape of capital and economic development (Bayarcelik & Tasal, 2012). According to P. M. Romer (1990) based on their growth model draw a relationship in between potential spending on technology and R&D expenditure leads to amplify productivity at public organizations. In this context, there are several studies that draw comprehensive overview regarding the role of R&D on economic development for example, Ballot et al. (2001) highlight the impact of human and technological capital on efficiency among public firms at national level in France and Sweden based on effective R&D mechanism. The study utilizes R&D as tool for human capital that enables public organizations to follow knowledge incentive program in order to sustain long term industrial growth. Chou (2002) explores the role of R&D and economic development based on human capital to observe the Australian economy from the year 1960 to 2000.

The presented model predicts the long term economic prosperity with steady state based on implementation of effective R&D mechanism at national in order to craft new ideas. The study concluded that the Australian economic development based on per capita income were not totally due to the financial growth factor accumulation but also depends on increasing productivity among public organization. More than 28% growth was due to progressive growth at high education level while 27 to 57% due to research intensity among public organization. Similarly, Lee (2005) evaluate the Korean economic development by utilizing the technique of growth accounting. The outcome of study shows that difference of performance per human capital gap in between Asian and western countries have been fallen during last three decade. The study concluded that Korean economy to enhance R&D spending in order to improve the innovation for advance technology and upgrade the quality of high education so the desire level of economic development can be achieved. Grossmann (2007) suggest a conceptual frame to determine the potential contribution of R&D and role of public research institutions to economic development. The study revealed that R&D subsidies consider as short term solution public welfare and for economic development due to imbalance income. The conceptual model for long term economic growth improving high education system with high skill in science and technology can provides positive impact on overall national development. Therefore, it recommended that R&D through the promotion of public education can be considered as significant instrument for economic development.

In case of Pakistan, there are some studies that used to recognize the role of R&D as potential contributor for long term economic stability but over the period of time. For example, Afza and Nazir (2007) suggested a role of R&D and human capital can be consider as potential tool for economic competitiveness among South Asian developing economies with special reference to Pakistan. But over a period of time, it was observed that Pakistan unable to gain the golden opportunities that created due to the globalization. Due to brain drain, consider as major factor that keeping Pakistan away of availing economic advantages. The study recommended that major improvement required in human capital, aggressive reforms required for higher education system, major investment required for skill development for R&D in public organization in order to confront any economic set back. Similarly, more emphases need on integration of human capital with available physical resources and allow public organization for joint venturing to get the technological capabilities in order to reduce the economic disparities. The potential economic performance of Pakistan remain notable as emerging economy based on Agriculture, industry and services sectors which consider as key contributor to GDP (Khan & Khattak, 2013). But, over the period of time, the contribution from agriculture sector is decline as compare to share from industrial and services which is growing due to industrial globalization (Khan & Khattak, 2013). The potential share of agriculture to GDP was almost 53.2% in 1950 which fall down to 30.6% in 1980. While, in year 2005 it rapidly decline upto 23.3% in case of industrial growth the proportion at early 1980s is about 9.6% to GDP which consistently increased its shares to 22.6% in 2008-09 (Khan & Khattak, 2013).

R&D plays a significant role in countries economic development by enabling advance technological capabilities and spill over effects. Research and Development spending can be more effective if it made more towards on technological sector rather than other sector. The trends on spending towards Research and Development (R&D) among developing countries were more on science and technology sectors which lead towards radical economic development. It has been observed from the investment pattern among majority of developed countries utilizing huge pool of resources toward

R&D as tool for their economic success. Due to the insufficient data regarding the effectiveness on R&D practices among public organization if Pakistan and lack of data availabilities regarding the exact spending on high education that drive scientific publications allow policymakers to take tough decision in order to retain value added growth (Khan & Khattak, 2013). As already discussed above that R&D among public sector is so far neglected area in contribution more value as far as it expected. It is observed from over the period of time that due to inadequate spending percentage with respect to the GDP may cause several economic disparities. Pakistan spent almost spent 0.16% of GDP in year 1997 and due to economic weakness, this value keep falling over few years. But from year 2001 to 2005, a visible expansion of R&D expenditure has been observed (0.44% of GDP) (UNESCO, 2018). Such visible expansion allows government to realize the significance of R&D as result government shares around 0.68% GDP in year 2007. But from 2008 to 2018, the situation getting worst in term of spending toward R&D and high education remain stagnant upto 0.29% (UNESCO, 2018).

2.7 Impact of R&D among Prooly Practice Developing Countries

R&D is extensively recognized as central steam for economic development across the developing countries and some of the prior studies suggested that for radical economic prosperity needs higher return on investment with higher R&D spending. Yet low income countries were poorly invest on R&D as result they trap in paradox which has significant implications on overall economic convergence of supporting management discipline among public organization. In order to reduce such implication policymakers among developing countries need to mobilize radical investment on absorptive capacity to opens their international investment opportunity. It has been estimated by OECD 2018 in their recent report that for higher social returns on R&D investment must be is round 0.5% to 1% (OECD, 2018). Based on their investment pattern OECD 2018 revealed that over the period of 5 years there has been effective scope at technology frontier among low-income countries gain their returns to R&D investment reach upto trip digit (OECD, 2018). Such return allows policymaker among low-income economies not to invest anywhere else other than R&D in order to elevate existing economic development (OECD, 2018). There are some studies conducted by some international monetary agencies regarding effective R&D practices among low-income or non-practiced developing economics especially their public organizations (OECD, 2018). Since, low-income economies were always looking to get higher social return with less investment.

In case of developing countries, there are several countries that were unsuccessful in enabling effective practices of R&D among public organizations. Such effort required strong mechanism for supporting management capability to exploit their economic advancement as similar to developed countries. According to World Bank (2018) estimation majority of developing economies pursued the path of economic change by utilizing their internal resources based on radical transformation on their R&D at national level (Bank, 2018). However, due to inadequate understanding towards classification of supporting management capabilities at sectoral basis allow governments to take aggressive steps in order to confront global industrial. For example according to recent word bank estimation in year 2018 about low income developing countries of Sub-Saharan Africa region (Ghana, Cameroon, Côte d'Ivoire, Nigeria and Sudan) which invest around 0.1 to 0.2 % on their GDP to R&D (Riemschneider, 2018). However, these low income countries need to understand two specific pathways for effective R&D practices which might be of unusual relevance for these developing countries. Firstly, it is significant to consider how R&D capabilities need to integrates with in the informal sector which may consider as potential sources of income for low and middle income countries (Riemschneider, 2018). Clearly, effective R&D practice in this context is not normally depends on general institutional capabilities but rather on supporting management capabilities. Secondly, growth in demand among relatively low income sector still required more effective capabilities related to R&D in order to foster more equal business opportunity for developing countries. Similarly, in Asian region several developing economies which invest around 0.2% to 0.3% for their GDP on R&D such as Pakistan, Indonesia, Philippines, Vietnam, Thailand, Bangladesh and Srilanka etc these countries requires to emphasis more on developing the foundations for R&D activities which based on supporting management discipline (Riemschneider, 2018). In case of economic prosperity these low to middle income countries within under limited resources are often looking to prioritizing potential skills and building strong mechanism for R&D effectiveness among public organizations to achieve minimum level of absorptive capacity (Riemschneider, 2018).

In case of Latin American, region developing countries like Bolivia, Guatemala, Venezuela, Uruguay, Paraguay and Ecuador add 0.2% to its GDP on R&D spending but due to lack of R&D, capabilities along with critical weakness among public institutions are unable to drive their national innovation mechanism. In case of effective R&D practices policymakers among these countries are emphases more on developing design capabilities and supporting management capabilities (Riemschneider, 2018). However, to confront dynamic industrial growth at global level incremental investment need at early stages to upgrade national innovation system by enable R&D capabilities at public organizations. While, in case of European region developing countries like Latvia, Estonia, Iceland and Bosnia/Herzegovina they invest almost 0.3% of their GDP on R&D. However, due to persistent lack clarity regarding the effective policies on in-house R&D capabilities for public organizations. The complete picture regarding the impact of R&D among less effective developing countries is shown in Table 2.4

Table 2.4 Impact of R&D among Poorly Practice developing countries

Regions(Developing countries)	**Prioritizing policies to develop R&D capabilities**	**Instrument for R&D practice among Public organizations**
In African region (Ghana, Cameroon, Côte d'Ivoire, Nigeria and Sudan)	Conventional economic element required to confront soci-economic challenges (focusing on	Strengthen capacity to acquire and adapt new knowledge
In Asian region (Pakistan, Indonesia, Philippines, Vietnam, Thailand, Bangladesh and Srilanka)	institutional productivity, knowledge creation, developing flexible economic policies)	Established innovative technologies among local setting
Latin American region (Bolivia, Guatemala, Venezuela, Uruguay, Paraguay and Ecuador)	Improve innovation management capabilities among public organization	Promote collaboration with private firms, educational institutes and Public R&D
In European region (Latvia, Estonia, Iceland, Bosnia/Herzegovina)	Enabling technology management capabilities towards integrating functional abilities within and beyond the organizational boundaries	Encourage technological and managerial competencies of local firms Encourages domestic innovation capabilities

Source: Riemschneider, (2018)

2.8 Global Trend on R&D in Public Organizations

A progressive R&D with strategic spending can sustain long term competitiveness at organizational and national level (Boscoianu et al., 2017; Harris, 2010). However, private firms could have more potential as compare to public firms in order to manage R&D for a long run (Boscoianu et al., 2017; Harris, 2010). Due to lack of strategic spending public firms unable to manage R&D at a national level and confront market dynamism (Boscoianu et al., 2017; Harris, 2010). In the long run, strategic spending can stimulate as significant contributors to R&D that shares boundaries with other supporting management disciplines (Bessant & Tidd, 2007; Bowns et al., 2003).

Although, some studies highlights influence of supporting management discipline on R&D and these studies were more focus on the development of technological innovation in the private sector as compared to R&D in public sector (Huang et al., 2008; Meesapawong et al., 2010). Additionally, there are numbers of developing economies that have to still bearing market diversification in public organizations due to lack of understanding regarding the capabilities that shares the boundaries with R&D (Cozzarin, 2008b; Geffen & Judd, 2004). Although, various studies suggest some of the criteria that used to evaluate the management processes in R&D especially seen during the execution of project routine (Huang et al., 2008; Meesapawong et al., 2010).

Although, these criteria were inadequate in expressing the complexity that involves across R&D in public organization in case of understanding other supporting management disciplines (Huang et al., 2008; Meesapawong et al., 2010). For long-term national growth R&D in public organization have to be multi-mission such as looking a support from external scientific communities and encouraging to manage internal R&D practice (Abramo et al., 2009; Lu & Hung, 2011). Therefore, it is necessary to assess decisive capabilities related to supporting management discipline that allow multi-mission which considered as a significant area that shares boundaries with R&D in public organization (Abramo et al., 2009; Lu & Hung, 2011). It is crucial to recognize organizational features before evaluating the resources that firm required for overall organizational growth. Such features allow decision makers a clear path to manage

R&D in public organization as compare to R&D in private organization (Cabrales et al., 2008). Over the period of time limited studies were discuss about the relevant capabilities that were utilizes as supporting sources to stabilize R&D in public organizations (Huang et al., 2008; Meesapawong et al., 2010).

This research observes, the role of "capabilities" related to supporting management disciplines share the influence on R&D in public organization. In simple word, it refers as perseverance to facilitate sustainable R&D practices at the governmental. In most cases, R&D in public organization could entirely or moderately be funded by federation. Prime mission of such funding is to develop and cultivate knowledge came from scientific society or individuals (Cozzarin, 2008a; Greener, 2009). In most of developing nations, extensive R&D has observed in universities and public R&D firms (OECD, 2015). But in many developed economies, the R&D in public organization represents a less visible stake as compared to R&D in private organization; for instance, in 2015-2016 the spending on R&D at public organization was more on basic research, USA alone spend around $54.10 billion on public sector as compared to $340.720 billion on private sector (UNESCO, 2018). Furthermore, the majority of 50% federal R&D funds have been allocated directly from national budget to supplement R&D in public organization. Universities have received 43% funds through governments firms while, rest of 7% drive through non-private organizations respectively (UNESCO, 2018). Since, R&D in Public firms substantially adds to economic growth (UNESCO, 2018). Therefore, well structure mechanism for R&D in public firms can substantially float the national innovation policy in long-term (Cozzarin, 2006).

Hence, a comprehensive understanding of R&D in public organization is essential for developing countries to manage their national competence in order to overcome innovation barriers (Huang et al., 2008; Meesapawong et al., 2010).

To manage R&D in public organization requires multiple domains; For example, Chiesa et al. (2008a) characterized various R&D configurations to R&D strategies and allowed their performance indicators to judge long-term national goal. Similarly, Teresa et al. (2008b) integrate effective R&D competitiveness as Public organization goal in the shape of customer expectation.

2.9 Current R&D Trend in Pakistan

Pakistan has far lagged behind to their regional and emerging counterparts in attracting foreign investment and unable to develop a competitive opportunities for them (Anwar-ul-Hassan & Ansari, 2015). The lack of potential opportunities created due to low technological growth (Anwar-ul-Hassan & Ansari, 2015). There are numbers of internal and external factors were involved in position to seize future opportunity further going forward (Muhammad & Bashir, 2014). The investment boost required in high education that initiates developing prospect to influence innovation and technology in order to cultivate Pakistan as knowledge-based economy (Muhammad & Bashir, 2014). The conceptual ideology of 'knowledge-based economy' cannot perceive without nurturing quality high education equip with advance R&D support- both play a significant character in shaping the economy and human skill development(Muhammad & Bashir, 2014)

Pakistan remain bottom in the region with approximately around 0.30% of the GDP tired on Research and Development (R&D) as compare other developing economies such as India, which spend around 0.82% of their GDP, while Turkey paid off approximately 0.94% exhausted to their GDP. Followed by Malaysia which allocate 1.13% of their GDP spending to R&D (Shahid, 2016). Interestingly, this expense of 0.30% of GDP interpret as Rs. 1300 per capita that government presently spending on R&D (Shahid, 2016). Israel place top with Annual expenditure of 4.21% of its GDP, following by South Korea which spend around 4.15%, while Japan and USA with annual expenditure of 3.41% and 2.81% GDP to their R&D , secure their position at 3rd and 4th places respectively (Shahid, 2016). However, current governments put into ultra low priority that directly reflect to major caused for conflict with National Science and innovation plan 2012-2022 (Shahid, 2016). According to that policy the preferred recommended expenditure forecast is around 1% of GDP for the year 2015, expected growth to 2% by 2020 (Shahid, 2016). But in real picture, at current situation is quite different, less than 0.30% share GDP (Shahid, 2016). The major projects related to the

MOST (Ministry of Science and Technology) was planned in 2007 still unfinished piling liabilities

Pakistan has made inspiring pace towards creating an advanced infrastructure to manage R&D in public organization with potential financial backing (Naqvi, 2011). However, the expected targets could not been accomplished. It finds quite reluctant to manage R&D in public organization developed through academia, however some limited momentum adds up from the private sector (Naqvi, 2011). Developing capabilities in various areas consider as significant step to superimpose the R&D competitiveness among majority of public organizations (Lau et al., 2010). Several scholars have understood R&D competitiveness as a critical factor to influence overall national innovation mechanism at domestic level, but also translating innovational mechanism to grapes new market opportunities (Lau et al., 2010). There are comparatively limited studies available regarding decisive capabilities related to supporting management discipline as useful tool under limited expenditure. There has been limited empirical evidence regarding capabilities related to supporting management discipline to cater R&D policymaking in order to propel National innovation mechanism (Hu et al., 2016; Jiaoa et al., 2016; Kafetzopoulos & Psomas, 2015; Samson & Gloet, 2014; Yam et al., 2011a; Zhu & Xu, 2014). However, there is more investigation and in-depth emphasis will required in drawing relationship in between capabilities related supporting management discipline along with their contributing impact on R&D. To draw a general guideline these interrelationship help R&D decision makers to develop adequate policies in order to expand and achieve R&D competitiveness at low spending (Akhavana & Hosseinia, 2016; Martin, 2015; Minin et al., 2012)

Pakistan continues to consider as growing developing economy according to science and technology (S&T) indicators represent by Pakistan Council of Science Technology (PCST). The S&T indictors also shows critical situations among majority of R&D in public organizations regarding their innovative ability due to less progressive and depleting national innovation mechanism (Naqvi, 2011). These deficiencies appears due to instable political drawbacks and complex bureaucracy that creates management barrier for sustaining R&D competitiveness (Naqvi, 2011). At existing environment, Pakistan’s major public firms have functioned at a loss and been incapable of generating enough capital for reinvestment on their technological advancement even after colossal bail out (Gilani & Ansari, 2015). The main constrain for this distress is paralyzed energy shortage that appeared at the start of the 1990s (Gilani & Ansari, 2015).

Due to such energy crisis, the economic pressure reverted to the private sector that contributes around two-thirds of GFCF (Gross Fixed Capital Formation) for dynamic growth. Evaluating from previous long-term performance Pakistan was unable to sustain an adequate level of GFCF to maintain stability in their public organization that loosely draws various R&D Projects (Gilani & Ansari, 2015).

Public organizations comprehensively depends on the number of factors-which comprise business policies, supporting management capabilities, strong institutional policies, macroeconomic conditions (Gilani & Ansari, 2015).

However, economic expansion strongly depended upon positive Indication to GFCF (Gross Fixed Capital Formation) (Hamdani, 2014).

A cross-country evaluation for 1960-2000 proposes the rang of GFCF in between 20-25% of GDP consider as the minimum threshold for the dynamic economic expansion (UNCTAD, 2003).

While, in case of Pakistan Gross Fixed Capital Formation has been well behind that level as compared to other regional economies (Hamdani, 2014).

Pakistan’s relatively weak progressor in technological advancements as compare to its neighbors even their regional counterparts also face same situation at the initial stage but have passed the 20% minium GFCF level is shown in Figure 2.1-2.2.

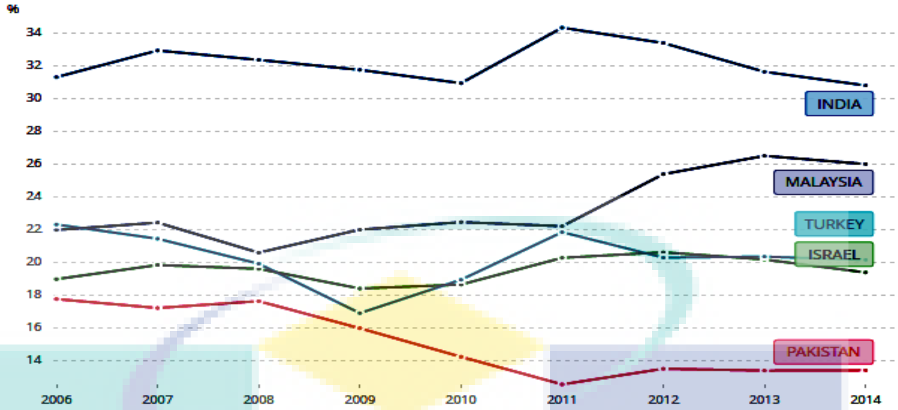

Figure 2.1 Capital Formation below the Threshold for Dynamic Growth

Source: (http://data.worldbank.org/)

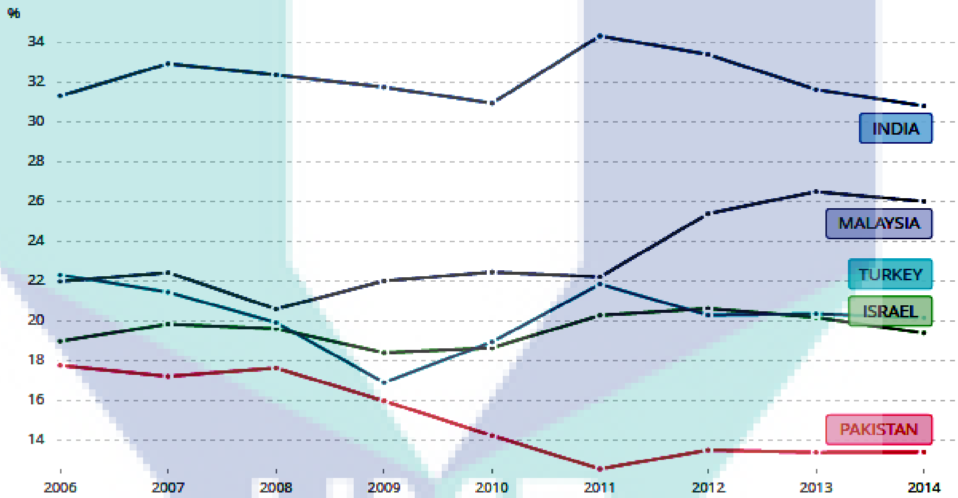

Figure 2.2 GFCF In South Asia (Percent Of Gdp)

Source (http://data.worldbank.org/)

Pakistan's spending toward R&D in public organizations has also been less as compared to the other South Asian economies to their GDP. Pakistan has faceless progress in acquiring technological achievement and consider as handicap that unable to attract global trade and investment (Hamdani, 2014). Textile believes as a primary contributing source from Public sector in Pakistan's export since the 1960's and now facing severe threats due to low-technology up-gradation and low-value addition. Pakistan still far behind in case of expanding their export due to lack of technological advancement among R&D in public organization (Hamdani, 2014). Pakistan even far behind, to catch up other middle-income economy in term of technical capabilities is concern (Shahab, 2015). According to OIC-2015 TAI (Technology Achievement Index) Pakistan place passively under the fragile rang with TAI-0.268 that indicates 127th position among 140 countries as shown in Figure 2.3. This gauges that Pakistan has a very limited R&D based capacity towards technology up gradation among public sector organizations, and consequently low pace innovation capabilities as compared to their middle-income economies (Shahab, 2015)

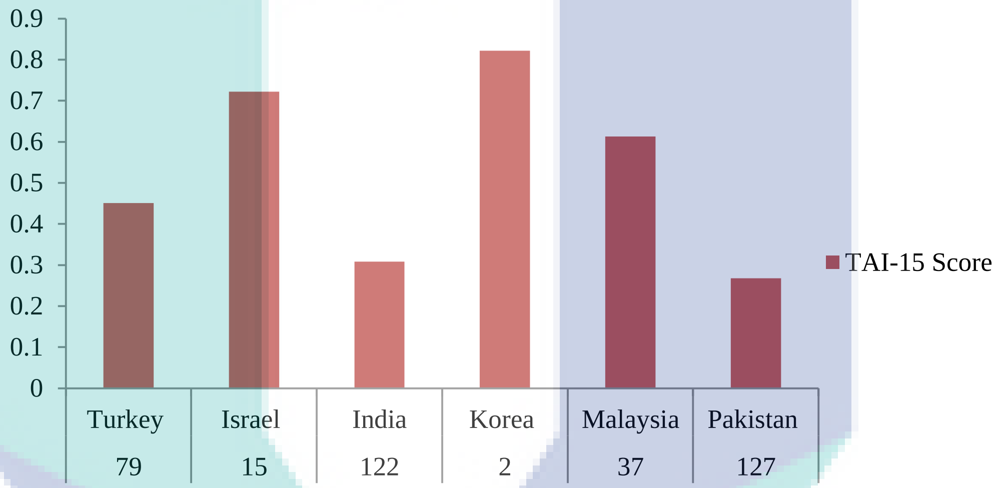

Figure 2.3 Technology Achievement Index -2015
Source: Shahab, (2015)

2.10 Current Status of R&D in Public Organization of Pakistan

Pakistan considers as the middle-income economy, where the significance of knowledge management capabilities at institutional level has been well recognized (Bashir et al., 2018). Arabella Bhutto (2012) highlights that due to inadequate practice and less effective integration to the national innovation program failed public sector R&D to fulfill current demand and unable to interpret current R&D as a tool for potential economic revival (Arabella Bhutto, 2012).

R&D in public organizations of Pakistan contributes to the production of knowledge and enables knowledge management practices as inputs in the industrial sector in three major ways (Bashir et al., 2018). First, the R&D in public organization receives the knowledge inputs from universities in the form of highly educated capital based on complete knowledge sharing as compatible resources that involve across public organizations for effective KM practices; second, by creating and delivering new knowledge by encouraging public organization to enable reward mechanism which is allows scholars to distributes their knowledge through publications and presentations; third, by creating and providing new knowledge through organizational commitment which is disseminated through collaborative research projects for the industrial sector (Bashir et al., 2018). However, over the period of time R&D in Public organization of Pakistan face knowledge crisis due to lack of unclear path in case of achieving capabilities related to knowledge management across different public organizations (Schwab, 2018). According to Global competitive index, 2018 Pakistan placed at 107th position out of 140 countries based on some of resources that measures the knowledge management practices across the Public organization of Pakistan (Schwab, 2018).

The recent report made by Pakistan chamber of commerce based on some measuring resources related to KM practices mention in global competitive index-2018 (Schwab, 2018).

This study draw current R&D situation in Public organization of Pakistan has revels a shocking picture related to various industrial sectors. Based on knowledge sharing and organizational commitment majority of R&D in public organization sectors were unable to classify the relevant capabilities for effective knowledge management practice.

Also, these public organizations were unclear for developing new resources to drive capabilities related to knowledge management. From Figure 2.4 only, fertilizer and textile sector enable certain parameter for effective KM practice (Schwab, 2018)

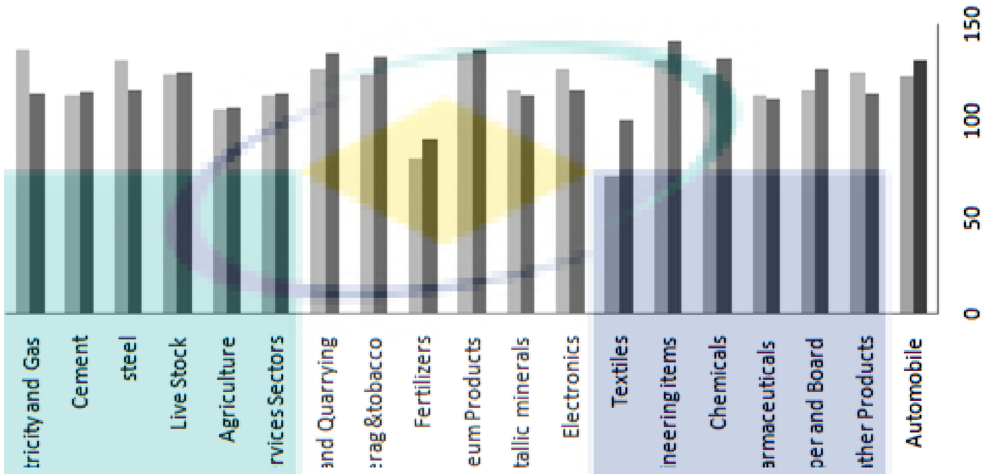

Figure 2.4 knowledge management Practices across the R&D in Public organization of Pakistan

Source: Schwab, (2018)

According to GCI-2018, the R&D progress across governmental fertilizer and textile sector has place there mark at 94th and 77th respectively out of R&D in public organization across 140 countries (Schwab, 2018). Such progresses were based on knowledge sharing and organizational commitment as potential pillar to measure KM effectiveness across R&D in public organization. While, rest of others R&D in public organizations remain below average in progress (Schwab, 2018). These R&D in Public organizations have past experience in patenting and has capability to enhance the R&D capacity but in current situation there, effectiveness has been compromised due to unclear determination towards sustaining KM capabilities. Majority of R&D in public organization remain ineffective because their research mission have more inclined toward export the knowledge from external sources.

Similarly, Pakistan remains bottom in the region with all the essential instruments used for measuring capabilities related to overall country's innovative ability according to GII, 2017 -2018 Pakistan faces severe challenges as compares to their regional counterparts regarding to acquires creative knowledge and technology advancement among their R&D in Public organizations (Dutta et al., 2017). Since approximately, 26% of overall GDP and 45% of total employment obtained from agriculture sector till 2010, now the economic scope shifted from posing innovative ability towards the service and manufacturing-based economies (IMF, 2016). However, due to the economic instability and regional politics Pakistan GDP growth decrease from 6.1 % in the year 2006 and it remains stagnant at a rate of 3.1% till the year 2017-2018.

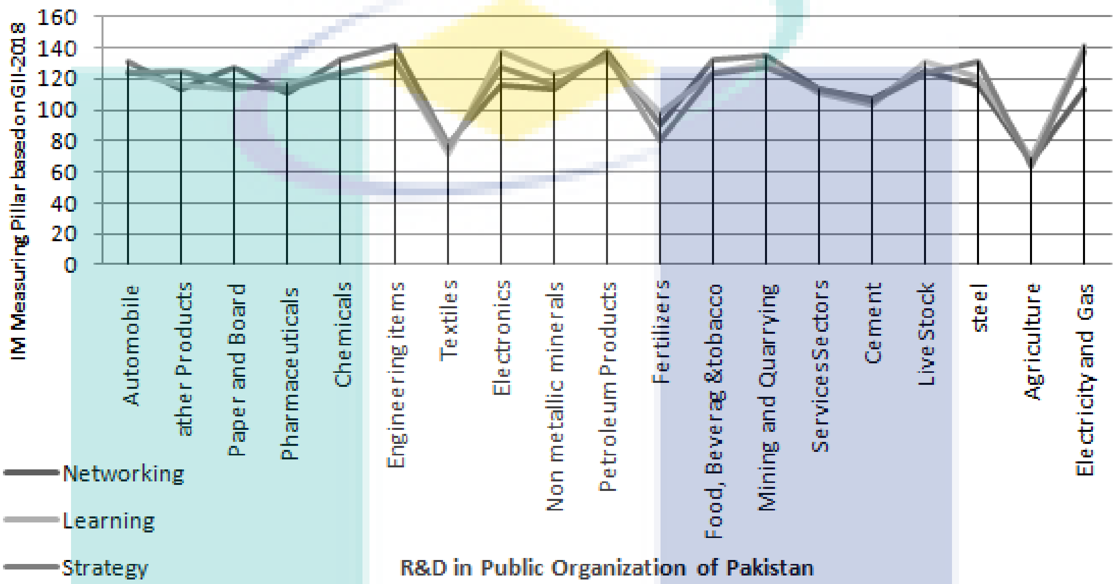

Figure 2.5 Innovation management Practices across the R&D in Public organization of Pakistan

Source: Dutta et al., (2017)

Majority of R&D in public organization were unable to classify the relevant capabilities for effective Innovation management practice. Also, these public organizations were unclear for creating in-house innovational resources to drive capabilities related to Innovation management (Dutta et al., 2018). From Figure 2.5 only, textile, cement and fertilizer sector enable certain parameter for effective IM practice. According to GII-2018, the R&D progress across governmental Fertilizer, Textile and Agriculture sector has place there mark at 90^{th}, 78^{th} and 64^{th} respectively out of R&D in public organization across 140 countries. Such progresses were based on organizational networking, organization learning and organizational strategy as potential pillar to measure IM effectiveness across R&D in public organization (Dutta et al., 2018). While, rest of others R&D in public organizations remain below average in progress (Dutta et al., 2018). These R&D in Public organizations have past experience in patenting and has capability to enhance the R&D capacity but in current situation there, effectiveness has been compromised due to unclear determination towards sustaining IM capabilities (Dutta et al., 2018). Majority of R&D in public organization remain ineffective because their research mission have more inclined toward export the knowledge from external sources.

Pakistan has conventionally supported the dominance of classified nature of industries and large R&D in public organization with almost no internal competitions in between them, that allow companies to operate with no pressure to turn out to be efficient (Jamali, 2012). Thus, due to such trend in acquiring or managing the technological capabilities for any purpose to become less productive and seem to be less practical (Jamali, 2012). In regional economy China operating in isolation- they kept sealing their local markets from import until their public sector had achieved adequate pace to compete international counterparts. Similarly, India intentionally did because of high tariff (Jamali, 2012)

According to OIC 2015-2016 TAI (Technology Achievement Index) Pakistan place passively under the fragile rang with TAI-0.268 that indicates 127th position among 140 countries as shown in Figure 2.6 (Shahab, 2015). This gauges that Pakistan has a very limited R&D based on capacity towards technology up gradation among R&D in public organizations, and consequently low pace to manage technology capabilities as compared to their middle-income economies (Shahab, 2015).

According the Technology Achievement Index 2015-2016 the picture were remain unsatisfactory among majority of R&D in public organization in all sectors as show in Figure 3 (Shahab, 2015).

Based on technology infrastructure and implementation as potential resource that were used to drives the technology management capabilities among 19 different sectors that contributes to GDP growth. Among 19 sector similar pattern were observed over 5 years (Shahab, 2015)

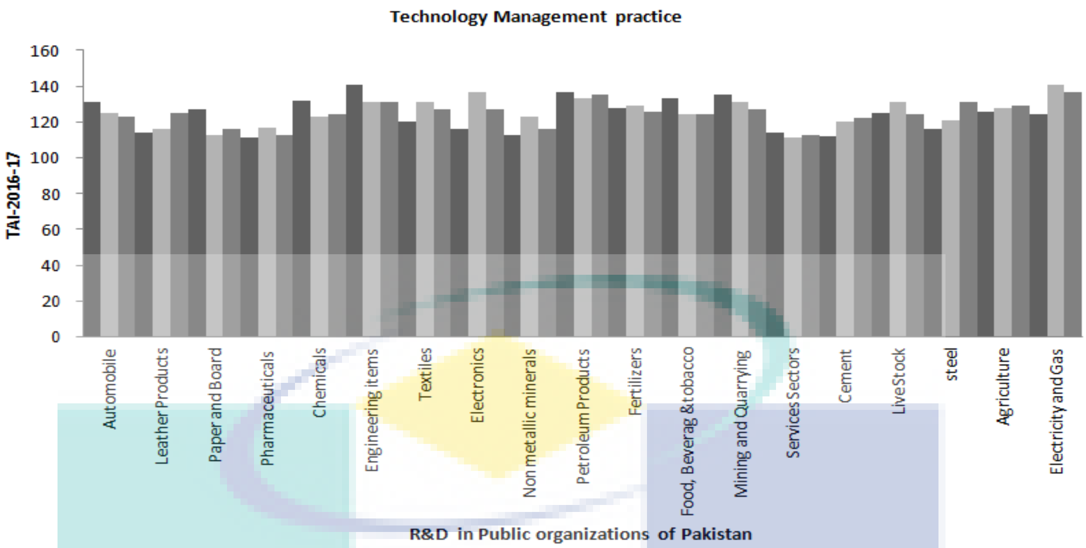

Figure 2.6 Technology management Practices across the R&D in Public organization of Pakistan
Source : Shahab, (2015)

2.11 Theoretical Review on Supporting Management Discipline Toward R&D

Scientific innovation, advanced technologies and supporting managerial disciplines diffuse slowly (Ehigie & McAndrew, 2005). Although these supporting management disciplines have involved as part of the significant contributor in research and development process for over 50 years (Allen, 2004). However, during such period the supporting management discipline evolves to drive functional orientation since the primary focus was R&D (Allen, 2004).

There are three common supporting management discipline that involve among majority of functional entities based on these dimensions are: ‘knowledge management’ in view as knowledge translation ability, ‘innovation management’ as to formulate new application and ‘technology management’ as to enhance the technology integration as shown Figure 2.7 (Brockhoff, 2017; Cetindamar, 2009)

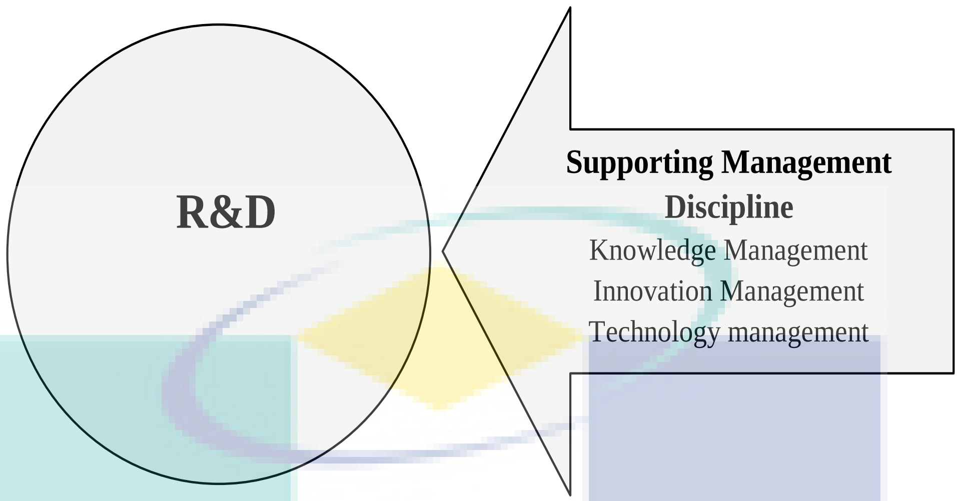

Figure 2.7Supporting Management Discipline to R&D
Source: Brockhoff, (2017); Cetindamar,(2009)

The task of undertaking knowledge management (KM) as supporting management discipline is a challenging endeavour (David, 2005; Shariq, 1997; Wang et al., 2018). For long-term, industrial stability KM as a discipline were consider as progressive tool for knowledge-based organization to satisfy the R&D demand (Armbrecht et al., 2016). The pioneers of knowledge management suggested that many advance organization runs primarily on the potential success of manufacturing-based capital (Armbrecht et al., 2016). These organizations have fallen rapidly due to economy transitions from an industrial economy to technology-based knowledge economy (Grossman, 2007). Thus, an urge of KM as supporting management discipline to enhance their capabilities related to R&D (Armbrecht et al., 2016; Cetindamar et al., 2009).

Mills and Smith (2011) investigate the particular ways to measure knowledge management as supporting management discipline for R&D. The study illustrates a substantial connection among knowledge resources that used to measure overall organizational performance based on R&D effectiveness. Gloet (2004) highlight the favourable, comprehensive view to adopt knowledge management as sufficient dimension for supporting management discipline, which creates an opportunity to produce new ways to understand the organizational performance based on R&D. It also helps to formulate new capabilities that encourage innovation. Similarly, Brockhoff (2017) portrays innovation and technology management as supporting management discipline to propel R&D for national growth. In advance management literature, distinguishing technology and innovation management consider as the critical success factor for collaborative R&D in case of dealing with economies and region counterparts (Marinkovic & Jakšić, 2014). There are high chances of abrupt rise in the development of new discipline to handle internal and external technology constraints (Cunningham & Kwakkel, 2011). Such chance acknowledge the practical relevance of technology management as potential source for competitive advantage (Eskandari et al., 2007; Unsal & Cetindamar, 2015).

According to Badawy, technology management (TM) emerges management source during integrating a technological strategy with business strategy within organization boundaries. Such integration requires reasoned coordination of R&D and production, as well as the function of marketing, finances and human resources within organization boundaries. Skilbeck (1997) used TM as supporting management discipline to reconfigure organizational attributes relating to dynamic environment. Such transformation can smoothly progress through consistent technological development in order to support R&D competitiveness. It is to be prominent that technology management should not be restricted to manage a particular set of technologies (Badawy, 1998; Gudanowska, 2017). In the broader spectrum, TM also used to drive technology strategy as resource to measure R&D effectiveness (Badawy, 1998; Gudanowska, 2017).

Similarly, the scope of innovation management (IM) has become highly significant as supporting management discipline that adds value to R&D competitiveness (Jasimuddin, 2012). Innovation management consider as tool to assess firms overall performance by driving inputs and outputs resources during fluctuating global environment, even though its consider comparatively dynamic area of supporting management discipline (Jasimuddin, 2012).

Some of prior studies, such as Clark and Wheelwright (1993) represent innovation management as supporting management discipline in the form of a standard framework, according to them it is used as potential indictor for recognizing organizational change. Such organizational transformation based on potential inputs resources such as: process of new knowledge acquisitions and relevant of technologies used for channelizing the overall R&D competitiveness (Clark & Wheelwright, 1993).

Goffin and Mitchell (2010) and Bessant et al. (2005) spotlight on a strategic aspect of innovation management as supporting management discipline and consider to map general guideline for the whole operating structure of R&D. Such operating mechanism includes processes and capabilities with relevant resources that allowing systematic interpretation to develop new concepts (Goffin & Mitchell, 2010).

Cantwell and Zhang (2005) highlight the significance of innovation management (IM) as supporting management discipline and highlighting its potential globally during recent decade, also globalized the R&D concept among various multinational organizations. According to them these organizations have conceived innovation management as organizational strength through which they transform their ability from sharing knowledge to exchange technological activities (Cantwell & Zhang, 2005). The idea of creativity is to declared as significant source of competitive advantage for many public sector organizations among developed and developing countries (Jasimuddin, 2012). Therefore, innovation management as an emerging discipline has gained considerable attention among several researchers (Jasimuddin, 2012). The transformation of this field since its initiation has been notable. This discipline has grown-up tremendously over the past three decades.

2.11.1 Knowledge Management Association with R&D

Fascinating evidence show even more surprisingly, the similarity in between knowledge management and R&D are virtually unreal (Rothwell, 1994a). Some studies claim the narrative that ‘not enough attention’ has made on knowledge management for the R&D driven firms (Rothwell, 1994a). In holistic view, knowledge management can broad functional advantage for R&D driven organization to their survival, it enables R&D driven firms to initiates knowledge screening to knowledge generation (Rothwell, 1994a).

But In practice, some of the studies relevant to technological development now transforming their focus from R&D to knowledge based resources (Nieto, 2002) such as : knowledge sharing and knowledge communication that can easily excess for single interface through online or world wide web (www) (Bolisani, 2000; Dennis et al., 1998). Just like any other technical processes, both knowledge management and R&D are following same evolution pattern along with a number of development occurs in recent time (Nelson & Winter, 1982).

In case of R&D, some of the scientist and researchers distinguish the intrinsic changing in managerial practices. These intrinsic variations will also influence organizational processes related to knowledge management (Amidon, 1996; Miller, 1995b; Stamboulis et al., 2002; Tiwana, 2000).

Similarly, the knowledge itself consistently is evolving in nature (Bowonder & Miyake, 2000; Park et al., 2002; Tiwana, 2000). Hence, the relationship in between knowledge management and R&D need to examined under dynamic perspective; which allows firms to configure their management approach with respect to dynamic business environment.

Some studies represent valuable association in between knowledge management and R&D for instance Rouse (1998) suggested that individuals who manage R&D firms must acknowledge relevant resources related to knowledge management practices. These resources help in structuring and configuring their organizations to satisfy maximum outcome of R&D spending.

Carneiro (2000) more focuses on recognizing the strategic aims of knowledge management. According to his opinion, organizations have to describe the type of knowledge which will be more significant to rectify R&D competitiveness. Knowledge management considers a tool to assess overall R&D competitiveness that relates circumstantial factors because it affects the overall organizational productivity and performance (Carneiro, 2000). Parikh (2001) advocates that variation among organizational culture, organizational structure and levels of information technology consider as potential resource that should be emphases more on crafting effective knowledge management related to R&D.

Yasunaga and Yoon (2004) suggested the comprehensive framework based on technology diffusion in order to design knowledge applicable for R&D. Designing knowledge means to classify the knowledge and to correlate its different types to translate the commercial aim related to R&D (Yasunaga & Yoon, 2004). In many developing countries, universities and governmental organizations are the leading institutes rely on effective R&D and building new knowledge for innovation. At an initial stage, Igel and Numprasertcha (2004) highlights some of the significant advantages that R&D can achieve by utilizing effective knowledge management across governmental institutes such as:

- knowledge acquisition, knowledge sharing, and knowledge diffusion
- Tacit knowledge, Explicit knowledge
- Better organizing and continuous improvement to reduce error

Park and Kim (2005a) proposed a model in which knowledge management and R&D strictly associated. They highlight the nature of R&D align according to knowledge ability possess by scholars, researchers, and manager which allows structuring of overall knowledge pattern for R&D. Goh (2005) has acknowledged nine objectives for knowledge management align with R&D these nine objectives were split into three kinds.

1. Products
   i. Designing and structuring knowledge
   ii. Developing resource based knowledge
   iii. Enabling knowledge as core for new product or process

2. Processes:
   i. Screening and reapplying knowledge
   ii. Sharing of experience
   iii. Efficient Management of knowledge resources
3. People:
   i. Developing knowledge teams
   ii. Developing knowledge through experience

iii. knowledge sharing among with organizational function and beyond the organizational boundaries

Huang and Huang (2007) suggested that knowledge management (KM) must align with R&D skill forces that acknowledge actual knowledge to resonant their responsibilities and accomplish organizational goals. Knowledge exchange as a resource allows knowledge management to starches its influence on organizations to rectify its R&D competitiveness.

Libing and Rong (2007) highlight knowledge sharing as resource that allows KM within the R&D function as core organizational ability during creation of new knowledge. Yang et al. (2007) recognized R&D firms as clusters of proficiently skilled individuals looking for further development in science and technology. Since knowledge management in R&D firms exemplify sharing, diffusion, assimilation and storage of knowledge as core resources. Therefore, researchers were more emphases on monitoring the externalization of implicit learning. Similarly, Plessis (2007) used knowledge management as tool to accomplish R&D goals.

i. Exchanging and protecting implicit knowledge
ii. Creating explicit knowledge in order to incorporate with new and existing ideas
iii. Encouraging coordination among suppliers, distributors, customers and employee to develop new knowledge resource communities
iv. Promoting effective culture that absorb knowledge for developing and sharing mechanism

Linlin and Hui (2008) suggested a decisive management role for a research team (a group of highly skilled professionals) during the innovation process and in the development of new knowledge for nurturing creative mines. According to them, the origination of new knowledge based upon extensive interaction among team members with high skills as source of integration.

Zaaimuddin et al. (2009) further elaborate according to them management complexity, strategic planning, culture, structure and knowledge management may significantly influence on firm to align their R&D process. However, from prior studies there were unexplored domains exist in areas of employing capabilities along with potential resources related to knowledge management as a catalyst for R&D (Andreeva, 2012; Foss et al., 2010).

To encounter future applications R&D in most of developing countries always looking long-term strategic knowledge management approach to sustain their R&D competitiveness (Winter, 2003). However, despite of numerous studies on knowledge management with their practical impact to measure R&D effectiveness; but there is still lack of an integrative perspective on how knowledge management navigates their processes, infrastructure, and strategic capabilities share their influence on R&D (Andreeva, 2012; Foss et al., 2010).

2.11.2 Innovation Management Association with R&D

R&D has a systematic association with innovation management and such association allow to utilizing current stock of existing knowledge to create new application (Teresa et al., 2008a). Innovation management conceived as facilitating ingredient in the process of converting technological creativity into physical phenomenon (Teresa et al., 2008a). Most of the R&D driven organization witness their growth due to rapid development in science and technology. In general context, increasing growth termed as knowledge to pursuit of innovation management as to advocate advancement in industrial policies with growing emphases to achieve R&D competitiveness (Chiesa et al., 2008b).

However, there are number of studies available in attempt to control R&D as functional entity which may influence overall organizational performance due to dynamic change of business competition over the period of time. In such circumstances, effective innovation management may associate as with R&D function to accomplish strategic goal (Chiesa et al., 2008b).

Ojasalo (2003) describe management of innovation as managing chaos. It was due to lack of appropriate configuration among organizational operations with respect to R&D which has to bear unexpected business change (Ojasalo, 2003). Innovation

Management has been channelized globally during recent decade. It also globalized the R&D concept among many multinational organizations through which they transforms their ability from sharing knowledge to exchange technological activities (Cantwell & Zhang, 2005).

Sternberg and Arndt (2001) highlight the number of internal factors that influence on firm's innovativeness more than external factors. Such internal influence allows effective innovation management as significant approach for R&D to understand the market behaviour with respect to companies' characteristics. These internal influences may varies with nature of organizational innovational behaviour (Cooper, 1998) – Due to these internal factors researchers were more focused to investigates suitability of firms internal innovation ability that match to execute innovation process in order to quantify the significance of R&D competitiveness. Galende and Fuente (2003) suggested number of methods to develop innovative features such as: " Intrinsic technique for new product generation", "significant source of information", "Basic observation", "Intrinsic mechanism for creative results" and concludes to rectify "The nature of innovation management associate with R&D" (Galende & Fuente, 2003).

Still, the significance of R&D has been transformed as an outcome of diverse innovation models (Trott, 2005). Due to such transformation effective innovation management required to enhance R&D competitiveness. Trott (2005) highlights five an evolutionary courses for innovation management frameworks that initiates from 'the first linear model of innovation management simply notify as technology push model'. The first linear model describes basic functional mechanism for any knowledge-driven organization initially starts with extensive research. R&D absorb some of core process related to innovation management in developing creative ideas and then passes to production function that transforms such creative ideas into physical reality in shape of prototype. After confirmation from many quality checks the product is then pass to distribution for promoting product with respect to current and new market (Trott, 2005).

The market requirement triggered the second linear framework which was termed as market pull model or generally know as the customer demand innovative model (Trott, 2005). In this model, dominance of functional stream places their supremacy to advocate development of new process. For such purpose, they used business surveys in order to notify R&D about the latest market behaviour and customer demand. Thus, the individual from R&D need to collaborate with production unit in order to introduce the number of thriving projects with respect to market requirement (Trott, 2005). Conversely, the market pull framework has been subject for many critism due to its distorted approach. Therefore, the third framework termed as coupling model that enables innovation management in house feedback mechanism instead of linearity. This coupling framework used to collaborates comprehensive R&D activities govern other organizational units in search of developing R&D direction (Trott, 2005). In the late 1980s and early 90s, various organizations had to rely on external bounding with other external stakeholders for instance: suppliers, customer and competitors in order to deal with complex and uncertain nature of innovation. Hence, fourth generation integrated model were introduced in order to correspond with external stakeholders. This framework comprise of internal and external interactive correspondence (Trott, 2005).

The collaborative concepts were extensively created and ensuring of system integration to next level which is simply termed as network model (Trott, 2005). This model consider as fifth generation model which enables fully integrated mechanism by focusing on strategic association with other collaborating organizations (Trott, 2005).

In general, the internal innovative factors depend upon extensive dependency on external and internal source of information. Accumulative feature in R&D allows firm to search new markets and seek new opportunities to get higher returns due to high R&D spending (Galende & Fuente, 2003; Lenz-cesar & Heshmati, 2012). There are comparatively limited studies regarding involvement of capabilities related innovation management as effective contributors in R&D (Dimitrios Kafetzopoulos 2015; Jiaoa et al., 2016; Mei-Chih Hu, 2016; Samson & Gloet, 2014; Yam et al., 2011a; Zhu & Xu, 2014). More investigation required to classify capabilities belongs to innovation management as supporting management discipline and their contributing impact on R&D. It helps R&D decision makers for developing policies by using criteria’s based on capabilities (Alberto Di Minin 2012; Hosseinia, 2016; Martin, 2015).

2.11.3 Technology Management Association with R&D

The scope of the study expends, as major technology shift has observed towards R&D. The organizational evaluation process relies on effective technology management for in-house R&D (Rousset et al, 1991). Strategically the focus related to effective utilization of technology management was shift in mid of 1980's when the commercial significance of technological innovation were associated with R&D through joint venture, outsourced, and subcontracted (Jacques & Jolly, 1999; Jolly, 1999)

To implements technology as a core enabler many researchers looking for urgent need to enhance the technology management resources for progressive R&D (Cohen & Levinthal, 1989). It was necessary to create resources for absorptive capacity to drive strategic capabilities relate to technology management (Cohen & Levinthal, 1989)

The number of studies examines companies' internal behaviour specific for managing technological ability influences technological innovation that develops under comprehensive R&D support. These studies also investigate the impact of technical know-how due to internal organizational characteristics (Einsehardt & Martin, 2000; Lichtenthaler & Ernst, 2007; Lin et al., 2006; Tsai & Wang, 2004).

Cohen and Levinthal (1990b) describe the long relationship between R&D and technology management which is complementary as applying core theory of absorptive capacity. According to their theory the utilization of absorptive capacity, consider as strategic resource for technology management. They also illustrate the effective utilization of technology management in shape of technology appropriability and technological opportunity that relates R&D competitiveness (Cohen & Levinthal, 1990b). Furthermore, they emphasis on organizational in-house R&D that not only support the development of new knowledge, but also extend the firm's ability to absorb and utilize to generate knowledge beyond the organizational boundaries (Searching for new external knowledge).

Vega-Jurado et al. (2008) draw capability based view in recognizing strong bonding between technology management and R&D which were consider as primary source for creating new knowledge for innovation (Vega-Jurado et al., 2008). Similarly, Oerlemans et al. (1998) proposed capabilities based view on fundamental concept on organizational innovative performance which extensively associates R&D with technology management resources (Oerlemans et al., 1998). They preferred analytical model that begins with the comprehensive selection of resources which drive capabilities related to technology management (Oerlemans et al., 1998). These resources were relay on intrinsic and extrinsic factors. The intrinsic factors were based on technological opportunity focusing on industrial and non-industrial requirements. While, remaining intrinsic factors were focusing on methods that enables strategic legal protection (Oerlemans et al., 1998). On the other hand, the selected extrinsic factors were completely focusing on technological competencies that primarily drive from R&D. This preference was established for a purpose to accomplish the primary goal of integrating both intrinsic and extrinsic factors to observe the innovative outcome is shown in Figure 2.8

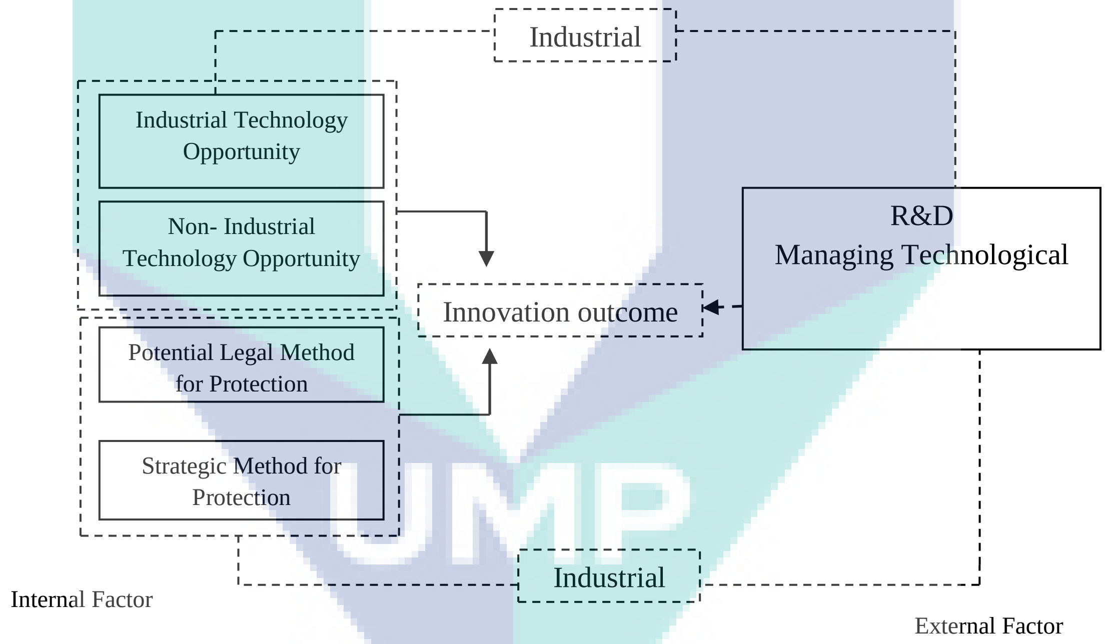

Figure 2.8 Relation between factor Technological Opportunity and R&D

Source: Oerlemans et al. (1998)

Gregory (1995) describes capability-based view on exploring the missing link between the R&D and technology management. According to him, the technology management domain has conventionally concentrated their capabilities to influence R&D competitiveness (Gregory, 1995). Some of the prior studies highlight the essential demand that allows most R&D based firms to a close integration of R&D with other value-add supporting management discipline including technology management (Gregory, 1995). These studies were more emphases on the association in between R&D and technology management which appears during the estimating and prioritizing of R&D projects (Roussel, Sand, et al., 1991). The focus remains very much around managing R&D as the function for development rather than more emphasizing on capturing technology and developing by utilizing all the intrinsic and extrinsic resources from the organization. Gregory (1995) revealed three layer linkages emphasizing on R&D as the function: (a) connecting R&D to understand nature of research related to basic science and technology, (b) assessing early visibility of technologies, (c) managing role of technology during the development of new process and product management

Talonen and Hakkarainen (2008) similarly portray the significance of technology management for R&D in a strategic context. According their postulation regarding core theories of technology management being consider as "an interdisciplinary area of research" that combines resources belongs to engineering, natural sciences, social sciences and management sciences in order to cater knowledge feasible to enhance R&D effectiveness (Khalil & Tarek, 2000). They more emphasize on the traditional definition developed by National research and council: According to their concepts Technology management consider as "A multidisciplinary field associated with forecasting, developing and executing the technological capabilities in order to achieve the operational and strategic aims for any organization (N. R. Council, 1987)". There are several divergences among strategies that propels the relationship between R&D and technology management, depends on mixture of complex strategies and tactics (Kaplan et al., 2004). Talonen and Hakkarainen (2008) draw association in between R&D and technology management by developing the roadmapping framework in order to configure strategic capabilities belongs to technology management.

Vega-Jurado et al. (2008) represents resource based theory by describing strategic perspective between technology management and R&D. There are common cross-functional strategies that exchange across functional and departmental boundaries (Vega-Jurado et al., 2008). They illustrates no specific organizational department separately make and sketch these strategies (Vega-Jurado et al., 2008). It is the integration of business and technology roadmaps that to connect company-wide strategic mechanisms by interfacing and searching strategies (Vega-Jurado et al., 2008). These mechanisms allow organizations to replicates overall functional strategies into resources and driving them operational (Vega-Jurado et al., 2008). In simple words, roadmap integrates the multiple approaches to gather; it is a driving force that sticks functional strategies as show in see Figure 2.9

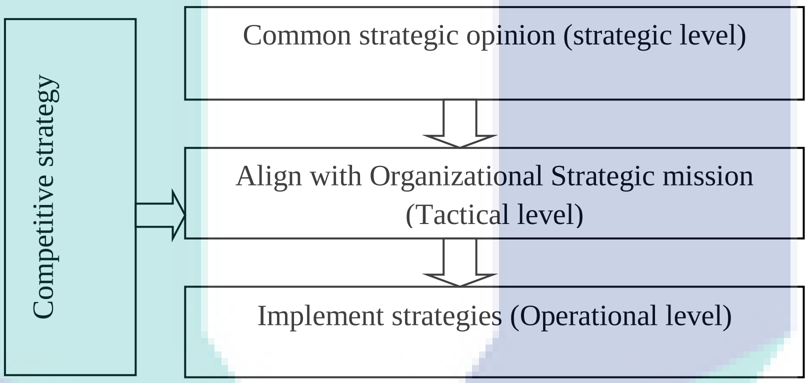

Figure 2.9: Roadmaps interlink the Essential strategies of R&D

Source: Vega-Jurado et al., (2008)

This framework has developed on the bases of the three-layered process; the first layer is known as “strategic level”- this level crucially utilizes to manage business and technological development via common strategic opinion and discussion. Second layer known as tactical level- this level is essential in connecting short-term project level activities align with the organizational strategic mission. In reality, this can be handled through portfolio management. While, third layer known as Operational level- this level is used to sustain and implement of the strategies involves across organizational operations.

2.12 Theoretical Framing

This research represents the capability perspective therefore theories that belongs to resources are applied that allow researcher on basic understanding knowledge, innovation, and technology management Resources Based Theory (RBT) was initially inducted in strategic management literature during the early 1950s (Wernerfelt, 1984). After 1950s, RBT was more extensively functional across operational and strategic management research. RBT illustrates that the possession of resources leads to reinforce organizational competitiveness. Due to heterogeneity these resources responsible in characterizing performance differences among organizations over the time (Barney, 1991b; Grant, 1991). Organizations relied upon bundle of resources that allows firms to hold by them self for long term sustainability. Generally, three significant types of resources were acknowledge in Resource Base View (RBV) such as human resource, organizational resource and physical resource (Barney, 1991b). In case of describing the competitive advantage at organizational level the nature of available resources must be precious or valuable, unique or rare, inimitable and non exchangeable (Barney, 1991b; Wernerfelt, 1984). The fundamental establishment of sustainable performance is determined through effective exploitation related to range organization resources, because an appropriate amalgamation of resources construct feasible capabilities that allows firm to prevents against market competitor to imitate stock of organizational resources.

2.12.1 The Role of Resource-Based Theory (RBT) in Knowledge Management

RBT was initially familiarized by the prominent economic theory presented by Penrose (1959) who orchestrate organization to attain remarkable performance not only equipped with improved resources, but also have a proficiency to utilize those resources in efficient way. Several research scholar’s in the field of operational and strategic management enables the role of RBT to recognize how organizations can efficiently utilized resources to achieve the competitive edge. The research espousing RBV also understand that resources hardly act separately in generating value. For instance Wade and Hulland (2004) suggested that the performance causes a significant effects due to resources related to communication mechanism depends upon how they are harmonizing to organizational resources. Black and Boal (1994) describe the resources can have ability to extend and suppresses impact on one and another. RBV suggest that resources are reconstructed into output of greater significance through various capabilities (Black & Boal, 1994; Grant, 1991). Capabilities may be repetitive in nature as actions during the utilization of resources to generate value in shape of products and services. Capability includes the concepts of organizational competency that leads towards effective proficiencies and practices (Prahalad & Hamel, 1990). In holistic view, RBT hypothesizes that resources can influence the development of capabilities as to improve organizational performance and effectiveness. Initially RBT generated to cater private sector, but over the period of time it is highly recognized as a theoretical foundation to investigate the knowledge assets to public organizations. These theoretical foundations also depends on the potential resources and capabilities to convey public value among potential stakeholders (Piening, 2013). Some application that sketch upon RBT For example, Melián-González et al. (2010) recognized IT as resource, that drive capabilities related to KM at state universities. These capabilities used to encouraging universities to offer training courses, and supervising teaching material. Similarly, the Pablo et al. (2007) represents the case of public health services, they discover the capability of related to knowledge management by experimenting to acknowledge potential demand of continuous improvement in spite the reduction in financial resources. RBT by designed more emphasizes on utilization of internally available resources, such characteristic allow RBT applicable to public sector organization (Pablo et al., 2007).

2.12.2 The Role of Capability-Based Theory (CBT) in Innovation Management

The capability-based theory represented by number of research scholar's adapted from resource-based view of the firms (Barney, 1991a; E. Penrose, 1959; Teece & Pisano, 1994; D. Teece et al., 1997; Teece, 2007). This perception within organizational boundaries visualizes capabilities as the potential aptitude to integrate, combine and relate potential resources to accomplish firm's competency and remain innovative (Schreyögg & Kliesch-Eberl, 2007). The concept of management capabilities has come to be noted as illustrating those actions that the organization is competent for functioning at each level: capabilities are considerably close to action. Theoretically they cannot be disconnected or practicing separately (Schreyögg & Kliesch-Eberl, 2007). Black and Boal (1994) claimed that capabilities are the "ability to arrange resources generally in-shape of collaboration by utilizing operational activities in order to achieve desired outcome." To interpret that Teece *et al.* (1997), acclaimed that it is not just potential assets that one has to deal with, but it also about how effectively one can arrange the resources to configure or reconfigure capabilities with respect to the market dynamism. Capabilities that belong innovation management has a potential characteristics related to firm's vigilance in case of development of organizational strength for innovation (Börjesson & Elmquist, 2011)

Under such theoretical conceptualization, a wide variety of capabilities related to innovation management that has been recognized after the year of operational practices. Leonard-Barton (1992) portrays a range of 'potential capabilities' that differentiate existing firm strength from others and drive firms to get maximum competitive advantages.

2.12.3 The Role Dynamic Capability Theory (DCT) in Technology Management

An organization confronts many challenges to attain overall organizational competiveness specifically when its resources and capabilities are static in nature with respect to the dynamic business environment (Winter, 2003). This is due to potential barriers of static resources and capabilities that reluctant to acknowledge effectively in extremely uncertain market environment. While on the other hand dynamic capability view (DCV) allows researchers to emphases more on the significance of resources that drive capabilities to confront market dynamism for example: the reconfiguring ability to attain organizational competitiveness even a market faces high dynamism. This research study enables dynamic capability theory (DCT) for technology management in order to postulate a novel conceptualization of capabilities that belongs to technology management. The dynamic capability theory is an modified version of resource based theory (RBT). The essential practices of dynamic capability regard as higher level capabilities that used to engaged in reconstructing and reconfiguring the normal capabilities in order to achieve maximum competitiveness (Zahra, 2010).

There are several theoretical interpretation that defined the fundamental concept of dynamic capability and also highlights its significance on firms overall performance. For example David Teece et al. (1997) define dynamic capabilities as firms aptitude to interface, rebuild and reconfiguring internal and external proficiencies to deal with market dynamism. It also exposes the potential trajectory of dynamic capabilities along with all the functions that support long-term organizational competitiveness.

In similar way, several other researches hypothesize with same narrative, according to them dynamic capability theory as a potential practices that facilitate firms to gain maximum competitive advantage under dynamic environment for example: Wu et al. (2018) consider both pervious research studies (Cetindamara et al., 2009; Dilek Cetindamara, 2016) based on dynamic capabilities theory (DCT) draw relationship in between Technology management capability (TMC) and New product development (NPD). They concluded that, dynamic capabilities more precisely act as high level management ability that positively integrate, readjust and develop capabilities with their resources in order to counter market fluctuation.

Cetindamara et al. (2009) describe the core concept of Technology Management (TM) under the scope of dynamic capability theory (DCT) and offers a Technology Management (TM) theoretical model which specifically emphasis on the improvement and utilization of technological capabilities. They suggested that technology management capabilities is dynamic in nature that enable the potential trajectory through which any firm implements its current resources, and identify the spots where it need to develop new onces. In simple word technology management capability can be viewed as the amalgamation of various resources which can be generated, deployed and confined to operates in most effective way in order to attain long-term organizational goal (Díaz-Díaz et al., 2008). It is significant in noting that capabilities which belongs to technology management emerges to be more crucial asset for R&D in service-based manufactures rather than to conventional producers as in shape of tangible assets (Gebauer et al., 2012a; Zhen, 2012). Technology management capability can reinforce the value creation in shape of sustainable technological development. Since it is ability of effective collaboration and exploitation of existing resources to manage technology at each organizational level with respect to their requirement (Gebauer et al., 2012a; Zhen, 2012).

2.13 Conceptual Connectivity To Bridge Theoretical Gap

This research highlights the capability-view from firms R&D perspective and describes the concepts of capabilities which gained traction in the fields of strategic management along with peripheral participation of supporting management discipline (Teece, 2017). This view appears beyond 'production function' to recognize the significance of how firms R&D may consider as orchestrate function that sustain the national competitiveness (Bank, 2010). This range of functionalities allows firms to accomplish full integrations in the development of un-priced assets. This discrete un-priced trait enables firms to capture value from R&D (Teece, 2017). Therefore, capabilities based view allow researcher to explores innovation, knowledge, and technology management as supporting management tools does not fall manna from heaven but somewhat associated R&D (Aleksandras Vytautas Rutkauskas & Jurgita Raudeliūnienė, 2014; Teece, 2010; Teece, 2017). In this way, capabilities-views endeavours to help in exploring the classification of heterogeneity among capabilities related to management supporting discipline with their significance on R&D. Such classification based on concepts from knowledge management, innovation management, and technology management discipline (Unsal & Cetindamar, 2015) is shown in Figure 2.10

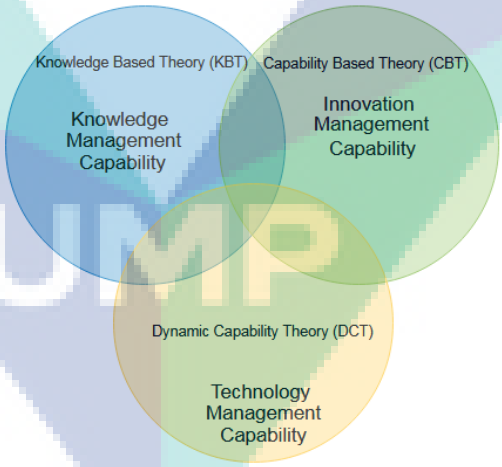

Figure 2.10 Theoretical Framing
Source: Constructed by Author

Knowledge management recognized as a significant source at a national level during policy development among various developing countries (Arrau, 2015). Every developing country has national innovation system (NIS) and policies regarding and implementation of knowledge to their public organizations specifically when addressing to improve their R&D competitiveness (Elahi et al., 2016). Knowledge management (KM) play a significant role to strength NIS policies among the majority of developing countries for their formal R&D in public firm (Tieng et al., 2016). According to Hutchings and Mohannak (2007) implementation of knowledge management in most of the developing countries confront various institutional factor that hinders knowledge management practices explicitly dealing with R&D in public firms. These factors include Inter-organizational and Intra-organizational relationship (Tsai, 2015). The ties suggested the direction of whether firms looking to manage existing knowledge or adapt the new knowledge.

The relationship in between knowledge management and R&D is necessarily close because R&D activities can mostly be seen as knowledge management processes, for example: translating information for technological advancements which requires overall knowledge stock for new product and processes (Park & Kim, 2005b). Surprisingly, the association in between the knowledge management and R&D were virtually inexistent. However, Some scholars acknowledge, the relationship in between knowledge management and R&D by drawing capabilities-based view and consider some of constructs which obtained during knowledge transfer (Liao et al., 2010).

Kamath et al. (2016) revealed a capabilities perspective of knowledge management by drawing relationship in between knowledge management effectiveness, R&D innovation, and firm performance. Dingyong et al. (2009) illustrate that the urgency of knowledge management capability as a core strength for those organization that is dealing with R&D projects. In contrast, they concluded that with formal R&D setting along with measurable tools and resources are not simple to figure out the R&D project. Similarly, Lilleoere and Hansen (2011) explore the impact of knowledge sharing as core KM process capability on R&D employee to reduce the knowledge barrier and emphasis more on a value of synergism. Shankar et al. (2009) looking to explore various attributes which influence the strategic alignment of capabilities that belongs to knowledge management in order to address R&D competitiveness.

Similarly, innovation recognized as a crucial element in the economic strength for various developing countries (Elahi et al., 2016). The national innovation system (NIS) is quite diverse between different countries have a different innovation management criteria to deal with R&D at a national level (Elahi et al., 2016). According to Lundvall et al. (2009), a national innovation mechanism consider as an openly dynamic and complex system that consists of inter and intra organizational affiliation. Such affiliation justifies the direction of the innovation. Therefore, the experience-based learning mechanism under this affiliation create capabilities (Elahi et al., 2016)

Pogrebnyakov and Kristensen (2011) address the challenges for the development of innovation management capabilities at subsidiaries level. Also, concluded that the significance of maintaining a central R&D function, allow firms to balance inter organizational talent. Similarly, Technology considered as a critical component for developing the national innovation system (NIS) policies among various developing countries (Unctad, 2014). Since the NIS deal with science, technology, and innovation, therefore every country has a different specification with respect to their own environment. For example, different countries have different technology management standard to develop their R&D strength (Gutterman, 2016).

Ang and Chai (2010) developed a framework that used to addresses defence R&D investment and optional theory; the basic concept behind his work based on technology management literature with prime emphasis on developing a capability for the indigenous defense industry

2.13.1 Theory Behind Conceptual Model

Prior studies were mostly highlights relationship in between knowledge, innovation and technology management at individual level and draw capability perspective that influence R&D. However, these studies somehow unclear regarding to draw relationship among the three concepts together. Therefore, to address this gap in the literature, we have looking to explore the relationship among three set of capabilities all together. Some researchers believe little association in between capabilities that belongs to knowledge management and innovation management that contributes potential significance on R&D (Kim et al., 2012). On the other hand, Rizzi et al. (2009)

believe that capabilities related to technology management consider as a catalyst for knowledge management for effective R&D competitiveness. Similarly, Reichert et al. (2011) conclude that capabilities related to innovation and technology management are the specific component in providing an appropriate environment for sustainable R&D growth at the national level. In this research, we tried to identify the proper proxies among which helps researcher to classify the capabilities related to knowledge, innovation and technology management with respect to their significant influence on R&D. The theory behind conceptual model based on combination of Resource Based Theory (RBT), Capability Based Theory (CBT) and Dynamic Capability Theory (DCT) already discussed in section 2.9. The conceptual model in this research suggested the classification of capabilities related to knowledge, innovation and technology management as supporting management discipline that contribute their influence in R&D, i.e., the conceptual framework that is not specific to R&D function.

The conceptual model in this research based on a modification of theoretical evidence by (Dilek Cetindamar, 2009; Unsal & Cetindamar, 2015) is shown an Figure 2.11

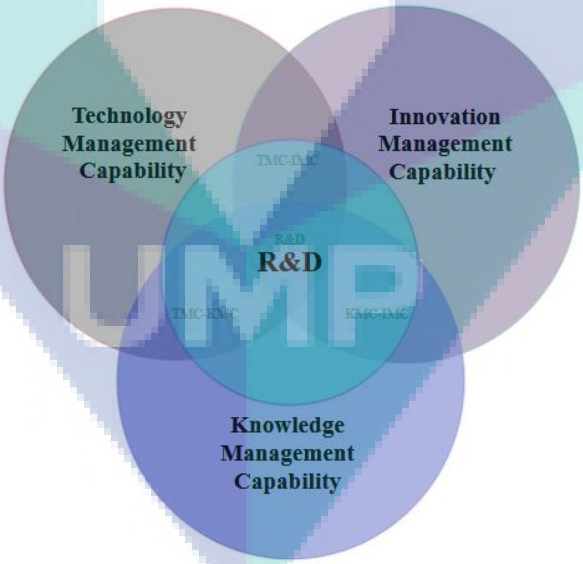

Figure 2.11: Boundaries among innovation, technology and knowledge Management
Source: (Dilek Cetindamar, 2009; Unsal & Cetindamar, 2015)

2.13.2 Conceptual Understanding

. The conceptual model suggested in this research assesses the potential capabilities that directly influence the generic R&D competitiveness, i.e., The author is aware of the reality that the significant output during the assessment depends upon three influential resources that drive capabilities belongs to knowledge, innovation and technology management. The unusual interrelating conditions can be represented below sections

2.13.2.1 Relationship in Between KM Capabilities and IM capabilities

According to Kim et al. (2012), the concept Knowledge Management (KM) capabilities overlaps to some extent with Innovation Management (IM) capabilities which contributes potential significance on R&D outcome. The innovative approach always relies comprehensively on capabilities that belongs to knowledge management to resolve complex innovative resources issue, add values to develop organizational competencies (Kim et al., 2012). Indeed, the basic concepts for innovation management to some extent overlap with knowledge management specifically when addressing the idea of intellectual property (Swan & Scarbrough, 2001). In general, R&D based organization must rely on capabilities that related to knowledge and innovation management that allow firms to upgrade relevant resources without acquiring them externally (Gunsel et al., 2011). In a broader spectrum, it translates as organizational ability and allow firms to encourages an responding mechanism regarding what they have to act before their business rivals by utilizing of their existing knowledge capabilities (Gunsel et al., 2011).

2.13.2.2 Relationship in Between KM capabilities TM capabilities

In recent decades, a sequence of questions and confrontation with potential criticisms have arisen regarding the selection of relevant capabilities related to technology management to cater knowledge management for complex R&D (Rizzi et al., 2009). However, to address compound industrial growth, firm existing knowledge management discipline needs to redesign in cross-functional way for external collaboration which required configuration approach for technology management (Chang & Chuang, 2011; Pisano & Figgie, 2016b). Accorsi and Costa (2008) consider capabilities related to technology management as an instrument to develop knowledge management system (KMS). Venters (2010), introduce a variety of process capabilities associated with the technology management these capabilities allows firms to reshape knowledge management capabilities (Venters, 2010).

2.13.2.3 Relationship in Between IM Capabilities and TM Capabilities

Innovation management and technology management now considered as research areas under the rubric of management scope (similar to strategic management or organizational behavior) (Reichert et al., 2011). Both supporting management discipline were utilize to sustain R&D competitiveness for organizations to strengthen their economic earning and consider as critical factors to enhance overall organizational competitiveness (Reichert et al., 2011). These vital factors were based on resources that drive capabilities belongs to technology and innovation management allow decision makers to address organizational requirements according to the industrial demand (Reichert et al., 2011).

2.14 Knowledge Management

knowledge management considers supporting management discipline and recognized as a significant tool that helps organization for sustainable business performance and access to achieve their maximum business goal (Akroush, 2006; Bruton et al., 2007). Grant (1996b) define knowledge as an indefinable resource, and its interfaces with existing input to the firm such as existing capital and available infrastructure to create capabilities. Knowledge assets can characterize in two different ways such as implicit and explicit. Polanyi (1967) describes at late 60's that the inherent character of knowledge asset as supporting management discipline considers as an ability to possess knowledge by the individual's which also known as tacit knowledge. While Nonaka and Takeuchi (1995b) describe explicit knowledge asset as the ability to maintain awareness that can transfer in the form of systematic code such as database reports. Considering the fact that knowledge and knowledge management essentially requires a research ingredient in the context of emerging businesses and developing economic (Akroush, 2006; Bruton et al., 2007)

The phenomena of knowledge management discipline from last two decades were considered in contributing for developing economies (Carrillo et al., 2003; Lin & Tseg, 2005; Maddan, 2009; Nonaka & Takeuchi, 1995b; Tsai & Shih, 2004; Wong & Aspinwall, 2004; Young, 2006). Some of prior studies highlight the effective knowledge management at national level as an essential component to make public firms as knowledge-base organization. They concluded that knowledge management consider as a fundamental source to develop a sustainable indicator for competitive advantages and allow improving the economic performance. Novak and Bojnec (2005) more focus on the essential features of knowledge management as a supporting instrument that helps the Slovenian Economy (Novak & Bojnec, 2005). They concluded that under limited number of capital acquiring new resources for knowledge management consider being difficult among small and medium scale firms to remain competitive (Novak & Bojnec, 2005). Similarly, Kwang et al. (1999) suggested to remain competitive, it is essential to enable effective knowledge management as a significant tool. But also necessary to understand integration of knowledge resource with organizational system that allows firms to produce positive outcome (Kwang et al., 1999). Knowledge management considers as supporting management discipline and recognized as significant tool for developing knowledge advancement for sustainable business performance (Akroush, 2006; Bruton et al., 2007).

2.14.1 Knowledge Management Capabilities

2.14.1.1 General Overview

Organizational knowledge offered consistent improvements in the path of developing processes, operational routine, capabilities and organizational growth (Nicolás & Cerdán, 2012; Zabot & Silva, 2002). Therefore, the classification of capabilities that belongs to knowledge management consider as essential for R&D function among many organizations in the twenty-first century as compared to the conventional assets such as manual labour, resources, and technology (Nicolás & Cerdán, 2012; Zabot & Silva, 2002). Before that, organizations were more focus on R&D that promotes mass production due to the valued for its orientation being depended up the quality. At present situation, the creative idea, technical know-how and digital code become center of foci (Nicolás & Cerdán, 2012; Zabot & Silva, 2002)

There are various resources to visualize capabilities that relates in contrast with knowledge management. However, there has been a universal consensus regarding its basic resources that drive knowledge management such as: ability to develop, proficiency related for knowledge codification, ability to utilization, transfer, and preservation of knowledge to accommodate organizational structural challenges or for developing additional value (Rowlei, 2000; Tobin, 1998). At current situation, organizations is a result of knowledge known as supporting management discipline developed through combination of management theories along with competitive resources such as: group of proficient skill workforce (Rodan & Galunic, 2004; Zabot & Silva, 2002)

Knowledge management capabilities can offer a possible advantages, because over the period of time most market competitors were frequently emphasis on cost or quality of the products (Chou et al., 2015). On the other hand, the organizations that were more emphases towards capabilities related to knowledge management will able to accomplish a new standard of quality, creativity, and effectiveness (Chou et al., 2015). The main benefit to acquire or obtain capabilities related to knowledge management as core organizational strength, because it produces extensive returns by applying knowledge as instruments for competitive advantages (Chou et al., 2015)

Since, the appropriate capabilities that drive knowledge management was also consider as primary base for innovation. Such foundation requires investigation and communication among multiple sources engage within and beyond functional boundaries (Chou et al., 2015). In order to adapt speedy market variation always requires the combination of multiple sources for example: organizational information regarding R&D and knowledge to handle market variation. This allows significant growth in the level of coordination among organizations (Chou et al., 2015)

Despite various positive outcomes, still a lot of complexity involve during the development of capabilities related to knowledge management. It was due to potential malfunction within knowledge resources or unsatisfied by skepticism due to lack of organizational ability. Capabilities related to knowledge management engage with insubstantial advantages and for such reason it is complex to measure especially during the evaluation of R&D effectiveness (Liebowitz, 2013; Poyhonen & Hamalainen, 2001; Roper & Dundas, 2015).

Mills and Smith (2011) investigate the impact of knowledge management capabilities on organizational performance. The study illustrates a substantial connection among knowledge resources and overall organizational performance which critically argued by several other scholars', but unable to draw any significant conclusion in case of addressing dynamic resources

Mills and Smith (2011) suggested that stable link between knowledge management and organizational performance. The outcome of their finding suggests that decompose approach under complex relationship among resources that effectively drive process and infrastructural capabilities related to knowledge management for example: organizational structure, knowledge acquisition, knowledge application, and knowledge protection were significantly related to organizational performance. However, there is no commonly agreed conceptualization that which resources make up these process and infrastructural capabilities (Alavi & Leidner, 2001).

Some of prior studies also highlights the impact of knowledge management capability to measure various organizational aspects such as: Hayashi (2004) illustrate that acquiring specified nature of capabilities related to knowledge management through the number of sources not only useful to resolve the technical complexity, but it also helps to resolve the risk and uncertain factors which allow firms to variate their R&D operations for maximizing competitive advantages. Similarly, Henderson and Cockburn (1994) develop a statement to acquire knowledge management capabilities from external sources allow maximum organizational success depend upon the collaboration of new external information mix with existing knowledge (Henderson & Cockburn, 1994). Henderson and Cockburn (1994) suggested that to sustain the effective performance that advance the organizational activities depend on capabilities and resource that drive knowledge management processes. Such capabilities allow smooth switching of information in between the function of the organization spread across the entire organizational units. Therefore the integration of specialized knowledge would impact to the organizational performance (Leonard-Barton, 1992; Teece et al., 1997).

Similarly, Teece et al. (1997) suggested that knowledge management capabilities allow knowledge transfer as potential resources that enables range of expertise shared in between functional units that helps individual's to observe and understand each other responsibilities and works together for the betterment of organization in order to get the common goal. Leonard-Barton (1992) describe the sharing a common knowledge as the process capabilities related to knowledge management enables a link in between un-associated features that create a character to possess a certain similarity in between the organizational units. From different studies, it observed that individuals that involve in organizational responsibility were more efficient in their responsibilities.

Gold et al. (2001); Khalifa and Liu (2003) argues on fundamental concepts of knowledge infrastructure and process capabilities relates to knowledge management that requires a complete makeover from state of low capacity (that highlights the less availability of resource, less accessibility to adopt the change and less contribution to the work practice) to the state of high influence (of more availability of support either from external and internal aspects, high accessibility to accept the change because of capabilities related to knowledge e management that can easily integrate with any work practices). Leonard-Barton (1995) stressed on resources related to process capabilities such as: creating, exchange/sharing at organizational level to resolve the issue related to KM effectiveness. Pentland (1995) similarly define KM processes as a continuously evolving in character which integrated in organizational physical and functional structure with core attributes of knowledge as final product. There are number of scholars and researchers who draw perspective of organizational capability by highlights knowledge acquisition, knowledge conversion, knowledge application, knowledge protection as resource to drive knowledge management processes capability (Aujirapongpan, 2010; Chan, 2008; Gold, 2001; Suzana, 2010)

Gold (2001) used to offer the knowledge management conceptual framework to measure capabilities aligned with organizational strength (Gold, 2001). These capabilities illustrate the processes and infrastructural perspective of knowledge management. The infrastructural stand point of knowledge management capability is comprised of technology, organizational structure, and culture (Gold, 2001). While process perspective includes acquisition, conversions, and protection, are the significant capabilities that aligned with organizational competence and consider as pre-requisite for effective knowledge management. In similar way, Smith (2006) developed a theoretical framework that supports organizational competencies by drawn criteria for KM infrastructure capabilities comprise of technology, culture, and structure. Hsu (2006) evaluate the relationship between the organizational effectiveness and Intellectual capital to enable specific modification of KM infrastructure capabilities adjusting Organizational leadership, corporate culture as potential resource. Aujirapongpan et al. (2010) also acknowledge knowledge management effectiveness by drawing various resources as sub-criteria for knowledge management process capability for example knowledge acquisition, knowledge conversion, knowledge application, knowledge protection. Similarly, Tseng (2010) developed a framework to measure corporate performance and finds relation in between knowledge conversion and organizational culture by draw criteria for process and infrastructural capability related to knowledge management. On the other hand, Yang (2010) resolve the regulatory issue developed due to changing industrial trend by combining KM strategic capability. Smith (2006) adds KM strategy as an essential component to aligned business strategy and establish a comprehensive model of KM capabilities with a complete perspective to recognize the organizational dynamics.

Nonaka et al. (2000) developed knowledge management strategic design to draw relationship between with KM process capability by applying SECI model to developed four strategies of knowledge conversion used in between codified and nonverbal expertise(Lee, 2003; Migdadi, 2005; Nonaka, 2000). Johannessen et al. (2001) used IT to influence tacit knowledge as essential for an organizational resource to assess the firm ability to create maximum competitive advantages. Johannessen et al. (2001) argue that the knowledge-base organization relies on both types of knowledge management strategies depending on the situation. The two common knowledge management strategic capabilities known as codification –personalization were involved in addressing these types of innovation (Lee & Choi, 2003; Nguyen & Pham, 2017). The number of scholars observed that codification and personalization strategies mainly used to facilitate the innovation, but over the range of application their impact was varied to their implementation (Choi & Jong, 2010).

2.14.2 Global Landscape on Knowledge Management Capabilities

Knowledge management presently considers as crucial debate in term of developing national innovation system (Tariq Mahmood Ali, 2015). But there is a lack of theoretical interpretation regarding utilization of knowledge management capabilities at a global level. Since the globalization influence on organizational strength, knowledge is considered as a surviving soul for any organization. It has been recognized as supplement to R&D in order to confronts global business dynamism (Yi, 2009). Therefore, it signifies that managing knowledge for an organization as similar to manage other adequate assets (Yi, 2009). To structure the pathway for strong competitive advantage numerous organizations massively rely on capabilities that produce new knowledge and that becomes a critical success factor at organizational and national level (Yi, 2009).

The main comprehension regarding the higher significance of knowledge lies beneath the foundation for effective management of knowledge at the organizational level (Mohammadi & Franzoni, 2014). As a result, many organizations lift their organization horizon due to the successful development and utilization of capabilities related to knowledge management. Existing literature suggested that role of knowledge management capabilities can consider as a crucial antecedent for sustaining long term creative opportunities (Mohammadi & Franzoni, 2014)

The high fluctuation in global economy ripples to substantial R&D investments around the globe. However, some cautionary steps were implied to reimburse and restore more aggressive financial regulation to reserve the global investment specifically on developing countries (Kim, 2014). To survive against the global competitive environment most developing countries possess retainable capability related to knowledge management at institutional level. These capabilities allows firms to share collaborative adjustment of their technical knowledge to address their internal and external stakeholder (Kim, 2014). In order to encounter future demands, R&D sectors in most of developing economies always looking more long-term strategic approach to sustain their capabilities that belongs to knowledge management at public sector organizations (Winter, 2003). According to Organization for Economic Cooperation (OECD, 2016) most of the private sector add majority of contribution in term of their domestic R&D spending for example, country like Israel which shares 80% of their total R&D spending drive from private sector in order to increase their knowledge stock, followed by Japan where 73% R&D spending came from private sector. Similarly, China and South Korea where private injected more than 70% to fulfill domestic R&D requirements (OECD, 2016)

The main philosophy among these countries possess behind their R&D success is due to strong knowledge management capability at institutional level. These philosophies allow them to keep formulating, protecting, diffusing, and utilizing knowledge as potential resources in shape of wealth creation and employment generation (Bakry, 2009). The execution of these activities has been covering enormous attention among several researchers over the period of time. This follows towards the knowledge-driven societies which encourages to promote knowledge-based culture (Bakry & Alfantoukh, 2010).

The actual concept of knowledge management has adapt at national level and acknowledged by the number of researchers during the development of new structure belongs to knowledge-based economies for both developing and developed countries (Jankowska et al., 2017). There is no specific systematic strategy or any scientific approach to determine the capabilities related to knowledge or knowledge management for developing countries.

Therefore, it is significant to browse numerous indexes that have been utilized for knowledge development. There are few indicators available to assess the knowledge management resources such as Global Competitive Index (GCI), Index of Economic Freedom (IEF), European Competitiveness Index (ECI), Knowledge Economy Index (KEI) and World Knowledge Competitive Index (WKCI) which covers 2 to 3 resources are related capabilities that belongs to knowledge management (Browne & Geiger, 2010; WEF, 2017).

According to these indexes, the highest rank countries like Singapore, Switzerland, Hong Kong, followed by USA and Scandinavian countries (Katić et al., 2012). These countries recognized resources related to capabilities that belongs to knowledge management processes such as knowledge creation and knowledge utilization as a potential source to propelled economic growth (Kriščiūnas & Daugėlienė, 2006). According to these indices, highly ranked countries are shown in see Table: 2.5

Table 2.5 Knowledge indices of competitiveness

	Name of the institution releasing the index and	**Frequency of publication**	**Number of countries ranked**	**Number of variables (quantitative/ qualitative data ratio)**	**Ratio of weighted coefficients**
Knowledge Economy Index (KEI) and Knowledge Index (KI)	Milken Institute, University of California	Periodically (1995, 2000, 2008)	1. Denmark 2. Sweden 3. Finland 4. Netherland 5.Norway Report: 2008.	329 (219/110)	quantitative - 1 qualitative – 0,64
Knowledge-based Economy Index	The World Bank Institute's Knowledge for Development Program (K4D) Since 1995	n/a	n/a	83 (total)	Equal weight
World Knowledge Competitivenes s Index (WKCI)	Centre for International Competitivene ss	Periodically (five releases), Latest 2008.	1.San Jose-Sunnyvale-Santa Clara, US 2.Boston-Cambridge -Quincy, US 3.Hartford, US 4.Bridgepo rt-Stamford-Norwalk, US 5.San Francisco-Oakland-Fremont, US Report: 2008.	19 quantitative	Equal weight

Table 2.5 Continued

	Name of the institution releasing the index and	Frequency of publication	Number of countries ranked	Number of variables (quantitative / qualitative data ratio)	Ratio of weighted coefficients
Global Competitiveness Index (GCI)	World Economic Forum since 1979.(upgraded in 2004)	Annually	1. Switzerland 2. Singapore 3. Sweden 4. Finland 5. USA Report:	111 (35/76)	Not same for all countries – dependent on the level of development

Source: Katić et al., (2012)

It can be observed that from the above distribution of indexes which comprise of specific resources that drive capabilities related to knowledge management that they can be incorporated differently in shape of competitiveness. Almost 60% of overall indicators reflect the entire evaluating parameters represented by Economic Knowledge Index. Among these indicators, still more required to deal with comprehensive knowledge management capabilities

2.14.3 Deficiencies among R&D's in Public Organization of Pakistan: Knowledge Management Capabilities

Pakistan considers as the middle-income economy, where the significance of knowledge management capabilities at institutional level has been well recognized (Bashir et al., 2018). Arabella Bhutto (2012) highlights that due to inadequate practice and less effective integration to the national innovation program failed public sector R&D to fulfill current demand and unable to interpret current R&D as a tool for potential economic revival (Arabella Bhutto, 2012).

Pakistan remains under extensive pressure as the country with limited resources, a balanced focus on R&D required for continuous research growth (Muqadas et al., 2017). Progressive advancement at individual level is required also necessary for future demand in order to elevate the social and economic status for common people (Abbas, 2012). Shahid (2016) draw some significant challenges that Pakistani government confronted in case of developing knowledge management capabilities in public R&D firms over the period of time these challenges are: consistent flight of capital, lack of funding agencies due to worst political turmoil, losing grip to retain technical skill causes extensive brain drain (Abbas, 2012). Similarly, Gilani (2015) highlights that alarming situation regarding spending or acquiring new knowledge capabilities according to him, Pakistan still far behind among regional economies due to less R&D spending and still facing critical issues in improving their existing industrial capabilities by starching their R&D organizations to adopt knowledge management routines as a critical factor to their performance .

Implementing knowledge management (KM) is all about delivering accurate information to the right set of people promptly (McElroy, 2003). The majority of public sector firms are looking for influential accumulated knowledge in order to facilitate firm's innovation ability. This generally came from firm's skill force which basically rely on people with high intellectual abilities that drive productive processes along with other organizational characteristics (Arabella Bhutto, 2012)

In case of Pakistan, KM trends quite discouraging as most of the industrial sectors were less progressive toward the R&D (Gilani, 2015). Such deficiencies allow public organizations to acquired knowledge and technological capabilities externally. Due to the inconsistent behavior among majority of public sector, firms in case of retaining capabilities related to knowledge management. As a result of such external acquisition the process of absorption required across several public organization allow them full transition from being working on static internal resources to practice on external knowledge resources (Goedhuys & Mytelka, 2005a). To observe such organizational transformation, Pakistan council of science and Technology only proposed some measuring indexes that refers patents and scientific publications which is unsuccessful to portray any parameters that reflects any role for capabilities related to knowledge management at institutional level (Arabella Bhutto, 2012)

It is observed that effective knowledge management allow firms to address their complicated issues that occur during the transformation of knowledge adoption. Acquiring new knowledge management capabilities also, allow R&D in public organizations to sustain the process of survival and competencies during dynamic industrial environment. In reality, it exemplifies that R&D sectors always looking synergistic blend of technical knowledge and processing capabilities for long term survival (Malhotra, 2001).

2.15 Innovation Management

Innovation Management has evaluated as a crucial enabler in case of delivering long-term stability for economic development (Elahi et al., 2016). Innovation is considered a core attribute among research based organizations. The fortune in achieving high market footprint and growing profitability of R&D firms usually based on retaining national competencies (Elahi et al., 2016). However, the present economic environment has had a sizable impact on organizations across the globe (Elahi et al., 2016)

Organizations have gone through difficult circumstances over a period of the extremely competitive environment exemplified by introducing more efficient and standardized processes. Such circumstances allows decision makers to understand the significance innovative strategies as essential for management process (Hitt et al., 2012; Porter, 2009). Therefore, to certify the survival of any business it is essential that all processes related to any business must create the potential value, merely not within the organizational domain, but also beyond the organizational boundaries (Serio & Vasconcellos, 2009)

The potential contribution of Schumpeter (1984) establishes to be very prosperous in recognizing the significance of innovation at organizational level. Several authors highlighted some of drastic changes during the identification of capabilities for effective innovation management. These author's emphases more on innovative dimensions belong to new products, new operating practices, and creating new resources for raw material. Schumpeter (1984) also an emphasis on connecting innovation with multidisciplinary knowledge and cultivating into new product or services to society

Number of studies highlights multidisciplinary innovation models that not only based on the basic concepts of product innovation for normal firms but, also feasible for various research based organizations. For instance, the models presented by Utterback (1970), Pugh (1991), Thomas (1993), used to relate market as an essential capability for concepts development with focus of new product and processes. To handle multidisciplinary innovation requires firms to have sufficiently awareness about capabilities related to innovation management to deal with complex and multidisciplinary integration.

Clark and Wheelwright (1993) represent innovation management as supporting management discipline in the form of a standard framework that allow to recognizes innovation as a potential input to the process of acquisitions, relevance of technology for competencies and channelizing the regular development route. The foundation of this framework based merely on the theory of preference (Silva et al., 2014). In which many concepts floating through various stages that are used for specifying only capable ones turn out to be feasible for innovation. In some cases effective innovation management potentially offers companies to build more competitive by merely utilizing new concepts or by just upgrading the existing theories (Forsman, 2011). Innovation is no longer considering complex factors but became an influential factor in connecting innovation capabilities (Forsman, 2011). Numerous studies still emphases on innovativeness that aspire to enable the potential concepts of creativity itself. In order to recognize such concepts potential capabilities are required for effective innovation management (Alves et al., 2011; Forsman, 2011; Wang et al., 2008; Yam et al., 2011b). However, beside these concepts various other factors are still required to fuse with the notion of innovation. Therefore, such integration consider as very complicated approach and demands effective capabilities related to innovation management in order to receive maximum contribution from other organizational functions.

There are several studies that highlights that how the role capabilities related innovation management were significant for research based firms in order to get maximum competitive advantages for instance: Rozenfeld et al. (2006), highlights a certain role capabilities related to innovation management were involve at early stages of new product development and allow R&D to align their strategic parameter.

However, their finding was more focus on complex product development processes. Similarly, Goffin and Mitchell (2010) emphasis regarding the role of organizational strategy as a significant resource to initiate processes related to innovation management. However, they more focus on organizational behaviors. Similarly, some of prior studies also highlights the role of innovation management for example Bessant et al. (2005); Khurana and Rosenthal (1998) illustrate the processes and resource structure for mapping guiding principles for a whole operating structure for innovation management allowing systematic interpretation during the development of new concepts. However, these studies more emphases on creating new capabilities for system level innovation (Silva et al., 2014)

In the present circumstances, innovation management consider as guiding principle has not yet accomplished the phase of progress to assure the significance to innovate among several R&D firms (Bes & Kotler, 2011; Bruce & Birchall, 2009; Sigala & Chalkiti, 2015). Therefore, complete transformation required to execute the innovation mechanism. However, some time innovation practices classified as unbalanced and irregular to understand overall attentiveness of innovation outburst which behaves differently to the various sector under specific durations. Similarly, in some case firms do not follow a linear model for incremental innovation because standard innovation model have a sizeable degree of ambiguity. As a result of the such problems innovative significances R&D firms were partially unknown. It exposes on cumulative basis specifically those innovation management capabilities that formulate changes within an established pattern (Rowlei, 2000; Song et al., 2014).

2.15.1 Innovation Management Capabilities

A firm can constantly innovate and retain its competitiveness in the robust business environment, depends on capabilities related to innovation management that used to facilitate verity of products and process. It also, allows firms to understand the conventional perception about innovation (Tidd et al., 2005). To secure and retain their market position for future growth, the firm's continuously looking in search of generating a new conceptual framework for acquiring and modifying their existing capabilities related to innovation management (Tidd et al., 2005). In order to get advance capabilities firm's divisional heads need to figure out which resources are significant for reconfiguration to match the existing capabilities (Crossan & Apaydin, 2010). A diverse set of literature available that represents the capabilities related to innovation management allow smooth transition during the process of creativity (Crossan & Apaydin, 2010). From the contingency point of view some specific questions arise on the universal applicability on resources and capabilities related to innovation management

The concept of innovation management does not appear overnight, many organizations realize that to sustain their current market position or to have significant growth in future requires a demand of change in order to survive in the dynamic industrial environment (Von Hippel, 1988). Commonly most of the firm's trip on creative concept to manage innovation and try to nurture existing capabilities (Tidd et al., 2005). But in most cases organizations who claimed consecutive market successes rely on capabilities that drive effective innovation management and enables creativity pattern for their operational activities (Tidd et al., 2005). In most cases firms extensively invested on their creative capability to generate new concepts to stimulate their existing innovation activities (e.g., Story, Hart & O'Malley, 2009). But to acquire such innovative ability requires core resources to drive existing innovation management capabilities. Adams et al. (2006); the suggested that the core capabilities related to innovation management must be widespread across the organizational boundaries. This allows firms to integrate their internal asset for effective innovation process. However, these capabilities were based on resources that over the period of time unable to deal with dynamic industrial demand. While, according to Akgün et al. (2007) core capabilities related to innovation management can also be accessible beyond the organizational boundaries which allows firms to accepts existing market pattern.

Most of the theoretical interpretations on innovation management represent the blends of capabilities that produce different variety of innovative outcome. For example: Danny Samson Benn Lawson (2001) suggested that most firms were rely an robust infrastructure capabilities to execute effective innovation management which depends on organizational culture, structure and organizational intelligence parameter for successful R&D in case of creating new product development. However, according to their theory developing these resources requires to account several external factors that behavior patterns change with respect to future trends (Danny Samson Benn

Lawson, 2001; Hii, 1999). In some case a robust processes technology transfer consider as potential resources that drive innovation management capabilities in order to avoid uncertainty during the selection processes to get maximum competitive advantages (Gryszkiewicz, 2011). Although, there are some studies still highlights that effectiveness of innovation management capabilities which allows firms to utilize current innovation potential in order to confront (Kalvarskaya, 2009; Saunila, 2012). Similarly, in the case of sustainable innovative development that firms were looking long-term strategic capabilities for innovation management (Richard Adams, 2014).

Kalvarskaya (2009) highlight two significant innovation management capabilities which represent processes perspective. According to him, process capability related to innovation management considers as a useful tool from the effectiveness and speed innovation process. However, their major focus were more on developing and motivating human capabilities rather than developing resources related to process capability. Saunila (2012) draw narrative on infrastructure and process capability to some extent related to innovation management. According to them, process capability enables overall system level activities that the organization utilizes to assess the current innovation potential. While, infrastructure capabilities is used to enables long term competitive edge in shape of organizational culture, external networking structure and organizational technical know-how to assess exiting organizational potential. However , they were unable to specified innovation processes, they were more emphases on general concept of innovation activities to observe normal innovative outcome. Similarly, some of prior studies replicating similar type of theories regarding the innovation management capabilities for example: Gryszkiewicz (2011) highlights potential utilization of process capabilities that drive innovation management as emerging sources to support new services by enabling knowledge creation as significant resource. However, they were unable to draw other external factors that influence process capabilities during the execution innovation activities. Similarly, Martínez-Román (2011) compares the significant contradiction in between incremental and radical innovation as potential resource to drive infrastructure capabilities and concludes that both entirely depended upon the level of knowledge that acquired to execute for effective innovation management. Although, there are few studies available which illustrate the dominance of capabilities as essential tool for innovation management but under limited scope. Some studies acknowledge significance capabilities but limits long term effects due to unclassified resources. But over the period of time understanding resources allow innovation to behave in complex industrial environment especially when triggering new creative concepts lunch in the market (Richard Adams, 2014). A comprehensive set of literature available that represents the significance of innovation management capabilities. However, prior studies limiting their scope regarding behavior patterns of internal and external resources that change over the period of time in order to drive capabilities related to innovation management. Such changed demands the classification of capabilities to exceeds or limit innovation mechanism (Adams et al., 2006; Crossan & Apaydin, 2010; Smith et al., 2008; Wolfe, 1994).

2.15.2 Global Landscape on Innovation Management Capabilities

Due to globalization world connects with persistent nature of science, and innovation activities. Because of such association innovation are significantly considered as a essential component of every policy and regulations (OECD, 2014). Most of the developing countries were unable to take precaution during the evaluation S&T (science and technology) policy making and cannot afford feasible management indicators for innovation. It is extensively acknowledged that diffusion mechanism and incremental transformation observed for the majority of the innovation activities emerges in developing countries from last two decade (Goedhuys & Mytelka, 2005b; Zanello et al., 2015). These diffusions and incremental transformation utilizes existing capabilities belongs to innovation management. The incremental transformations always depends on various innovation activities such as function collaboration within or beyond the organizational boundaries

Innovation is described as the execution of new or somewhat modified product or process; potentially rely on existing capabilities that can manage with effective innovation management. Although, such effectiveness were potentially observe among developed countries as compare to developing countries that try to practice innovation at institutional level (OECD, 2005, 2007a, 2016). Most developing countries were utilizing their existing innovation management capabilities on the bases of two significant characteristics (OECD, 2005, 2007a, 2016). First innovation can perceive a range of multiple functions for instance: managing innovation at product level, managing innovation at production level and managing innovation at commercial level. Such perspective enable diverse mode for capabilities related to innovation management and allows firms to distinguish their operating and diffusing pattern (OECD, 2005, 2007a, 2016). For instance, some recent studies suggested that countries belong to OECD (organization of economic cooperation and development) have observed the high impact of product innovation on economic productivity. It was basically due to effective utilization of capabilities that drive innovation management (Hall, 2011). Secondly, innovation could recognize effectiveness among functional entities of any individual organization or industrial sector with high impact on their operational productivity (Hall, 2011). The impact could describe as capability enhancement which relies on resources that execute innovation management at individual firm's level or entire industrial level. There are several indicator that measure portion of resources that drive capabilities related to innovation management for example "The Global Innovation Index (GII)" the fundamental aim of this index is used to bargain potential metrics and strategies that might be better to conceive and utilize capabilities related to innovation management for the betterment at institutional level (Dutta et al., 2017).

The primary role of the Global innovation Index GII is to accept the role of innovation as a potential driver among governmental institute for economic growth and prosperity (Dutta et al., 2017). Initially GII is to develop for confining the various characteristics of innovation that were relevant for developing countries (Dutta et al., 2017). It also helps to measure multiple R&D characteristics that allow policymakers to switch their focus from one adaptive resources to other creative resources (Usman & Liu, 2015). The global innovation index comprises of two partial-indices (innovation input and output as sub-index) each sub-indices already has further interacting pillars for example: the five input pillars are institutions, human capital, research infrastructure, market complexity and business complexity; while two output pillars are knowledge and technology (Usman & Liu, 2015). These indicators cover a portion of resources that drive capabilities that belongs to innovation management.

The Organization for Economic Co-operation and Development (OECD) highlight two key dimensions when evaluating the resources that belongs to innovation management capabilities in R&D context. These two dimension are Gross Research and Development and (GERD) and Business Enterprise Research and Development (BERD) (Pellens et al., 2016). The recent reports argue that to propel the national innovation system among developing countries, it is necessary to starch R&D investment on emergency bases (Dutta et al., 2017). According to this report investment and productivity increase, but still relatively low as compared to desire prediction (Dutta et al., 2017). There are several studies that includes various measuring index that used to assess portion resources that drives innovation management capabilities at R&D level of example: Erciş and Ünalan (2016) developed comparative case study on Turkey and South Korea used to compare capabilities pertaining to manage innovation. They used to evaluate the microeconomic impact by drawing relationship in between GDP, R&D expenditure and international trade on the bases of GII-2016 (Global innovation Index) (Dutta et al., 2017).

Similarly, Usman and Liu (2015) suggested some resources that enables effective utilization of capabilities related to innovation management as tool for measuring innovation and efficiency among SARAC countries on the bases of their S&T (science and technology) and R&D spending at public organizations. Jankowska et al. (2017) observed rigorous pattern among different developing countries and concluded that potential impact of national innovation system on economic growth depended on two major characteristics: The first one related to effective utilization of capabilities that belongs to innovation management at institutional level and second defines institutional performance by measuring the transformation of innovative input into innovative output.

There are few other measuring indexes that internationally recognized to assess certain portion of innovation management capabilities for instance: GCI (Global competitive Index) the knowledge economy index (KEI) and world Knowledge Competitive index (WKEI) ((Huggins et al., 2008). Global Competitive Index (GCI) developed by the World Economic Forum (WEF) is considering as one of the most well-known competitiveness evaluation (Schwab, 2016b). Global Competitive Index (GCI) potentially relates to the concept of innovative effectiveness as its theoretical foundation based on main resources that drive innovation mechanism (Schwab, 2016b).

In simple word, overall countries innovation competitiveness not only rely on acquisition exports but also intrinsically rely on effective utilization of capabilities related to innovative management at organizational level (Petrylė, 2016). According to the current situation, Switzerland and USA have placed 1st and 2nd position in the context of innovation and sophistication with an average score about 5.80 and 5.63 followed by Germany and Netherland and with an average rating of 5.61 and 5.62. The ranking and score is shown in Table: 2.6

Table 2.6 The Global Competitiveness Index 2016–2017

Countries	**Overall index**		**Basic Requirement**		**Efficiency enhancers**		**Innovation and sophistication factors**	
	Rank	Score	Rank	Score	Rank	Score	Rank	Score
Switzerland	1	5.80	2	6.29	3	5.62	1	5.80
Singapore	2	5.72	1	6.37	2	5.73	12	5.25
United States	3	5.70	27	5.43	1	5.85	2	5.63
Netherlands	4	5.57	4	6.12	9	5.38	6	5.52
Germany	5	5.57	10	5.94	7	5.40	3	5.61
Sweden	6	5.53	7	6.06	12	5.31	5	5.54

Source: Dutta et al., (2017)

2.15.3 Deficiencies in Pakistan R&D Public Organization's: Innovation Management Capabilities

Pakistan remains bottom in the region with all the essential instruments used for measuring capabilities related to overall country's innovative ability according to GII, 2016 -2017 Pakistan faces severe challenges as compares to their regional counterparts regarding to acquires creative knowledge and technology advancement (Dutta et al., 2017). Since approximately, 26% of overall GDP and 45% of total employment obtained from agriculture sector till 2010, now the economic scope shifted from posing innovative ability towards the service and manufacturing-based economies (IMF, 2016). However, due to the economic instability and regional politics Pakistan GDP growth decrease from 6.1 % in the year 2006 and it remains stagnant at a rate of 3.1% till the year 2016-2017 is shown in Table 2.7

Table 2.7 World Economic Outlook

Years	Real GDP				Consumer Prices				Unemployment			
	Projections				Projections				Projections			
Years	2015	2016	2017	2018	2015	2016	2017	2018	2015	2016	2017	2018
Pakistan	2.5	3.1	3.5	5.8	5.7	5.2	4.8	3.9	3.4	4.1	-	

Source: IMF, (2016)

According to Pakistan Science and Technology Council, STI policy 2015-16 Pakistan has established comprehensive infrastructure of about 160 High Education Institute (HEIs) and these keep rising along with 100 R&D organizations till 2015 (Anwar-ul-Hassan & Ansari, 2015). But unfortunately, due to the distributed financial and innovational mechanism, only 58 public R&D organizations remain functioning from 2015 (Anwar-ul-Hassan & Ansari, 2015). This is because of different organization structures complex bureaucracy and lack of coordination during exchange of capabilities related to knowledge and innovation management at institutional level (Anwar-ul-Hassan & Ansari, 2015). At current circumstance without any proper coordination R&D deteriorates specifically when there has been no correlation among capabilities that draw as supporting management tool (Anwar-ul-Hassan & Ansari, 2015). According to STI, 2015 indicators overall national innovation productivity remain low and not reach to predicted projection as compared to the other regional economies. The situation getting even worst according to GII-2016-2017 (Dutta et al., 2015-2016) Where Pakistan remain at rank 131 positions out of 141 countries and similarly according to the Global Competitive Index 2016-2017, Pakistan made up 129th mark among 141countries (Schwab, 2016b).

In current situation, effective utilization of capabilities related to innovation management at governmental institute level requires major funding from the government agencies (Haq et al., 2014). As according to the current statistics accumulate by Pakistan Council of Science and Technology they draw conclusion that the Pakistan Gross R&D expenditure spends 0.29% to 0.59% of their GDP to their R&D is shown in Table: 2.8. That represents total spending with respect to percentage of their GDP (WDI, 2016). The major contribution in gross domestic expenditure came from the government side which around 83%. While, the other contributors includes private funding non-profit agencies, non-profit business firms and the universities with 1%, 3%, 10% respectively (WDI, 2016). Further looking forward the R&D major portion is used to spend in agriculture sector which consider as recipient of major source of funding. Followed by defense, Health sciences, industrial production and engineering and technology respectively (Haq et al., 2014). From above statistical indictors illustrate that Pakistan need long way to go for developing more advance resources that drive capabilities related to innovation management and more effort required to adapt these resources at R&D in public sector firms to promote domestic research solutions (Haq et al., 2014).

Table 2.8 Gross Domestic R&D Expenditure

GERD($ millions)	2009	2011	2013	2014	2015	2016	2017	2018
Pakistan	3119	2471	2454	2441	2325	2319	2291	2310
India	39402	48063	-	-	48078	-	48070	48064
Malaysia	5400	6457	-	6741	6789	6791	-	6761
Turkey	8867	11246	13315	13221	13241	13253	13251	13230
Japan	136954	148389	160247	17027	17035	17031	17039	17033
Israel	8507	9523	10774	10671	10709	-	10708	10703

Source: Bank, (2018)

Pakistan faces severe challenges as compares to their regional counterparts regarding to acquire creative knowledge and technology advancement, comparing with other economic. Pakistan remain at 89th position out of 140 countries (Schwab, 2015–2016). Similarly, India place at 42nd out of 140 countries with slightly higher GDP spending on R&D. on the other hand Malaysia and Turkey is more progress middle income economies that place their mark 20th and 41st respectively out of 140 countries (Schwab, 2015–2016) is shown Figure 2.12

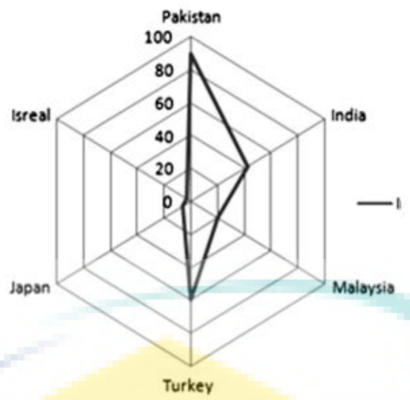

Figure 2.12 Pakistan Current Status on Global Innovation Index
Source: Dutta et al., (2016a)

2.16 Technology Management

The underlying theoretical concept of 'technology' has brought association to estimate relevant possibilities, processes, operational routines and regular practices through which organizational resources are essentially translates into the individual capabilities (Shu-hsienLiao, 2005). Kalantaridis et al. (2013) have described technology as "Application of intelligence." On the other hand, some prior studies highlighted the fundamental concepts related to technology such as: Gendron (1977) has illustrated a concept that: "Technology consider as systematic practices of professional knowledge, comprehensively based on practical experimentation and conceptual theory which is personified in shape of productive skills, processes and processes" (Gaynor, 1989)

Over the period, technology has presumed as a significant contributor in developing competitiveness among research based firms. Several scholars have more focusing on the configuring strategies and processes related to technological parameters in order to sustain operational strategy among these firms (Sun & Hong, 2002; Yam et al., 2011b).

Technology Management considers as an ability which comprises of efficient planning, effective collaboration, developing and implementation of technological resources to achieve strategic goal (Technology, 1987). At organizational level technology management comprise of: (1) Forecasting further improvement of technological capabilities; (2) Recognizing the significant technological trends and it relevant domain for development; (3) Formulating weather ‘to buy or make ’, i.e. means externally acquired or developed internally; (4) Organizing institutional method to create active policy indicators for technology controls (Wang, 1993). Noticeably, technology management considers not only for accomplish the management needs (of a particular range of technologies within the same functional domain and cross-functional domain), but it develop the robust strategies to the available resource or existing technologies for future markets (Linn et al., 2000).

In a holistic view, Technology Management is enormously viable to business competencies and organizational performance (Sun & Hong, 2002; Yam et al., 2011b). Sun and Hong (2002) discover a positive association in between technology management and organizational performance according to them technology management consider as potential source for strategic business alignment. They proposed a suggestion regarding the integration of technology as potential resource in between business precedence, technological strategies, and R&D. Such integration, enables technology management as a crucial aspect for managing organizational competitiveness (Sun & Hong, 2002). Some of prior also highlights significance of technology management as tool for achieving strategic goal according to Badawy (1998) suggested that technology management can play significant role in integrating technological strategy into business strategy but somehow such integration may left certain ambiguities. However, they concluded that for more effective integration requires relevant capabilities that might be more effectively allow technology management in coordinating among R&D and production.

Jin and zedtwitz (2008) define Technology management as the ability to utilize technical know-how and proficiency not only attempt to create products and processes. But also upgrade existing technology in order to develop new knowledge to confront competitive business environment (Nonaka & Takeuchi, 1995a; E. smith et al., 2008).

Zarządzenie (2009) concluded that technology management consider essential attribute that involves all the operating activities. According to him effective technology management within organizational boundary consider influences assets in determining relevant factors for effective technological policies that allows firms to maximize their technological advantages. However, they suggested that for radical technological progress firms needs to emphases more on capabilities related to technology management. Klincewicz (2010) recognize the significance of technology management (TM) as potential tool that allows firms to forecast the impact of new technologies on existing system. Also, they recognized its significance as role to take effective decision making in case of conducting individual R&D activities or development technological products. However, they concluded that for effective decision making process always relied on firms capabilities that allow TM to execute collaborative or individual R&D activities.

2.16.1 Technology Management Capabilities

Technology can be considered as the personification and implementation of technical and systematic knowledge that predicts the generation of new products and services (Drejer, 1997).

There were number of studies and theoretical concepts which represent the comprehensive description of technology management (Floyd, 1997; Steele, 1989; Whipp, 1991). These theoretical concepts highlight the potential resources that exemplify the nature of technology which reflects specific category of knowledge (Drejer, 1997).

Technology management in simple words, consider as significant discipline for firms to have sustainable competitiveness, because it refers to the strategic dimension for long term organizational growth as major organizational assets (Phaal et al., 1998). Cetindamara et al. (2009) have investigated the scope of technology management under the lens of dynamic capabilities and suggested that technology management framework based on technology selection, technology development and technology implementation as vital resource in that drive capabilities related to technology management as supportive tool for innovation.

Several scholars' were advocate that technology management capability (TMC) can be categories as dynamic capability that leads the firms to recreate its existing resources. In general, technology management capability can be observed as the combination of process, routines and strategies which are implemented through effective utilization of technology management to accomplish long term profitable goals (Díaz-Díaz et al., 2008). It is worth significant that technology management capabilities (TMC) emerges as service-oriented rather than the manufacturing- oriented (Gebauer et al., 2012b).

There were some other descriptive theories also available regarding the comprehensive overview on technology management capability (Gaynor, 1996; Roussel, Sand, et al., 1991).

This theories highlights two significant themes:

1. Developing and sustaining the link in between the technological reserves and organizational goals were significantly curial (Council, 1987; Drejer, 2002). It helps organizations to urges an effective interaction in between capabilities related technology management which can be relevant for organizational instruments and processes (Council, 1987; Drejer, 2002).

2. Efficient technology management based on number of appropriate capabilities that was evolve through various process resources such as: identification, selection, technological acquisition, technological exploitation and protection of the technology (Council, 1987; Drejer, 2002). These resources were considered as backbone mechanism behind value addition to organizational inputs.

In practical circumstances technology management capability highlights the active functional mechanism for commercialization that requires sustainable flow in between products and services (Council, 1987; Drejer, 2002). It actively involves dealing with all the relevant aspect such as interacting technological challenges during business decision making (Council, 1987; Drejer, 2002). It also exerts enormous impact during the development of business strategies with active influence on innovation process and new process for product development (Council, 1987; Drejer, 2002). Technology Management capabilities considers as systemic approach known for forecasting, creating and enabling technical know-how suitable for organizational functions (Council, 1987; Drejer, 2002).

The basic scope of technology management capabilities is extend a range far wider than as compared to the aspects that directly interface with R&D (Rush et al., 2007). Most of the research scholar's highlights the multi-layer mix fusion of capabilities that used to manage a variety of technological attributes.

Croteau et al. (2001) represent three layers of infrastructure capabilities belongs technology management the first layer constitutes the technological architecture consist of applications. The second layers refers to the operation of technological infrastructure while, the last layer related to the skill which requires for operating complex technical capability. Yildirim et al. (2001) assess technology management capabilities by draw capability profiles for machine manufacturing industry in turkey that use to diagnose actual deficiencies in among process capabilities related to TM. Croteau et al. (2001) draw infrastructural aspect of TM capabilities that used to reconfigure the organizational performance on the bases of potential resources such as effective individual's involvement, functional connectivity and organizational flexibility. However, they recommend that some other external factors were also recognizes in case of utilizing capabilities for effective TM at each management level. Phaal et al. (2006) draw some of theoretical perspective on processes related to TM capabilities. They emphases more on the role of process capabilities that allows firms to enables extensive technological planning, technology monitoring, mapping the future trends and complete integration of firms technological attribute at functional level in order to achieve the strategic and operational goal. However, they find complexity surrounds during functional integration in case of resources specific process resources that drive capabilities related to technology management. Unsal and Cetindamar (2015) represent the process and strategic perspective of technology management capability by drawing a relationship between technology management practice and firm performance. However, they concluded that for effective TM firms need to screen out certain infrastructure resources that enable long term competitive advantages

Similarly, Cetindamar et al. (2017) highlights infrastructure capabilities that belong to technology management which based on organizational potential as driving force that used to analyze strength and weakness during technology development audit.

2.16.2 Trends around Globe: Technology Management Capability

Most of the policymakers always confront this question from time to time, why nations are technologically deprived? . This issue has been troubling policymaker for a very long time (Omer, 2013). The variances among technologically developed and underdeveloped countries vary time to time (Omer, 2013). Some of these differences were due to industrial productivity, Health, and education system, and more specifically, in technology with all its resources. In many research studies, it may consider as a long-term phenomenon. Silberglitt *et al.* (2006) suggested that countries fluctuate in their capabilities that belongs to technology management in governmental level always requires technology urgent tool to fulfill dynamic industrial demand (Silberglitt et al., 2006).

According to United Nation Conference of Trade and Development in 2016 highlight that most of the developing countries facing severe technology gaps as compared to developed countries and it has grown over the years (UNCTAD, 2017). Therefore, a critical argument arises as "why these technology gaps were exits?", and "how it can rectify?" . However experts readily accept that a stable increase in economic growth will reduce these gaps, but reality does not support this argument in all cases (UNCTAD, 2017). Few developing nations have sustainable technological escalation, but they don't have the supportive infrastructure (Omer, 2013; UNCTAD, 2017). Since, it is necessary to developed resources that drive TM capabilities at public sector firms (Omer, 2013; UNCTAD, 2017).

Romer (1990) draw diverse resources that drive capabilities related to technology management in relation with R&D to get firm competency for effective performance. In reality, it directly enhance the technological growth and considers as source to propel national productivity in a long-term run among several developed and developing countries (Omer, 2013).

In reality, developing theoretical phenomena to measure capabilities belongs to technology management; with absences of standard unit of analysis allows most researchers to rely upon composite indexes (Omer, 2013). This is because to take account of prevailing circumstances and suggests policies for the national level (Omer, 2013). A valuable composite index considers as a base for theatrical foundation and helps to construct accurate methodology (Omer, 2013). There are various indexes to screen out certain portion of resources that drives capabilities related to technology management. These indexes were developed by many international institutes and forum such as: European Commission (EU), United Nation (UN), and World Economic Forum (WEF)(Omer, 2013).

There are various new indicators also utilized to measure effectiveness of technology management capabilities at government level for instance: Technology Readiness index (TRI), Human Development Index (HDI) and TAI (Technology Achievement Index) (Shahab, 2015). These indicators allow states to screen out the conventional and non-conventional nature of technological changes. Despite these composite indexes used to capture number technical variation (Shahab, 2015). But still somehow unclear in various aspects to evaluate the strength and weakness (Shahab, 2015)

Technology management considers as an inevitable challenge among several researchers to prioritize and managing capabilities related to technologies (Omer, 2013). Today, most of the significant technological developments in the context of advance innovation are confined to developed countries such as the UK, USA and Japan and Germany while, most of the developing countries are far way behind to acquire capabilities related to technology management at institutional level(Omer, 2013).

From the technological development point of view Castellacci and Archibugi (2008) suggested that the unbalances distribution of knowledge stock across nations extensively acknowledge around the globe. Many countries in the global economy were symbolizing by different level of technological growth with unbalance knowledge stocks.

In 1990 there is an empirical study carried out that illustrate the cross-country distribution of knowledge stock in a large sample that distinguished countries based on adapting capabilities related to technology management, in order to identify the technological progress governmental institutions across developed and developing countries (Omer, 2013).

The outcome of this study explains the different segment of technological growth split into three categories is shows in Table 2.9 with detail list of countries for their categories.

Table 2.9 list of countries with respect to their categories

Clusters	Countries
Advance Countries	Japan, US, Israel, UK, Scandinavian countries, Australia, New Zealand, Canada
Developing countries	China, Hong Kong, Singapore, Malaysia, Philippines, Thailand, Fiji, Austria, Belgium, France, Luxembourg, Cyprus, Greece, Ireland, Italy, Malta, Portugal, Spain, Turkey, Bahrain, Jordan, Kuwait, Lebanon, Pakistan, Saudi Arabia, Syria, United Arab Emirates, Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, Jamaica, Mexico, Panama, Paraguay, Peru, Puerto Rico, Uruguay, Venezuela, South Africa, Trinidad and Tobago, Armenia, Azerbaijan, Belarus, Bulgaria, Croatia, Czech Republic, Georgia, Estonia, Hungary, Kazakhstan, Kyrgyz Republic, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russian Federation, Slovak Republic, Slovenia, Tajikistan, Turkmenistan, Ukraine, Uzbekistan
Underdeveloped Countries	Indonesia, Vietnam, Bangladesh, India, Mongolia, Nepal, Papua New Guinea, Sri Lanka, Iran, Oman, Yemen, Albania, El Salvador, Guyana, Honduras, Guatemala, Haiti, Nicaragua, Algeria , Botswana, Mauritius, Tunisia, Zimbabwe

Source: Castellacci and Archibugi (2008)

Similarly, comparative study was conducted by Tariq Mahmood Ali (2015) pointing out the some relevant resources drive capabilities related to technology management (TM) by comparing the Organization of Islamic Council (OIC) and Organization of Economic Co-operation and Development (OECD) Countries on bases of Technology Achievement Index (TAI) which cover certain portion of Technology management capabilities that were practices across their governmental institutes. The study concluded the OIC countries are far behind as compare to OECD countries to achieve both technologically and economically prospective (Tariq Mahmood Ali, 2015). Although the majority of OIC countries are relying on natural resources but still deprived in shape of real life necessities. The result reveals that 10 % of OIC countries have index value above 0.5 % while, rest of OIC countries have to face a long journey ahead in catching up to high technological development (Tariq Mahmood Ali, 2015)

Even the gap within OIC countries during the comparison of different indicators is also enormous. For instance, over the years Tajikistan has published 1005 research articles from the period of 1996 till 2013 which is 350 times less than Turkey which produces 348,836 publications over the last 18 years. Similarly, Malaysia extends their educational spending to 5.94% their GDP which almost double than Pakistan which spends 2.22% to their GDP on education. Similarly, Saudia Arab spend 0.07% of their GDP on R&D which around 15 times lesser than Malaysia which pays 1.07 % of their GDP (Tariq Mahmood Ali, 2015)

2.16.3 Deficiencies in Pakistan Public R&D Sector: Technology Management Capabilities

Pakistan has conventionally supported the dominance of classified nature of industries and large public sectors organization with almost no internal competitions in between them, that allow companies to operate with no pressure to turn out to be efficient (Jamali, 2012). Thus, due to such trend in acquiring or retaining the technological capabilities for any purpose to become less productive and seem to be less practical (Jamali, 2012). In regional economy China operating in isolation- they kept sealing their local markets from import until their public sector had achieved adequate pace to compete international counterparts. Similarly, India intentionally did because of high tariff (Jamali, 2012)

At current global industrial situation and with high tariffs policies under WTO (World Trade Organization) the major industrial sectors of Pakistan facing extreme challenges to starched their quality standard as well as allow technological modification to retain their retain industrial competencies (Jamali, 2012). Therefore, the significance of technology management capabilities will turn out to be the crucial contributor for the public sector firms in order to adopt and absorbs intelligent technologies blend with existing industrial strength to modify and create new product and processes (Jamali, 2012)

The current R&D infrastructure of the country focused more towards the supply side, less attention made towards interaction with local industry (Jamali, 2012). Due to insignificant R&D activities practiced across in the primary industrial sector decline overall R&D related policies across the country (Jamali, 2012). Thus, a serious effort has required to re-orient the management policies for R&D in public organizations in order to redefine their existing capabilities related to TM (Jamali, 2012).

2.17 Summary

This chapter has theoretically reviewed some of similar research studies, including the role of supporting management discipline in R&D, the theoretical overview on R&D, global trends on R&D in public organization, Current R&D trend in Public organization of Pakistan, Developing theoretical framing for overall conceptual connectivity. Moreover, developing a conceptual framework to explore capabilities related to supporting management discipline that influence R&D. The review of literature supports this research in helping to identifying gaps in supporting management disciplines and their significance influence on R&D and proposed study in a systematic approach. The following is a summary of the core subjects that discussed in this chapter.

- Theoretical and historical overview on R&D that helps to understands researcher to identify the R&D initial characteristics
- Evaluating current global trends on R&D that allow to researcher to identify the R&D capabilities that are currently practices across developed and developing countries
- Analyzing the current R&D trends among public organizations across developing countries

- Analyzing the current R&D trends among public organizations across Pakistan public organizations
- Exploring theoretical interpretation related to supporting management disciplines that comprise on knowledge, innovation and technology management
- Identifying the theoretical barriers among supporting management disciplines that draw significant influence on R&D
- Developing theoretical framing to draw a conceptual connectivity among supporting management discipline along with their influence on R&D
- There is a need for further research on R&D in public examining how to manage supporting management discipline that draw their significance on R&D. Such significance were based on driving capabilities related to knowledge, innovation and technology management and could be viewed as a new perspective fitting the context of developing countries, a conceptual model required to justify its significance to R&D in public organization .

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter aims to describe and justify the research design and methodology upon which this research-based on. This chapter links the fundamental literature review of Exploring the capabilities related to management supporting discipline that contributes their influence on R&D (Chapter 2, 4) for findings (Chapters 4&5) to achieve the thesis objectives (stated in Chapter 1).

First, this chapter presents an overview of philosophical approaches with a view of positioning this thesis research approach and justifying the choices of research design with data collection processes. The three stages of research methods combining theoretical and empirical studies also presented in this chapter. The systematic approaches employed at each also step explained in detail.

3.2 Research Paradigm Adopted in This Research

Exploring the capabilities related to supporting management discipline that contributes to R&D in public organization requires complex social coordination due to the involvement of multi-discipline related to R&D. Since the multi-disciplinary view requires to assess the research question. In case of this research author considered '*Pragmatism*' as valid research paradigm.

Experts may implement pragmatism as the paradigm which is more relevant for answering specific questions. Pragmatism argues that the most significant aspect of research philosophy is the research question. This philosophy may also compatible with positivism and interpretivism viewpoint. It enables practical relevancy interface with different perceptions in order to assist data collection and interpretation (Saunders et al., 2009)

This research based on Multi-disciplinary R&D which deals with multi-disciplinary view and may embrace pragmatism as most suitable research paradigm that navigates significant understanding in practices rather than in ambiguous philosophical debate.

Pragmatism research paradigm helps to deal the scientific subject of knowledge management which play significant role in R&D. Adopting pragmatism allows significant knowledge in practices, rather than considering a tool for collection of facts (Blosch, 2001).

Pragmatism will offer experts to influence their environment with respect to specific task. This appears to resemble the nature of relevant knowledge and realistic dimension. A conceptual framework developed using a pragmatic approach highlighting a comprehensive association among knowledge, context and practice (Blosch, 2001). Recognizing such association allows practical sketch for both R&D experts and researchers to develop knowledge based economic both at organizational level and national level

In case of this research, a pragmatic paradigm allows intuitive and rich understanding in context for addressing the complex issues associated with organizational R&D and practices. A pragmatic approach is not restricted to the question of how knowledge claims are validated, but rather explores or assess alternative orientations.

For such characteristics of pragmatism allows range of diversity to the study of organizational R&D and practices such as considering the outcome of action

3.3 Research Design Employed in This Research

In reality, 'feasibility to identify the outcome of research question requires research design,' the general sketch to tackle research question for searching the research reliability (Polit & Beck, 2010b). A research design comprises of data collection design and development of research instrument that assists the researchers to reconfigure their limited resources (Cooper, 1985; Lee & Lings, 2008).

Due to sensitive nature of research domain, limited research has been drifting out to exploring capabilities related to supporting management discipline that contributes on R&D. To dressing up the gap requires extensive exploration to justify the research questions and enables multidisciplinary view to assess the research outcome. Thus, the research model was chosen to justify the research objectives. The research design adopted in this thesis as shown in Figure 3.1 split into two phases.

The first phase starts with an explanatory research study through a general literature review to identify the theoretical foundation following by systematic literature review (PRISMA with Co-word Analysis) in search of studies specifically under R&D scope.

The literature review comprehensively based on exploring capabilities that belongs to knowledge, innovation and technology management as supporting management discipline. This phase of research design helps to develop an appropriate framework that represents capability perspective fitting to address capabilities learning issue which appears majorities of R&D in public firms. In case of second phase its splits into two steps, step (I) based on conducting focus group within the domain of specific country. While, step (II) based on conducting DANP (DEMATEL Based ANP) techniques in case to establish model that used to fit among R&D in public organizations of Pakistan.

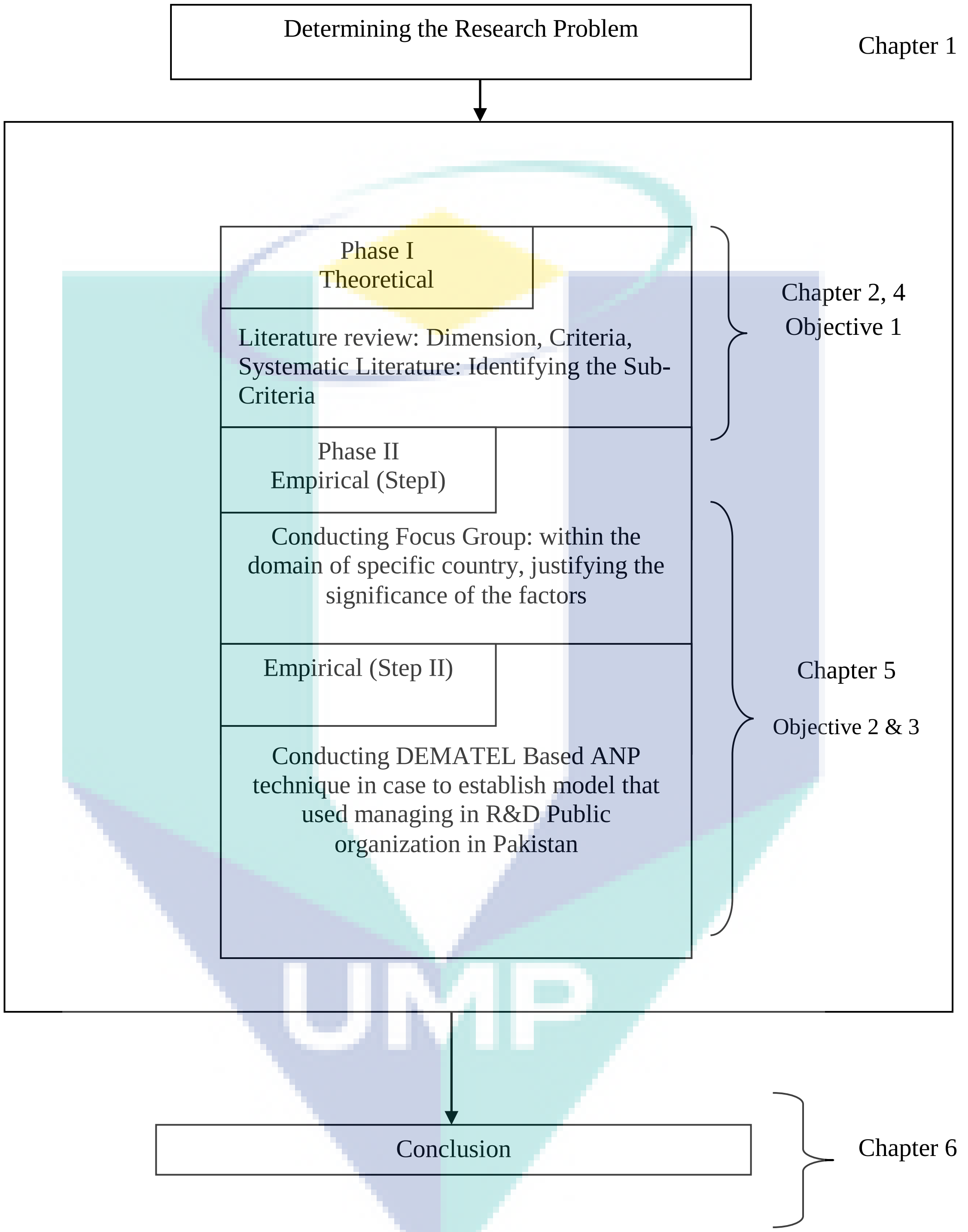

Figure 3.1 Research Design

First phase of research design describe general literature review based on theories belongs to knowledge, Innovation and technology management know as “Supporting management discipline”. The first phase represents the basic interpretation that allows researcher to select dimension and criteria related that related to supporting management discipline with their contributing impact on R&D. These basic theoretical interpretations allows researcher to conduct systematic review presented in (chapter 4). The systematic review based on (*PRISMA with Co-word analysis*) allow researcher to represents in-depth findings related to supporting management discipline (knowledge, innovation and technology management) in form of "sub criteria" along with practical relevance with R&D. In second phase split into two steps: First step (I) belongs to data gathering depends upon the instruments used for retrieving data under practical setting. This step used to rectify the selected attributes drive from systematic literature review allows researcher ease data collection for specific orientation such as: the collected data were country specific (focus group). The basic purpose of the second step (II) is to test significance related to the factors that were extract from focus group discussion. This allows researcher to sketch the future orientation base on prioritizing capabilities related to supporting management discipline that influence R&D based on their interdependency. DANP (DEMATEL Based ANP) justifies its suitability in resolving the complex multi-dimensional issues by interlink the criteria and sub-criteria related to R&D (Cheng et al., 2017). The result and extensive analysis presented in chapter 5 while conclusion is describe in chapter 6

3.4 Systematic Literature review

This research uses to uncovering all the relevant empirical substantiation that flexibly adjust to pre-defined eligibility criteria to support the specific research question. It utilizes conventional techniques that allow selecting studies with less bias, therefore taking credible decisions from which the conclusion can draw (Antman et al., 1992; Oxman & Guyatt, 1993). This research preferred systematic literature review based on these features: (1) a transplanted set of aims with unambiguous stated goals, with consistent applicable methodologies; (2) a intelligent searching scheme allow researchers to recognized the all the relevant studies that would precisely fit under eligible criteria ; (3) An evaluation regarding to the validity of pertinent findings which uncovers the cumulative quality of the studies; or risk of bias; (4) complete synthesis of relevant information for selected studies. This study enables systematic search to identify empirical studies that involved under the scope of knowledge, innovation and technology management that focused on contributing their significance on R&D. The identified studies meet the pre-determine inclusion criteria that were based on Title, rational, methods and results.

3.5 PRISMA Protocol Employed In This Research

PRISMA (Preferred Reporting Items for Systemic View and Mata Analysis) employing in this research followed transparent reporting system recommended by Liberati et al. (2009) and Kagohara et al. (2013)

Study design: The systematic review includes all the relevant study designs. The studies that qualified for inclusion are Journal articles, working paper, editorial reviews, short surveys, commentaries and Technical notes.

1. *Populations:* Overall, 2674 studies were included in the data synthesis.
2. *Interventions*: The research literature available before 1990 is excluded.
3. *Comparators*: All stakeholders that engage in R&D were eligible for inclusion.
4. *Outcomes*: The outcome of bibliometric visualization pattern belongs to knowledge, innovation and technology management capabilities were based on an extensive searching string applied on Scopus to reclaim all the significant studies related to all three set of supporting management capabilities that influence on R&D. The typological configuration is represented in Appendix G
5. *Timing*: The analysis highlighted from the period 1990 to 2018.
6. *Setting*: There were no location restrictions.

3.5.1 Report Characteristics:

1. *Geographical location*: We include studies from any country as this will enable us to analyze the current situation of R&D sector
2. *Language*: English language studies were eligible for inclusion

3. *Publication type:* unpublished and published article were identified and with respect to source tile while unpublished studies may have been less likely to satisfy the literature outcome

3.5.2 Information Sources

Scopus were selected as the major database sources for the extensive search from the period 1990 to 2018.

3.5.3 Search Strategy

The recommended criteria according to the PRISMA guideline were applied to identify the literature:1) research with popular exposure of keywords for instance "capability", "Knowledge", "Innovation", "Knowledge management", "Innovation management", "Technology management", "Innovation management capabilities", and "technology management capabilities" with all the typology (ies) or taxonomy (ies); and 2) literatures review reporting with respect to specific research area that selected typology (ies) or taxonomy (ies) for instance "R&D". The medium of understanding or publication language is English. The complete searching sequence along with Boolean operators a logical and systematic research pattern can be explained in Appendix G.

3.5.4 Study Records

1. *Data management*

Overall, the studies that were found were downloaded into Microsoft Excel in the Csv file (Comma separated value) format from the Scopus database from the 1990 to 2018 period.

2. *Inclusion criteria*

The inclusion criteria based on assessing the strength of the studies which reflects from article title, key-phrases that appear in other studies that have also been extensively analyzed. The strength of study also relies on study title, relevant abstract, rationale, methods, future implications and limitations. While the exclusion criteria were based on weakness among studies that's unfulfilled criteria, no registration number, weak searching strategy, few detail in methods section, and studies unable to draw relationship between knowledge, innovation, and technology management under R&D. Any disagreements regarding the inclusion processes was noted and were discussed with a supervisor to determine whether a research article should be included or not. Any causes for exclusion were recorded.

3. *Data collection process*

After summering the data inclusion process, the data extraction allow author to get more specified results. Therefore, in order to get more instant picture, a Co-word analysis allow author to recognize two key-phrases co-occurring within the same research article indicates a signal of concern association to which they refer (Callon et al., 1991; Cambrosio et al., 1993). Since the 'Co-word analysis' condenses enormous data sets that allow author to draw specific visualized patterns that preserve the crucial information enclosed in the data (Raan & Tijssen, 1993). This analysis depends on the word characteristic that represents an emerging scientific concepts, creative ideas and new knowledge. A bibliometric mapping tool known as the VOSviewer was used to construct a recognizable pattern based on occurrence of words. The initial mechanism that the VOSviewer software used to construct the bibliometric pattern based on the large quantity of data downloaded from Scopus database. The VOSviewer enables multi-dimensional scaling (MDS) technique to visualize the bibliometric data. By default, the VOSviewer at the initial level only exhibits the nodes in bibliometric analysis and allows the illustration of the numerous inflow and outflow edges between the nodes. The node represents the strength of key phrases, while the edges represent the occurrence among two entities (Van Eck, 2014). For, further comprehensive evaluation of extracted dataset was analyzed as a discrete time series, i.e., a series of inspection that is arranged with respect to time dimension. Many studies are created at frequency-spaced intervals (in weeks, months, issues, volumes, or years). The Sci2 tool currently uses the Kleinberg's burst detection algorithm which assesses unexpected increases in the occurrence of words with respect to time (Kleinberg, 2002). The basic mechanism behind the algorithm allows a probabilistic estimation that responds when there is an increasing occurrence of individual words with respect to time. State switches correspond to the approximate time at which the occurrences of words significantly appear. In addition to the co-word analysis the data extraction from included study were also approved by supervisor along with data mining expert who verified the data accuracy. In case of disagreement on extracted data article were re-examined until consensus (100% agreement) was reached. The extracted data is presented on Tables 4.4-4.6, 4.10-4.12, 4.16-4.18

3.5.5 Data Items

Data was extracted from the eligible studies and summarized in Table: 4.3, 4.9, 4.15 after vigilant assessment, twenty eight research studies were selected; these revealed three sets of criteria: (1) process capabilities, (2) infrastructure capabilities and (3) strategic capabilities. Data (dimensions, criteria and sub-criteria) included specific study distinctiveness on the degree to which the study theme and preliminaries reveals the nature of each criteria

3.5.6 Outcomes and Prioritization

The primary outcome of this review is to assess at what extent that three research theme appear frequently. Any areas which do not comply with the frameworks or that are missing entirely will be re-examined.

3.5.7 Data Synthesis

A descriptive analysis will be carried out in order of analyze the degree to which studies meet the relevant criteria. The narrative analysis will pursue the complete structure recommended by the PRISMA-P 2015 that will be used as a framework for this systematic review protocol (Moher et al., 2015)

3.6 Focus Group

Focus group considered as a discrete instrument that utilizes the group of individuals with a range of pre-determined questions that lead directed to the particular discussion in order to retrieve valuable data (Corbin & Strauss, 2008). In this approach, wider research questions along with all positive and negative pre-classified concepts were recognized in a structured pattern from data" (Corbin & Strauss, 2008). In several research studies, focus group discussion termed as premeditated persistent technique. It is systematic in character, which can execute sequentially in a consistent manner (Krueger & Casey, 2009). The methodology has an upsurge in both business and academic research. "Most extensively famous among researcher and widely used as research tools in Business and social sciences (Stewart et al., 2007b). According to Krueger & Casey (2009), the main purpose for a focus group discussion is to identify the range of definitive perception on complicated research domain systematically as for data collection. The focus group discussion (FGD) gives research scholar' s a possibility to examine the relevant association among the group candidates, how they behave and confront to each other's arguments, in order to offer a data not accessible through papers or observational evaluations" (Byers & Wilcox, 1991). The Focus groups primarily utilized for creating information through collective discussion. While, the translation of information fundamentally depend upon the judgment made through consensuses during that discussion. Focus group discussions (FGD) were also constructive in developing a rich understanding among participants concerning their professional knowledge and experiences (Morgan, 1998).

3.6.1 Conducting Focus Groups: Group Composition and Size

The configuration for the focus group requires enormous care to obtain the most exceptional quality of discussion. Typically, there is no significant clarification about simple group configuration, and mix-group configuration. Some studies indicates that mix-group configuration will always influence data, according to items for instance: ages, sexes, and the professional and social profile of the participants (Stewart & Shamdasani, 1990b). But, what else more crucial is that researcher provides suitable consideration to observe the impact of mix group (for example: to understands the behavior of entire group, researchers need to emphasize more on how the focus group cooperates with each other) before the discussion proceeds (Stewart & Shamdasani, 1990b)

The group size and group composition is an essential feature in focus group discussion. There were some prior studies which highlights general composition of focus group for example: Stewart and Shamdasani (1990a) proposed that it is exceptional to have some extent over-recruits for a focus group discussion and progressively controls as a slightly oversized group. This avoids researcher to bear potential risk of an under-size group, which leads to short debate. It is advisable that each focus group likely to have two non-attenders (Bloor et al., 2001). The perfect size for the focus group is around five to eight individuals (Excluding Moderator). However, in normal circumstances focus group work smoothly with as few as four as many as 14 individuals. While, over sizable group can be more chaotic and stressful to handle and also annoying for participants because they feel inadequate opportunities to contribute their opinion (Bloor et al., 2001)

3.6.2 Preparing an interview schedule

Like any other research interviews, the interview agenda for focus groups are generally presented with flexible schedule related to the theme of discussion. But, Stewart and Shamdasani (1990b) proposed two universal principles:

- The nature of question should shift from more general to more precise questions
- Question precedence should be comparative to the significance of issues in the research schedule

However, there is still a lack of clarity between these two principles. A flexible bargain is frequently required, although frequent discussions will verify the order through which the research problem is described (Chioncel et al., 2003). Generally, not more than a dozen prearranged questions were required for research interviews as with an interview discussion, the researcher will also investigate and mold the research problem according to the focus group discussion (Chioncel et al., 2003)

3.6.3 Moderating

The moderation is considering as a significant entity that weight till the successful completion of a focus group discussion. While, several focus group patterns utilize the least amount of moderator’s involvement. These focus groups mostly rely on highly proficient researchers that carry forward the group discussion. “An expert moderator always conceived as the crucial feature for gathering rich and legitimate insight from focus discussion (Stewart et al., 2007a). Redmond and Curtis (2009) mention a description of active moderators has a personality with analytical and listening skill. But these are not simply the only proficiencies that moderator must be competent. Focused interview gurus Merton et al. (1956) reveals that facilitator must be skilful with neutrality as much as equivalent to a professional journalist or social scholar's. Some of the recent studies also reveal moderator acquire multitasking ability. "It signifies that the facilitator initially drafted relevant activities whose basic goal is to promote both coherence and comforting judgments within the group discussion that is why, moderators have to support a group argument instant of group meeting" (Acocella, 2012). Krueger and Casey (2009) have an as same opinion: "Interviewing session appears to be deceptively simple, but it involves psychological sentiments, during the interview preparation and group interaction. In most case, the success of focused interview session relies on a well-structured questionnaire, but in addition to that moderator seems to be considered as another essential component."

At the first step moderator starts is a welcome note to all the focus group participants with an opening speech. Then moderators allow groups to initiate; group interaction initiates with the introduction of the subject and the research team. Then in second step moderator describe the complete rules for engagement for the conversation and it is necessary to appeal all participants for their extensive involvement during interview discussion. From second steps moderator must productively switch conversation into the line of the primary debate along with detail questioning. Fundamental approach that preferred in most of focus group discussion such as: (1) moderator must carry pausing and probing ability, (2) during discussion moderator must enquire the relevant clarification or detailing, (3) To overcome temperamental behaviour of participants and encourages under spoken ones into part of discussion, also infusing non-verbal reply and humour when conceivable (Krueger & Casey, 2009). The moderator must obtain some observational notes during the focus group discussion as a caution to registered information to maintain the reliability and assess along with terminating argument for consideration in a suitable manner

Selection of moderators in case of this research , In the first phase of focus group discussion, the questionnaire sends to various experts belongs to expertise related to knowledge management, innovation management, and technology management by NPO

(National Productivity Organization) to rectify moderators. This process split into two phases at first stage covers 32 Public organizations out of 81 R&D's among Public organizations (Bhutto et al., 2012). Almost 71 comprehensive questionnaires along with complete instructions defining all set of rule relate to focus group discussion were sends to different moderators at the national level. In return, 25 questionnaires were received with 78.91% response rate. Similarly, in second stage almost 71 complete questionnaire were sends to covers remaining 47 R&D's in Public organization nearly 30 questionnaires were receive with 63.78% response rate. These moderators agreed to consider as the role for moderator in focus group discussion. These moderators are the certified professional along with expertise dealing with R&D. A group of 45 moderators were selected from 81 R&D in Public organization these moderators were certified from National Science Foundation, Pakistan Engineering Council and Pakistan science and technology council; a list of active public organization is represented in Appendix E. During the Focus group discussion this moderators responsible to make sure that within focus group discussion all experts unwraps each of the research questions, to enquire for further clarification or additional debate, ultimately to recommend a concise review. During the argument moderate must be adequately engage to fullfil the responsibility as facilitator, but not consider as dominant bias or slow down the discussion. Over enthusiastic or aggressive participant within the focus group who seeks to dominate, the group need to handle carefully. Uninterested and marginalized participant were carefully handle.

In case of this research, the gender dimension both during the configuration of the group may relate to reliability of focus group. In short, creating consistency as a supporting instrument for wide range of argument requires the moderator to strive for an active contribution during discussion without influencing argument among participants. Moderator also responsible for descriptive and interpretive validity and also responsible for scanning the missing non-verbal communication These moderators were also responsible in translating information that is certainly exhorting and complicated process. Summarizing information not so complicated, but translating the information is difficult this result a conflict in between theoretical and interpretive validity. Such confrontation guide to a computational practice that follows the actual research questions so that it further align with respect to the expert's desire.

3.6.4 Setting

The Focus group venue based upon some aspects. If the exploring domain is related to Business Administration than formal configuration is used. While in the case of social sciences focus group may be operated with the flexible and suitable location near operating domain related to research subjects (Krueger & Casey, 2009). These research venues may be a recreational center, a community center, university union center, private home or college campus (Krueger & Casey, 2009). Generally, focus group discussion mostly around 60 to 90 minutes. But in some cases, researchers sketch the pattern that leads participants to commit approximately up to two hours (Krueger & Casey, 2009).

The focus group is generally arranged in a way that each participant within the group can be visible faces to face and can hear easily. Usually, the participant remains seated around the table with facilitator join them. The presence of the researcher within the room helps to avoid any complexity involve during the discussion. During the discussion refreshments and drinks usually are caters to group participants.

3.6.5 Number of Group Discussions in a Study

Greenbaum (1993) soon suggests that quantity of focus group remain as low as possible, according to him expense is proportional to number of groups. "For instances six focus groups are roughly one third time more expensive as compare to four groups; while, the cost of bearing ten groups roughly twice than five. Many firms handle as many as more focus groups then they requires in order accommodating their research objectives" (Greenbaum, 1993). Crabtree et al. (1993) suggested the significant thumb rule to meet the detail research objectives requires eight to ten groups, while in several circumstances more than 30-40 groups might be preferred. Morgan (1996) suggests that four to seven focus groups are usual preferred in normal circumstance; however, both researchers in their research case have handled up 30-40 focus clusters in one sitting.

3.7 The Focus Group study in a particular country: Data Collection Tool

From prior discussion on focus group technique, allow author in adapting focus group as core method to assess the impact of capabilities related to knowledge, innovation and technology management as “supporting management discipline” with their influence on R&D. In order to present practical relevance author must portray suitability of this research fitting to serve in public organization. Therefore, this research study adopting focus group technique for refining relevant capabilities related to knowledge, innovation and technology management as “supporting management discipline” gathered from the systematic literature review.

3.7.1 Multi-section questionnaires preparation

A questionnaire is a tool that circulated among interviewing participants to gather data by enquiring the range of questions (Bryman, 2004). Collecting data by circulating questionnaire under the supporting values of a moderator is the most attractive mean in focus group technique (Krueger & Casey, 2009).

In case of this research the preparation of focus group questionnaires from literature engages a set of questions based on the interconnected sections (e.g., the initial questionnaire section, reflects the dimensions related to exploring theme, criteria based on relevant dimensions, and the appropriate sub-criteria based on relevant criteria)

The initial questionnaire of this research study based on relevant aspects about capabilities belongs to knowledge, innovation, and technology management were known as ‘Management supporting discipline’ that contributes their significance on R&D. The initial design of questionnaire was based on the combination of open-end questions and closed-ended questions. These questions were based on the data drive from systemic review presented in chapter 4. The first section of questionnaire was based on open-ended questions, asking the participant to rate the appropriate capabilities with respect to their practical relevancy according to their influences. The section two based on closed-ended questions assist participants to rate the influences among the capabilities in shape of criteria and sub-criteria.

The initial questionnaire was pre-tested and dispatched to an expert who has expertise related to research Methodology and R&D Management. A modified version of the questionnaire, based on the comment of the first experts was dispatched to second and thirds experts

3.7.2 Panel selection

The primary objective for using focus group technique is because of its comprehensible and transparent characteristics. The basic concept is to recognize the decisive procedure for compromise on the most exceptional outcome (Kreuger, 1998), In addition Morgan and Kreuger (1998) affirm that the method practicability makes it ultimate in areas where complicated decision may cause conflict of consensus.

In case of this research, panel selection depends upon expertise to understand the research domain and the number of available participants. Various research studies preferred that self-rated proficiency can be utilized to classify the expertise (Bloor et al., 2000). The consensus rating approach permits experts to offer a possible consensus score in the ordinal-scaled question which reflects their level of expertise. Several empirical research studies related to focus group technique usually selects experts based on their professional experience within the same domain of research problem (Agar & MacDonald, 1995). In case of this research, besides the professional designation of participants that could be considered as a potential specification for the expert selection. This study follow three main criteria for recruiting experts which depends on comprehensive guideline presented by Meesapawong (2013) specifically for R&D in public organization all the following criteria:

- People who hold the position as Chief scientific officer, Consultant, Professional engineer, Academician, Technical research offices, and R&D managers or senior researchers
- Experts in R&D management, knowledge management, Technology management and innovation management
- People who respond to invitation letters that they agree to participate.

According to Colucci (2008), conducting focus group discussion on cross-cultural research which includes diverse range of experts and due to the involvement of multidisciplinary view, it produces different outcome due to varied socio-economic factor. Therefore, in this research the participants were country-specific (Pakistan). In several developed countries, the potential spending on private R&D firms quite higher than public R&D firms. In case of developing economies majority of R&D is carry out on public funds. Therefore, majority of R&D related activities is performed in public organizations setting (Kim, 2014). In case of, applying focus group to address R&D deficiencies in public organization for developing countries might bring the economic benefit to the state and enhance the R&D competitiveness at national level. In this research, the focus group panel comprises of experts from the multidisciplinary field of science and technology those have a robust professional credential in managing multi-mission R&D at the public organization. In the case of Pakistan, experts from public R&D organization with multidisciplinary backgrounds will be invited for focus group session. All the arrangement has been made by Asian Science Consortium (ASC) and National Productivity organization (NPO) under the umbrella of the Ministry of Production Pakistan. The degree of quality in focus group discussion is traditionally quantified by recognizing the novelty of a scope based on R&D with appropriate practicability that rectifies complex problem. The participant comply their justification by using consensus-based rating questionnaire. Experts from 58 Public R&D firms were invited for focus group discussion with at least 8 to 15 years professional experience.

3.8 Overview of Focus Group Discussion (FGD) study in Pakistan

The focus group study has the primary goal to rectify capabilities related to the knowledge, innovation, and technology management discipline that were influencing R&D by merely emphasizing on a country-specific context. The three essential management supporting discipline (i.e., knowledge management, innovation management, technology management) gather from the literature review become initial scope for focus group discussion. A set of questions specifically design based on five-point scale (0, 1, 2, 3, and 4) allows experts to draw significance of each discipline. The consensus also allowed the experts to suggest additional factors related to knowledge, innovation and technology management and illustrate their levels of significance by using the five-point rating scale

In the first phase of focus group discussion, the questionnaire sends to various experts belongs to expertise related to knowledge management, innovation management, and technology management by NPO (National Productivity Organization) to rectify moderators. This process split into two phases at first stage covers 32 Public organizations out of 81 R&D's among Public organizations (Bhutto et al., 2012). Almost 71 comprehensive questionnaires along with complete instructions defining all set of rule relate to focus group discussion were sends to different moderators at the national level. In return, 25 questionnaires were received with 78.91% response rate. Similarly, in second stage almost 71 complete questionnaire were sends to covers remaining 47 R&D's in Public organization nearly 30 questionnaires were receive with 63.78% response rate. These moderators agreed to consider as the role for moderator in focus group discussion

In case inviting experts for focus group discussion, NPO (National Productivity Organization) under Pakistan Ministry of Production send invitation on behave of Asian Science consortium. All active R&D in public organization those organization missions relates to 'Knowledge Management', 'Innovation Management' and 'Technology management' were carefully screened. Out of 81 active Public R&D organization 58 were acknowledge rest of them discarded on the bases of three significant criteria first 'Organization mission', 'Source of funding ', 'Number of Existing R&D projects '

On 3 Mar 2018, the researcher sent invitation letter (see Appendix B) to target experts from 81 public organizations. These R&D experts acquired the position of manager or research scientist, or senior research fellow. Around 58 firms were responds and agree to participate in Focus group discussion.

On 16 April 2018, At morning, the A group discussion comprise of two session were organized by NPO (National Productivity Organization) and sponsored by Asian Science consortium under the Asian Science Fund (see Appendix C) verified and pre-tested questionnaire was distributed during the session that were validated by the experts belongs to Asian Science consortium (ASC) and NPO.

At first session Focus group discussion (FGD) were performed based on purposive sampling. While, second session was based on the outcome of first session in order to measure the interrelationship among capabilities and prioritizes with respect to their significance. Almost 195 participant, where compose into 41 groups.

Out of the 41, only 39 groups were choose as valid group for discussion with the potential response rate ((No of met respondent)/ (Total number of respondent) ×100) for first session was 95.121 % is shown in Table 3.1.

According to (Arber, 2001; Hall, 2001). The response rate of return of 50-60% is justifiable, whereas Kelley et al. (2003), Sitzia and Wood (1998), and Sumsion (1998) recommended a response rate of 70% for each session of focus discussion group (FGD). The complete Demographics analysis is represent in (Appendix G)

Table 3.1: Focus Group Discussion Evaluations

Issue		**Section 1**	
Purpose of Questionnaire	Evaluating dimension	Evaluating Criteria	Evaluating sub-criteria
No of listed capabilities	3	9	89
No. of distributed questionnaires	41 Groups (5 people)	41 Groups (5 people)	41 Groups (5 people)
No moderators	39	39	39
No. of retuned questionnaires	39	39	39
Response rate (%)	95.121 %	95.121 %	95.121 %

The principal behind the selections of criterion is to refine capabilities that reflect as dimension by simply taking the average of each dimension appears after consensus among each focus group.

While the criteria and sub-criteria related to the capabilities also follows in a similar manner applying mean technique to represents average significance that drives after group consensus.

These capabilities gathered from the literature review (theoretical and systematic review) based on three dimensions, nine criteria, and 89 sub-criteria. The experts-suggested capabilities having acceptable levels of significance based on following condition (Average ≥ 3 out of 5) is shown in Figure 3.2

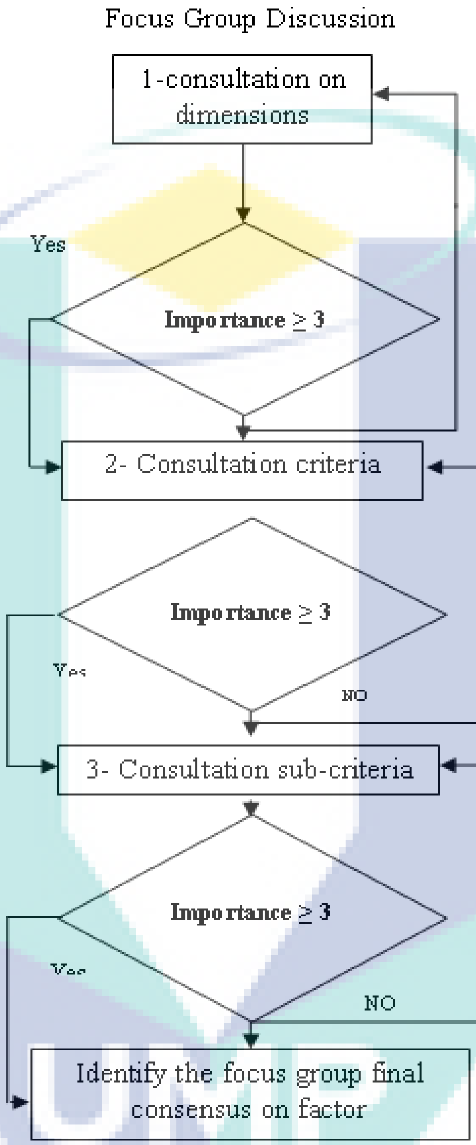

Figure 3.2 Focus Group Discussion Rating Instrument

Therefore, On 16 April 2018 an open-ended structure questionnaire comprising the three dimension, nine criteria, 89 sub-criteria, was distributed.

The set of questions also allows experts to suggest additional factors related to knowledge, innovation and technology management.

The experts were requested to evaluate the listed capabilities. Out of the 41 distributed questionnaires, 39 received. The data analysis based on following condition (Average ≥ 3 out of 5) to refine capabilities derived from each section in case of evaluating dimension, criteria and sub-criteria.

3.8.1 Pre-Test Study

The pilot study was carrying out before Focus Group discussion. A group of 45 experts who were currently associated with R&D in Public organizations were recruited as moderators also choose for pre-test. The utilization of few respondents for pre-test is predominant and widely acceptable for Focus group discussion. If one looks to the study at small scale in order to test, the instrument nine groups that comprise of 5 experts each were adequate for consensus study such as current study. The same group of panellist were also involve in piloting both DANP instruments

The main purpose of pilot study is to overcome any shortcomings before data collection to test data gathering instrument in order to assure the potential quality of the questionnaire. Furthermore, the pilot study were also utilize to test the effective mechanism for conducting focus group discussion in order to observe to ensure that the instrument were free from any bias as possible. All the experts in the pilot study were not being a part of main study. Although the pilot groups small in nature, but it did give some interesting facts, hence the data gathered from pilot test were consider as significant in administrating the actual study with large panel of experts. This attempt could insert more confidence to the author that the information gathered from the focus group was effective and reliable. Therefore, the pilot study was conducted from 10 April 2018 to 12 April 2018, and the comprehensive suggestion were describe below

- The sentence structure of questionnaire was to be improved, specifically reducing the number of phases in statement
- Proofread the complete questionnaire and lengthy statement
- Review the grammatical mistake
- Provide comprehensive description of each key indicator.

All the feedbacks were acknowledged from the pilot focus group were considered, and revaluation required in order rectifying any unusual ambiguity to structured instrument for Focus grouped and DANP studies. Furthermore, for more clarity sentence phases were changed as to accommodate the expert's recommendations

3.9 DANP (DEMATEL BASED ANP)

3.9.1 DEMATEL (Decision making Trial Evaluation Laboratory)

DEMATEL was firstly implemented by Battelle Memorial Institute for resolving the mathematically lead project by Geneva Research Center (Naser et al., 2010). It was designed to address the complex causal effects issues which require interrelating approach to rectify complex factors. DEMATEL is more useful to validate the complicated interrelationship cause because of the nature of factors involved during the selection of criteria's (Chiu et al., 2006; Jiann & Gwo-Hshiung, 2011; Wu & Lee, 2007). DEMATEL allow researcher to solve the structure problem based on multicriteria and consider as significant tool in order to estimate the interrelationship by analyzing causal influence among criteria

3.9.2 Mathematical overview

DEMATEL used to state the better working link and more robust to illustrate the practical solution for any cascaded cluster problem (Chiu, 2006). DEMATEL enable some of the sufficient features to optimize overall system by translating the characteristics of factors in the form of matrices. These factors allow decision makers to understand direct and indirect effects among them. This study use to highlight the bidirectional relationships among capabilities with respect to their dependency on certain criteria and sub-criteria. This study followed complete range of mathematical steps presented by Gölcük and Baykasoğlu (2016)

Step 1: Estimates the initial average matrix by scores: To formulate the initial average matrix first, the responded are asked to draw degree of influence whether direct influence or indirect influence on each factor or element in criteria *i* exert on each factor *j* under the effective range of scale (0, 1, 2, 3, and 4). This range of scale used to translate the linguistic variable range from "no influence" to "high influence." This method helps responded to develop a direct matrix. As result of such formulations of influences, an average Matrix A is derived by calculating the mean value of same elements in direct matrices. The average matrix A is used to represents by Equation 3.1

$$A=\begin{bmatrix} a_{11} & \cdots a_{1j} & a_{1n} \\ \vdots & \vdots & \vdots \\ a_{i1} & a_{ij} & a_{in} \\ \vdots & \ddots & \vdots \\ a_{n1} & \cdots a_{nj} & a_{nn} \end{bmatrix} \quad 3.1$$

Step 2: Estimate the initial influence matrix. To formulate the direct influence matrix some pre-normalization method required to carry this method further step forward. Therefore, it is necessary to normalization the average the matrix *A, as* result of normalization matrix $X = [x_{ij}]_{n\times n}$ obtained. In order to illustrate in simple way using Equation 3.2 and Equation 3.3 give a general idea to obtain the matrix *X*

$$X=s.A \quad 3.2$$

$$s = \min\left[\frac{1}{\max_i \sum_{j=1}^{n}|a_{ij}|}, \frac{1}{\max_j \sum_{j=1}^{n}|a_{ij}|}\right] \quad 3.3$$

Step 3: Estimate the full direct and indirect influence matrix

To develop the interface with the indirect effects in order to address relevant problem along with the power of $X^1, X^2, X^3, X^4, \ldots, X^k$ *and* $\lim_{k\to\infty} X^k = [0]_{n\times x}$, when $X = [x_{ij}]_{n\times n}, 0 \le x_{ij} < 1$ *and* $0 \le \sum X_{ij}$ *or* $\sum X_{ij} < 1$ only one column or one row sum equals 1, As result of that the total influence matrix used to illustrate as follow $T = X^1 + X^2 + X^3 + X^4 + \cdots + X^k = T = X(1 + X^1 + X^2 + X^3 + X^4 + \cdots + X^k)$ the complete mathematical steps represented in Equation 3.4

$$T = X(I - X^k)(I - X)^{-1}$$

$$T = X(I - X)^{-1} \text{ when } \lim_{k\to\infty} X^k = [0]_{n\times x} \quad 3.4$$

Where $\boldsymbol{T} = [t_{ij}]_{n\times n}$, $i, j = 1, 2, \ldots, n.$ In addition, the method presents each row sum and column sum of matrix $\boldsymbol{T}$ shows in Equation 3.5

$$r = (r_i)_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \text{ or} \qquad 3.5$$
$$c = (c_i)_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right]_{n\times 1}$$

From set of above, equations r_i use to represent the row sum of the i^{th} row that belongs to matrix T, and used to draw the sum of direct and indirect causal and effects of the elements on i^{th} row to the other elements. In similar way, c_j represents column sum of the j^{th} column that belongs to *T* matrix, represents the sum of the direct and indirect causal and effect of the elements on j^{th} column on the other elements. To analyze the mechanism let as investigate with deep complexity as i=j (i.e., the sum of elements in row and sum of the element in column cumulative) $(r_i + c_j)$ this show that the degree of strength of influence deliver and received. In simple words $(r_i + c_j)$ represent the degree of significant control of *i* used to carry during translating the problem. Similarly $(r_i - c_j)$ is positive in nature than it used to translate that factor *i* is going to affect other factors, if $(r_i - c_j)$ is negative in nature than it used to represent that factor *i* is being influenced by other factors (Tamura et al., 2002; Tsang et al., 2015)

Step 4: Formulate the threshold value

To minimize the minor effects, it is necessary to establish the specific threshold value 'α' which filters out the insignificant results appears in Matrix *T*. It is essential to isolate the relation structure of the elements. As verifying a matrix *T*, each factor in matrix *T* uses to illustrate the specific information. To reduce the complexity for researchers and decision makers a set the specific threshold value allow scaling the influence level. The threshold value can formulate by using Equation 3.6

$$\propto = \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} t_{ij}}{N} \qquad 3.6$$

Where N represents the number of elements in Matrix

The general representation of direct influence matrix can shown in Equation 3.7

$$T = \begin{matrix} C_1 \\ \\ C_2 \\ \\ C_3 \end{matrix} \begin{bmatrix} t_{11} & \cdots t_{12} & t_{13} \\ \vdots & \vdots & \vdots \\ t_{21} & t_{22} & t_{23} \\ \vdots & \ddots & \vdots \\ t_{31} & \cdots t_{32} & t_{33} \end{bmatrix} \qquad 3.7$$

One most exciting feature that leads DEMATEL different among other decision-making tools it used to illustrates feedback relations. It also highlights the bidirectional association and quantifies the direct and indirect relationship among the significant elements with their effect on each other element

3.9.3 DANP for Finding the Influential Weights in Each Criterion

Several researchers have overviewed number integrated techniques based on DEMATEL and ANP over the period. The DANP technique utilized by Chen et al. (2011a) used to modify the traditional ANP to ease its inherent complexity in case original ANP (Analytic Network Process) the survey questionnaire can be quite complicated for decision makers to translates and present the precise information. The DANP technique integrates four different strategies as shown in Figure 3.3

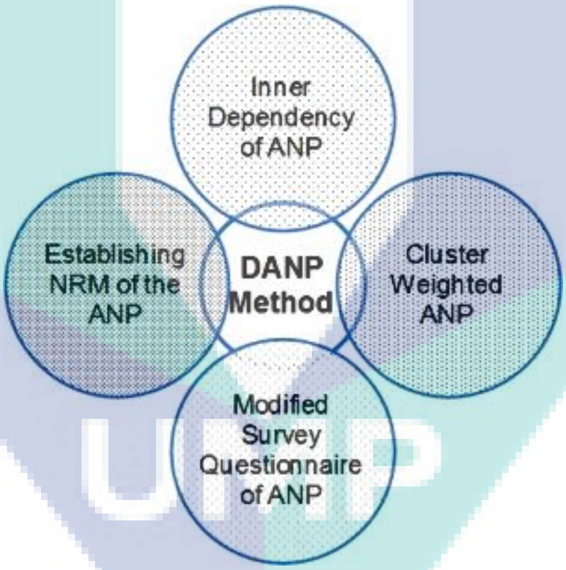

Figure 3.3 Components of DANP Method
Source: Gölcük & Baykasoğlu, (2016)

In original ANP technique, the unweighted supermatrix is materialize with respect to pair-wise comparisons and fundamentally the criteria weights which designate to 'Eigen values' are represented into relevant columns of the supermatrix. In order to rectifying complexity during pair wise comparison as decision makers bears intellectual burden. DANP technique modifies the exiting pair wise comparison pattern with respect to questions used to determine the values. Despite that, DANP structures a comprehensive unweighted matrix by constructing direct-influence matrix where pair wise comparisons were not only performed within the clusters but to overall system. In this regard, DANP technique simplifies the complex design of inner-dependency segregations by DEMATEL technique. Finally, DANP technique by-passes the complexity of 9 scale pair wise compassion survey questions and puts the total relation matrix configuration as substitute. The DANP (DEMATEL based ANP) is a suitable instrument to include interaction and interconnectivity in between the dimension and criteria that materialized in the cases of real practical problems. DANP can satisfy the interrelationship among characteristics of variables involve in developing criteria's or dimensions, and it ease to construct a relationships that replicates those features with an essential system and transformative in nature (Jeng & Tzeng, 2012; Liou, 2012; Liu et al., 2012; Shen et al., 2011; Tzeng & Huang, 2011; Wang & Tzeng, 2012; Yang et al., 2011).

Step 5: Estimation of Network Relation Map for ANP

The fundamental steps of DANP techniques were adopted from Chen et al. (2011b) and represented as follows; At first stage, the estimation of ANP is measured by simply applying traditional DEMATEL techniques after measuring the threshold value "α" presented by İlkerGölcük and AdilBaykasoğlu (2016). After that, an unweighted supermatrix of overall system is assembled. The total influential matrices for dimension and criteria are determined. The total relation matrix of overall criteria is represent as T_c as shows in Equation 3.8

$$T_c = \begin{array}{cccccc} D_1 & \cdots & \cdots & D_2 & \cdots & D_3 \\ \vdots & C_{11}C_{12} & \cdots & C_{1m1} & \cdots & C_{nm_n} \\ \vdots & \vdots & T_c^{11}\cdots & \cdots & \cdots & T_c^{1n} \\ \vdots & C_{12} & \vdots & \cdots & \cdots & \vdots \\ D_2 & \vdots & \vdots & \cdots & \cdots & \vdots \\ \vdots & C_{1m_1} & \vdots & \cdots & \cdots & \vdots \\ \vdots & \vdots & \vdots & \cdots & \cdots & \vdots \\ D_3 & C_{nm_n} & T_c^{n1} & \cdots & \cdots & T_c^{nn} \end{array} \qquad 3.8$$

Step 5: Normalizing Total Influence Matrix

The normalized total influential matrix for overall criteria, represented as $T_c^{\propto}$ which is drive from row sum of each sub-matrix $\boldsymbol{T_c}$ for normalization is shown Equation 3.9

$$T_c = \begin{array}{cccccccc} D_1 & \cdots & \cdots & D_2 & \cdots & D_3 & & \\ \vdots & C_{11}C_{12} & \cdots & C_{1m1} & \cdots & C_{nm_n} & & \\ \vdots & \vdots & T_c^{11}\cdots & \cdots & \cdots & T_c^{1n} & & d_1^{12}\sum_{j=1}^{m} t_{1j}, \text{i=1, 2, 3} \\ \vdots & C_{12} & \vdots & \cdots & \cdots & \vdots & & \\ D_2 & \vdots & \vdots & \cdots & \cdots & \vdots & & \\ \vdots & C_{1m_1} & \vdots & \cdots & \cdots & \vdots & & \\ \vdots & \vdots & \vdots & \cdots & \cdots & \vdots & & d_{m_1}^{12}\sum_{j=1}^{m} t_{1j}, \text{i=1, 2, 3} \\ D_3 & C_{nm_n} & T_c^{n1} & \cdots & \cdots & T_c^{nn} & & \end{array} \qquad 3.9$$

Where t_{cmi} i^{th} row sum of the total influential matrix of $\boldsymbol{T_c}$ .The individual row is divided by equivalent row sum to normalized the total influential matrix represent in Equation: 3.10

$$T_c^{\propto} = \begin{array}{ccccccc} D_1 & \cdots & \cdots & D_2 & \cdots & D_3 \\ \vdots & C_{11}C_{12} & \cdots & C_{1m1} & \cdots & C_{nm_n} \\ \vdots & \vdots & t_{c^{11}}^{11} \div d_{c_1}^{11} & \cdots & \cdots & t_{c^{1m1}}^{11} \div d_{c_1}^{11} \\ \vdots & C_{12} & \vdots & \cdots & \cdots & \vdots \\ D_2 & \vdots & \vdots & \cdots & \cdots & \vdots \\ \vdots & C_{1m_1} & \vdots & \cdots & \cdots & \vdots \\ \vdots & \vdots & \vdots & \cdots & \cdots & \vdots \\ D_3 & C_{nm_n} & t_{c^{m11}}^{11} \div d_{cm_1}^{11} & \cdots & \cdots & t_{c^{nm_n}}^{11} \div d_{cm_1}^{11} \end{array} \qquad 3.10$$

The normalized total influential matrix for overall criteria represents in Equation: 3.11

$$T_c^{\propto} = \begin{bmatrix} T_{c^{11}}^{\propto 11} & \cdots & T_{c^{1m1}}^{\propto 11} \\ \vdots & \ddots & \vdots \\ T_{c^{m11}}^{n11} & \cdots & T_{c^{m1m_n}}^{\propto 12} \end{bmatrix} \qquad 3.11$$

Step 6: Construct the Unweighted Super Matrix

The next stage is to construct the unweighted supermatrix. The unweighted supermatrix is constructing by simply taking the transpose of normalized $T_c^{\propto}$ matrix now as seen in Equation:

$$W_c^{\propto} = \qquad =(T_c^{\propto})=\begin{bmatrix} W_{11} & \cdots & W_{1n} \\ \vdots & \ddots & \vdots \\ W_{n1} & \cdots & W_{nn} \end{bmatrix} \qquad 3.12$$

After developing unweighted supermatrix for criteria, the total relation matrix for dimension, T_D is used to weight the unweighted supermatrix the entire steps regarding developing total relation matrix for dimension can be represent in following Equations 3.13, 3.14, 3.15, 3.16

$$T_c^{\propto}=\begin{bmatrix} t_{c11}^{\propto 11} & \cdots & t_{c1m1}^{\propto 11} \\ \vdots & \ddots & \vdots \\ t_{cm11}^{n11} & \cdots & t_{c m1mn}^{\propto 12} \end{bmatrix} \qquad 3.13$$

Step 7: Total influential matrix for Dimensions

Traditional cluster- weighted ANP based model utilizes DEMATEL approach to estimate the significant influence among dimension, and employ these potential values to weight the overall unweighted supermatrix. But the inner and outer interconnectivity among the dimensions are still evaluated through normal pair wise comparison approach of ANP. Each weighted section in supermatrix has been drive by using DEMATEL method. The comprehensive procedural steps on dimension weighted ANP DEMATEL method technique is represented in Equation 3.14 (Yang et al., 2008)

$$T_D^{\propto}=\begin{bmatrix} u_D^{11} & \cdots u_D^{1j} & u_D^{1n} \\ \vdots & \vdots & \vdots \\ u_D^{1j} & u_D^{ij} & u_D^{1n} \\ \vdots & \ddots & \vdots \\ u_D^{n1} & \cdots u_D^{nj} & u_D^{nn} \end{bmatrix} \qquad 3.14$$

Total relation matrix is drived from DEMATEL techniques that allows to set the threshold value in order to estimate the significant values for relevent dimensions and ignor the relations that have minor influence. The relationship influence smaller than thresold the value set to be zero in total influenctial matrix. The total influential matrix for dimension can be represented as T_D. In next stage to normalized the overall total relations matrix row-sum are calculated where total sum of i^{th} row is represented as Equatiom: 3.15

$$T_{D=} \begin{bmatrix} t_D^{11} & \cdots t_D^{1j} & t_D^{1n} \\ \vdots\ t_D^{i1} & \ddots\ t_D^{ij} & \vdots\ t_D^{in} \\ t_D^{n1} & \cdots t_D^{nj} & t_D^{nn} \end{bmatrix} \qquad \boxed{d = \sum_{j=1}^{m} t_{c1}, \quad i = 1, 2, 3 \ldots m} \quad \boxed{d = \sum_{j=1}^{m} t_{cn}, \quad i = 1, 2, 3 \ldots m} \qquad 3.15$$

Row sum are utilized to estimate the normalized total influential relation matrix for Dimension, which is represent by $T_D^{\propto}$

Step 8: Normalized Total Influential Relation Matrix

The normalized total influential relation matrix for Dimension, which is represent by $T_D^{\propto}$ shown in Equation 3.16 and 3.17

$$T_D^{\propto} = \begin{bmatrix} t_D^{11} \div d_1 & \cdots t_D^{1j} \div d_1 & t_D^{11} \div d_1 \\ \vdots & \ddots & \vdots \\ t_D^{i1} \div d_i & t_D^{ij} \div d_i & t_D^{in} \div d_i \\ t_D^{n1} \div d_n & \cdots t_D^{nj} \div d_n & t_D^{nn} \div d_n \end{bmatrix} \qquad 3.16$$

$$T_D^{\propto} = \begin{bmatrix} t_D^{\propto 11} & \cdots t_D^{\propto 1j} & t_D^{\propto 1n} \\ \vdots & \ddots & \vdots \\ t_D^{\propto i1} & t_D^{\propto ij} & t_D^{\propto in} \\ t_D^{\propto n1} & \cdots t_D^{\propto nj} & t_D^{\propto nn} \end{bmatrix} \qquad 3.17$$

Step 9: Weighted Supermatrix

The weighted supermatrix can be represented as following as shown in Equation 3.18

$$\begin{bmatrix} t_D^{\mathbf{11}}.W^{11} & \cdots t_D^{\propto 1\boldsymbol{i}}.W^{i1} & t_D^{\mathbf{11}}.W^{n1} \\ \vdots & \ddots & \vdots \\ t_D^{\propto \mathbf{1j}}.W^{1j} & t_D^{\propto \boldsymbol{ij}}.W^{nj} & t_D^{\propto \boldsymbol{nj}}.W^{nj} \\ t_D^{\propto n\mathbf{1}}.W^{1n} & \cdots t_D^{\propto \boldsymbol{ni}}.W^{in} & t_D^{\propto \boldsymbol{nn}}.W^{nn} \end{bmatrix} \quad 3.18$$

As the weighted super matrix is constructed, the limiting super matrix can be estimates to reach overall priorities by rising to the power until it converges to large stable matrix in order to drive the global weight with vectors precedence w= $(w_1 \dots \dots . . w_j \dots . w_n)$ represent as influential weights $W^* = \lim_{g \to \infty} W_w^g$

3.10 Overview on DANP In Case of R&D in Pakistan Public Organization

After completion of first session, the outcome from expert's consensus would develop a pre-determined model fit to the characteristic related to R&D in Public organizations of Pakistan. The experts were responsible for approving the model relevant to address the research problem. The experts invited for focus group discussion were agreed that the capabilities should be split up into three dimensions, nine criteria and 51 sub-criteria. The outcome of first session allow researcher to arrange conceptual framework based on dimensions, criteria's and sub-criteria. In conceptual model knowledge, innovation and technology management set as prime dimension based on the nine criteria that involve in managing R&D in-shape of processes, infrastructural and strategic levels. While, these criteria also depend upon 51 sub-criteria which the author already investigate through a systematic review in chapter 4

Outcome of focus group discussion draw conceptual orientation based on three dimensions that used to contributes their significance on R&D. Therefore, DANP technique were applied to measure contributing impact among dimensions, criteria's and sub-criteria's with respect to their interrelationship. DANP technique allows researcher, an in-depth configuration to map interrelations between capabilities. Also, prioritise them according to their interrelated significance. For in-depth discussion, same panel of experts were invited for session 2. Now, the experts approved model was used for further discussion in case of developing interrelationship and prioritization among capabilities. Therefore, closed-ended questionnaires were step up to gauge interrelationship among criteria and sub-criteria (see Appendix B). The numerical values were derived from the DANP questionnaire includes the significance among capabilities with their contributing influence. The numerical information formulates the intensity among capabilities which allow decision makers to canvas the deficiencies among appropriate orientation for R&D in public organizations of Pakistan. On 16 April 2018, after completing the first section the experts from 58 public organizations were also invited for second session allows to answer the DANP questionnaire and rate their judgment

3.11 Validity

The research characteristic creates the research design to rectify the research question; however, the suitability of each stage requires to be considered. This relates to the basic concepts of validity. Validity relates to the integrity of the outcome developed from research (Bryman, 2004).

3.11.1 Validation of This Research

In this research, validity based on the core characteristics of estimation whether a test used to measure an actual variable that researcher is looking to measure (Cooper & Schindler, 2008). Numerous types of validities created; this research study based on Face validity: (Kumar, 2011). This validity is more related to an intellectual consensus on whether a research tool and its measuring variables used to satisfy the research objective. The level of agreement was based on expert's professional experience and level of expertise. That allows the formulation of logical connection in between selected research instrument and research objective is known as face validity (Kumar, 2011)

3.11.1.1 Validity Test

In the current study, R&D in public organization experts were scrutinized based on the pre-determine criteria and invited to be the expert panellists. Additionally, the focus group discussion was performed into single round, thus complied with validation criteria suggested by (Krueger & Casey, 2009). In addition, three more are applied test related to justify the validity of this research. First, the supervisor was consulted regarding to validate the readability, quality of content, ease of answering and the instrument scale used. Second, the expert's were consulted to valid content in order to rectify the validity issues related to interview questionnaire. Two experts from Asian Science Consortium (ASC) and the National Productivity organization (NPO) were selected to evaluate the initial interview questionnaire. It intended to make sure that all definitions were valid, comprehensible and practically applicable. Experts have proven their research expertise related to focus group study and R&D in Public organization. These experts did not participate in any contribution during content validity exercise. Third, pilot study base on eight focus group based on 40 moderators who comply with pre-determine criteria were performed to analyze the effectiveness of interview instrument. All of these three validity test were used to establish the face validity related to interview questionnaire, in order to be achieved the content validity. Moreover, the focus group discussions were statistically calculated using SPSS 22.0 statistical software packages. As the data was not large, it was controlled by the researcher's supervisor for accurate feedback during focus group discussion to increase the validity. In case of missing data, the panelists were informed accordingly to ensure the validity of the rated measures. The utilization of importance scales for consensus development in order to ensure and achieved internal consistency.

3.12 Reliability Test

The features of traditional focus group discussion make it unfeasible to carry out the reliability analysis as similar in case of quantitative research. Such similarity, is because the interview questionnaire in case of focus group discussion may consider as open-ended questions where the reliability analysis ineffective to apply. However, the question arise regarding how if the preliminary step of the focus group discussion utilizes a structured questionnaire in case current research study, can reliability measure? To this end, the author argued regarding reliability analysis which can possibly implement on focus group discussion where more structured interview questionnaire is utilizes specifically when dealing with modified scales in contrast to current study. Therefore, in case of this research study Cronbach's α analysis is applied for reliability analysis and internal consistency for each element asked during the interview session by using SPSS version (22.0). The Cronbach's α correlation coefficient is extensively recognized as statistical instrument in order to analyze the internal reliability. Thus, it is adequate to estimate reliability of interview questionnaire that is used in focus group discussion.

3.12.1 Instrument Realibility

However, there was no indication in the literature regarding the reliability of the focus group study, but, an effort has been made to establish the reliability of the focus group instrument being used. The researcher argued regarding the measurement of the instrument reliability could be achievable if the pre-test can be performed by using more structured questionnaire.

However, during the focus group research may apply the more open-ended questionnaire in order to get the reliable feedback. Reliability was determined by using Cronbach's α that evaluates the internal consistency.

All the relevant criteria or sub-criteria as variable were allowed to test by using the reliability function of the SPSS (22.0) from the data retrieve from pilot study. According to instruction made by George and Mallery (2010) were used proposed certain value Cronbach's α for effective reliability such as: $\alpha \geq .9$ consider as excellent to measure reliability among the variable while, $\alpha \geq .8$ rated good for reliability. After analysis, the Cronbach's α for the instrument was found as $\alpha = .82$ which consider as good reliability (George & Mallery, 2010).

The overall result of item- total statistics shows that just minor adjustment in the Cronbach's α if any of the criteria or sub-criteria were deleted. Due to such minor adjustment in Cronbach's α, allow researcher to utilize the same variables without altering any of the items asked being remove from the instrument.

The following Table 3.2 show the overall reliability analysis among the criteria and sub-criteria that were presented during focus group discussion

Table 3.2 Reliability Analysis of The Evaluation Scale for the Focus Group

	Items	α	α if items deleted
Overall		0.948	
1	KM Process Capability		.983
2	KM Infrastructure Capability		.983
3	KM Strategic Capability		.983
4	IM Process Capability		.984
5	IM Infrastructure Capability		.983
6	IM Strategic Capability		.983
7	TM Process Capability		.983
8	TM Infrastructure Capability		.983
9	TM Strategic Capability		.983
10	Knowledge Sharing		.983
11	Join Scense		.983
12	Affective Commitment		.984
13	Knowledge Transfer		.984
14	Knowledge creation		.984
15	Knowledge generation		.983
16	Knowledge utilization		.983
17	Knowledge protection		.984
18	Knowledge Acquisition		.983
19	Knowledge implementation		.983
20	Intellectual knowledge portfolio		.983
21	Organization Learning		.984
22	Culture		.983
23	IT		.983
24	Community of Practice		.983
25	Technology		.984
26	People		.984
27	Contribution of Skill and Expertise		.984
28	Novelty & uniqueness of innovation		.984
29	Role of leadership innovation & supports		.984
30	Structure		.984
31	R&D cooperation		.984
32	Acquisition Internal R&D		.984
33	Acquisition External R&D		.983
34	Technology Transfer trends		.983
35	Decision Making process		.983
36	Knowledge Sharing Ability		.983
37	Inbound Open Innovation		.983
38	Project management (control & monitoring)		.984
39	Innovativeness compatibility		.983
40	Rate of introduction of new product/ service per year		.983

Table 3.2 Continued

	Items	α	α if items deleted
41	Internal & external Knowledge sharing ability		.983
42	Knowledge creation practice		.983
43	R&D investment		.983
44	External Networking		.983
45	R&D Employee		.984
46	New Knowledge		.984
47	Radical Innovation		.984
48	Knowledge incentives		.983
49	Formulation		.983
50	Absorptive capacity		.983
51	External knowledge Trends		.983
52	IP performance		.984
53	Technological Performance		.983
54	Innovative Performance		.983
55	Technology trends		.984
56	Organization strategy		.984
57	Innovation strategies and initiatives		.983
58	Technology Acquisition		.983
59	Technology Exploitation		.983
60	Technology Identification		.984
61	Technology learning		.984
62	Technology Protection		.984
63	Technology Selection		.984
64	Technology Planning		.984
65	Technology Development		.984
66	Technology deployment		.984
67	Technology Assessment		.984
68	Technology Forecasting		.983
69	Technology Watch		.983
70	Technology Transfer		.984
71	Technology Improvement		.983
72	Management competency		.983
73	Facility		.983
74	Organization potential		.983
75	Personal skill		.983
76	Strategic Technology Road Mapping		.983

Table 3.2 Continued

	Items	α	α if items deleted
79	Technology absorptive capability		.984
80	Technology innovation capability		.983
81	Absorptive capacity		.983
82	Descriptive capacity		.984
83	Corporate Technology Strategy		.983
84	Corporate Business Strategy		.984
85	Technology Alliance Strategy		.983

3.12.1.1 Error Ratio Gap Reliability Test for DANP Method

The most important factor that endorsed reliability factor that one-on-one focus group discussion provide a better understanding to review true value of data (Garcia-Hernandez, 2015). Some of the previous studies enable formulates reliability in case of DANP is shown Table 3.3

Table 3.3 Reliability Test for DANP

Studies	Reliability	
	Error Ratio Gap(α) Must be less than 5%	Confidence(1- α) must over 95%
Liou et al. (2017)	1.70%	95%
Yang et al. (2017)	3%	97%
Chen et al. (2016)	4.766%	95.234%
Lu, Tzeng, and Tang (2013)	3.16%	96.84%,
Su et al. (2015)	0.34%	99.652%
Lu, Tzeng, Hu, et al. (2013)	0.082%	99.918%

It was necessary to design the interview guideline in such pattern that provide complete understanding to respondents and help to produce an accurate nature of data. Some pre-analysis to develop an interview guideline base on clarification of content, basic terms and statements need to be clear along with appropriate response time for interview. The sample size based on the principle of theoretical saturation and to justify the reliability with sustainable consistency among responded (Chiu et al., 2013). DANP used EGR (Error Gap and Ratio) as shown in Equation 3.19

$$EGR= \frac{1}{n(n-1)} \sum_{i=1}^{n} \sum_{j=1}^{n} \frac{\left|a_{ij}^{p} - a_{ij}^{p-1}\right|}{a_{ij}^{p}} \times 100\% \qquad 3.19$$

Where p denotes the number of samples and a_{ij}^{p} is the average influence of i criteria on j; the number of gap ratio elements is n (n - 1). When EGR is α, the significant confidence is (1 - α). In general, when α is less than 5%, and have over 95% confidence to note that there are no significant differences between evaluations of sample sizes p and p -1. Consequently, it is reasonable to propose that sample size p is significantly closer to the theoretical saturation and is qualified to be an appropriate size (Chen et al., 2016).

3.13 Summary

This chapter has presented research paradigms, research design, research methodology related to this research. At current circumstance researcher adopted the paradigm of pragmatism which illustrates the significant insights regarding influential contribution of supporting management discipline on R&D. In term of research design, this research follows mixed-method to fill the research gap during the exploring capabilities related to supporting management discipline that contributes to R&D. Thus, the research design comprise on three stages: on theoretical and two empirical studies. The main purpose of dividing the research into three stages is draw a clear understanding towards subjects that under investigation. First phase of research design describe general literature review based on theories belongs to knowledge, Innovation and technology management know as "Supporting management discipline. These basic theoretical interpretations allows researcher to conduct systematic review presented in (chapter 4). The systematic review based on (*PRISMA with Co-word analysis*) allow researcher to represents in-depth findings related to supporting management discipline (knowledge, innovation and technology management) in form of "sub criteria" along with practical relevance with R&D. In second phase split into two steps: First step (I) belongs to data gathering depends upon the instruments used for retrieving data under practical setting. While, the second step (II) is to test significance related to the factors that were extract from focus group discussion.

CHAPTER 4

SYSTEMATIC REVIEW

4.1 Introduction

This Chapter concentrates to achieve RO_1 which is requires classification the capabilities related to supporting management discipline that adds their influence on R&D and RO_2 which requires development of Framework that draw interconnectivity among the capabilities related to supporting management discipline. This Chapter portraying a theoretical interpretation on systematic review of the literature. For this purpose, extensive bibliometric interpretations based on (PRISMA with co-word analysis) were performed. Such extensive research helps author to investigate the existing research studies gauging on the bases of the number of published research article within the domain of specific topics. The extraction of some of emerging dimensions depends upon on reliable sources; In case of this research, Scopus database allow research to extract some of the emerging themes under the scope of given research domain. This chapter used to represents the complete set of information that satisfies the adaption of appropriate literature suitable for this research thesis. Furthermore, it also highlights a systematic approach for literature section by analyzing co-word analysis for existing studies in order to get results that are more specific.

4.2 Co-word Analysis

In conventional bibliometric techniques such as authors, journals and co-citation exploration generally based on the assessment of citations included in research articles. While this type of extensive analysis shaped some of the exciting outcomes, but it does not drive, an instant picture of the factual content is compatible with literature. Co-word analysis, used to assess the co-occurrence of keywords in a given research topic within a specified research area (Courtial & Sigogneau, 1993). Co-word analysis condenses enormous data sets that allow researcher to draw specific visualized pattern with the preservation of crucial information enclosed in the data. It depends on the characteristic of words, which consider as the significant carrier to represents emerging scientific concepts, creative idea and new knowledge (van Raan & Tijssen, 1993). Co-word analysis sketch the postulations that a research article keywords comprise a sufficient narration of its content or the adequate associations that paper recognized between problems. Two key-phrases co-occurring within the same research article indicates a signal of concern association to which they refer (Cambrosio et al., 1993). The traces of multiple co-occurrences around the same word or clusters of words regarded as a cornerstone of strategic association within papers that may reflect emerging research theme. Co-word analysis illustrates research pattern in a particular research discipline by estimating the correlating strengths of various terms. The most crucial feature of the co-word analysis is that it sketches specific research domain into maps of the theoretical space with respect to time-frame (Ding et al., 2001)

A most advanced bibliometric mapping tool know as VOSviewer developed by Van Eck and Waltman 2010 in Leiden University, The Netherlands, for constructing the recognizable pattern among existing literature and visualizing the bibliometric model (Van Eck, 2014). The initial mechanism of VOSviewer software used to build the bibliometric profile based on a significant amount of data source which can be downloaded from famous international bibliographic database sources such as Scopus

In order to formulate the most emerging and dwindled trend within specific scientific domain smart algorithm known as burst detection can be applied by using Sci2 tool that explores the keywords and article title helps researchers to determine the emerging and faded trends (Leydesdorff, 2006). Before analyzing the information specific option used to configure sci2 tool that allow data need to lowercased; with common set for stop and tokenized (Kleinberg, 2003) (Note: Complete description represents in Appendix I)

4.3 Classifying Knowledge Management Capabilities

On 12 Dec 2017, an extensive searching string applied on Scopus data was performed based to reclaim all the significant studies related to Knowledge management capabilities impact on R&D.

The following typology configuration was applied into Scopus search engine: Searched for article: "Research and Development", "R&D", "Knowledge management with R&D" OR "Knowledge organization capabilities" OR "R&D and Knowledge capabilities" OR "Knowledge and R&D" OR "Knowledge Management in R&D" OR "Knowledge Management on R&D" OR "Knowledge Management Capability related to R&D " OR "Knowledge Capabilities in R&D " OR "Knowledge Management Public sector" OR "K.M capabilities" OR "K.M capabilities with R&D" OR "K.M infrastructure", Boolean operator "K-M", "K&M and R&D", "KM and R&D", "K.M and R&D"

All the probable keywords relevant to Knowledge management Capabilities (K.M capabilities) were take into account during systematic searching query. The search reclaimed 1040 document which had emerges in 412 journals from 1990 to 2018.

Those article were published frequently by 25 institutions spread across 52 countries and by 156 frequent authors these documents comprise on 788 (62%) journals article, conference article 208 (31.3%), Review 28 (4.2%), Book chapter 7 (1.05%), conference review 5 (0.75%), Article in Press 3 (0.45%), Short survey 1 (0.15%)

The outcome of bibliometric visualization belongs to knowledge management capabilities from the sequential point of view is drive from the smart configuration of key phrases with unique typological pattern used to apply during the advance searching string which discuss earlier.

The analysis was spotlight from most product period 1990 to 2018. Now, Comprehensive representations for exclusion of records at each stage are acknowledged in the PRISMA Flow diagram is shown in Figure 4.1

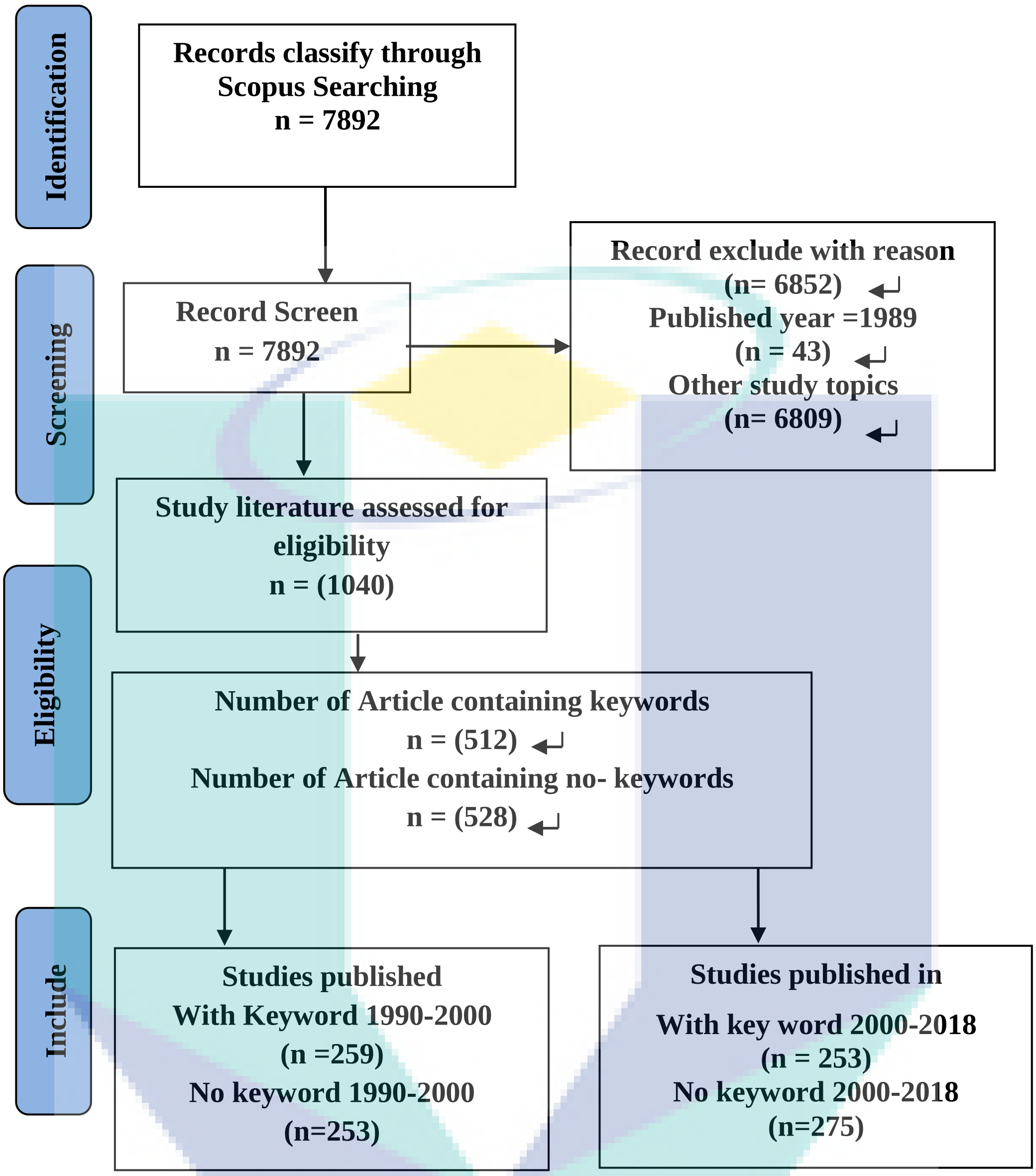

Figure 4.1Flow diagram on Knowledge Management Capabilities during 1990–2018

We acknowledged 7892 relevant article by systemically searching on Scopus Database. After removing research article that were not fulfill the eligibility criteria based on PRISMA already discuss during in chapter 3. A total of 1040 articles were recognized, Number of research article with author supplied keywords (n=512) from period 1990-2018, While the number of research studies without Keywords (n=528) from period 1990-2018 were also analyzes. Research article analyzes on the bases of Tile, Keywords and Abstract. Because of the characteristic of acknowledge in eligibility criteria, we exclude overall 6852 article. The bibliometric illustration of the knowledge management capabilities from the sequential perspective is derived from the smart configuration of key phrases with unique typological patterns that are used to apply an advanced searching string technique. The analysis highlighted the period 1990 to 2018 periods can be shown in Figure 4.2 as below

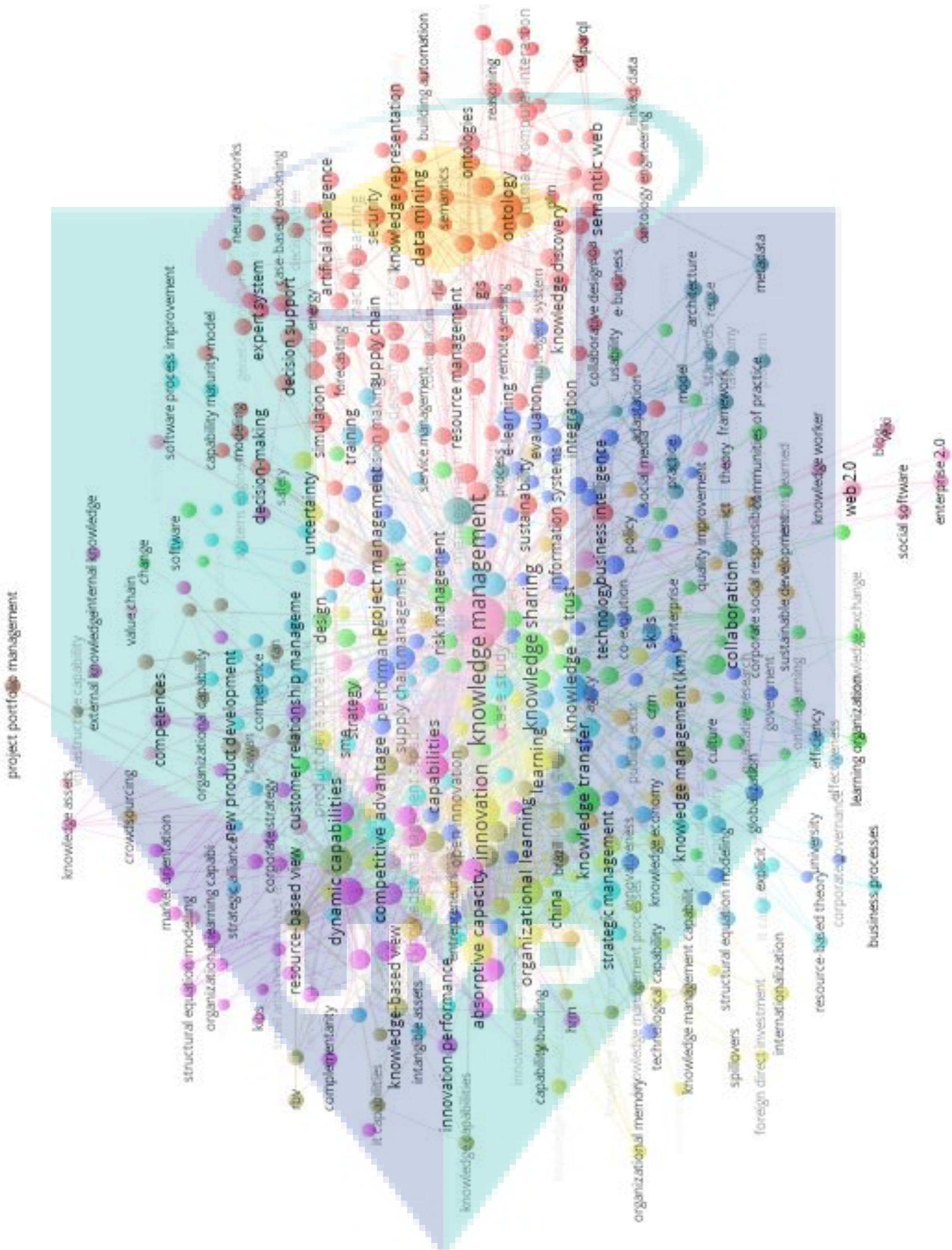

Figure 4.2: The term maps from the 1990 to 2018 period

A total of 15534 authors supplied keywords; however, only 692 met the minimum occurrence threshold value; therefore, the 692 keywords were split into 13 clusters. A complete descriptive analysis can be shown in Table 4.1

Table 4.1 Descriptive Analysis 1990 -2018

Descriptive Analysis		
years	1990-2000	2001-2018
Total Paper	512	528
Minimum no of keywords	107	2243
Minimum occurrence	5	5
Minimum Threshold	13	112
Highest total link strength	245	232
Highest occurrence	28	165

As 13 clusters shown in Figure 4.2, the group of keywords in these clusters helps researcher to identify the overall connectivity with the emerging research theme. The complete sketch of some of the clusters highest occurrence of keyword was shown in (Appendix-F).

Currently, within research domain of KMC (knowledge management capabilities), most clusters indicates various research domain for instance clusters 1 shows keywords that belong to "computer science and Artificial intelligence" , cluster 2 more focus towards "E-learning and Education sector", while cluster 3 & 4 more emphases on "social impact of new product development", cluster 5 more relate towards " Banking and operational management", while cluster 6, 7 and 8 used to represent core concepts of KM capabilities belongs to process, infrastructure and strategic domains within R&D are represented by prospective keywords, which include: combination, internalization, socialization, knowledge generation, knowledge creation, knowledge implementation, organization culture, IT, organization structure. While cluster 9 and 10 more relates to the value, creation and value chain under dynamic capability with more precisely focus on organizational design and organizational performance. Cluster 11 more relates to "Business strategy and business performance," while cluster 12 more toward the architecture and environment development and 13 clusters relate more to developing innovativeness more towards services and corporate social response.

4.3.1 Emerging and disappearing themes (burst detection)

In order to get more specified outcome, the extracted data used for further analysis by applying burst detection technique on extracted dataset in order to explores emerging and faded them. After applying burst detection techniques 18 emerging and fading themes were appear in after exploring, both title and author supplied keywords with respect to time frame are shown in Table 4.2.

Table 4.2 Keywords of Emergent and Fading subject

latest bursting and disappearing topics					
In the titles					
Word	Level	Weight	Length	Start	End
volum	1	8.146203	3	2011	2013
technolog	1	3.82957	11	1992	2002
sustain	1	3.57236	2	2009	2010
2012	1	4.380297	1	2012	2012
2013	1	6.13927	1	2013	2013
America	1	5.614195	2	2012	2013
servic	1	6.476224	2	2010	2011
amci	1	5.614195	2	2012	2013
confer	1	8.482029	2	2012	2013
inform	1	10.58485	2	2012	2013
empir	1	3.918114	7	2002	2008
ici	1	3.476513	3	2011	2013
18th	1	3.748391	1	2012	2012
research	1	1.908279	1	2012	
book	1	1.479245	1	2010	2010
mechan	1	1.652	1	2010	2010
patient	1	1.54516	1	2012	
In author supplied keywords					
Word	Level	Weight	Length	Start	End
combin	1	3.68998	1	2016	
chang	1	3.591327	2	2011	2012
explicit	1	6.205393	9	1998	2006
implicit	1	7.290948	9	1998	2006
extern	1	6.506434	7	1997	2003
extern	1	8.439011	1	2016	
collabor	1	7.101395	8	1994	2001
social	1	5.52395	1	2016	
inform	1	3.461626	1	2013	2013
intern	1	7.051246	7	1997	2003
intern	1	4.481888	1	2016	
base	1	3.658767	8	1996	2003
innov	1	4.338578	1	2011	2011
technolog	1	4.513605	11	1997	2007
human	1	8.174665	27	1976	2002
perform	1	9.010913	27	1976	2002
process	1	5.869818	3	2014	

The start, and end dates explain the emergence and fading indication. If there is no end date, this indicates that the term remains active; when the keyword possesses both start and end dates, this shows the inactive emergence of conditions that less frequently appear among various publications over the period. Currently, in the field of KMC (knowledge management capabilities), most crucial phrase themes that are used to influence the process, infrastructure and strategic domains within R&D are represented by prospective keywords, which include: combination (2016-Active), internalization (2016- Active), and socialization (2016- present).

These keywords represent the probable research themes that are very active in the current research pattern; conversely, there are faded themes that are not significant and that are less followed in contemporary research trends.

The following keywords have not been included in either the Author's supplied keyword list or in the research titles: implicit (1998-2016), Explicit (1998-2006), external (1997-2003), internal (1997-2003), Performance (1976-2002), base (1996-2003), system (2012-2013), Human (1976-2002), and collaboration (1994-2001); these have appeared less in contemporary research.

It has been observe from the huge range of article selected from 1990 to 2018. By applying multi-dimensional scaling (MDS) along with burst detection algorithm explores around 132 words meet the minimum threshold 5 occurrence among these 132 words there are number of emerging and fading themes appears with respect to selected scientific domain (Nadzar et al., 2017).

These key words splits into five clusters that associated with respect to the nature of their characteristics, as result these co-occurrence keywords represented with five different colours based on highest co-occurrence. From Figure 4.3 the 3rd, 4th and 5th cluster visualizes more closes to KM capabilities that influence processes, infrastructure and strategic prospective of R&D.

.

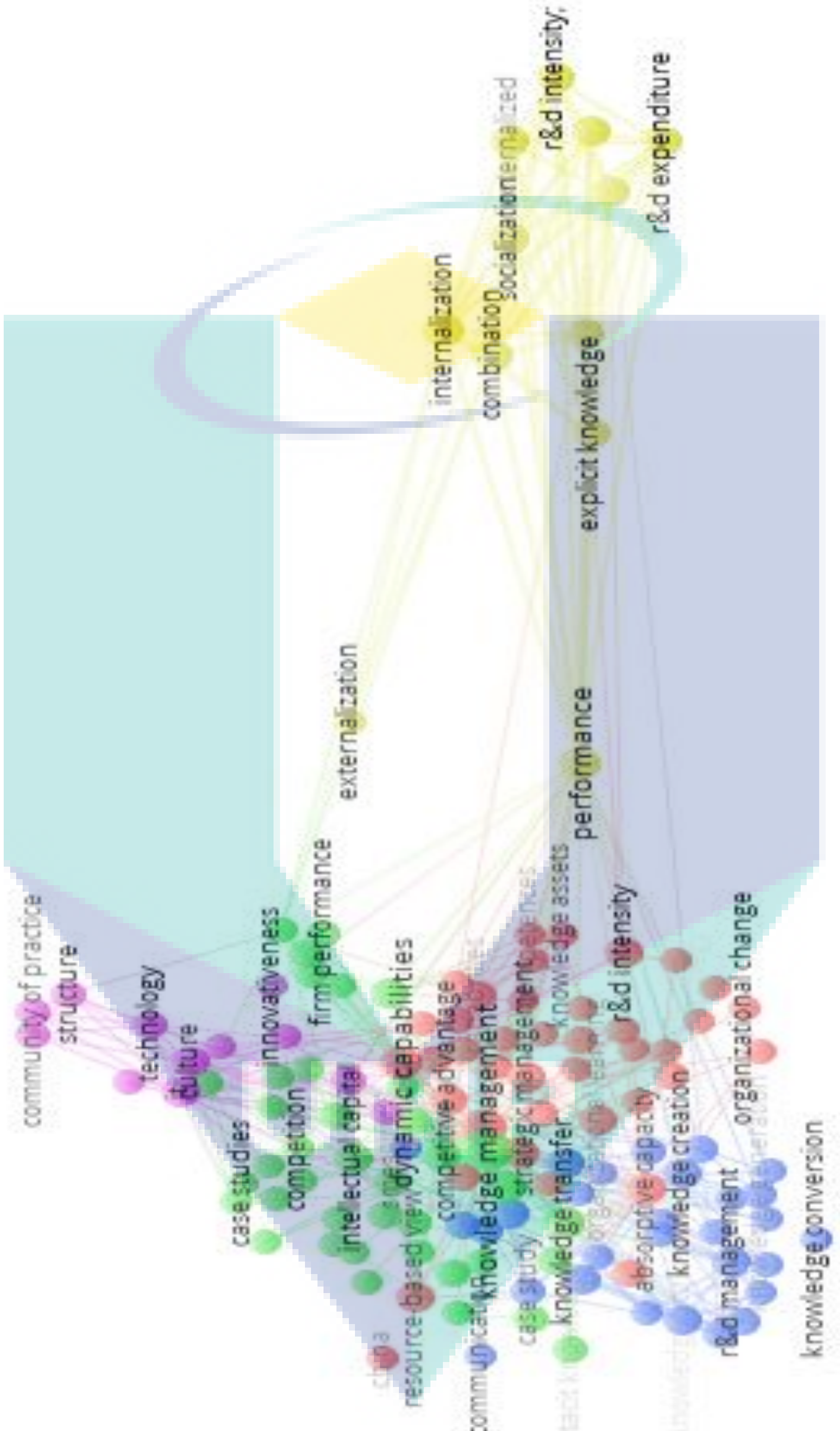

Figure 4.3: VOS viewer Pattern of Knowledge Management Capabilities

It is quit appealing that after extensive analysis cluster 3 (Blue in colour) the nature occurrence-keyword represents closer to knowledge management capabilities.

This cluster more aligned to reflect capabilities closer to processes perspective related to knowledge management some of keywords are represents as: Knowledge sharing, Joint scene-making, Knowledge Implementation, Knowledge Transfer, Knowledge creation, Knowledge generation, Knowledge protection, Knowledge Acquisition, Knowledge Utilization. While, cluster 4 (yellow in colour) expended with in-depth focus on occurrence-keywords reflects more strategic aspect related to knowledge management capabilities along with internal and external organizational dimensions some of key trends are represents as: External knowledge sourcing; internal knowledge sourcing; explicit knowledge; joint learning internal collaboration; joint learning external collaboration; Externalized; Internalization; Combination; Socialization; R&D expenditure.

At last, cluster 5 in (Pink in colour) the pattern of occurrence keywords that directly referred to infrastructure that arrange comprehensive knowledge infrastructure interface with firms existing culture and structure some of trends are represents as Organizational learning; Culture; IT; Community of Practice; Technology; Structure; People; Contribution of skills & expertise

This study explores new opportunities in knowledge management capabilities as catalyst that shares the influence with R&D. Not only has that it also, led researcher to understand all the assessment and validation towards new practical evolution that retain R&D competitiveness. After careful consideration there are some studies emerges that closely relates with topics as shown in Table 4.3

Table 4.3 KM capabilities Dimensions

Authors	Process	KM infrastructure	Strategy
Denicolai et al. (2016)	N/A	N/A	External Knowledge source Internal Knowledge source
Bäck and Kohtamäki (2016)	Knowledge sharing Joint scene-making Knowledge Implementation	N/A	Joint learning : internal collaboration External collaboration
Žemaitis (2014)	Knowledge Transfer	N/A	Tacit Knowledge (Personalization) Explicit Knowledge(Codification)
Potgieter et al. (2013)	Knowledge sharing Knowledge creation	Organizational learning Culture Structure	K.M strategy: Personalization (Human-oriented)
He-jiang (2013)	Knowledge Acquisition	N/A	N/A
Zammit and Woodman (2012)	N/A	N/A	Codification Personalization
Camelo-Ordaz et al. (2011)	Knowledge Sharing Organization commitment	N/A	HRM Practices Performance
Satyanarayan and Azumah (2011)	Knowledge generation Knowledge protection	Culture IT Community of Practice	Codification
Jain et al. (2010)	Intellectual knowledge portfolio	-Contribution of skills & expertise -Novelty & uniqueness of innovation -Role of leadership innovation & supports	-R&D expenditure - Success rate of R&D products R&D intensity
C. Liao, H.-Y. Wang, S.-H. Chuang, M.-L. Shihand, et al. (2010)	Knowledge Creation Knowledge Sharing Knowledge Utilization	Technology Structure Culture People	N/A

After a vigilant assessment, ten research studies were selected; that characterise three sets of capabilities: (1) process, (2) infrastructure and (3) strategic capability. (1) process capabilities relates as knowledge management recognized as an, effective process that influence to R&D in order to sustain the core competencies for developing new set of Skill and knowledge through the comprehensive transformation of implicit knowledge into open knowledge. (2) Similarly, the KM infrastructure capabilities translate long-term organizational goals based on new knowledge as an R&D fundamental source. While, (3) KM strategic capabilities encourage the organizations to maintenance of knowledge as the exceptional strategic factor as for sustainable growth. From the existing literature, numerous practitioners and researchers have examined critical resources that drive KM capabilities that share its influence on R&D. Therefore, the comprehensive bibliometric extraction as shown in Table 4.4-4.6

Table 4.4 Internal Determinates of KM dimension under R&D scope

		Enablers	Description	References
Knowledge Management Capability	Process	knowledge Acquisition	The process which is use to enables firms regarding knowledge from external sources.	(Burton-Jones, 2000);(Satyanarayan & Azumah, 2011),(Yli-Renko, 2001)
		Intellectual knowledge portfolio	The process of intellectual knowledge used as potential indicator to measure R&D knowledge management capability. Intellectual knowledge relies on number of innovative product count and number of scientific linkage in shape of patent, publications and number citation.	(Carayannis & Provance, 2008a; Daniels & Smits, 2005), (Wang et al., 2007b), (Jain et al., 2010)

Table 4.4 Continued

		Enablers	Description	References
Knowledge Management Capability	Process	Knowledge sharing	Define as process to exchange knowledge through official and unofficial coordination among customer, suppliers and customer.	(Chang, 2007; Selnes & Sallis, 2003), (Corsaro et al., 2012), (Garvin, 1993; Kohtama¨ki & Bourlakis, 2012.), (Gro¨nroos, 2013)
		Joint scenes Making	The process through which collaborative parties can mutually interact with respect to their ability under define step of rules.	(Echtelt et al., 2008), (Weick, 2005), (Chang & Gotcher, 2007; Huikkola et al., 2013), (Huikkola et al., 2013)
		Knowledge Implementation	It engages in the comprehensive trigging of creation, combination, sharing, and transformation of knowledge among individuals.	(Crossan & Apaydin, 2010; Kuwada, 1998), (Fang, 2011)
		knowledge Creation	Process through which organizations were looking to expends knowledge capability across functional domain.	(Cuervo-Cazurra & Asakawa, 2010; Gulati & Singh, 1998; Nieto & Santamaria, 2010), (Eisenhardt & Martin, 2000; Shihand, et al., 2010)
		Affective commitment	A process through which individual commitment and personal affiliation with the organizations is consider as prime goal.	(Allen, 1996; Camelo-Ordaz et al., 2011; Hislop, 2003; Meyer, 2002), (Cabrera, and Cabrera, 2005; Hislop, 2003; Kim, 1998; Tagliaventi, 2006)
		knowledge Utilization	The process which enables potential consumption of knowledge capacity that used to illustrate organizational value-added activities.	(Grant, 1996c); (Potgieter et al., 2013); (Liao et al., 2010);(Stefan Güldenberg 2008),(Potgieter et al., 2013)

Table 4.4 Continued

		Enablers	Description	References
Knowledge Management Capability	Process	knowledge Transfer	Knowledge exchange processes among employees, groups of employees or from on organization to others.	(Arvanitis et al., 2008); (Van Zyl et al., 2007); (Brennenraedts et al., 2006)
		Knowledge Protection	The potential process which is used to protect confidential information related to organizational resources such as: Advance knowledge stock, products designs and process designs.	(Satyanarayan & Azumah, 2011);(J. Barney, 1991; Porter-Liebskind, 1996)

Table 4.5 Internal Determinates of KM Dimension under R&D scope

		Enablers	Description	References
Knowledge Management Capability	Infrastructure	Organization Learning	Consider as organizational infrastructure resource for KM that enables organizational transformation due to the knowledge which is generated via organizational practices.	(Miron-Spektor, 2011); (Davies, 2000; Kotnour, 2000); (Tomblin, 2010); (Alasoini et al., 2006)
		Culture	Consider as resource for KM infrastructural capability that engages for shared value and brief that produces norms.	(DeLong, 1997),(Ginsberg, 1998),(Satyanarayan & Azumah, 2011),(Holden, 2002)

Table 4.5 Continued

		Enablers	Description	References
Knowledge Management Capability	Infrastructure	Structure	A KM infrastructural resource that fundamental purpose is used to reduce the individual functionality that creates a physical constrain.	(Shih, et al., 2010),(Choi, 2003), (Nonaka, 1995)
		Technology	Considers as the medium to mobilize the information during the development of new knowledge	(Grant, 1996c),(Scott, 1998),(C. Liao, H.-Y. Wang, S.-H. Chuang, M.-L. Shih, et al., 2010; Sanchez & Mahoney, 1996),(Satyanarayan & Azumah, 2011)
		People	Consider as resource for Infrastructural potential and contributors in successful delivering KM capabilities	(C. Liao, H.-Y. Wang, S.-H. Chuang, M.-L. Shihand, et al., 2010), (Holsapple, 2001; Ndlela & Toit, 2001),(Choi, 2003)
		Community of Practice	Enable as potential resource belongs to KM infrastructural ability that is used for creating virtual or face to face informal meeting for collaborative learning.	(Erasmus, 2005),(Satyanarayan & Azumah, 2011), (Cristol & Mellet, 2013),(Rhéaume & Gardoni, 2016)
		IT	Firm's technical competency reflects as KM infrastructure resources that allow flexible interface with internal and external factors.	(Fink & Neumann, 2007),(Bharadwaj, 2000; Byrd et al., 2000; Chuang et al., 2005)

Table 4.5 Continued

		Enablers	Description	References
Knowledge Management Capability	Infrastructure	Contribution of skills & expertise	Competences and proficiencies may contributes to sustain a coordinated implementation of assets and resources as infrastructural strength that enabling the firms to utilize potential competencies and unique skills for competitiveness	(Mohammed et al., 2017), (Blomqvist, Harkink, Kuittinen, et al., 2004; Jain et al., 2010)
		Novelty & uniqueness of innovation	Novelty or uniqueness normally reflects R&D commitment to delivers the product innovativeness through certain modification on existing products.	(Freel & Jong, 2009), (Tödtling et al., 2008), (Jain et al., 2010)
		Role of leadership innovation & supports	Consider as potential resource for KM infrastructure strength. That allows recognizing the role of innovation within the boundaries of organization along with administrative tolerance. It helps in modify the best environment for delivering innovation, where the conflict declaration may be essential.	(Muzamil & Naqshbandi, 2018), (F. Damanpour, 1991), (Jain et al., 2010), (Dodge et al., 2017)

Table 4.6 Internal Determinates of KM Dimension under R&D scope

		Enablers	Description	References
Knowledge Management Capability	Strategies	Tacit Knowledge	A resource that allow firms to inherit personal wisdom and professional experienced that enables firms to get long term strategic goals.	(Nonaka, 1995), (Kidd, 1998),(Stewart, 1997)

Table 4.6 Continoued

		Enablers	Description	References
Knowledge Management Capability	Strategies	Codification	Capturing and storing knowledge in explicit forms. Codified knowledge can easily be transferred from one organizational entity to other organizational entity.	(Zammit & Woodman, 2012); (Potgieter et al., 2013); (Žemaitis, 2014)
		Personalization	Facilitates and encourages knowledge sharing "person-to-person", IT is used to interpersonal communication, connecting people	(Zammit & Woodman, 2012); (Potgieter et al., 2013); (Žemaitis, 2014)
		R&D expenditure	K.M strategic capability that basically allow decision makers to aware about amount of spending on R&D resource and high education	(Murovec & Prodan, 2009b), (Kostopoulos et al., 2011), (Blomqvist, Harkink, et al., 2004a; Elahi et al., 2016; Vitola & Erina, 2015)
		Success rate of R&D products	Success rate of R&D product consider as a resource that indicates profit share on innovative product sale.	(Arora et al., 2008; Jain et al., 2010), (Wang et al., 2008), (Haner, 2002a), (Aziz et al., 2011)
		R&D intensity	R&D intensity basically strategic KM resources that illustrates percentage ratio of researcher and experts over all employee, pattern of technology trends in filed patents over an year, technical skill employees, individual innovativeness and the efficiency of innovative development.	(Jimenez-Barrionuevo et al., 2011a; Muralidar & Santhanam, 1990; Murovec & Prodan, 2009b), (Jain et al., 2010)

Table 4.6 Continoued

		Enablers	Description	References
Knowledge Management Capability	Strategies	External Knowledge Source	To reduce in house knowledge gaps by acquiring knowledge externally.	(Prodan, 2008), (Gunasekara, 2006), (Keeble, 1999), (K. a. A. S. Laursen, 2006); (Brockhoff, 1992; Pisano, 1990; Shan, 1994), (McGrath, 2013)
		Internal Knowledge Source	Developing new knowledge by utilizing existing knowledge practices	(Prodan, 2008),(Shane, 2000), (Khilji, 2006; Smith, 2006), (Grimpe & Kaiser, 2010)
		Joint internal Collaboration	An opportunity to interface with the capability of isolated subdivisions	(Andersson, 2003; Mcevily, 1999; Yamin, 2011),(Kohtamäki, 2016)
		Joint External Collaboration	Proficiency to interface and switch the valuable knowledge to their partners	(Huikkola et al., 2013), (Kogut, 1996), (Brennan, 1999; Walter, 2003), (Walter, 2003), (Van Echtelt, 2008; Wagner, 2006; Walsh, 1995), (Moorman, 1997); (Kohtamäki, 2016)
		HRM	Promoting individuals to exchange knowledge	(Cabrera et al., 2006); (Cabrera, 2005);(Camelo-Ordaz et al., 2011)
		Innovation Performance	The potential resource which indicate internal and external sourcing that become positive gain to overall innovation activity	(Kaiser, 2010), (Barthélemy, 2006; DeSarbo, 2005), (Howells, 2006; Howells et al., 2008)
		Explicit	A potential knowledge source that comprised of technical data sets, academic facts, mathematical expression scientific notation and patents	(Liebowitz & Wilcox, 1997), (Potgieter et al., 2013),(Satyanarayan & Azumah, 2011),(Žemaitis, 2014)

From the recent findings, some of emerging trends draw within R&D context allows to address process capabilities related to KM, which include (Knowledge sharing, knowledge implementation, knowledge transfer, Joint-sense-making, knowledge creation, organizational commitment, knowledge protection, knowledge identification, and knowledge exchange). Similarly, finding also includes some of trends that were focuses on enabling technologies that conceived as potential resource for infrastructure capability related to KM that interface with firms' existing cultures and structures. In this manner, some publication topics mainly stressed certain general perspectives of firms' existing capabilities (technology, People, organizational culture, organizational structure, the community of practices, and employees). Lastly, it also shows some of strategic aspect of knowledge management capabilities in addition to internal and external organizational dimensions. These researcher trends allow researchers to emphasis on knowledge sharing through inter-functional integration such as: implicit knowledge, joint learning internally, and internal functional collaboration

4.4 Classifiying Innovation Management Capabilities

The innovation management capabilities strongly referred as firms core ability that allow to manage R&D for new product development (Laurindo, 2016).

In simple words, innovation management capability is not only sufficient for radical innovation at governmental level, but it also promotes science and technology to enhance R&D competitiveness in order to create new innovative products.

For example accommodating accessibility toward internal and external collaboration, encouraging relevant environment for social exchanges, and strong research support mechanism (Serje Schmidt 2016).

Since, innovation has been recommended as the major contributor on public sector firms to drive overall innovation mechanism at governmental level (Dutta et al., 2014; OECD, 2007b; Van de Ven, 1986). This study suggested new opening in Innovation management capabilities as potential booster to enhance R&D

competitiveness, with all the estimation and justification that leads towards new practical progression.

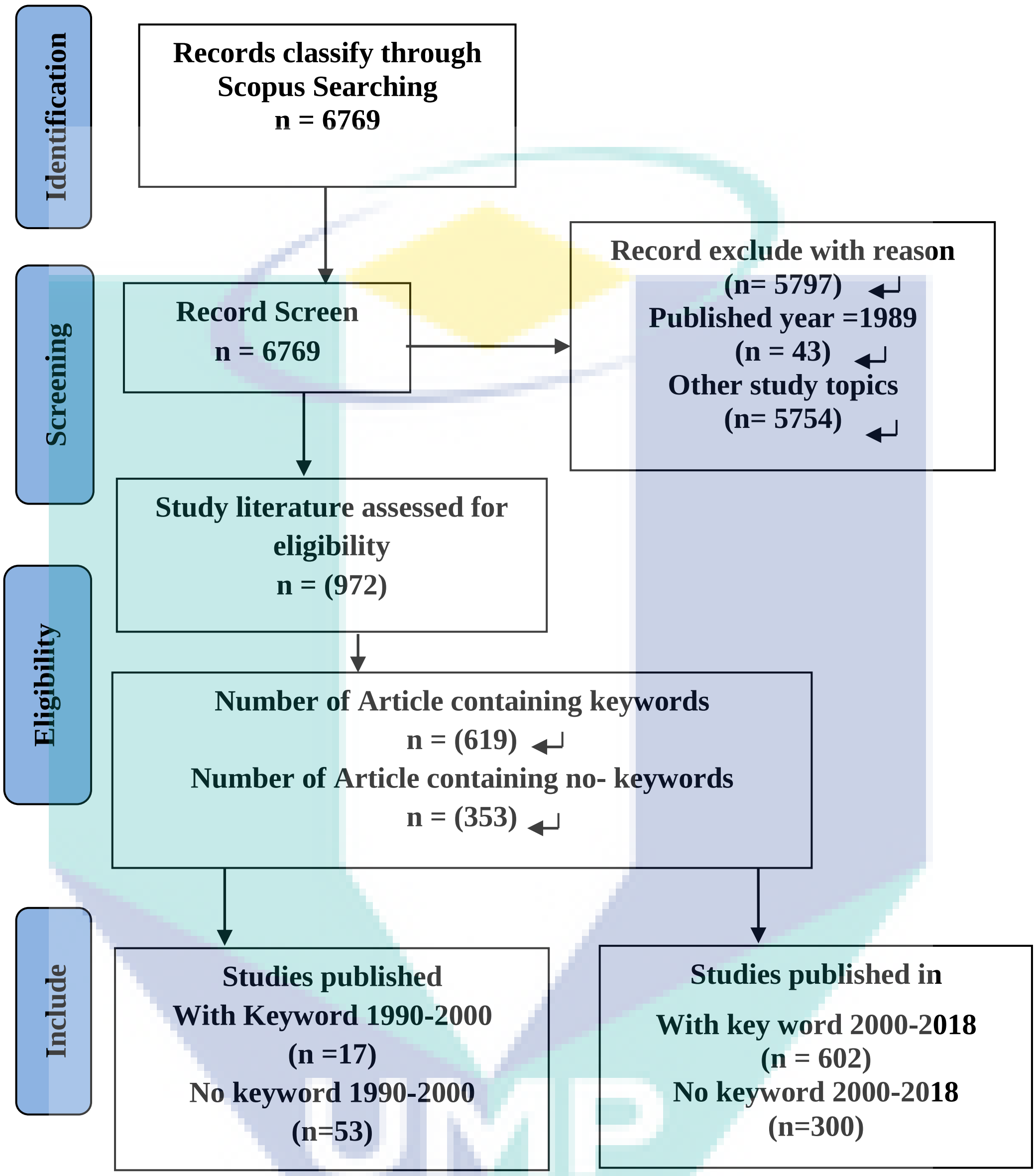

Figure 4.4 Flow diagram for Innovation Management Capabilities during 1990–2018

This research accepted 6769 relevant articles by systemically searching the Scopus Database. After removing research article that were not fulfill the eligibility criteria based on PRISMA already discuss during in chapter 3, a total of 972 articles were recognized. Research articles with author-supplied keywords (n=619) from the 1990-2018 period and research studies without Keywords (n=353) from the 1990-2018 period were analyzed. The research articles were analyzed on the based on Tiles, Keywords and Abstracts. Because of the characteristics described in the eligibility criteria, we excluded a total of 5797 articles. The comprehensive representation of the record exclusion at each stage is shown in Figure 4.4. The outcome of bibliometric visualization of Innovation management capabilities from the sequential point of view is drive from the smart configuration of key phrases with unique typological pattern used to apply during the advance searching string as we discuss earlier. The analysis highlighted the 1990 to 2018 period, is shown in Figure 4.5.

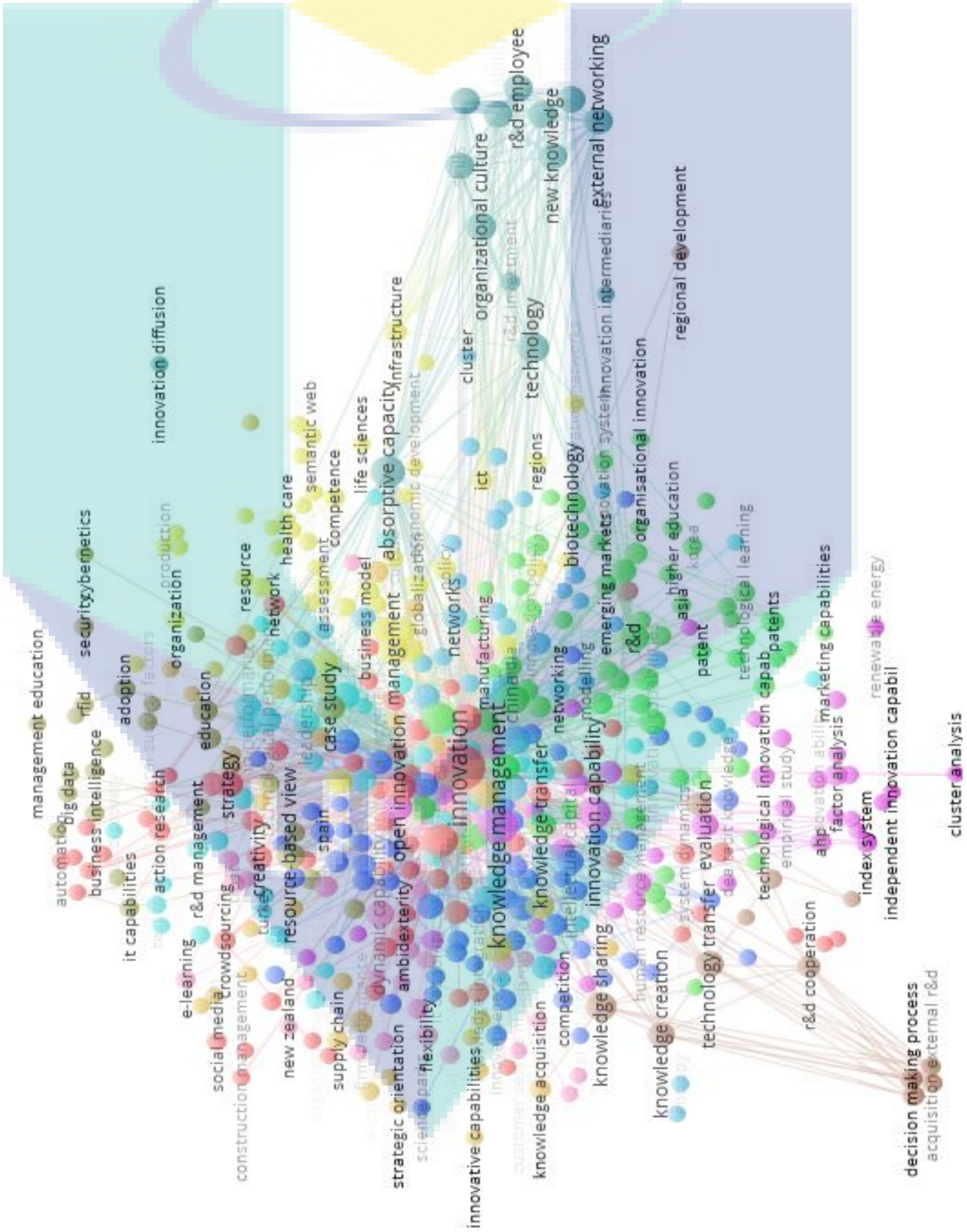

Figure 4.5 VOS viewer Pattern of Innovation Management Capabilities

Although 9394 authors supplied keywords, only 480 meet the threshold minimum 5; therefore, nearly 9394 author supplied keywords were traced from the corpus. The 480 keywords were split into 5 clusters. A basic descriptive analysis is shown in Table 4.7 (Note: Appendix I)

Table 4.7 Descriptive Analysis 1990 -2018.

Descriptive Analysis 1990 -2018		
years	1990-2000	2001-2018
Total Paper	70	902
Minimum no of keywords	66	873
Minimum occurrence	3	5
Minimum Threshold	3	26
Highest total link strength	6	219
Highest occurrence	6	51

The outcome of VOS viewer pattern based on 12 clusters, the group of keywords in these clusters helps researcher to characterize some of emerging research themes. The complete sketch of some of the clusters highest occurrence of keyword where shown in (Appendix-F). Currently, with in research domain of IMC (Innovation management capabilities), most clusters relates to diverse research themes for instance clusters 1 shows keywords that belong to "Business Administration and business performance", cluster 2 focuses more on towards themes which addresses technological aspect of IM which allow to setting up overall firms "technological strategies and initiatives for innovation". While cluster 3, represents some of the key trends that were more aligned towards 'innovation competitiveness' that represents innovation diffusion as tool for IM. The cluster 4 shows some of emerging themes that belongs towards "innovation policy". In case of cluster 5, it used to represents core concepts that associate innovation management with corporate governance. The cluster 6 represents some of emerging concepts that used to measure innovation and technological performance at organizational and functional level'. The cluster 7 reflects some of emerging trends that used to illustrate the commercial aspects of IM. In case of cluster 8, it highlights trends that enable the role of innovation management related to 'supply chain'. The cluster 9 emanates some of key trends that used to draw the relationship between IM and IT in case of handling 'Big data' and cloud computing'. The clusters

10 highlights some of IM themes belong to address manufacturing flexibility'. The cluster 11 refers to process capabilities related to IM such as knowledge sharing process, knowledge creation, and technology transfer. The cluster 12 represents the concepts of absorptive capacity as firm core innovation resources

4.4.1 Emerging and disappearing themes (burst detection)

In order to get more specified outcome, the extracted data used for further analysis by applying burst detection technique on extracted dataset in order to explores emerging and faded them. After applying burst detection, technique 26 emerging and fading themes were appearing by exploring title only. While, 29 emerging and fading themes were appear by exploring keywords of extracted data with respect to time frame are shown in Table 4.8.

Table 4.8 Keywords of emergent and fading subjects

latest bursting and disappearing topics					
In the titles					
Word	Level	Weight	Length	Start	End
success	1	2.507393	2	2006	2007
energi	1	2.524447	1	2010	
product	1	6.210285	3	2001	2003
element	1	2.649457	1	2010	
develop	1	2.925772	2	2001	2002
small	1	3.206891	1	2006	2006
organ	1	2.963422	4	2003	2006
2008	1	2.690328	1	2008	2008
2007	1	3.388337	1	2007	2007
nuclear	1	2.61664	2	2003	2004
health	1	2.464596	2	2003	2004
competit	1	2.511899	2	2001	2002
firm	1	2.841077	1	2003	2003
agenda	1	2.489341	4	2001	2004
share	1	2.810559	1	2007	2007
new	1	4.053195	3	2002	2004
tool	1	2.480229	3	2003	2005
continu	1	2.438552	1	2008	2008
integr	1	3.056669	1	2005	2005
compet	1	2.489125	2	2002	2003
key	1	2.679947	5	2001	2005
sector	1	2.697859	4	2003	2006
lead	1	3.392705	4	2002	2005
strategi	1	2.522441	1	1995	1995
success	1	2.507393	2	2006	2007
energi	1	2.524447	1	2010	

Table 4.8 Continued

latest bursting and disappearing topics					
In author supplied keywords					
analysi	1	3.411704	1	2008	2008
success	1	2.507393	2	2006	2007
process	1	3.506707	1	2005	2005
corpor	1	2.736561	2	2003	2004
univers	1	3.135266	1	2008	2008
custom	1	2.731154	1	2006	2006
global	1	2.518794	2	2007	2008
disrupt	1	2.436466	3	2003	2005
internet	1	3.35806	2	2002	2003
strategi	1	2.76029	3	2001	2003
research	1	6.745098	3	2001	2003
technolog	1	4.365171	1	2002	2002
mechan	1	3.207627	1	2010	
continu	1	2.479377	3	2001	2003
compet	1	3.131403	2	2002	2003
collabor	1	2.67418	3	2006	2008
r&d	1	2.088961	1	2012	2012
absorpt	1	2.565614	1	2012	2012
intern	1	2.619999	1	2012	2012
collabor	1	2.67418	3	2006	2008
retract	1	6.510619	1	2010	
mechan	1	3.854026	1	2010	
evalu	1	7.319149	2	2009	
base	1	2.725118	1	2010	
energi	1	2.524447	1	2010	
independ	1	2.923765	2	2009	
proceed	1	2.469733	3	2008	

The start, and end dates explain the emergence and fading indication. If there is no end date, this indicates that the term remains active; when the keyword possesses both start and end dates, it shows the inactive emergence of conditions that less frequently appear among various publications over the period. Currently, in the field of IMC (knowledge management capabilities), the above as show in Table 4.8 trends signify with respect to their occurrence in studies belong to R&D. Therefore, from the co-occurring keyword perspective some of emerging themes are: Evaluation (2010-Active), Base (2010- Active), independent (2009-Active), and retract (2010-Active). These themes are the probable research themes that are very active in the current research patterns. Conversely, there are certain faded themes that are not significant and that follow contemporary research trends less; these keywords are not included in the

Author's supplied keyword list or in the research titles: Development (2001-2002), Competitive (2001- 2002), strategies (1995- 1995), integration (2005-2005), and health (2003-2004). These key words splits into 5 clusters that associated with respect to the nature of their characteristics and co-occurrence is shown in Figure 4.6

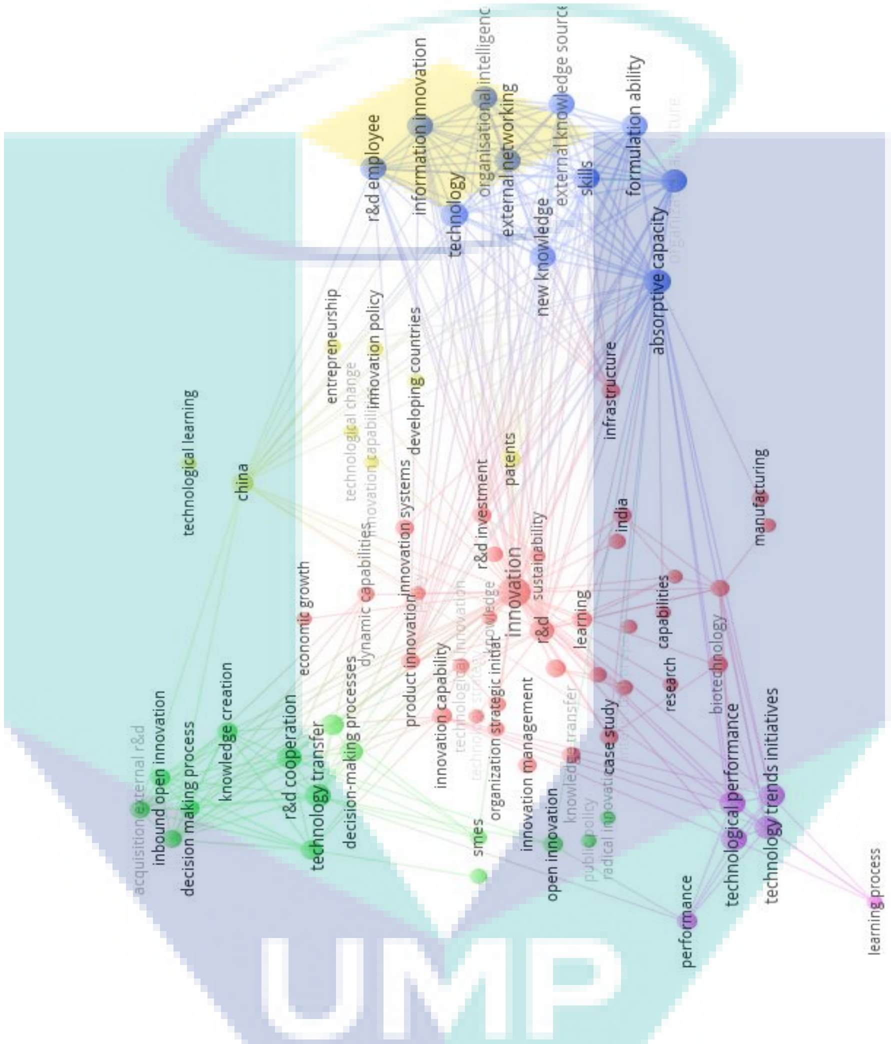

Figure 4.6 VOS viewer Pattern of Innovation Management Capabilities

It has been observe from the huge range of article selected from 1990 to 2018. By applying multi-dimensional scaling (MDS) along with burst detection algorithm explores around 1627 keywords that were screen out. Among 1627 keywords 75 words meet the minimum threshold of 5 occurrences. Among these 75 words there are number of emerging and fading themes appears with respect to select research topic (Nadzar et al., 2017). In case of cluster 2; (Green in colour) represents some of trends that reflect the process aspect of IM capabilities that contributes their influence on R&D. Some of keywords trends includes (R&D cooperation; Acquisition Internal R&D; Acquisition External R&D; Technology Transfer Decision Making process; Knowledge Sharing; Inbound Open Innovation; Project management (control & monitoring) Innovativeness compatibility; Internal & external Knowledge sharing ability; Open Innovation; Knowledge creation process). The cluster 1 and 5 (Red and pink in colour) reflects some of the themes that represents the strategic prospective of IM capabilities these themes includes (IP performance, Technological Performance, Innovative Performance, Technology trends, Organization strategy, Innovation strategies and initiatives. In case of cluster 3 (Blue in colour) represents infrastructural aspects of IM capabilities these themes includes: (R&D investment; External Networking; R&D Employee; New Knowledge; Radical Innovation; External knowledge; Formulation; Absorptive capacity; Knowledge incentives). At last clusters, 4 represents some of key trends related to effective policy development for technological learning among developing countries

- Clusters 2 (Green in colour)

R&D cooperation; Acquisition Internal R&D; Acquisition External R&D; Technology Transfer; Decision Making process; Knowledge Sharing; Inbound Open Innovation; Project management (control & monitoring) Innovativeness compatibility; Internal & external Knowledge sharing ability; Open Innovation; Knowledge creation process. It is quite interesting that after extensive analysis Cluster 2 seems to be observing as an operational agent. Due to characteristics of occurrence-keywords reflect as innovative capabilities was basically influential on developing processes for managing innovation

- Cluster 3 (Blue in colour)

R&D investment; External Networking; R&D Employee; New Knowledge; Radical Innovation; External knowledge ; Formulation; Absorptive capacity; Knowledge incentives. Its seems to be more expending as majority of research studies reflects infrastructural prospective of innovation management capabilities

- Cluster 1 and 5 (Red and Pink in colour)

IP performance, Technological Performance, Innovative Performance, Technology trends, Organization strategy, Innovation strategies and initiatives In similar in case of

Innovation Management this co-occurrence keyword helps to identify the appropriate studies with core concepts of Innovation management capabilities with enablers behind the dominance of Innovation capability with influence on R&D as show in Table: 4.9

Similarly, for Innovation management, after an attentive assessment, the nine selected research articles revealed three sets of capabilities split into several different sub-criteria.

These three sets of capabilities are classified into the following: (1) process, (2) infrastructure, and (3) strategic capabilities for the Innovation management (IM). The innovation-oriented process was split into three segments: front end, new product creation, and induction of new product or services into the market.

The essential scope of innovation management is far broader than the aspects that directly interface during process innovation and research and development. Similarly, (2) Infrastructure capabilities are recognized as the tendency of the firm's innovation capability to create and patent innovations. (3) Strategic capabilities that respond to the time progression enable rapid resource distribution and encourage the execution of R&D goals. Therefore, the overall driving factors are represented in Table 4.10-4.12.

Table 4.9 IM Capabilities Dimension

Authors	Process	IM infrastructure	Strategy
Rodriguez and Wiengarten (2017)	-R&D cooperation -Internal R&D -External R&D	N/A	N/A
Chanwoo Cho (2016)	N/A	-R&D investment, -External Networking -R&D Employee	-IP performance -Technological Performance
Kondratiuk-Nierodzińska (2016.)	Technology Transfer	-New Knowledge -Absorptive capacity	N/A
GarcÃa-Granero et al. (2014)	-Decision Making process -Internal R&D - External R&D	-External knowledge -Formulation	-Innovative Performance
Sáenz et al. (2012)	-Knowledge Sharing (IT, Personal Interaction, Embedded in Management process)	N/A	N/A
Spithoven et al. (2011)	-Inbound and outbound Open Innovation	-Absorptive capacity	N/A
Jain et al. (2010)	-Project management (control & monitoring) -Innovativeness compatibility -Rate of introduction of new product/ service per year -Internal & external Knowledge sharing ability	N/A	-Innovation strategies & initiatives Technology trends assessment
Numprasertchai et al. (2009)	-knowledge creation process	-Knowledge incentives	-Organization strategy
Stüer et al. (2008)	-Inbound Open Innovation	-Radical Innovation	N/A

Table 4.10 Internal Determinates of IM Dimension under R&D scope

		Enablers	Description	References
Innovation Management Capability	Process	Technology Transfer	A process that is utilize for licensing or acquiring skilled knowledge along with technological capabilities.	(Rombach, 2007; Tran, 2009),(Allen, 2014; Dasgupta, 2011; Mom, 2012; Morrissey, 2005),(Sazali & Raduan, 2011)
		Decision Making Process	A process capability that enables assessment mechanism that supports firm's for developing new innovations.	(GarcÃa-Granero et al., 2014),(Damanpour, 1991),(Song, 2005),(Rios, 2011)
		Open Innovation	A process capability that enables a combination of in-house R&D and the knowledge source acquired externally for new innovation.	(Laursen, 2006), (Collins, 2006), (Dahlander, 2010; Huizingh, 2011; Lichtenthaler, 2011; Trott, 2009; Van De Vrande, 2010); (Chesbrough, 2003a)
		Project Management	Describe as process to organize R&D responsibilities in shape of projects rather than performing just simple functional responsibilities.	(Kavanagh, 2009), (Edgett, 2014), (Filippov & Mooi, 2010)
		Innovativeness Compatibility	End customer would acknowledge the innovativeness	(Xiaofen Ji, 2007), (Oostrom, 2013), (Damanpour, 1989; Hall, 1986; Haner, 2002b; Jain et al., 2010)
		Knowledge creation process	The process capability belongs to IM that is used intrinsically based on idea of developing new knowledge concepts.	(Dachs, 2008),(Popadiuk, 2006), (Soo, 2002; Swan, 2000), (Liebowitz, 2000)

Table 4.10 Continued

		Enablers	Description	References
Innovation Management Capability	Process	R&D Corporation	The process that allows collaboration with external stakeholder to enhancing firm's efficiency in shape of managing innovative capabilities for new market.	(Beers & Zand, 2014), (Amara & landry, 2005; Belderbos et al., 2004), (Chanwoo Cho, 2016)
		Internal R&D Acquisition	Consider as resource for process capability that refers to R&D activities within a firm boundary.	(Kim et al., 2014; Liu & Wan-Hsin, 2014),(Santos et al., 2005), (Kale, 2012a)
		External R&D Acquisition	External R&D network consider as resource that drive IM process capability based on relationships with external partners such as research institutions, other firms (local and multinational), and the government.	(Helble & Chong, 2004); (Gulati, 1998; Gulati et al., 2000; Holm et al., 1999)
		Knowledge Sharing	Knowledge sharing consider as main indictor in forecasting the success of knowledge sourcing. A resource that allow Firm's to predict the requirement of new knowledge from external source	(Cummings, 2004), (Kim, 2012), (Ford, 2003; Lee, 2002), (Shu-hsien Liao, 2007), (Weenen, 2004), (Quinn et al., 1996)

Table 4.10 Continued

		Enablers	Description	References
Innovation Management Capability	Process	Internal & external Knowledge sharing ability	It considers as resource that drive process capability belongs to innovation management. The main criteria for internal and external knowledge sharing ability depends on the potential intensity to collaborate with external R&D units through knowledge networking and newness of innovation related to firms and new to market	(Blomqvist, Harkink, et al., 2004b; Wang et al., 2007a), (Carayannis & Provance, 2008b), (Svetina & Prodan, 2008)
		Rate of introduction of new product/ service per year	Process driven resource that normally estimated number of patents registered as criteria	(John Hagedoorn, 2003), (Freeman, 1997), (Acs, 1989; Ahuja, 2001; Archibugi, 1992; Ernst, 2001; Freeman, 1997; Grupp, 1994.; Lanjouw, 1999; Stuart, 2000; Trajtenberg, 1990), (Singal, 2010)

Table 4.11 Internal Determinates of IM Dimension under R&D scope

		Enablers	Description	References
Innovation Management Capability	Infrastructure	R&D Investment	A resource that is used to drive IM infrastructural capabilities as a potential input for R&D in order to generate intangible returns on investment in shape of product innovation.	(Deepika rohatgi, 2016), (Yasemin, 2006),(Peters, 2009),(Chanwoo Cho, 2016)

Table 4.11 Continued

		Enablers	Description	References
Innovation Management Capability	Infrastructure	External Networking	Firms expend their potential knowledge in order to starching their innovative ability.	(Brunswicker, 2014; Chesbrough, 2003c; Chesbrough & Crowther, 2006), (Harold Alvarez 2015),(Antikainen, 2010),(Freeman & Soete, 1997)
		R&D Employee	Potential resource that drives R&D inputs that in order to estimate firm's percentage of R&D expenses over R&D staff.	(Albaladejo, 2000),(Fan, 2006) ,(Chanwoo Cho, 2016),(Edler et al., 2016)
		Absorptive capacity	Organizational ability absorbs external knowledge.	(Cohen & Levinthal, 1990a) , (Veugelers, 1997) , (Lane, 2006),(George, 2002), (Chiara Franco, 2012),(Raisch, 2009)
		New knowledge	A potential resource that is used to drives IM infrastructure capabilities in search of technical knowledge in order to carry forward long term innovation processes.	(Prajogo, 2006), (Bukhamsin, 2015), (C. Liao, H.-Y. Wang, S.-H. Chuang, M.-L. Shihand, et al., 2010), (Kale, 2012b), (Wamae, 2009), (Kondratiuk-Nierodzińska, 2016.)
		External Knowledge Acquisition	A compatible tool that allow firms to drives infrastructure capabilities related to IM and enables technical know-how according to market competitor.	(Brunswicker, 2014; Chesbrough, 2003c; Chesbrough & Crowther, 2006), (Harold Alvarez 2015),(Freeman & Soete, 1997),(Antikainen, 2010)

Table 4.12 Continoue

		Enablers	Description	References
Innovation Management Capability	Infrastructure	Formulation	Resource that drive infrastructural capabilities related to I.M used in order to strengthen existing operational processes and bound employee's liberty not to diverge from standard procedures	(Chang, 2012; GarcÃa-Granero et al., 2014; Jansen, 2006), (Benner, 2003; Benner, 2002)
		Knowledge Incentive	Ability that drives infrastructural capabilities related to I.M and enable rewards scheme for R&D to encourages R&D employees to put their effort	(Lerner, 2007), (Numprasertchai et al., 2009), (Coombs, 1991), (Lévêque & Ménière, 2004)
		Radical Innovation	Radicalness" consider as resource that enables firms to oversee emerging technologies and allow them to adapt with rapid pace.	(Chandy & Tellis, 2000; Slocum & Rubin, 2008),(Garcia, 2002)

Table 4.12 Internal Determinates of IM Dimension under R&D scope

		Enablers	Description	References
InnovationManagement Capability	Strategy	Innovative Performance	Ability to drive strategic capability related to IM that purely draw organizational financial performance which include share price, profit and capital return on investment.	(Calantone, 2002),(Tidd, 2001),(Lawless, 1996),(Subramanian, 1996),(Gopalakrishnan, 2000)

Table 4.12 Continued

		Enablers	Description	References
Innovation Management Capability	Strategy	Innovation strategies & initiatives	Resources that drive strategic capabilities belong to IM, and allow firms to integrate appropriate knowledge with current operational activities.	(George et al., 2002; Zahra, 2002),(Oana Branzei a, 2006), (Chesbrough, 2003b), (Fey, 2005),(Evangelista, 1997),(Burgelman, 2004),(Wang, 2007), (Hollenstein, 1996), (Blomqvist, 2004)
		Technology Trends	Consider as firm strategic instrument to drive IM strategic capability by enabling technological forecasting methods that estimate future trends.	(Yoon, 2012), (Martino, 1993),(Jain et al., 2010),(Coates, 2001; Griliches, 1990; Pianta, 1996)
		Organization strategy	Resource that used to enables strategic alignment at organizational level and allows R&D for crafting prosperous innovation mechanism.	(Danny Samson Benn Lawson, 2001),(Reichstein & Salter, 2006),(Numprasertchai et al., 2009),(Schroeder, 1990)
		Intellectual Property Performance	Ability of R&D firms to strengthen intellectual property rights as major means for firm's strategic ability, in order to manage efficient innovation management.	(Choong, 2008), (Edler et al., 2015), (Doyle & O'Connor, 2013; Edler et al., 2015; Schwab et al., 2011; Stern, 2003)

Table 4.12 Continued

Innovation Management Capability	Strategy	Enablers	Description	References
		Technological performance	Firm's innovational resource that drive IM capabilities under strategic means and relates R&D with overall innovational ability for instance: R&D expenditures and Patent data	(Jimenez-Barrionuevo et al., 2011b; Kostopoulos et al., 2011), (Sher & Yang, 2005), (Antonio et al., 2010; Jacobsson et al., 1996)
		External R&D Function	A resource that drives firm strategic capabilities related to innovation management. Purely depends upon the ability to understand intrinsic R&D relationship with external collaborators.	(Helble & Chong, 2004); (Gulati, 1998; Gulati et al., 2000; Holm et al., 1999)

The selected articles from 1990 to 2018 were illustrated and divided into three different areas of innovation management capabilities (IMC) with respect to their similar characteristics; First research area directly refer as: Process capabilities, which includes (Technology transfer, Project management, Decision Making process, Open innovation, knowledge creation process, compatibility and Rate of Introduction of new product). The second research area refer to drive infrastructure capabilities related to innovation management that is required for the R&D function to strengthen their competencies that interface with existing capabilities. In this manner, publication topics have mainly focused on several different dimensions that directly relate to the R&D such as (R&D intensity, External Networking, Employee learning, new knowledge, Absorptive capacity, Formulation, Internal and external knowledge sharing, organization strategy, Incentives, and Knowledge management). The third research areas were fall to drive strategic capabilities relate to Innovation management, this research area includes: (Performance, Innovation capability, own R&D function, Innovation strategies Initiative, Technology Assessment, and R&D capabilities)

4.5 Classifying Technology Management Capabilities

In most recent studies, extensive bibliometric analyses related to Technology management (TM) have been performed to represent general trends on TM (Pilkington, 2014); however, these studies have been unable to identify the core capabilities that were involved contributing their influence on R&D competitiveness.

Many studies highlight specific research areas adjacent to technology management. For instance, Culnan (1986) applies a co-citation strategy to identify the fundamentals of IS (information system) and canvases the area of research to create more resemblance of an information system rather than more specific to organizational learning.

Similarly, Karki (1996) investigates the pillars of the sociology of sciences literature and identifies the unique relationship between information scientists and sociologists, who share creative ideas only when they scholarly interact with each other. The closest study that discusses the extensive analysis on Technology management (TM) through the bibliometric review is Pilkington 2014, which illustrates the various trends of technology management over the 2007 to 2014 period.

Somewhat unpredictably, all this existing literature they identifies the utilization of TM with a diverse approach to draw general perspective of TM; however, they rarely classify the resources that drive capabilities related to Technology Management (TM).

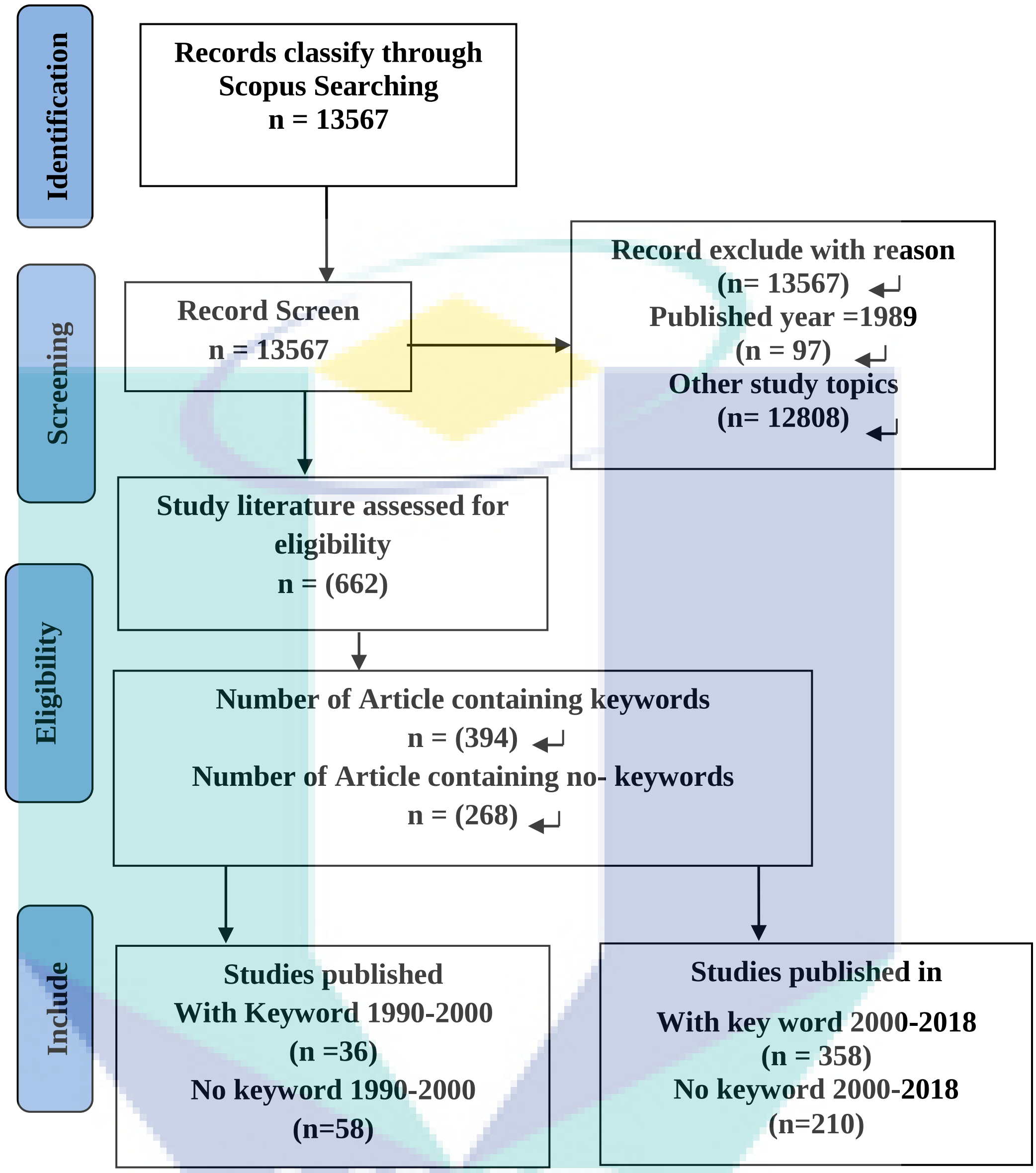

Figure 4.7 Flow diagram for Technology Management Capabilities during 1990–2018

We accepted 13567 relevant article by systemically searching on Scopus Database (n=13567). After removing research article that were not fulfill the eligibility criteria based on PRISMA already discuss during in chapter 3, a total of 662 non - duplicate articles were recognized, Number of research article with author supplied keywords (n=394) from period 1990-2018. While, the number of research studies without Keywords (n=268) from period 1990-2018 were also analyzes. Research article analyzes on the bases of Tile, Keywords and Abstract. Because of the characteristic of acknowledge in eligibility criteria, we exclude overall 12808 article. The comprehensive representation of the record exclusion at each stage is shown in the PRISMA diagram Figure 4.7. Similarly, to trace the potential literature on technology management capabilities, a logical configuration of key phrases with a unique typological pattern was employed in the advanced searching string, which was discussed earlier. The analysis highlighted the 1990 to 2018 period, as shown in Figure 4.8. (Appendix I)

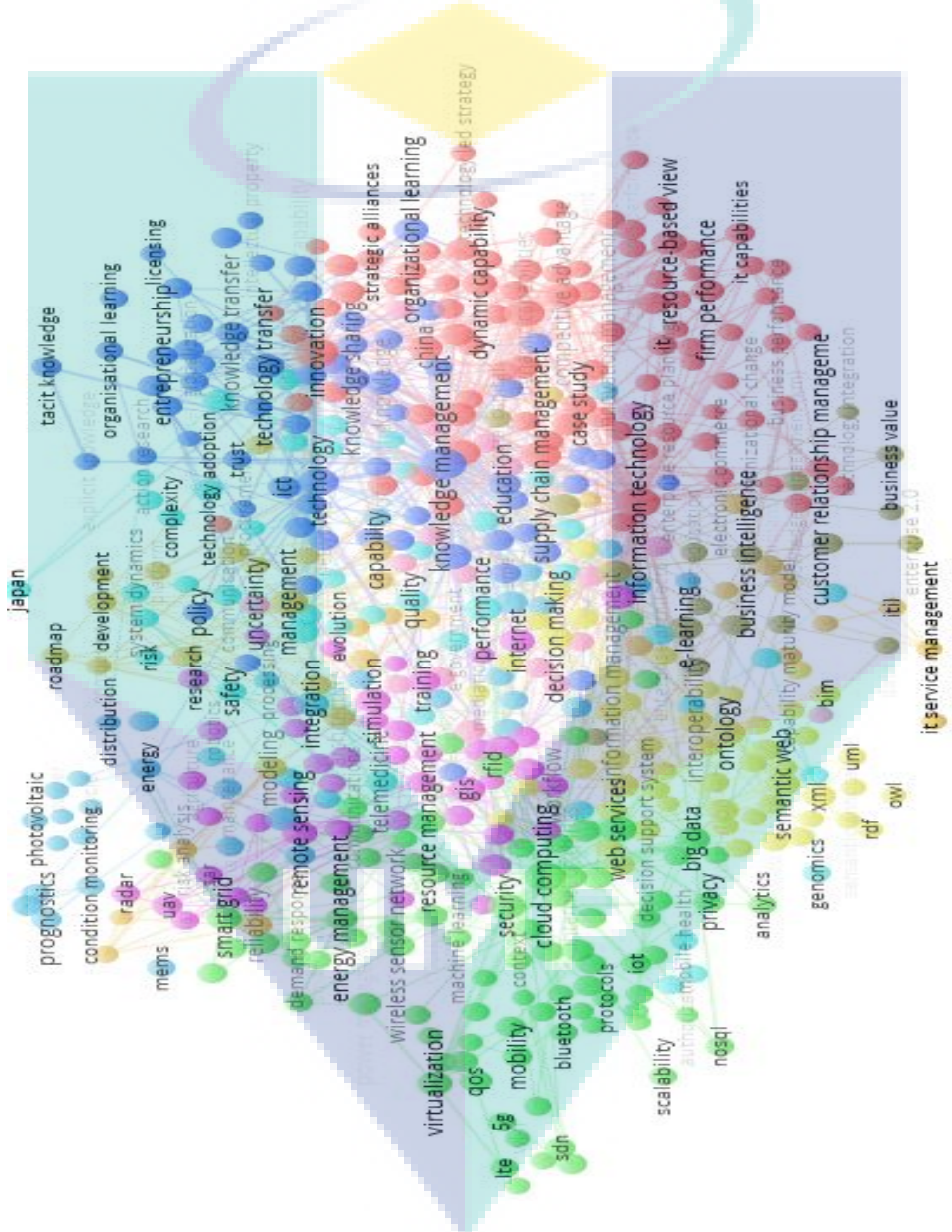

Figure 4.8: The term maps from period of 1990 to 2018

Table 4.13 Descriptive Analysis 1990 -2018

Descriptive Analysis 1990 -2018		
years	1990-2000	2001-2018
Total Paper	94	568
Minimum no of keywords	152	1129
Minimum occurrence	3	5
Minimum Threshold	4	35
Highest total link strength	9	389
Highest occurrence	3	37

The 10 clusters shown in Figure 4.8 the group of keywords in these clusters helps researcher to identify the overall connectivity with the emerging research theme. Table 4.13 represents the complete descriptive analysis. The complete sketch of some of the clusters highest occurrence of keyword where shown in (Appendix-F).

Currently, with in research domain of TMC (Technology management capabilities), most clusters relates to various research trends for instance clusters 1 shows keywords that belong to "Business strategy, business performance", cluster 2 more focus towards computer networking and mobility management while cluster 3 more emphases on "knowledge creation ", cluster 4 more relate towards "determining and distributed system", while cluster 5 shows core concepts of crisis management and risk management. In case of cluster 6 and 7, they describe telemedicine and health management system. Cluster 8 more relates toward "IT service, process modeling and IT governance". Cluster 9 emphases more on towards business intelligence and business value; cluster 10 reflects more emerging themes related to information security and intelligent agent.

4.5.1 Emerging and disappearing themes (burst detection)

In order to get more specified outcome, the extracted data used for further analysis by applying burst detection technique on extracted dataset in order to explores emerging and faded them. After applying burst detection technique almost 47 to 50 emerging and fading themes were appear by exploring title. While, 50 emerging and faded themes were appear after exploring keywords with respect to time frame is shown in Table 4.14

Table 4.14 keywords of emergent and fading subjects

latest bursting and disappearing topics					
In the titles					
Word	Level	Weight	Length	Start	End
volum	1	4.663473	2	2012	2013
util	1	2.377221	1	2013	2013
softwar	1	2.205353	1	2014	2014
system	1	4.108759	1	2013	2013
design	1	3.430824	2	2015	
19th	1	2.535035	1	2013	2013
17th	1	2.53569	1	2011	2011
2011	1	5.13143	1	2011	2011
compani	1	3.287214	1	2011	2011
2010	1	2.502768	1	2010	2010
2013	1	6.568964	1	2013	2013
america	1	2.784436	3	2011	2013
decis	1	2.08223	1	2010	2010
amci	1	2.784436	3	2011	2013
confer	1	2.12198	2	2012	2013
inform	1	6.198066	1	2013	2013
adopt	1	2.36177	2	2013	2014
ici	1	2.21862	1	2013	2013
organis	1	2.273573	2	2012	2013
role	1	4.4471	7	2011	
busi	1	2.933504	3	2001	2003
capable	1	5.761972	3	2015	
product	1	4.999968	11	1990	2000
Enterprise	1	5.227033	5	2013	
design	1	4.710003	3	2013	2015
2012	1	6.499614	1	2012	2012
2011	1	6.32575	1	2011	2011
manufacture	1	8.434381	15	1985	1999
2013	1	7.731247	1	2013	2013
America	1	7.832402	3	2011	2013
manag	1	4.454555	3	1987	1989
inform	1	8.727171	1	2013	2013
acquisition	1	4.499209	11	1996	2006
ici	1	4.052319	3	2011	2013
18th	1	3.887223	1	2012	2012
volum	1	9.277554	4	2010	2013
system	1	7.586908	2	2012	2013
strateg	1	3.903115	1	1995	1995
innov	1	4.33185	2	2010	2011
electron	1	4.8662	13	1991	2003
decis	1	5.130489	2	2010	2011
amci	1	7.997926	3	2011	2013
confer	1	11.78668	3	2011	2013
emerg	1	5.903353	4	2011	2014
softwar	1	2.183268	1	2014	2014
compani	1	3.796763	1	2011	2011
decis	1	2.344426	1	2010	2010

Table 4.14 Continued

latest bursting and disappearing topics					
In the Keywords					
Word	Level	Weight	Length	Start	End
framework	1	2.394371	2	2015	
design	1	2.111547	3	2014	
led	1	2.577693	1	2011	2011
Technology breadth	1	2.396732	2	2013	2014
emerg	1	2.396732	2	2013	2014
govern	1	2.396569	1	2014	2014
framework	1	2.101704	2	2015	
led	1	2.621172	1	2011	2011
plan	1	2.680235	1	2013	2013
posture	1	2.396569	1	2014	2014
process	1	4.812644	5	1998	2002
manufacture	1	4.914048	4	2004	2007
Technology level	1	4.885668	2	2014	2015
strategi	1	8.30742	12	1990	2001
electron	1	4.308646	12	1992	2003
dynam	1	4.732141	2	2014	2015
analysi	1	3.732285	1	2008	2008
area	1	3.043425	4	2007	2010
busi	1	2.933504	3	2001	2003
micro grid	1	3.685219	4	2014	
smart	1	2.96581	2	2016	
Techno timing	1	4.281443	1	2014	2014
virtual	1	3.256993	2	2011	2012
execute	1	2.944126	3	2011	2013
leadership	1	2.97387	2	2012	2013
acquisition	1	2.924045	3	2003	2005
storage	1	2.948039	4	2014	
cloud	1	3.628274	5	2013	
big	1	2.985318	4	2014	
framework	1	2.394371	2	2015	
control	1	4.186465	1	2014	2014
brand	1	3.146538	2	2012	2013
power	1	3.166639	4	2014	
inform	1	2.842111	1	2013	2013
adopt	1	2.397288	2	2013	2014
organis	1	2.559503	2	2012	2013
intellig	1	3.170296	2	2008	2009
compani	1	4.643708	1	2011	2011
step	1	2.931369	4	2003	2006
web	1	3.337052	6	2002	2007
orient	1	2.912103	2	2006	2007
data	1	3.684005	3	2012	2014
chang	1	3.339958	2	2002	2003
program	1	3.620025	4	2001	2004
engin	1	4.391811	2	2007	2008
captur	1	3.005358	1	2015	2015
model	1	3.050095	1	2015	2015
control	1	2.992354	1	2014	2014
mission	1	3.686478	3	2004	2006
outsourc	1	3.964885	5	2005	2009
assess	1	3.492136	4	2001	2004

The start, and end dates explain the emergence and fading indication. If there is no end date, this indicates that the term remains active; when the keyword possesses both start and end dates, it shows the inactive emergence of conditions that less frequently appear among various publications over the period.

Therefore, some of active emerging theme are: Framework (2015-active), design (2014- active), Microgrid (2014-active), Smart (2016-active), storage (2014-Active), cloud (2013-active), Big (2014- active), Power (2014-active), capability (2015-Active).

These are the probable research themes that are very much active in current research pattern on the other hand there are some fade theme that not significant and less followed on contemporary research trends such keywords are unsuccessful to be included either the part of Author's supplied keyword list or in research titles:

dynamic (2014-2015), Analysis (2001- 2002), strategies (1990- 2001), technology Breadth (2013-2014), emergence (2013-2014), technology level (2014-2015), execution (2011-2013), technology posture (2014-2014), leadership (2012-2013), acquisition (2003-2005), technology timing (2014-2014), model (2015-2015), control(2014-2014), mission (2004-2006), Assess(2001-2004), outsource (2005-2009).

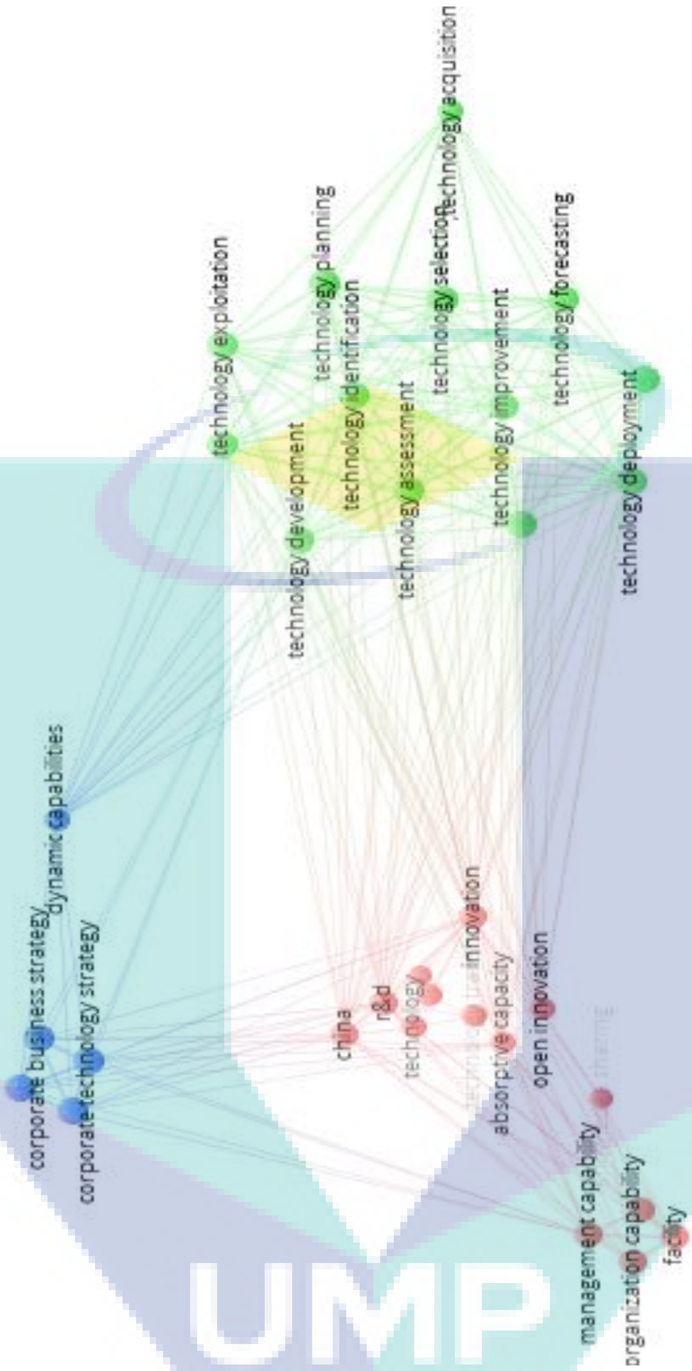

Figure 4.9 VOS viewer Pattern on Technology Management Capabilities

From Figure 4.9, It has been observed from the range of articles selected from 1990 to 2018, 3 cluster appear to be linked to due to the frequent appearance of co-occurrence keywords therefore with respect to the nature of their appearance these co-occurrence keywords represented with three different colour with regard to highest co-occurrence some of the keywords belong to these clusters for instance: The cluster 1 (Red in colour) includes (Management Capability; Facility; Organization capability; Personal skill) more align to represents capabilities that translates infrastructural perspective of TM. While, cluster 3 (Blue in colour) comprises (Strategic Technology Road Mapping; Descriptive capacity; Corporate Technology Strategy; Corporate Business Strategy; Technology Alliance Strategy), which is more aligned toward capabilities that translates strategic perspective of TM that adequately involve in R&D as supporting management discipline.

On the other hand, cluster 2 (Green in colour) visualizes more closes to capabilities represents process perspective of TM that contributes their significance on R&D (Technology Acquisition, Technology Exploitation, Technology Identification, Technology learning, Technology Protection, Technology Selection)

Cluster 1 (Red in colour): Management Capability; Facility; Organization capability; Personal skill: It is used to drive capabilities that refer infrastructure perspective of TM.

Cluster 2 (Green in colour): Technology Acquisition; Technology Exploitation; Technology Identification; Technology learning; Technology Protection; Technology Selection: Visualized pattern illustrates the resemblance and the characteristics of their occurrence to some themes which drive process capabilities that belong to TM

Cluster 3 (Blue in colour): Strategic Technology Road Mapping; Desorptive capacity; Corporate Technology Strategy; Corporate Business Strategy; Technology Alliance Strategy: From clusters logical traces leads toward capabilities that illustrates strategic prospective of TM. These occurrences- keywords helps to identify the traces of relevant studies through which Technology management capabilities with influential enablers may recognize as a potential driving factors behind the dominance of Technology management capability influential impact of R&D as show in Table: 4.15

Table 4.15 TM Capabilities Dimension

Authors	Process	IM infrastructure	Strategy
Dilek Cetindamara (2016)	Technology Acquisition Technology Exploitation Technology Identification Technology learning Technology Protection Technology Selection	N/A	N/A
Günther Schuh (2015)	Technology Planning Technology Development Technology deployment Technology protection Technology Assessment Technology Forecasting	N/A	N/A
W.-I. Lee (2015)	N/A	N/A	Strategic Technology Road mapping
Zabala and Iturriagagoitia (2014)	Technology Watch Technology Exploiting Technology Development	N/A	N/A
Lee (2013)	N/A	N/A	Strategic Technology Road Mapping
Won and Sangbum (2011)	N/A	N/A	Strategic Technology Road mapping
Arasti et al. (2010)	N/A	N/A	Corporate business strategic capability Corporate Technology strategic Capability Technology Alliance
Lichtenthaler (2010)	Technology transfer	N/A	Absorptive capacity Descriptive capacity
Cetindamara et al. (2009)	Identification Selection Acquisition Exploitation Protection Learning	Management Competency, Facility, Organization Potential, Personal skill	N/A
Jun Jin (2008)	Technology Acquisition Technology Assimilation Technology Improvement	N/A	N/A

Table 4.16 Internal Determinates of TM dimension under R&D scope

		Enablers	Description	References
Technology Management Capability	Process	Technology Acquisition	A resource that drive process capability belong to TM allow R&D to adopt the new technologies with respect to technological environment.	(Lanctot, 2000),(Hung, 2008),(Pavitt, 1990),(Dilek Cetindamara, 2016; Jun Jin 2008)
		Technology Exploitation	Technology exploitation is consider to be somewhat sourcing of known technologies.	(Cetindamara et al., 2009),(Escher, 2001),(Levin & Barnard, 2008)
		Technology Identification	The firm ability that is used to enables general browsing of new technologies through conferences, symposiums, and supplier's feedback.	(Cetindamar, 2009),(Phaal et al., 2006),(Jemala, 2012),(Schmidt, 2011),(Kirby, 2011),
		Technology Learning	Technological proficiency that reflects on accomplishing complex technical project and processes carried out within and beyond organizational boundaries.	(Dilek Cetindamara, 2016),(Nordhaus, 2009),(Gillingham et al., 2008)
		Technology Planning	The process of determining firm's intensity that can utilize technology to retain their organizational mission.	(Sungjoo Lee, 2009),(Strebel, 2007),(Pleschak, 2002),(Klappert, 2006)
		Technology Development	The development process that is used to enables systematic utilization of scientific, technical and commercial knowledge to meet organizational requirements.	(Cetindamar et al., 2009), (Ehrlenspiel, 2007), (Nazarko, 2013), (Halicka, 2015)
		Technology selection	Ability to match right technology in order to expanded technical domain within the organizational boundaries.	(Kodanu, 1992),(Meyer, 1993b),(Abetti, 1989),(Clark, 1989)

Table 4.16 Continued

		Enablers	Description	References
Innovation Management Capability	Process	Technology Deployment	Establishing innovation that involves creation of new knowledge's and processes to resolve complex issues and extend human capabilities.	(Croteau & Bergeron, 2001), (Sagar & van der Zwaan, 2006),(Günther Schuh, 2015)
		Technology Assessment	Technological evaluation that based on short term and long term technical deficiencies at each organizational level due to utilization of technologies.	(Thien A. Tran, 2008); (Rasa Laliene, 2014); (Jemala, 2012);(Fleischer, 2008)
		Technology Forecasting	The ability to estimate technological trend and rate of technological dynamic for effective	(Ying, 2012),(Ayse Kaya Firat, 2008), (Linstone, 2003), (Preez & Pistorius), (Fildes, 2006), (Meade & Islam, 2006)
		Technology Assimilation	Describe as a use of technology spreads across organizational processes and become operational in activities.	(Watanabe, 2007), (Silva, 2011), (Isabel et al., 2015), (Niosi, 2010)
		Technology research	It reflects the way that most of firms utilize technology as significant source for operational means.	(Technology, 2007),(Jemala, 2012)
		Technology Protection	A ability that directly linked with preservation of the technical knowledge and potential competencies that acquire during development of product	(OMITI, 2011), (Cetindamar et al., 2016),(Cetindamara et al., 2009)
		Technology Improvement	Ability to execute all the technical functions entailed in improving productive facility.	(Lin, 2003) , (Anadon, 2016),(Jun Jin 2008)

Table 4.17 Internal Determinates of TM dimension under R&D scope

		Enablers	Description	References
Innovation Management Capability	Infrastructure	Management competency	Define as potential infrastructural resources that drive TM capabilities on the bases of strong decision making within complete synchronization of technological resources.	(Zawislak et al., 2012), (Pufal et al., 2014), (Cetindamar et al., 2016), (Baecker, 2006)
		Organizational Potential	Define as organizational strength that based on resources that were more aligned with R&D function such as New Product Development NPD and R&D proficiency.	(Grant, 1996a; Matear et al., 2004; Pavlou & Sawy, 2006) (Guo et al., 2014)
		Facility and Equipment capability	Describe as potential resources that refer to satisfy TM capabilities on the bases of such arguments for instance: whether there is availability sufficient equipment support for R&D, whether there is adequate facility for R&D team.	(Baccarini et al., 2004), (Cetindamar et al., 2016), (Eugenia et al., 2006)
		Personal Skill	Refer as, relevant skills and proficiencies in shape of resources (human) that were required to support as TM infrastructural strength in term of increasing R&D knowledge domain.	(Hammond, 2011; Kristensson, 2010; Weisberg, 1999), (J. Edler et al., 2016), (Huw Lloyd-Ellis, 2002),(Cetindamar et al., 2016), (Karahanna & Watson, 2006), (Jolly & Nasiriyar, 2007)

Table 4.18 Internal Determinates of TM dimension under R&D scope

		Enablers	**Description**	**References**
Technology Management Capability	Strategy	Desorptive capacity	Desorptive capacity is refers as firm's internal strength to classify comprehensive transfer of technology depends on a firm's strategy to externalized technology to end user	(Lichtenthaler, 2009),(Dell'Anno & Del Giudice, 2015),(Cohen & Levinthal, 1990b)
		T.M (Corporate Technology Strategy)	Corporate technology strategy refer as process to identify the technological strategies at all level with in the corporations for long term technological planning.	(Dodgson et al., 2008), (Unsal & Cetindamar, 2015), (Burgelman et al., 2001; Cetindamara et al., 2009; Sahlman, 2010)
		T.M(Corporate Business Strategy)	Define as strategic ability that based on four principles to such as: portfolio management, restructuring, transferring skills and enable sharing activities.	(Arasti et al., 2010), (I. A. F. M. O. Technology, 2007), (Unsal & Cetindamar, 2015)
		T.M(Technology Alliance Strategy)	Define as inter-firm collaboration that involves the use of resource (technology) to achieve specific organizational goals setup by other organizations.	(Reuer, 2002),(Rothaermel, 2009), (Cohen & Levinthal, 1990b)
		Strategic Technology Road Mapping	Define as flexible planning tool to help strategic long-term planning by matching long-term and short-term goals.	(W. Lee, 2015), (Phaal et al., 2004), (Martin, 2004; Won & Sangbum, 2011), (Lee, 2013)
		Absorptive capacity	Absorptive capacity refers to inbound technology transfer. The basic idea involves the notion of the prior technological knowledge needed to acquire external technologies for successful development.	(Volberda et al., 2010),(Lichtenthaler, 2009),(Lichtenthaler & Lichtenthaler, 2010)

Similarly, for technology management after evaluation, Ten studies were selected that revealed three set of TM capabilities. These three capability sets are classified as follows: (1) process, (2) infrastructure, and (3) strategic capabilities. The Technology management process capability consists of numerous processes within functional units of an organization. The basic scope of technology management is far wider than the aspects that directly interface during process innovation and R&D. Similarly, (2) Infrastructure capabilities are recognized as an essential contributor to the knowledge-oriented economy. To construct and utilize new knowledge, the sharing of information among the existing knowledge need to be supported by integrating the different technological platforms. However, (3) strategic capabilities should not be created alone independent of the existing business strategy; relative technological assets should be recognized as major components of business planning. Therefore, the comprehensive driving factors are represented in Table 4.16-4.18.

4.6 Conceptual Framework

After extensive systematic review the researcher, allow to unlock the existing research studies which comprehensively based on capabilities which belong to knowledge, innovation and technology management that contributes their significance on R&D. The outcome of systematic review draw the three critical capabilities that were emerges consistently over the period of time which reflects process; infrastructural strategic perspective of knowledge, innovation and technology management. Thus, the capabilities related to knowledge, innovation and technology management as supporting management discipline that contributes their influence on R&D can be represents in conceptual framework as show in Figure 4.19

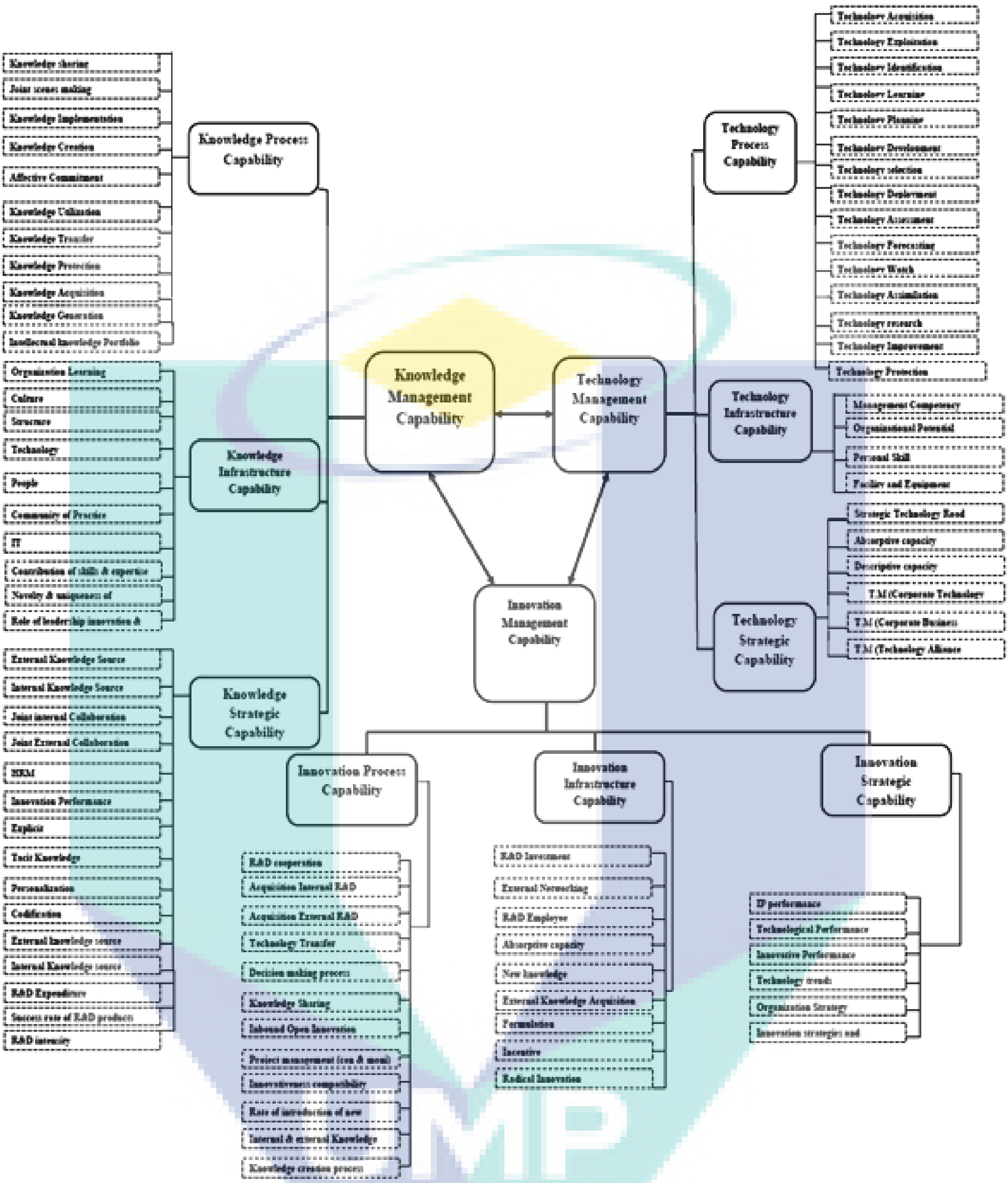

Figure 4.10 Conceptual Framework

4.7 Summary

The overall aim of this chapter is to explore the classifications of capabilities related to supporting management discipline that contributes to R&D through a systematic literature review. The including theories and literatures from both developed and developing countries, allow researcher to identify 101 factors- classified into three dimensions along with nine criteria driven by 89 sub-criteria –consider as supporting management discipline for R&D in public organization. However, the comprehensive set of gathered capabilities needs to be refined with suitable orientation related to country-specific by the number of experts in the same field.

The systematic literature review is comprised on PRISMA with Co-word analyses that allow researcher an in-depth search on studies specifically under R&D scope. The systematic literature review comprehensively based on exploring the classification of capabilities that belongs to knowledge, innovation and technology management as supporting management discipline.

Since co-word analysis' condenses enormous data sets that allow author to draw specific visualized patterns that preserve the crucial information enclosed in the data. This analysis depends on the word characteristic that represents an emerging scientific concepts, creative ideas and new knowledge. A bibliometric mapping tool known as the VOSviewer was used to construct a recognizable pattern based on occurrence of words. The initial mechanism that the VOSviewer software used to construct the bibliometric pattern based on the large quantity of data downloaded from Scopus database.

The outcome of systematic review draw the three critical capabilities that were emerges consistently over the period of time which reflects process; infrastructural strategic perspective of knowledge, innovation and technology management. Thus, the classification of capabilities related to knowledge, innovation and technology management as supporting management discipline that contributes their influence on R&D can be represents in conceptual framework in the end

CHAPTER 5

DANP RESULT AND DISCUSSION

5.1 Introduction

The content of this chapter split into two parts in order to achieve RO_2 and RO_3. The primary objective of the first part is to answer the first research question. That argues about the classification of capabilities regarding supporting management discipline (knowledge, innovation, and technology management) that were appears after systematic review. This part illustrates the process of refining and validating these capabilities by applying Focus Group Discussion (FGD) technique, with a complete analysis of seeking expert's consensus. The outcome of focus group discussion becomes the initial step to address second research question. The prime objective second part is to address second and third research question by applying DANP (DEMATEL based ANP) in order to determine the interrelationship among these capabilities and prioritizes with respect to their influence.

5.2 Overview on Focus Group Discussion on R&D in Public Organization of Pakistan

The focus group study has the primary goal to rectify capabilities related to the knowledge, innovation, and technology management discipline that were influencing R&D by merely emphasizing on a country-specific context. The three essential management supporting discipline (i.e., knowledge management, innovation management, technology management) gather from the literature review become initial scope for focus group discussion. A set of questions specifically design based on five-point scale (0, 1, 2, 3, and 4) allows experts to draw significance of each discipline. The consensus also allowed the experts to suggest additional factors related to knowledge, innovation and technology management and illustrate their levels of significance by using the five-point rating scale

In the first phase of focus group discussion, the questionnaire sends to various experts belongs to expertise related to knowledge management, innovation management, and technology management by NPO (National Productivity Organization) to rectify moderators. This process split into two phases at first stage covers 32 Public organizations out of 81 R&D's among Public organizations (Bhutto et al., 2012). Almost 71 comprehensive questionnaires along with complete instructions defining all set of rule relate to focus group discussion were sends to different moderators at the national level. In return, 25 questionnaires were received with 78.91% response rate. Similarly, in second stage almost 71 complete questionnaire were sends to covers remaining 47 R&D's in Public organization nearly 30 questionnaires were receive with 63.78% response rate. These moderators agreed to consider as the role for moderator in focus group discussion

In case inviting experts for focus group discussion, NPO (National Productivity Organization) under Pakistan Ministry of Production send invitation on behave of Asian Science consortium. All active R&D in public organization those organization missions relates to 'Knowledge Management', 'Innovation Management' and 'Technology management' were carefully screened. Out of 81 active Public R&D organization 58 were acknowledge rest of them discarded on the bases of three significant criteria first 'Organization mission', 'Source of funding ', 'Number of Existing R&D projects '

On 3 Mar 2018, the researcher sent invitation letter (see Appendix B) to target experts from 81 public organizations. These R&D experts acquired the position of manager or research scientist, or senior research fellow. Around 58 firms were responds and agree to participate in Focus group discussion. On 16 April 2018, At morning, the A group discussion comprise of two session were organized by NPO (National Productivity Organization) and sponsored by Asian Science consortium under the Asian Science Fund (see Appendix C) verified and pre-tested questionnaire was distributed during the session that were validated by the experts belongs to Asian Science consortium (ASC) and NPO. At first session Focus group discussion (FGD) were performed. While, second session was based on the outcome of first session in order to measure the interrelationship among capabilities and prioritizes with respect to their significance. Almost 195 participant, where compose into 41 groups. Out of the 41, only 39 groups were choose as valid group for discussion with the potential response rate ((No of met respondent)/ (Total number of respondent) ×100) for first session was 95.121 % is shown in Table 5.1. According to (Arber, 2001; Hall, 2001). The response rate of return of 50-60% is justifiable, whereas Kelley et al. (2003), Sitzia and Wood (1998), and Sumsion (1998) recommended a response rate of 70% for each session of focus discussion group (FGD). The complete Demographics analysis is represent in (Appendix G)

Table 5.1 Focus Group Discussion Evaluations

Issue		**Section 1**	
Purpose of Questionnaire	Evaluating dimension	Evaluating Criteria	Evaluating sub-criteria
No of listed capabilities	3	9	89
No. of distributed questionnaires	41 Groups (5 people)	41 Groups (5 people)	41 Groups (5 people)
No moderators	39	39	39
No. of retuned questionnaires	39	39	39
Response rate (%)	95.121 %	95.121 %	95.121 %

5.3 Importance and consensus of factors

The mean values for criteria, have been carefully evaluated on the bases of two principles: (a) to examine proficiency among focus groups (b) whether the results show enough stability to conclude the final list of dimensions, criteria, and sub-criteria. Based on Median value that allow to researcher to find index of middle number in order to estimate stability among the discussion. Moreover, the information obtained from the sub-criteria was compared with every focus group as they exhibit the same number of factors. The questionnaires comprise on two sections. The first section was based on open-ended questions comprising on three dimensions, nine criteria, and 89 sub-criteria. The analysis of focus group was made accomplished through M.S Excel. The degree of opinion on dimensions, with respect to their relevant criteria's are shown in Table 5.2 to 5.5

Table 5.2 Medians and Average of Dimension-related to R&D

Dimensions involve in R&D	Median	Average
Knowledge Management Capability	3	3.158
Innovation Management Capability	4	3.24
Technology Management Capability	3	3.13

Table 5.3 Medians and Average of Criteria-related to KM Capability

Criteria's belong Knowledge Management Capability	Median	Average
Knowledge Management Process Capability	3	3.273
Knowledge Management Infrastructure Capability	4	3.105
Knowledge Management Strategic Capability	3	3.05

Table 5.4 Medians and Average of Criteria-related to IM Capability

Criteria belong Innovation Management Capability	Median	Average
Innovation Management Process Capability	3	3.42
Innovation Management Infrastructure Capability	4	3.211
Innovation Management Strategic Capability	3	3.052

Table 5.5 Medians and Average of Criteria-related to TM Capability

Criteria belong Innovation Management Capability	Median	Average
Technology Management Process Capability	4	3.26
Technology Management Infrastructure Capability	4	3.3412
Technology Management Strategic Capability	3	3.18

5.4 Findings from Focus group Discussion

From data analysis (Table: 5.2-to 5.5). In the First section from Focus group discussion, the data reveals that all 9 capabilities meet the criterion with (mean value ≥ 3 out of 4). Additionally, all dimensions were also acceptable amongst experts. The complete information about the level of consensus among dimensions and criteria's selected by each focus group were presented from Table 5.6 to 5.11

Table 5.6 Consensus on knowledge Management capability as Dimension

Dimension	Level/degree	No of additional Dimension
Dimension Knowledge Management Capability	0= not Important at all =0	Nil
	1= of little significance =0 2= moderately important= 2 3= Important= 22 4= very Important= 13	
Level of consensus	Agreed to all dimension = 39 Disagreed to any dimension =0	

Out of 41 focus groups 39 were consider as valid for data analysis. While, remaining two focus groups are based on experts who unable to meet the evaluation criteria based on (listing/ranking, discourse analysis, conversation analysis). From Table: 5.6, among 39 focus groups two groups are agreed on the significance of knowledge management capability as 'moderately important' to shares its influence on R&D .While, 22 focus groups considered knowledge management capability as an essential dimension that can easily get along with R&D in public organizations. The remaining thirteen focus groups are highly rated knowledge management capability, as most significant dimension that contributes its influence on R&D. The overall degree of consensus is shown in Figure: 5.1 the outcome of focus groups discussion based on the total mean value which is equal to 3.252, while the median value is equal to 3.

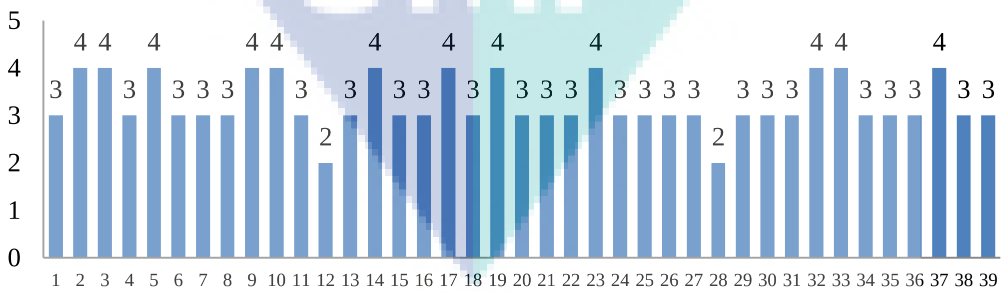

Figure 5.1 Overall Focus Groups Consensus on KM Capability

From Table 5.7, among 39 selected groups only one focus group consider Innovation management capability as "moderately important" dimension, which shares the boundaries with R&D. While, rest of the other focus groups are highly accepted as a critical dimension, which influence on R&D in public organizations. Among these 39 groups, 27 of them consider as 'significant' entity, while 12 of them rated as 'highly significant' or substantial dimension that can potentially interact with R&D.

Table 5.7 Importance and consensus on Innovation Management Dimension

Dimension	Level/degree	Additional Dimension
Dimension Innovation Management Capability	0= not Important at all =0	Nil
	1= of little significance =0 2= moderately important= 1 3= Important= 27 4= very Important= 12	
Level of consensus	Agreed to all dimension = 39 Disagreed to any dimension =0	

The overall degree of consensus among 39 focus groups is shown in Figure: 5.2. The outcome of focus groups discussion based on the total means value which is equal to 3.23 while, the median value is equal to 4.

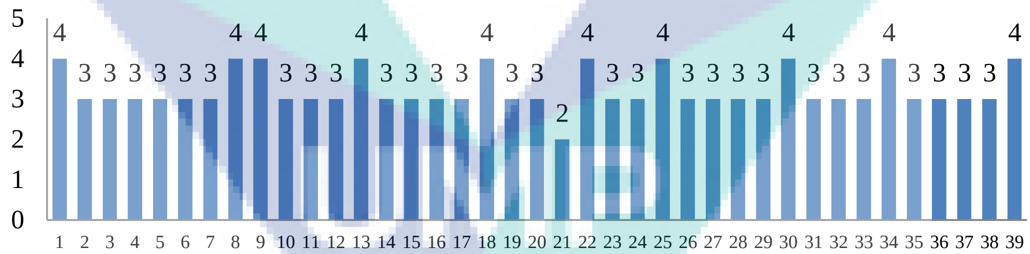

Figure 5.2 Overall Focus Groups Consensus on IM Capability

From Table 5.8, among 39 focus groups, two groups accepted Technology management capability as "moderately important" dimension, which contributes their influence on R&D as supporting management discipline. While, 27 focus groups rated technology management capability as "important" or significant entity. The remaining seven focus groups highly rated as most important dimension, due to its utilization to enhance R&D competitiveness as various levels.

Table 5.8 Importance and consensus on Technology Management as Dimension

Dimension	Level/degree	Additional Dimension
Dimension Technology Management Capability	0= not Important at all =0	Nil
	1= of little significance =0 2= moderately important= 2 3= Important= 29 4= very Important= 8	
Level of consensus	Agreed to all dimension = 39 Disagreed to any dimension =0	

The overall degree of consensus is shown in Figure: 5.3. The outcome of focus groups discussion based on the total means value which is equal to 3.13 while, the median value is equal to 3

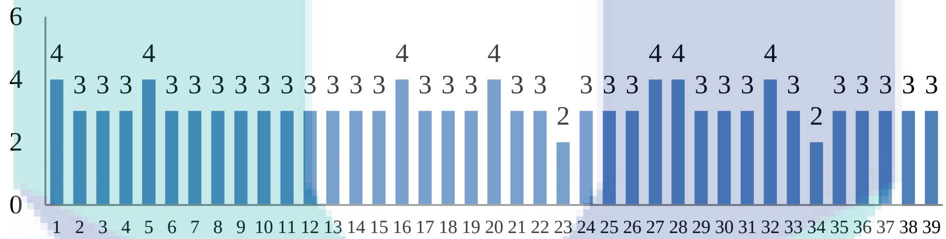

Figure 5.3 Overall Focus Groups Consensus on TM Capability

In case of selecting criteria, the outcome of focus group discussion from Table: 5.9 reveals that, all three criteria related to knowledge management capability meet the expert's expectation with respect of their significance (mean ≥ 3 out of 4). Additionally, all criteria were highly acknowledge by multi-disciplinary experts during the discussion. In case of Knowledge management capabilities, there has been common consensus spread across all focus groups regarding three criteria. These criteria’s were illustrated as knowledge management process capability, knowledge management infrastructural capability, knowledge management strategic capability. There is no additional criteria were recommended after panel discussion. There is no additional criteria were recommended for further panel discussion.

Table 5.9 Importance and level of consensus on KM Capability as criteria

Criteria	**Level/degree**	**Additional Criteria**
Criteria		
Knowledge Management Process Capability	0= not Important at all =0 1= of little significance =0 2= moderately important= 2 3= Important= 27 4= very Important= 12	Nil
Level of consensus	Agreed to all criteria = 39 Disagreed to any Criteria =0	
Knowledge Management infrastructure Capability	0= not Important at all =0 1= of little significance =0 2= moderately important= 2 3= Important= 26 4= very Important= 11	Nil
Level of consensus	Agreed to all Criteria = 39 Disagreed to any Criteria =0	
Knowledge Management Strategic Capability	0= not Important at all =0 1= of little significance =0 2= moderately important= 2 3= Important= 30 4= very Important= 6	Nil
Level of consensus	Agreed to all Criteria = 39 Disagreed to any Criteria =0	

The level of consensus among experts on *knowledge management process capability*, as criteria was highly accepted across 39 focus groups is shown in Table: 5.9. Among 39 discussions group, two focus groups rated as “moderately important” criteria. While, 27 groups rated as “important” criteria. The remaining 12 focus groups strongly preferred to rate as “very important” criteria for knowledge management (KM) capability. The overall mean value among 39 focus groups is equal to 3.231, while the median value is equal to 3. Similarly, *knowledge management infrastructure capability* consider as another criteria for Knowledge management capability. Among all focus groups, two groups were preferred to recognize as “moderately important” criteria. While, 26 of them rated as “important” criteria to measure knowledge management capability. The remaining 11 groups rated as “very important” criteria for knowledge management capability. The total average value across 39 focus groups with overall mean values is equal to 3.13, while the median value is equal to 4. The *knowledge management strategic capability* considers as a third criteria that highly acceptable among experts, 30 focus groups were preferred to rate as “important” criteria. While, 6 groups highly preferred as “very important” criteria, only two groups rated “moderately important” as criteria for *knowledge management capability*. The total average value across 39 groups was equal to 3.104 while the median value equal to 3 overall degrees of consensus is shown in Figure 5.4

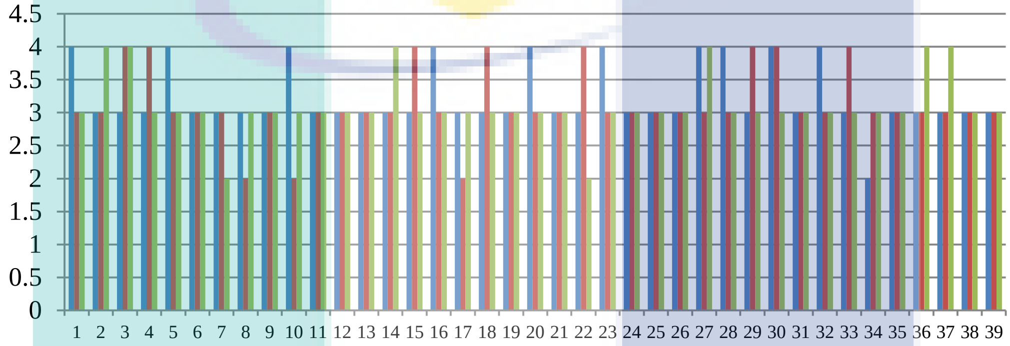

Figure 5.4 Overall Focus Groups Consensus on Criteria related to KM Capability

In similar fashion, Innovation management capabilities commonly accepted for further consensus on evaluating the primary criteria. The common judgment reveals that all three criteria that are presented all of them meet the expert’s expectations with respect to their significance (mean ≥ 3 out of 4). These three criteria illustrate as process, infrastructure and strategic aspect of innovation management capability. There is no additional criteria were recommended for further panel discussion.

Table 5.10 Importance and consensus on criteria IM Capability as criteria

Criteria	Level/degree	Additional Criteria
Innovation Management Process capability	0= not Important at all =0 1= of little significance =0 2= moderately important= 2 3= Important= 19 4= very Important= 20	Nil
Level of consensus	Agreed to all Criteria = 39 Disagreed to any Criteria =0	
Innovation Management infrastructure capability	0= not Important at all =0 1= of little significance =0 2= moderately important= 2 3= Important= 25 4= very Important= 12 Agreed to all Criteria = 39 Disagreed to any Criteria =0	Nil
Innovation Management strategic capability	0= not Important at all =0 1= of little significance =0 2= moderately important= 2 3= Important= 28 4= very Important= 9	Nil
Level of consensus	Agreed to all Criteria = 39 Disagreed to any Criteria =0	

The level of consensus among experts on Innovation management process capability as criteria highly accepted across 39 focus groups is shown in Table: 5.10. Among 39 groups, two focus groups rated as "moderately important" criteria. While, the majority of the groups accepted as significant criteria. Around, 19 focus groups consider to rate as "important" criteria. While, 20 groups strongly preferred as "very important" criteria for IM capability. The overall mean value across 39 focus groups is equal to 3.41, while the median value is equal to 3. Similarly, Innovation management infrastructure capability also accepted as major criteria for IM capability. From 39 focus groups 2 groups were recommended as "moderately important" criteria. While, 25 of them rated as "important" criteria. The remaining last 12 groups strongly preferred to rates as "very important" criteria for innovation management capability. The average mean value across 39 focus groups is 3.205 with the median value 4.

The Innovation management (IM) strategic capability considers as third criteria that highly acceptable among experts, around 29 groups strongly preferred as "important" criteria. While, nine groups strongly preferred as "very important" criteria, only two groups suggested IM strategic capability as "moderately important" criteria for Innovation management capability.

The total average value across 39 focus discussion groups equal to 3.05 with median value equal to 3 overall degrees of consensus is shown in Figure 5.5

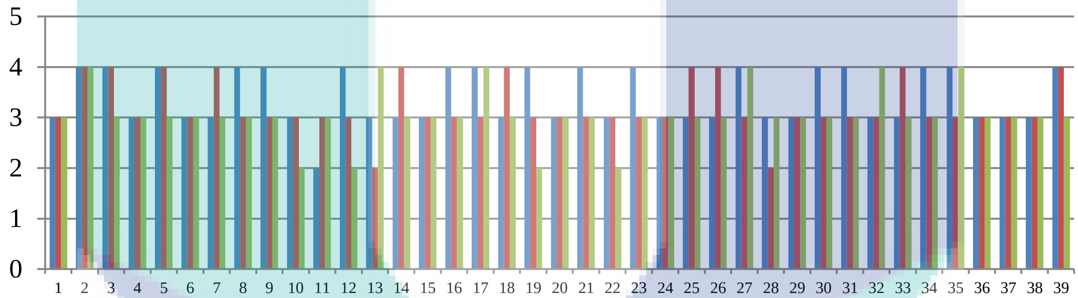

Figure 5.5 Overall Focus Groups Consensus on Criteria related to IM Capability

Technology management capabilities were also accepted for further consensus in case of exploring their basic criteria.

The experts across 39 groups agree upon the common consensus on three major criteria that meet expert's required expectations with respect to their significance (mean ≥ 3 out of 4).

These three criteria illustrate the process, infrastructure and strategic aspect of Technology management capability

Table 5.11 Importance and consensus TM Capability as criteria

Criteria	Level/degree	
Technology management process Capability	0= not Important at all =0	Nil
	1= of little significance =0	
	2= moderately important= 2	
	3= Important= 26	
	4= very Important= 11	
Level of consensus	Agreed to all Criteria = 39	
	Disagreed to any Criteria =0	
Technology management Infrastructure Capability	0= not Important at all =0	Nil
	1= of little significance =0	
	2= moderately important= 2	
	3= Important= 21	
	4= very Important= 16	
Level of consensus	Agreed to all Criteria = 39	
	Disagreed to any Criteria =0	
Technology Management Strategic Capability	0= not Important at all =0	Nil
	1= of little significance =0	
	2= moderately important= 2	
	3= Important= 25	
	4= very Important= 12	
Level of consensus	Agreed to all criteria = 39	
	Disagreed to any criteria =0	

The level of consensus among experts on *Technology management process capability* as criteria highly rated across 39 focus groups is shown in Table: 5.11. Among 39 discussions group, two of them preferred as “moderately important” criteria. While, the majority of the groups accepted as “significant criteria”. Almost 26 groups were preferred to rate as “important” criteria. While, 11 focus groups strongly preferred to rate as “very important” criteria for *Technology management capability*. The overall mean value is equal to 3.26 while the median value is equal to 4. Similarly, *Technology management infrastructure capability* also recognized as major criteria. Among all focus groups, two groups were recommended “moderately” as criteria, while 21 of them suggested as “important” criteria. The remaining 16 focus groups strongly preferred to rates as "very important" criteria for technology management capability. The average mean values overall 39 focus groups in case of infrastructure capability are 3.333 with the median value 4. *Technology management strategic capability* also considers as third criteria that were highly acceptable among experts across 39 focus groups. Around 25 focus groups rated as "important" criteria.

While, 12 focus groups strongly preferred as "very important" criteria. The remaining two groups suggested strategic capability as "moderate important" criteria for Technology management capability.

The total mean average value across 39 focus groups is equal to 3.18, while the median value equal to 3 overall degrees of consensus is shown in Figure 5.6

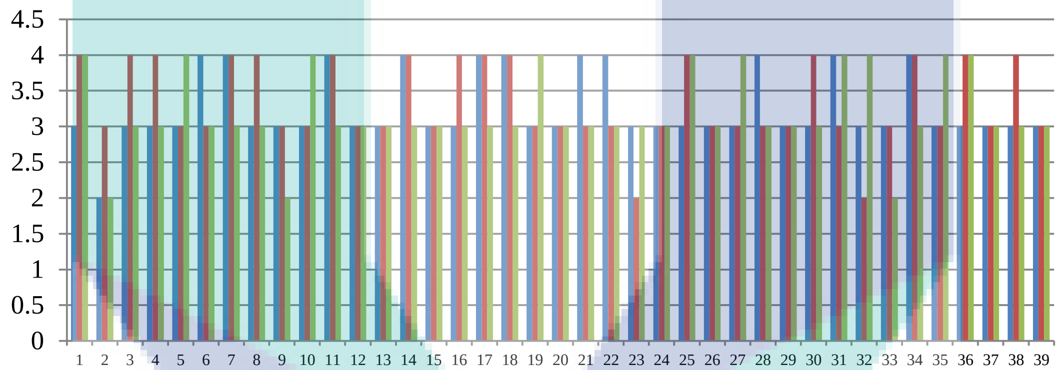

Figure 5.6 Overall Focus Groups Consensus on Criteria related to TM Capability

In case of selecting sub-criteria, around 89 elements were extracted from systematic literature review (Chapter 4). For knowledge management process capability eleven sub-criteria were chooses for expert opinion.

Out of 11 sub-criteria, only 6 of them meet the experts expectations on which knowledge management process capability rely on. *Intellectual knowledge portfolio* consider as additional sub-criteria recommend through group consensus. The all the sub-criteria along with their mean value is presented in Table 5.12

Table 5.12 Importance and consensus on sub-criteria

Sub-Criteria	**Level of consensus**							**Additional Sub-criteria**
Knowledge Management Process Capability (Criteria)	0= not Important at all	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	
Knowledge Sharing	0	0	3	21	15	3	3.256	
Join Scense	6	20	13	0	0	2	1.179	
Affective Commitment	3	21	15	0	0	1	1.31	
Knowledge Transfer	0	0	2	26	11	4	3.23	
Knowledge creation	0	0	3	24	12	4	3.205	
Knowledge generation	3	23	13	0	0	2	1.256	
Knowledge utilization	2	18	19	0	0	2	1.44	
Knowledge protection	6	23	10	0	0	1	1.103	
Knowledge Acquisition	0	0	3	17	19	4	3.41	
Knowledge implementation	0	0	0	25	14	3	3.359	
Intellectual knowledge portfolio	0	0	3	22	11	4	3.256	

The overall mean value across 39 focus groups is shown as: knowledge sharing (3.256), knowledge transfer (3.23), knowledge creation (3.205), knowledge acquisition (3.41), knowledge implementation (3.359) and Intellectual knowledge portfolio (3.256) with respect of their significance (mean ≥ 3).

While join scene (1.179), Affective Commitment (1.31), Knowledge generation (1.256), Knowledge utilization (1.44), Knowledge protection (1.103) overall average value is shown in Figure 5.7

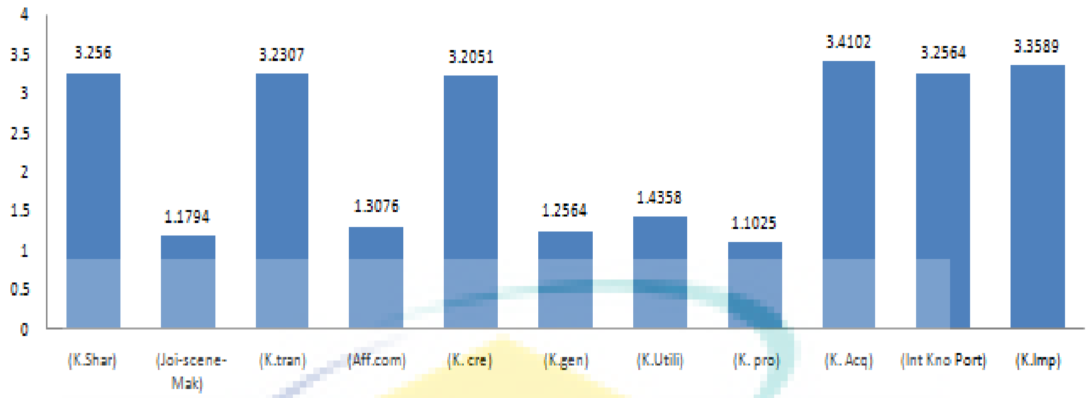

Figure 5.7 Overall Sub- Criteria Average value For KM Process Capability

After mutual consensus, among 39 groups Intellectual knowledge portfolio perceived as only the sub-criteria that used to add during evaluation. In case of knowledge management process capability, the level of consensus across 39 focus groups during the selection of sub-criteria they highly rated knowledge acquisition with respect to its significance, while knowledge protection made limited significance among experts opinion. During refining process, experts from focus groups have made reasonable preference on knowledge acquisition process due to its significance. These preferences were based on group consensus. According to their judgment on knowledge acquisition process, consider as resources to drive KM process capability. Similarly, majority of experts agreed on utilization other processes with respect to their significance like: *knowledge transfer, knowledge creation, Intellectual knowledge portfolio, and knowledge implementation* as a core pillar to manage their internal knowledge capacity. Similarly, they agreed upon common opinion on knowledge creation. According to their judgment, it helps to execute a routine for translating new set of proficiency to enhance existing R&D competitiveness. Similar type of arguments were float during the selection of intellectual knowledge portfolio and knowledge implementation . However, limited preferences were made during the group discussion on "*Joint scene making*, *Affective commitment*, *knowledge generation*, *knowledge utilization and knowledge protection*". According to experts opinion, less concentration were observe with respect to operational relevancy in the case of R&D in public organizations. Similarly, for KM strategic capability fifteen elements were extracted from systematic review (Chapter 4). These elements were chosen for further expert's opinion as sub-criteria, which belong to KM strategic capability. Out of 15 sub-criteria, only 6 of them meet the experts' expectations. From Table:5.13 the overall mean values across 39 focus groups is presented as Codification (3.231), Personalization (3.256), External Knowledge source (3.308), Internal Knowledge source (3.28), R&D expenditure (3.3) and Success rate of R&D stocks (3.256) with respect of their significance (mean ≥ 3 out of 4). While External Knowledge source (1.154), Internal Knowledge source (1.256), Joint learning: internal collaboration (1.18), Joint learning: External collaboration (1.1), tacit knowledge (1.26), Explicit knowledge (1.18), HRM Practices (1.282), Performance (1.05) with respect to their significance their mean value (less ≤3) overall average value shown in Figure 5.8

Table 5.13 Importance and consensus on sub-criteria

Sub-Criteria	**Level of consensus**							**Addition aSub-criteria**
Knowledge Management strategic Capability (Criteria)	0= not Important at all	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	
Joint learning :internal collaboration	4	24	11	0	0	2	1.18	
Joint learning :External collaboration	4	28	7	0	0	1	1.1	
Tacit knowledge	3	25	11	0	0	2	1.26	
Explicit knowledge	4	24	11	0	0	2	1.18	
HRM Practices	3	22	14	0	0	1	1.282	
Performance	6	25	8	0	0	2	1.05	
Codification	0	0	2	27	10	3	3.231	

Table 5.13 Continued

Sub-Criteria	Level of consensus							Additional Sub-criteria
Knowledge Management strategic Capability (Criteria)	0= not Important at all	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	
Personalization	0	0	2	24	13	4	3.256	
External Knowledge source	0	0	2	24	13	3	3.308	
Internal Knowledge source	0	0	2	23	13	3	3.28	
R&D expenditure	0	0	1	26	12	4	3.3	
Success rate of R&D products	0	0	2	25	11	3	3.256	
R&D intensity	6	21	12	0	0	2	1.154	

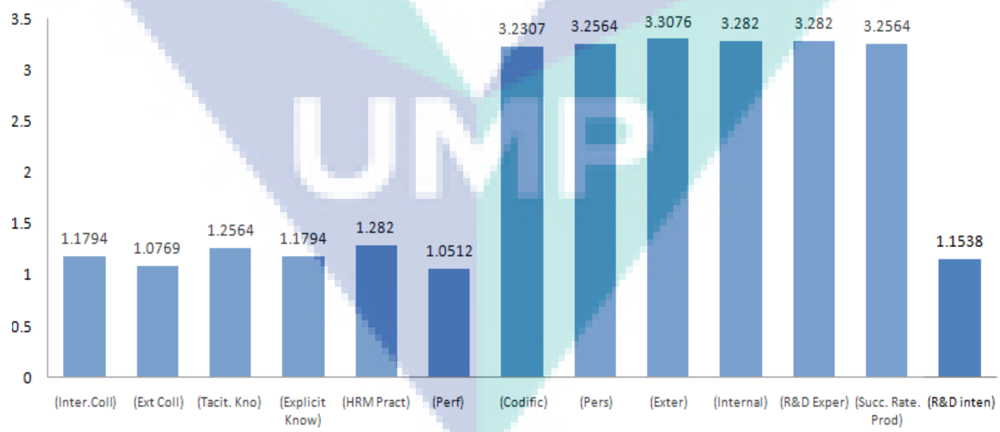

Figure 5.8: Overall Sub- Criteria Average value For K.M Strategic Capability

Based on their professional relevancy majority of experts were agreed on general perspective of *Personalization*, and consider driving resource for KM strategic capability. According to them, human-oriented strategy enables collaborative and face to face interaction. It helps R&D managers to draw analytically rigors recommendations on complex strategic problems by channelizing individual's experience. Similarly, majority of experts were also agreed on the adaption of *External knowledge* as a KM strategic tool that allows R&D managers to adapt new knowledge and blend with existing knowledge in order to achieve long term strategic goal. Majority of experts were agreed on considering an option for public firm whether or not pursing R&D sourcing for spreading the potential risk involved during the development process. Similarly, majority of experts across 39 focus groups were developed positive consensus on *internal knowledge sourcing.* According to them, it is crucial element to drive KM strategic capability for obliging R&D to accomplish long term strategic goal. It helps to develop new knowledge by utilize existing knowledge practice. Similarly, overall consensuses across 39 focus groups were also made on "*success rate of R&D product*" and represents as profit share on innovative product sale, skill compatibility with overall acceptance rate throughout the workforce. Also, the majority of experts were agreed regarding the strong narrative on *R&D expenditure,* According to them, continuous investment in R&D is a crucial pre-requisite for the development of the knowledge based economy and for achieving strategic goals in shape of spending on knowledge capabilities. On the other hand, limited priorities were made among the experts' opinion during focus group discussion on *Joint learning: internal collaboration, Joint learning: External collaboration, tacit knowledge, explicit knowledge, HRM Practices, Performance, R&D intensity* to accept as sub-criteria. These limitation were based on certain factors such as: lack professional relevancy, organizational barriers and internal deficiencies among R&D in public organizations due to complex organizational bureaucracy. In case of, KM infrastructural capability Out of 9 sub-criteria only 6 of them meet the expert's expectations. From Table: 5.14 the overall mean values across 39 focus groups is presented as organization learning (3.179), Culture (3.282), Technology (3.31), People (3.256) and Role of Leadership innovation & support (3.41), Structure (3.307) with respect of their significance (mean ≥ 3 out of 4). While IT (1.03), Community of Practice (1.331), Contribution of skill and Expertise (1.44), Novelty and uniqueness of innovation (1.103), with respect to their significance, their mean value (less ≤3) the overall average value shows in Figure 5.14

Table 5.14 Importance and consensus on sub-criteria

Sub-Criteria	Level of consensus							Additional Sub-criteria
Knowledge Management Infrastructure Capability (Criteria)	0= not Important at all	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	
Organization Learning	0	0	3	26	10	4	3.179	
Culture	0	0	2	24	4	3	3.282	
IT	5	27	7	0	0	2	1.03	
Community of Practice	0	21	15	0	0	2	1.33	
Technology	0	0	2	21	14	3	3.31	
People	0	0	4	23	12	3	3.256	
Contribution of Skill and Expertise	2	18	19	0	0	2	1.44	
Novelty & uniqueness of innovation	6	23	10	0	0	1	1.103	
Role of leadership innovation & supports	0	0	3	17	19	4	3.41	
Structure	0	0	3	21	15	3	3.307	

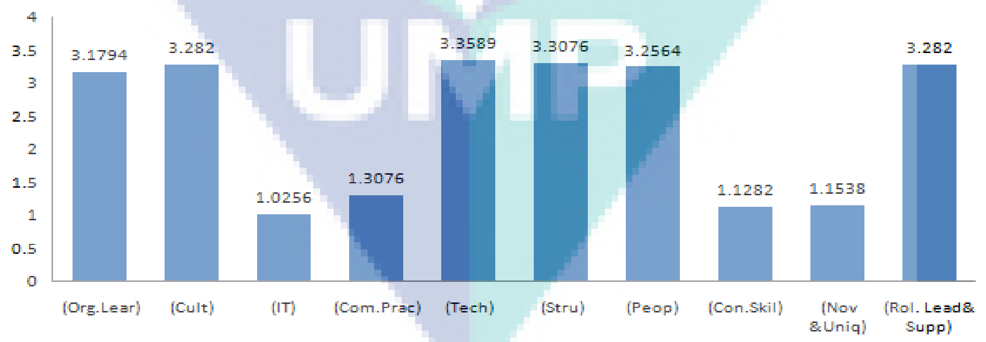

Figure 5.9 Overall Sub- Criteria Average value For KM Infrastructure Capability

During refining process, experts from focus groups have made reasonable preference to involvement of Technology is necessary due to its significance. Majority of experts across 39 focus groups were agreed on involvement of some other resources that can consider as sub-criteria for KM infrastructural capability with respect to their significance like: *culture, structure, organizational learning, and people, Role of leadership & innovation support.*

Based on their professional relevancy majority of experts were agreed on general narrative about the role of technology as sub-criteria. According to them, an active R&D support relies on technology as a medium to mobilize the information during the development of new knowledge. Similarly, majority of experts were also agreed on *organizational culture* need to be considered as sub-criteria. According to their opinion, it helps in managing knowledge with the comprehensive shared value under organizational norms. Similarly, majority of experts were agreed upon the suitable role of organizational learning need to consider as potential sub-criteria for KM infrastructural capability. From their opinion, it's allowing organizational transformation under knowledge which is generated via organizational practices. Similarly, majority of experts agreed upon the significant *Role of leadership.* According to their opinion, it helps in modify the best environment for delivering innovation, where the conflict declaration may be essential. Similar types of arguments were also float during the selection of right individual's (people) as potential resource to drive KM infrastructural capability.

On the other hand, limited priorities were made among the experts' opinion during groups' discussions on *IT, community of practice, contribution of skill & expertise, Novelty & uniqueness of innovation*. Since they already select technology and consider IT as part of technology.

These limitations were based on certain factors such as: lack professional relevancy, organizational barriers and internal deficiencies among R&D in public organizations due to complex organizational bureaucracy.

In the case of IM process capability, twelve sub-criteria were chooses for expert opinion. Out of 12 sub-criteria, only 8 of them meet the expert's expectations on which process capability rely on. From the Table: 5.15.

The overall mean values across 39 focus groups is presented as; cooperation (3.308), Technology Transfer (3.32), Decision Making process (3.23), Inbound Open Innovation (3.359) and Project management (control & monitoring) (3.256), Innovativeness compatibility (3.211), Rate of introduction of new product/ service per year (3.2615), Internal & external Knowledge sharing ability (3.2308) with respect of their significance (mean ≥ 3 out of 4). While, acquisition Internal R&D (1.36), Acquisition External R&D (1.101), Knowledge Sharing (1.28), Knowledge creation process (1.26), concerning their significance their mean value (less ≤3 out of 4) the overall average value is shows in Figure 5.10

Table 5.15 Importance and consensus on sub-criteria

Sub-Criteria	**Level of consensus**							**Additional Sub-criteria**
Innovation Management Process Capability (Criteria)	0= not Important at all	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	
R&D cooperation	0	0	2	23	14	3	3.308	
Acquisition Internal R&D	2	21	16	0	0	2	1.36	
Acquisition External R&D	6	23	10	0	0	1	1.101	
Technology Transfer	0	0	2	21	15	3	3.32	
Decision Making process	0	0	4	23	12	3	3.23	
Knowledge Sharing	3	22	14	0	0	1	1.28	
Inbound Open Innovation	0	0	2	21	16	3	3.359	
Project management (control & monitoring)	0	0	2	25	12	3	3.256	
Innovativeness compatibility	0	1	1	28	9	3	3.211	
Rate of introduction of new product/ service per year	0	0	2	25	12	4	3.2615	
Internal & external Knowledge sharing ability	0	0	2	26	11	3	3.2308	
Knowledge creation process	5	19	15	0	0	2	1.26	

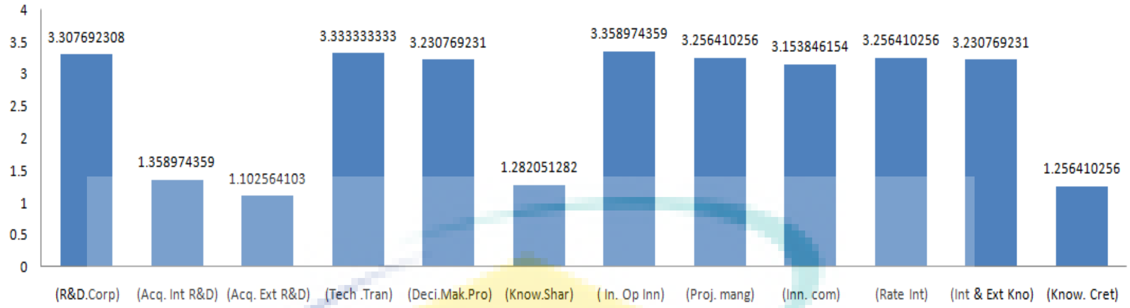

Figure 5.10 Overall Sub- Criteria Average value For IM Process Capability

During refining process, experts from focus groups have made reasonable preference to R&D cooperation due to its significance. Majority of experts agreed on involvement of other elements that can consider as sub-criteria for IM process capability. In similar way, according to their significance these elements: *R&D cooperation, Decision-making process, Technology Transfer, Inbound Open Innovation and Project management (control & monitoring), Innovativeness compatibility, Rate of introduction of new product/ service per year, Internal & external Knowledge sharing* ability were also selected for further discussion.

Based on their professional relevancy majority of experts were agreed on general narrative upon the role *R&D cooperation* as sub-criteria for IM process capability. According to their opinion, the impact of R&D cooperation allowing external collaborator's to enhancing the firm's efficiency in shape of managing innovative capabilities for new market. Majority experts were also agreed on active role of decision-making process. According to their opinion, effective decision making can boost up firm's external knowledge sourcing ability by decreasing the essential barrier for consistent feedback to a higher management. Similarly, majority experts were also agreed on role technology transfer. According to their opinion, adopting technology transfer as core resource for process capability which allow R&D to acquire and license skills knowledge in shape of advancing intellectual property, production equipments and facilities to and from other public and private research agencies. Similarly, majority experts were also agreed on utilization Project management (control & monitoring) tools. According to their opinion, it provides comprehensive understanding to control and monitor processes such as idea evaluation, innovation design, and concept testing, profitability analysis. It helps R&D managers to draw consistent translation of overall innovation processes to upper streams of management. Similarly, majority experts were also agreed on Innovativeness compatibility as essential element. According to their opinion, it helps to R&D decision maker, to draw the degree of innovativeness, type of innovation and innovation newness with the effective rate of innovation adoption. Similar type of arguments were float during the selection of *Rate of introduction of new product/ service per year, Internal & external Knowledge sharing*

On the other hand, limited priorities were made among the experts' opinion during groups' discussions on acquisition *Internal R&D, Acquisition External R&D and Knowledge creation process.* Since they already selects knowledge creation process as part of KM process capability. These limitations were based on certain factors such as: lack professional relevancy, organizational barriers and internal deficiencies among R&D in public organizations due to complex organizational bureaucracy. In the case of Pakistan, most of R&D in Public organization faces specific hindrance in promoting or transferring knowledge due to operational and managerial bureaucracy

In the case of IM infrastructure capability, nine sub-criteria were driven from systematic literature for expert opinion. Out of 9 sub-criteria, only 5 of them meet the expert's expectations. From Table: 5.16

The overall mean value across 39 focus groups is presented as: External Networking (3.2), R&D Employee (3.28), Radical Innovation (3.28), knowledge incentives (3.26) and, Absorptive capacity (3.282) with respect of their significance (mean $\geq$ 3). While, R&D investment (1.385), New Knowledge (1.15), Formulation (1.077), External Knowledge (1.4), concerning their significance their mean value (less $\leq$3) the overall average value shows in Figure 5. 11

Table 5.16 Importance and consensus on sub-criteria

Sub-Criteria	**Level of consensus**							**Additional Sub-criteria**
Innovation Management Infrastructure Capability (Criteria)	0= not Important at all	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	
R&D investment	0	22	16	0	0	2	1.385	
External Networking	0	0	2	24	12	3	3.2	
R&D Employee	0	0	2	26	0	3	3.28	
New Knowledge	5	23	11	0	0	1	1.15	
Radical Innovation	0	0	2	24	13	3	3.28	
Knowledge incentives	0	0	3	21	14	3	3.26	
Formulation	5	26	8	0	0	1	1.077	
Absorptive capacity	0	0	2	24	13	3	3.282	
External knowledge	1	23	15	0	0	2	1.4	

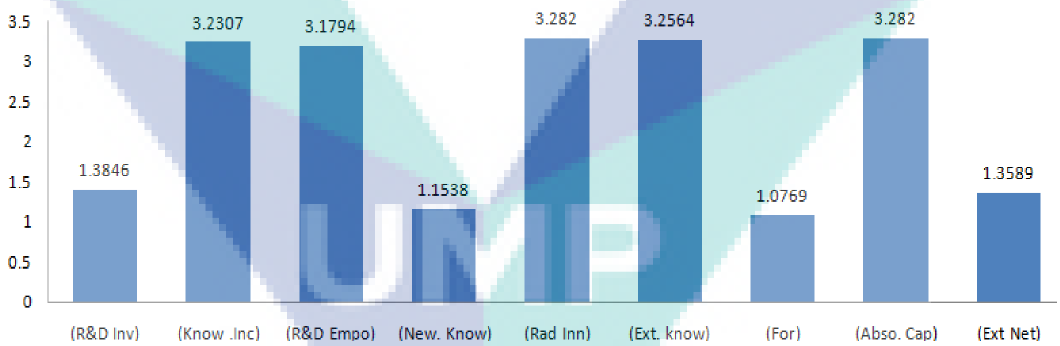

Figure 5.11 Overall sub- criteria average value for I.M Infrastructure Capability

During refining process, experts from focus groups have made highest preference on *Absorptive capacity and R&D Employee* due to its significance. Majority of experts were agreed upon the involvement of other elements that can consider as sub-criteria for IM process capability with respect to their significance these elements are: *External Networking, Radical Innovation, and knowledge incentive.* Based on their professional relevancy majority of experts were agreed on general narrative of

Absorptive capacity as sub-criteria for IM infrastructural capability. According to their opinion, for long term R&D competitiveness its essential for organizations must have resources to absorbs external knowledge. In case of *R&D Employees* majority of experts were agreed on the significance of *R&D Employees.*

According to their opinion, it indicates firms' R&D spending as a percentage of their revenue on R&D staff with respect to percentage of total employment. Similarly, majority experts were also agreed on utilization *Radical Innovation* to get competitive advantages. According to their opinion, R&D firms need to enhance their innovative infrastructure by acknowledging market deficiencies.

Therefore, radical innovation as resources allows R&D firms to get rid traditional innovational approach in order to remain sustainable with respect to the market demand. Similar types of arguments were float during the selection *External Networking, and knowledge incentive.*

On the other hand, limited priorities were made among the experts' opinion during groups' discussions on *New Knowledge, Formulation, and External Knowledge*. These limitation were based on certain factors such as: lack professional relevancy, organizational barriers and internal deficiencies among R&D in public organizations due to complex organizational bureaucracy

In case of IM strategic capability, six sub-criteria were drive from systematic literature for expert opinion. Out of 6 sub-criteria, 4 of them meet the expert's expectations. From Table: 5.17 the overall mean value across 39 focus groups is presented as: Innovative Performance (3), Technology trends (3.23), Organization strategy (3.28), and Innovation strategies and initiatives (3.26) with respect of their significance (mean $\geq$ 3 out of 4). While, IP performance (1.282), Technological Performance (1.2), Formulation (1.077), Knowledge incentives (1.4), with respect to their significance their mean value (less $\leq$3) the overall average value shows in Figure 5.12

Table 5.17 Importance and consensus on sub-criteria

Sub-Criteria	**Level of consensus**							**Additional Sub-criteria**
Innovation Management strategic Capability (Criteria)	0= not Important	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	
IP performance	0	22	14	0	0	1	1.282	
Technological Performance	5	21	13	0	0	2	1.2	
Innovative Performance	0	0	3	22	14	3	3	
Technology trends	0	0	2	26	11	3	3.23	
Organization strategy	0	0	2	25	11	3	3.21	
Innovation strategies and initiatives	0	0	2	23	13	4	3.26	

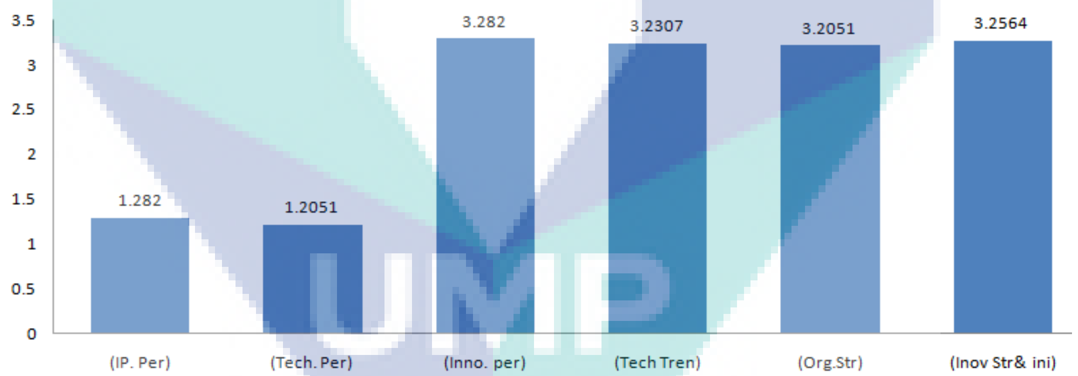

Figure 5.12 Overall sub- criteria average value for IM Strategic Capability

During refining process, experts from focus groups have made highest preference on *Innovation strategies, and initiatives* due to its significance. Majority of experts were agreed upon the involvement of other elements that can consider as sub-criteria for IM process capability with respect to their significance these elements were: *Innovative Performance, Technology trends, Organization strategy*. Based on their professional relevancy majority of experts were agreed on general narrative of *Innovation strategies, and initiatives* as sub-criteria for IM strategic capability. According to their opinion, the involvement of Innovative strategies and initiatives allow firms strengthen their R&D on the bases of consistent assessment to their existing technological capabilities, innovativeness on core machineries and long-term policy for strategic innovation. Similarly, majority experts were also agreed on *innovative performance.* According to their opinion, it indicates organizational financial performance (profit and capital return on investment in percentage) and firm current organization market value in-shape share prices. Similar types of arguments were float during the selection *Organization strategy, and Technology trends.*

On the other hand, limited priorities were made among the experts' opinion during groups' discussions on *IP performance, Technological Performance.* These limitation were based on certain factors such as: Weak mechanism towards measuring intellectual property along with all the licensing rights, lack professional relevancy, organizational barriers and internal deficiencies

In the case of TM process capability, fifteen sub-criteria were drive from systematic literature for expert opinion. Out of 15 sub-criteria, 7 of them meet the expert's expectations. From Table: 5.18

The overall mean value across 39 focus groups is presented as, Technology Acquisition (3.231), Technology Exploitation (3.28), Technology Identification (3.28), Technology Protection (3.181), Technology Selection (3.308), Technology Development (3.333) with respect of their significance with and mean ≥3. While, Technology Planning (1.282), Technological deployment (1.15), Technology Assessment (1.179), Technology Forecasting (1.256), Technology Watch (1.103), Technology Transfer (1.23), Technology Improvement (1.18), with respect to their significance their mean value (less ≤3 out of 4) the overall average value is shows in Figure 5.13

Table 5.18 Importance and consensus on sub-criteria

Sub-Criteria	Level of consensus							Additional Sub-criteria
Technology Management Process Capability (Criteria)	0= not Important at	1= of little	2= moderately	3= Important	4= very Important	Median	Average	
Technology Acquisition	0	0	2	26	11	4	3.231	
Technology Exploitation	0	0	2	24	13	3	3.28	
Technology Identification	0	0	3	18	18	4	3.38	
Technology learning	0	0	3	25	11	3	3.21	
Technology Protection	0	0	4	24	11	3	3.181	
Technology Selection	0	0	4	19	16	4	3.308	
Technology Planning	4	20	15	0	0	2	1.282	
Technology Development	0	0	4	18	17	3	3.333	
Technology deployment	6	21	12	0	0	2	1.15	
Technology Assessment	5	22	12	0	0	1	1.179	
Technology Forecasting	5	19	15	0	0	0	1.256	
Technology Watch	4	27	8	0	0	1	1.103	
Technology Transfer	4	22	13	0	0	2	1.23	
Technology Improvement	6	20	13	0	0	2	1.18	

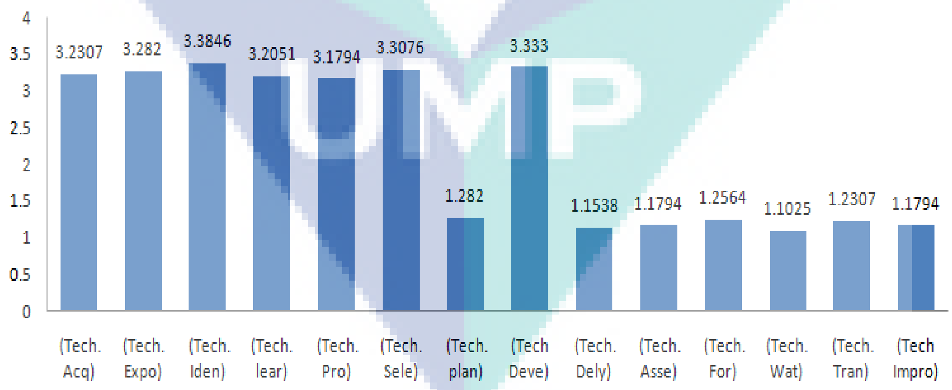

Figure 5.13 Overall sub- criteria average value for TM Process Capability

During refining process, experts from focus groups have made highest preference on *Technology development* Majority of experts were agreed upon the involvement of other elements that can consider as sub-criteria for TM process capability with respect to their significance these elements were: *Technology Acquisition, Technology Exploitation, Technology Identification, Technology learning, Technology Protection, and Technology Selection.* Majority of experts were agreed that it illustrates essential requirement for technical planning. This interprets that, for new technological development requires utilization of existing internal resource within R&D or acquired externally to get higher market returns. Similarly, majority experts were agreed on basic narrative of *Technology Acquisition.* According to their opinion, acquiring new technology for consistent sustainability allow firm to strengthen their R&D capabilities to get the edge over their competitors. Similarly, majority experts were agreed on *Technology Exploitation process.* According to their opinion, it helps to indicates somewhat sourcing of known technologies to get aggressive R&D growth. Similarly, majority experts were agreed on *Technology Identification process.* According to their opinion, it helps R&D firms to remain competitive by general browsing on technology through conferences, technology symposiums, and supplier's feedbacks and through scientific publications to relevant technical specifications. Similar types of arguments were float during the selection *Technology learning, Technology Protection, and Technology Selection.*

On the other hand, limited priorities were made among the experts' opinion during groups' discussions on *Technology Planning, Technology deployment, Technology Assessment, Technology Forecasting, Technology Watch, Technology Transfer, and Technology Improvement.* These limitation were based on certain factors such as: Some element contrasting similar meaning, lack professional relevancy, organizational barriers and internal deficiencies

TM Infrastructure capability four sub-criteria were chooses for expert. Out of 4 sub-criteria, 4 of them accept the expert's expectations. From Table: 5.19 the overall mean value across 39 focus groups is presented as: Management competency (3.35), Facility (3.3), Organization potential (3.28), Person Skill (3.281), with respect of their significance (mean $\geq$ 3 out of 4) the overall average value shows in Figure 5. 14

Table 5.19 Importance and consensus on sub-criteria

Sub-Criteria	Level of consensus							Additional Sub-criteria
Technology Management Infrastructure Capability (Criteria)	0= not Important at all	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	
Management competency	0	0	2	22	16	3	3.35	
Facility	0	0	2	24	14	3	3.3	
Organization potential	0	0	1	23	16	4	3.38	
Personal skill	0	0	2	25	13	3	3.281	

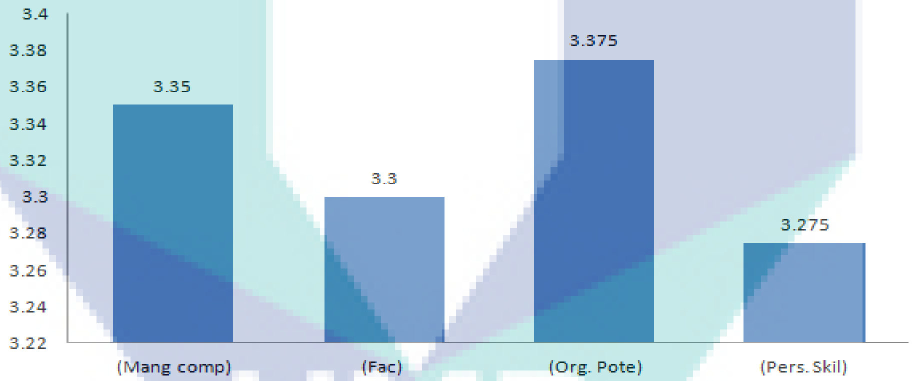

Figure 5.14 Overall sub- criteria average value for TM Infrastructure Capability

During refining process, experts from focus groups have made highest preference to *Organization potential* due to its significance. Majority of experts agreed on involvement of other elements that can consider as sub-criteria for TM infrastructural capability with respect to their significance these elements are: *Personal skill, management competency, Facility and equipment.* Based on their professional relevancy majority of focus groups were agreed on general narrative regarding impact of *Organization potential* as potential resource that used to align organizational strength with R&D function in order to support New Product Development (NPD) and R&D

competency.. Similarly, majority experts were agreed on active role of *management competency* as potential resource for TM infrastructure capability. According to their opinion, it facilitates R&D function to translate firm's potential ability into technology development ability. Similar types of arguments were float during the selection of *Personal skill and Facility and equipment.*

TM strategic capability eight sub-criteria were drive from systematic literature. Out of 8 sub-criteria, five of them meet the expert's expectations. From Table: 5.20, the overall mean value across 39 focus groups is presented as: Strategic Technology Road Mapping (3.21), Descriptive Capacity (3.29), Corporate Technology Strategy (3.395), Corporate Business Strategy (3.368), Technology Alliance Strategy (3.184) with respect of their significance (mean $\geq$ 3). While Technology absorptive capability (1.11), Technology Innovation capability (1.16), Absorptive capacity (1.24) to their significance their mean value (less $\leq$3) overall average cost shows is Figure 5.15

Table 5.20 Importance and consensus on sub-criteria

Sub-Criteria	**Level of consensus**							**Additional Sub-criteria**
Technology Management Strategic Capability (Criteria)	0= not Important at all	1= of little significance	2= moderately important	3= Important	4= very Important	Median	Average	Technology absorptive capability Technology innovation capability Two groups among 39 FGD Insisting to add how ever majority of groups draw less significance
Strategic Technology Road Mapping	0	0	4	22	12	3	3.21	
Technology absorptive capability	6	22	10	3	3	2	1.11	
Technology innovation capability	4	24	10	0	0	1	1.16	
Absorptive capacity	4	21	13	0	0	1	1.24	
Descriptive capacity	0	0	3	21	14	3	3.29	
Corporate Technology Strategy	0	0	2	21	17	4	3.395	
Corporate Business Strategy	0	0	3	18	17	3	3.368	
Technology Alliance Strategy	0	0	4	23	11	3	3.184	

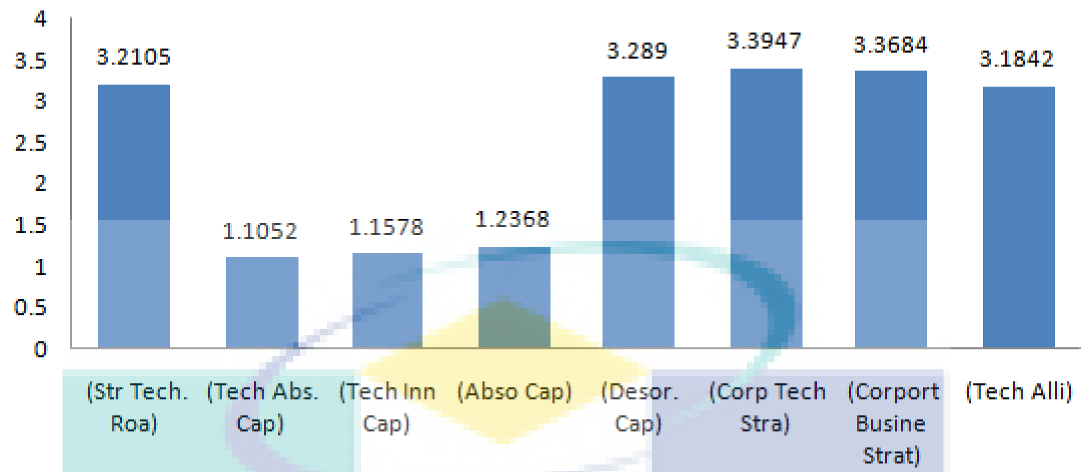

Figure 5.15 Overall sub- criteria average value for T.M Strategic Capability

During refining process, experts from focus groups have made highest preference to *Corporate Technology Strategy* due to its significance. Majority of experts agreed on involvement of other elements that can consider as sub-criteria for TM strategic capability with respect to their significance these elements are: *Strategic Technology Road Mapping*, *Desorptive capacity*, *Corporate Business Strategy Technology Alliance Strategy*. Based on their professional relevancy majority of focus groups were agreed on general narrative regarding impact of *Corporate Technology Strategy* as potential resource that allow "technology-centric know-how," and enables R&D decision makers to consider strategic role of technology in corporate business. Similarly, majority of consensus were also made on *Strategic Technology Road Mapping*. According to their opinion, it helps to upgrade existing R&D by measuring technological exploration and technological utilization for long term competitive advantages. Similar types of arguments were float during the selection of *Desorptive capacity*, *Corporate Business Strategy Technology Alliance Strategy*. On the other hand, limited priorities were made among the experts' opinion during groups' discussions on Technology Absorptive capacity. This limitation was based on contrasting argument made during the selection sub-criteria for IM infrastructure capability. The outcome of comprehensive consensus among 39 focus groups were approved 3 dimension, 9 criteria's and 51 sub criteria's for capabilities related to knowledge, innovation and technology management. The expert approved capabilities is presented in Figure 5.16

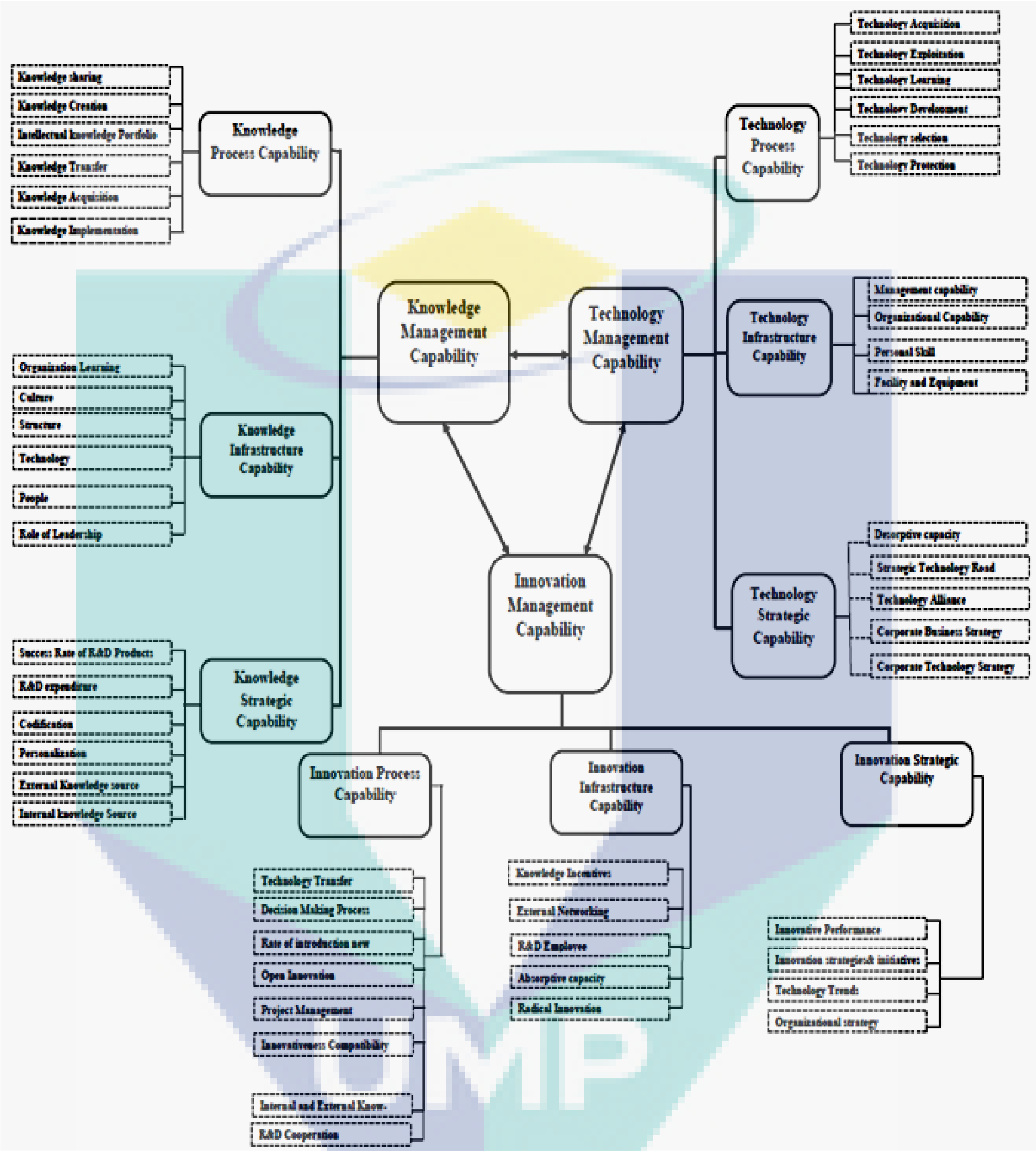

Figure 5.16 Expert-approved model for devising R&D orientation

5.5 Overview on DANP in case of R&D in Pakistan Public Organization

The second section of this chapter reflect the rating of experts–approved capabilities related to knowledge, innovation and technology management (supporting Management discipline) used in R&D in public organization. In order to investigate interrelation among these capabilities DANP technique were applied. The outcome of FGD allow researcher to utilise this information as input to DANP model (In order to priorities the capabilities in between the criteria's and sub-criteria's along with relevantweight). The Error gap ratio also explained in the following section in order to justify the reliability of measuring tool. The last section concluded the finding the third stage designed instrument, based on the DANP

5.6 Finding from DANP (DEMATEL Based ANP)

After completion of first session, the outcome from expert's consensus would develop a pre-determined model fit to the characteristic related to R&D in Public organizations of Pakistan. The experts were responsible for approving the model relevant to address the research problem. The experts invited for focus group discussion were agreed that the capabilities should be split up into three dimensions, nine criteria and 51 sub-criteria. The outcome of first session allow researcher to arrange conceptual framework based on dimensions, criteria's and sub-criteria. In conceptual model knowledge, innovation and technology management set as prime dimension based on the nine criteria that involve in managing R&D in-shape of processes, infrastructural and strategic levels. While, these criteria also depend upon 51 sub-criteria which the author already investigate through a systematic review in chapter 4

Outcome of focus group discussion draw conceptual orientation based on three dimensions that used to contributes their significance on R&D. Therefore, DANP technique were applied to measure contributing impact among dimensions, criteria's and sub-criteria's with respect to their interrelationship. DANP technique allows researcher, an in-depth configuration to map interrelations between capabilities. Also, prioritize them according to their interrelated significance. For in-depth discussion, same panel of experts were invited for session 2. Now, the experts approved model was used for further discussion in case of developing interrelationship and prioritization among capabilities. Therefore, closed-ended questionnaires were step up to gauge interrelationship among criteria and sub-criteria (see Appendix B). The numerical values were derived from the DANP questionnaire includes the significance among capabilities with their contributing influence. The numerical information formulates the intensity among capabilities which allow decision makers to canvas the deficiencies among appropriate orientation for R&D in public organizations of Pakistan. On 16 April 2018, after completing the first section the experts from 58 public organizations were also invited for second session allows to answer the DANP questionnaire and rate their judgment

In case of criteria, the outcome of second session helps to formulate the total average matrix **T** $_{\text{(Criteria)}}$ from 39 focus groups is shown in Table: 5.21

Table 5.21 Total Average matrix ***T*** $_{\textit{(Criteria)}}$ (Drive From 39 Focus Group)

	KM Process Cap	KM Infra Cap	KM Strate Cap	IM Process Cap	IM infra Cap	IM Strate Cap	TM Process Cap	TM Infra Cap	TM Strat Cap	
KM process Cap	0	2.179	2.231	2.1026	2	2	2.3	2.3	2.2	17.3
KM Infra Cap	2.13	0	2.359	2.1282	2.128	2	2.2	2.4	2.4	17.7
KM Strate Cap	2.23	2.769	0	2.0256	2.282	2	2.2	2.3	2.5	18.3
IM Process Cap	2.31	2.231	2.103	0	2.128	2	2.4	2.5	2.3	17.9
IM infra Cap	2.26	2.128	2.051	2.1026	0	2	2.2	2.3	2.2	17.4
IM Strate Cap	2.46	2.103	2.205	2	2.051	0	2.1	2.5	2.1	17.6
TM Process Cap	2.15	2.154	2.821	2.9231	2.897	3	0	2.5	2.2	20.5
TM Infra Cap	2.1	2.385	2.205	2.1538	2.41	3	2.5	0	2.2	18.5
TM Start Cap	2.62	2.359	2.231	2.9231	2.436	3	2.4	2.2	0	19.7
	18.3	18.31	18.21	18.359	18.33	18	18	19	18	

% of Error gap is used to test the reliability for data instrument that is employ in second session, Total Average matrix T (Criteria) were also formulated again (*n-1*) number of focus groups. In this case, (*n-1*) =38 focus groups. Therefore, the total average matrix from 38 focus groups is shown in Table 5.22

Table 5.22 Total Average matrix $T_{(Criteria)}$ (38 Focus Group)

Total Average of Criteria Matrix (T_cri) 38 Focus group	KM Process Cap	KM Infra Cap	KM Strate Cap	IM Process Cap	IM infra Cap	IM Strate Cap	TM Process Cap	TM Infra Cap	TM Strat Cap
KM process Cap	0	2.11	2.16	2	1.9	1.96	2.2	2.2	2.1
KM Infra Cap	2.06	0	2.29	2.1	2.1	1.94	2.1	2.3	2.3
KM Strate Cap	2.16	2.68	0	2	2.2	1.99	2.1	2.2	2.4
IM Process Cap	2.24	2.16	2.04	0	2.1	1.94	2.3	2.4	2.2
IM infra Cap	2.19	2.06	1.99	2	0	2.14	2.1	2.2	2.1
IM Strate Cap	2.39	2.04	2.14	1.9	2	0	2.1	2.4	2
TM Process Cap	2.09	2.09	2.73	2.8	2.8	2.78	0	2.4	2.1
TM Infra Cap	2.04	2.31	2.14	2.1	2.3	2.44	2.4	0	2.1
TM Start Cap	2.54	2.29	2.16	2.8	2.4	2.46	2.3	2.1	0

Errors of gap ratio (%) = $\frac{1}{n(n-1)}\sum_{i=1}^{n}\sum_{j=1}^{n}\frac{\left|g_c^{ijp}-g_c^{ij(p-1)}\right|}{g_c^{ijp}} =$ 3.05 % less than 5%, i.e., significant confidence is 96.95%, where p=39 denotes the number of focus groups and t_{ij}^{p} is the average influence of criterion *i* on criterion *j*, and denotes number of criteria; here when =9, *n*×*n* matrix deducts the diagonal elements; the number of gap ration element *n* (*n* -1) =9×8 (Appendix D)

In order to formulate the direct and indirect influence some pre-normalized method required to carry further steps forward. Therefore, the normalized matrix is shown in Table: 5.23

Table 5.23 Normalized initial direct-relation ***T*** *(Criteria)*

	KM Process Cap	KM Infra Cap	KM Strate Cap	IM Process Cap	IM infra Cap	IM Strate Cap	TM Process Cap	TM Infra Cap	TM Strat Cap
KM process Cap	0	0.1	0.1	0.1	0.1	0.1	0	0.1	0.1
KM Infra Cap	0.11	0	0.1	0.1	0.11	0.1	0	0.1	0.1
KM Strate Cap	0.11	0.1	0	0.1	0.11	0.1	0	0.1	0.1
IM Process Cap	0.12	0.1	0.1	0	0.11	0.1	0	0.1	0.1
IM infra Cap	0.11	0.1	0.1	0.1	0	0.1	0	0.1	0.1
IM Strate Cap	0.12	0.1	0.1	0.1	0.1	0	0	0.1	0.1
TM Process Cap	0.11	0.1	0.1	0.1	0.14	0.1	0	0.1	0.1
TM Infra Cap	0.12	0.1	0.1	0.1	0.12	0.1	0	0	0.1
TM Start Cap	0.12	0.1	0.1	0.1	0.11	0.1	0	0.1	0

After Pre-normalization of initial direct matrix, the total relational matrix for T (Criteria) can be obtained that is shown in Table 5.23 , While the Total relation matrix T (Criteria) is shown in Table 5.24

Table 5.24 Total relation matrix ***T*** *(Criteria)*

	KM Proc Cap	KM Infra Cap	KM Strat Cap	IM Proc Cap	I.M infra Cap	IM Strat Cap	TM Process Cap	TM Infra Cap	TM Strat Cap	
KM process Cap	1	1.1	1.1	1	1.1	1	1	1.1	1.1	9.99
KM Infra Cap	1.2	1.1	1.2	1	1.2	1	1	1.2	1.2	10.4
KM Strate Cap	1.2	1.2	1.1	1	1.2	1	1	1.2	1.2	10.8
IM Process Cap	1.3	1.2	1.2	1	1.2	1	1	1.2	1.3	11.1
IM infra Cap	1.2	1.2	1.2	1	1.1	1	1	1.2	1.2	10.4
IM Strate Cap	1.2	1.2	1.2	1	1.2	1	1	1.2	1.2	10.6
TM Process Cap	1.3	1.3	1.3	1	1.3	1	1	1.3	1.3	11.8
TM Infra Cap	1.3	1.3	1.2	1	1.3	1	1	1.1	1.3	11.2
TM Start Cap	1.3	1.3	1.3	1	1.3	1	1	1.3	1.2	11.5
	10.9	10.8	10.8	10.69	10.8	10.7	11.1	10.85	10.99	

The r_i use to represents the row sum of the i^{th} row of the matrix *T (Criteria).* While, c_j represents column sum of the j^{th} column of the matrix *T (Criteria)..* *R (row)* + *C (Column)* shows that the degree of strength of influence delivers and received. In simple words, R (row) + C (Column) represent the degree of significant control of *i* used to carry during addressing the problem. Similarly if R (row) - C (Column) is positive in nature than it used to translate as factor *i* is going to affect other factors, if R (row) - C (Column) is negative in nature than it used to represent that factor *i* is being influenced by other factors. Therefore, the cause and effect among the *T (Criteria)* is shown in Table 5.25.

Table 5.25 Sum of the columns and row from the total-influence matrix ***T (Criteria)***

R(row)	**C(Column)**	**R(row)+ C(Column)**	**R(row)- C(Column)**	
9.98522	10.93184	20.9170585	-0.94661324	Affected
10.4227	10.85479	21.2774573	-0.43211685	Affected
10.8135	10.81541	21.6289274	-0.00189395	Affected
11.0937	10.68941	21.7830994	0.404280608	Cause
10.4269	10.82518	21.2520527	-0.3983149	Affected
10.5923	10.73754	21.3298047	-0.14528481	Affected
11.7754	11.11227	22.8876222	0.663082074	Cause
11.1664	10.84698	22.0133558	0.31939364	Cause
11.5228	10.98532	22.5081145	0.53746743	Cause

From Table 5.26 *Technology management process capability* has the highest positive value of R (row) - C (Column) (0.663082074) such a positive value implies a strong influence on other sub-criteria.

On the other hand, *Knowledge management process capability* reflects very low R (row) - C (Column) value (-0.94661324) thus, it has been susceptible for further influence.

Therefore, the improvement priorities can be ordered from *Technology management process capability* as highest priority while *Knowledge management process capability* corresponds to low precedence for further improvement

Table 5.26 Summary of the influences given and received among criteria

$T_{(Criteria)}$	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	$R_{(row)}-C_{(Column)}$	Rank
KM process Cap	9.98522	10.93184	20.9170585	-0.94661324	9
KM Infra Cap	10.4227	10.85479	21.2774573	-0.43211685	8
KM Strate Cap	10.8135	10.81541	21.6289274	-0.00189395	5
IM Process Cap	11.0937	10.68941	21.7830994	0.404280608	3
IM infra Cap	10.4269	10.82518	21.2520527	-0.3983149	7
IM Strate Cap	10.5923	10.73754	21.3298047	-0.14528481	6
TM Process Cap	11.7754	11.11227	22.8876222	0.663082074	1
TM Infra Cap	11.1664	10.84698	22.0133558	0.31939364	4
TM Start Cap	11.5228	10.98532	22.5081145	0.53746743	2

In case of sub-criteria, the outcome of second session based on pair-wise comparison questionnaires that collected across 39 focus groups that helps to formulate the total average matrix **T** **(Sub- Criteria)** from 39 focus groups is shown in Table: 5.27 (Note: The List of Abbreviation Appendix F)

% of Error gap is used to test the reliability for data instrument that is employ in second session, Total Average matrix **T** **(Sub- Criteria)** were also formulated again (*n-1*) number of focus groups. In this case, (*n-1*) =38 focus groups. Therefore, the total average matrix from 38 focus groups is shown in Table 5.29

$$\text{Errors of gap ratio (\%)} = \frac{1}{n(n-1)}\sum_{i=1}^{n}\sum_{j=1}^{n}\frac{\left|g_c^{ijp}-g_c^{ij(p-1)}\right|}{g_c^{ijp}} = 3.43\ \%\ \text{less}$$

than 5%, i.e., significant confidence is 96.57 %, where p=39 denotes the number of experts and t_{ij}^{p} is the average influence of criterion *i* on criterion *j*, and denotes number of criteria; here when =9, *n*×*n* matrix deducts the diagonal elements; the number of gap ration element *n* (*n* -1) =51×50 (Appendix C). In order to formulate the direct and indirect influence some pre-normalized method required to carry further steps forward. Therefore, Normalized initial direct-relation T **(Sub- Criteria)** is shown in Table 5.30

Table 5.27 Total Average matrix $T_{(Sub-Criteria)}$ 39 Focus group The list of Abbreviation used for this Matrix is in Appendix F

Total Average Sub-criteria Matrix (T_Sub) (39 Focus Group)	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(Int & Ext Kno)	(R&D.Corp)	(Ext Net)	(Know .Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Pot)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)	
(K.cre)	0	2.1	1.9	2.9	3.4	1.1	3.2	2.1	2.2	2.4	2	1	2	2.9	0	2	2	3	3.4	1	3	2.1	2.2	2.4	2	1.4	1.9	2.9	0	2	2	2.9	3.4	1.1	3.2	2.1	2.2	2.4	2	1.4	1.9	2.87	2.1	1.8	2.9	3.3	1.2	3.2	2	2.1	2.4	109
(K.Acq)	1.9	0	2.6	2.6	1.8	1.3	1.4	2.4	1.4	1.1	1.5	1	1	1.9	1.9	0	3	2.6	1.8	1	1	2.8	1.4	1.1	1.6	1.4	1.1	2	2	0	3	2.6	1.9	1.4	1.3	2.5	1.4	1.1	1.5	1.4	1.1	1.98	1.9	0	2.7	2.6	1.9	1.4	1	2.7	1.4	84
(Int Kno Port)	2	2.7	0	3.4	1.9	1.4	1.5	2.8	1.5	1.1	1.5	2	1	1.6	2	3	0	3.4	1.9	1	1	2.8	1.5	1.1	1.5	1.5	1.1	1.6	2	3	0	3.4	1.9	1.4	1.5	2.9	1.5	1.1	1.5	1.6	1.2	1.63	2.1	2.7	0	3.4	1.9	1.4	1	2.9	1.5	89
(K.shar)	3.1	3.6	3.1	0	1.9	1.3	1.7	3.1	2	1.5	1.6	1	1	2.6	3.1	4	3	0	1.9	1	2	3.1	2	1.5	1.6	1.4	1.2	2.6	3	4	3	0	1.9	1.4	1.8	3.2	2	1.5	1.6	1.4	1.2	2.62	3.1	3.6	3.1	0	1.9	1.4	2	3.1	2	105
(K.Imp)	2.1	1.9	1.6	1.9	0	2.8	2.2	1.5	1.1	1.4	1.2	1	1	2.7	2.1	2	2	1.9	0	3	2	1.5	1.1	1.5	1.2	1.2	1.5	2.7	2	2	2	1.9	0	2.5	2.2	1.5	1.1	1.5	1.2	1.2	1.5	2.71	2.1	1.9	1.6	1.8	0	2.8	2	1.5	1.1	84
(K.tran)	1.2	1.7	2.1	2.1	2.9	0	2	1.7	1.7	1.7	2	2	2	2.1	1.2	2	2	2.1	2.9	0	2	1.7	1.7	1.8	2	1.7	1.9	2.1	1	2	2	2.1	2.9	0	2	1.8	1.8	1.8	2	1.8	1.9	2.13	3.1	1.2	1.2	2	2.5	1.4	0	1.5	1.4	89
(cult)	3.1	1.2	1.2	2	2.5	1.4	0	1.5	1.4	2.5	1.2	1	1	2.6	3.1	1	1	2	2.5	1	0	1.5	1.4	2.4	1.2	1.2	1.5	2.6	3	1	1	2	2.4	1.4	0	1.5	1.4	2.5	1.2	1.2	1.5	2.62	3.1	1.2	1.2	2	2.5	1.4	0	1.5	1.4	84
(stru)	2	3	2.8	3	2	1.6	1.8	0	2.1	1.6	1.8	1	1	1.6	2	3	3	3	1.9	2	2	0	2.1	1.6	1.7	1.1	1.4	1.6	2	3	3	3	2	1.6	1.7	0	2.1	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	1.9	1.6	2	0	2.1	95
(Tech)	1.7	1.2	1.5	1.6	1.7	1.6	2	1.6	0	2.7	1.9	2	2	1.6	1.7	1	1	1.6	1.7	2	2	1.6	0	2.7	1.9	1.7	2.2	1.6	2	1	1	1.6	1.8	1.6	2	1.6	0	2.7	1.9	1.7	2.2	1.62	1.7	1.2	1.5	1.6	1.7	1.6	2	1.6	0	82
(Peop)	2	1.1	1.2	1.6	1.5	2.2	3	1.2	2.9	0	1.4	2	2	1.6	2	1	1	1.6	1.5	2	3	1.3	2.9	0	1.4	1.9	2.1	1.6	2	1	1	1.6	1.5	2.3	3	1.3	2.9	0	1.4	1.9	2.1	1.63	2	1.1	1.2	1.6	1.5	2.2	3	1.2	2.9	88
(Lead& Supp)	1.7	1.4	1.1	1.6	1.2	1.6	1.5	1.5	1.6	1.6	0	1	1	1.4	1.7	1	1	1.6	1.2	2	1	1.5	1.6	1.6	0	1.4	1.1	1.4	2	1	1	1.6	1.2	1.6	1.5	1.5	1.6	1.6	0	1.4	1.1	1.37	1.7	1.4	1.1	1.6	1.2	1.6	1	1.5	1.6	69
(org. Lear)	1.2	1.1	1.4	1.5	1.6	1.6	1.2	1.2	3.1	2.2	1.2	0	3	2.1	1.3	1	1	1.5	1.6	2	1	1.2	3.1	2.2	1.2	0	3.5	2.1	1	1	1	1.5	1.6	1.6	1.2	1.2	3.1	2.2	1.2	0	3.5	2.12	1.2	1.1	1.4	1.5	1.6	1.6	1	1.2	3.1	83
(Succ. Rate)	1.5	1.2	1.2	1.5	2.2	2.4	1.7	1.4	3.1	2.7	1	3	0	1.9	1.5	1	1	1.5	2.2	2	2	1.4	3.1	2.7	1	2.9	0	1.9	1	1	1	1.5	2.2	2.4	1.7	1.4	3.1	2.7	1	2.9	0	1.87	1.5	1.2	1.1	1.5	2.2	2.4	2	1.4	3.1	90
(R&D Exper)	3	2	2	3.1	3	2	2.5	1.5	1.4	1.6	0.9	1	2	0	3	2	2	3.1	2.9	2	2	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.1	3	2.5	2.5	1.5	1.4	1.6	0.9	1.5	1.8	0	3	2	2	3.1	3	2.5	2	1.5	1.4	100
(Code)	1.9	2.1	1.8	2.9	3.4	1.2	3.2	2.2	2.2	2.4	1.9	1	2	2.9	0	2	2	2.3	3.3	1	3	2.1	2.2	2.3	2	1.4	1.8	2.9	0	2	2	2.8	3.4	1.1	3.1	2.2	2.2	2.4	2	1.4	1.9	2.87	2.1	1.8	2.1	3.3	1.2	3.1	2	2.1	2.4	109
(Pers)	2	0	2.6	2.6	1.8	1.3	1.4	2.6	1.4	1.2	1.5	1	1	1.9	0	0	3	2.6	1.8	1	1	2.8	1.3	1.1	1.6	1.4	1.1	1.9	2	0	3	2.6	1.9	1.4	1.3	2.5	1.4	1.1	1.5	1.4	1.1	1.95	1.9	0	2.6	2.6	1.8	1.4	1	2.7	1.4	82
(Ext)	3.1	2.7	0	3.3	1.9	1.4	1.5	2.7	1.5	1.1	1.5	1	1	1.6	1.9	3	0	3.4	1.9	1	1	2.8	1.5	1.1	1.5	1.5	1.1	1.6	2	3	0	3.4	1.9	1.4	1.5	2.9	1.5	1.1	1.5	1.6	1.2	1.63	2.1	2.7	0	3.3	1.9	1.4	1	2.8	1.5	90
(Inter)	2.1	3.6	3.1	0	1.9	1.3	1.7	3.1	2	1.5	1.7	1	1	2.6	2	4	3	0	1.8	1	2	3.1	2	1.5	1.6	1.4	1.2	2.6	3	4	3	0	1.8	1.4	1.8	3.2	2	1.5	1.6	1.4	2	2.62	3.1	3.6	3.1	0	1.9	1.4	2	3.1	2	103
(Tech .Tran)	1.2	1.9	1.6	1.9	0	2.7	2.2	1.5	1.1	1.4	1.2	1	1	2.7	3.1	2	2	1.9	0	3	2	1.5	1.1	1.5	1.2	1.3	1.5	2.6	2	2	2	1.9	0	2.5	2.2	1.5	1.1	1.5	1.2	1.2	1.5	2.73	2.1	1.9	1.6	1.8	0	2.7	2	1.5	1.1	83
(Dec.Mak)	3.1	1.6	2.1	2.2	2.9	0	2	1.7	1.7	1.7	2	2	2	2.1	2.1	2	2	2.1	2.8	0	2	1.7	1.7	1.7	2	1.7	1.9	2.1	1	2	2	2.1	2.9	0	2	1.7	1.7	1.7	2	1.7	1.9	2.12	3.1	1.2	1.2	2	2.5	1.4	0	1.5	1.4	92
(In. Op Inn)	2	1.2	1.2	2	2.5	1.4	0	1.5	1.4	2.5	1.2	1	1	2.6	1.2	1	1	2	2.5	1	0	1.5	1.4	2.4	1.2	1.2	1.5	2.6	3	1	1	2	2.4	1.4	0	1.5	1.4	2.5	1.2	1.2	1.5	2.61	3.1	1.2	1.2	2	2.5	1.4	0	1.5	1.4	81
(Proj. mang)	1.7	3	2.7	3	2	1.6	1.7	0	2.1	1.6	1.7	1	1	1.6	3.1	3	3	3	1.9	2	2	0	2.1	1.6	1.7	1.1	1.4	1.6	2	3	3	2.9	2	1.6	1.7	0	2.1	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	1.9	1.6	2	0	2.1	95
(Inn. com)	2	1.2	1.5	1.6	1.7	1.6	2	1.6	0	2.7	1.9	2	2	1.6	2	1	1	1.6	1.7	2	2	1.6	0	2.7	1.9	1.7	2.2	1.6	2	1	1	1.6	1.8	1.6	2	1.6	0	2.7	1.9	1.7	2.2	1.62	1.7	1.2	1.5	1.6	1.7	1.6	2	1.6	0	82
(Rate Int)	1.7	1.1	1.2	1.7	1.5	2.2	3	1.2	2.9	0	1.4	2	2	1.6	1.7	1	1	1.6	1.5	2	3	1.2	2.9	0	1.4	1.9	2.1	1.6	2	1	1	1.6	1.5	2.2	2.9	1.2	2.9	0	1.4	1.9	2.1	1.62	2	1.1	1.2	1.6	1.5	2.2	3	1.2	2.8	87
(Int & Ext Kno)	1.2	1.4	1.1	1.6	1.2	1.6	1.5	1.5	1.6	1.6	0	1	1	1.4	2	1	1	1.6	1.2	2	1	1.5	1.6	1.6	0	1.4	1.1	1.4	2	1	1	1.6	1.2	1.6	1.5	1.5	1.6	1.6	0	1.4	1.1	1.35	1.7	1.4	1.1	1.6	1.2	1.6	1	1.5	1.6	69
(R&D.Corp)	1.5	1.1	1.4	1.5	1.6	1.6	1.2	1.2	3.1	2.2	1.2	0	3	2.1	1.7	1	1	1.5	1.6	2	1	1.2	3.1	2.2	1.2	0	3.5	2.1	1	1	1	1.5	1.6	1.6	1.2	1.2	3.1	2.2	1.2	0	3.5	2.12	1.2	1.1	1.4	1.5	1.6	1.6	1	1.2	3.1	84
(Ext Net)	3	1.2	1.2	1.5	2.2	2.4	1.7	1.4	3.2	2.7	1	3	0	1.9	1.2	1	1	1.5	2.3	2	2	1.4	3.1	2.7	1	2.9	0	1.9	1	1	1	1.5	2.2	2.3	1.7	1.4	3.1	2.7	1	2.9	0	1.87	1.5	1.2	1.1	1.5	2.2	2.4	2	1.4	3.1	91
(Know .Inc)	1.9	2	2	3.1	3	2	2.5	1.5	1.4	1.6	0.9	1	2	0	1.4	2	2	3.1	2.9	2	2	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.1	3	2.4	2.3	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.1	3	2.5	2	1.5	1.4	97
(Rad Inn)	2	2.1	1.8	2.8	3.3	2	3.2	1.5	2.2	2.4	1.9	1	2	2.9	3	2	2	2.5	3.2	1	2	2.2	2.2	2.3	2	1.4	1.9	2.7	0	2	2	2.7	3.3	1.1	3.2	2.1	2.2	2.3	2	1.4	1.9	2.86	2.1	1.6	2.1	3.3	1.2	3.2	2	2.1	2.1	111
(Abso. Cap)	3.1	0	2.7	2.6	1.8	1.2	1.4	2.2	1.4	1.2	1.5	1	1	1.9	0	0	3	2.7	1.8	1	3	2.7	1.3	1.1	1.6	1.4	1.1	2	2	0	3	2.6	1.9	1.4	1.3	2.5	1.4	1.2	1.5	1.4	1.1	1.98	1.8	0	2.6	2.6	1.8	1.4	1	2.7	1.4	85
(R&D Empo)	2.1	2.7	0	3.3	1.9	1.3	1.5	2.6	1.5	1.1	1.5	1	1	1.6	1.9	3	0	3.3	1.8	1	1	2.8	1.5	1.1	1.5	1.5	1.1	1.6	2	3	0	3.4	1.9	1.4	1.5	2.9	1.5	1.1	1.5	1.6	1.2	1.63	2.1	2.7	0	3.3	1.9	1.4	1	2.7	1.5	88
(Tech Tren)	1.2	3.6	3.1	0	1.9	1.4	1.7	2.7	2	1.5	1.6	1	1	2.6	2	4	3	0	1.9	1	1	3.1	2	1.5	1.6	1.4	1.2	2.6	3	4	3	0	1.9	1.4	1.7	3.2	2	1.5	1.6	1.4	1.2	2.61	3.2	3.6	3.1	0	1.9	1.4	2	3.1	2	101
(Inno. per)	3.1	1.9	1.6	1.9	0	1.3	2.2	3.1	1.1	1.4	1.2	1	1	2.7	3.1	2	2	1.9	0	3	2	1.5	1.1	1.5	1.2	1.2	1.5	2.6	2	2	2	1.9	0	2.5	2.2	1.5	1.1	1.5	1.2	1.2	1.5	2.73	2.1	1.9	1.6	1.8	0	2.7	2	1.5	1.1	85
(Inov Str& ini)	2	1.6	2.1	2.2	2.9	2.7	2	1.5	1.7	1.7	2	2	2	2.2	2.1	2	2	2.1	2.8	0	2	1.7	1.7	1.7	2	1.7	1.9	2.1	1	2	2	2.1	2.9	0	2	1.7	1.7	1.7	2	1.7	1.9	2.11	3.1	1.2	1.2	2	2.5	1.4	0	1.5	1.4	93
(Org.Str)	1.7	1.2	1.2	2	2.5	0	0	1.7	1.4	2.5	1.2	1	1	2.6	1.2	1	1	2	2.5	1	2	1.5	1.4	2.4	1.2	1.2	1.5	2.6	3	1	1	2	2.4	1.4	0	1.5	1.4	2.5	1.2	1.2	1.5	2.61	3.1	1.2	1.2	2	2.4	1.4	0	1.5	1.4	81
(Tech. Acq)	2	3	2.7	3	2	1.4	1.7	1.5	2.2	1.6	1.7	1	1	1.6	3.1	3	3	3	1.9	2	0	0	2.1	1.7	1.7	1.1	1.4	1.6	2	3	3	3	2	1.6	1.7	0	2.2	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	1.9	1.6	2	0	2.1	95
(Tech. Expo)	1.7	1.2	1.5	1.6	1.7	1.6	2	0	0	2.7	1.9	2	2	1.6	2	1	1	1.6	1.7	2	2	1.6	0	2.7	1.9	1.7	2.2	1.6	2	1	1	1.6	1.8	1.6	2	1.6	0	2.7	1.9	1.7	2.2	1.62	1.7	1.2	1.5	1.6	1.7	1.6	2	1.6	0	80
(Tech. Pro)	1.3	1.1	1.2	1.7	1.5	1.6	3	1.6	2.9	0	1.4	2	2	1.6	1.7	1	1	1.6	1.5	2	2	1.2	2.9	0	1.4	1.9	2.1	1.6	2	1	1	1.6	1.5	2.2	3	1.2	2.9	0	1.4	1.9	2.1	1.62	2	1.1	1.2	1.6	1.5	2.2	3	1.2	2.8	85
(Tech. lear)	1.5	1.4	1.1	1.7	1.2	2.2	1.5	1.2	1.6	1.6	0	1	1	1.4	2	1	1	1.6	1.2	2	3	1.5	1.6	1.6	0	1.4	1.2	1.4	2	1	1	1.6	1.2	1.6	1.5	1.5	1.6	1.6	0	1.4	1.1	1.33	1.7	1.4	1.1	1.6	1.2	1.6	1	1.5	1.6	71
(Tech. Sele)	3	1.2	1.4	1.5	1.6	1.6	1.2	1.5	3.1	2.2	1.2	0	3	2.1	1.7	1	1	1.5	1.6	2	1	1.2	3.1	2.2	1.2	0	3.5	2.1	1	1	1	1.5	1.6	1.6	1.2	1.2	3.1	2.2	1.2	0	3.5	2.12	1.2	1.1	1.4	1.5	1.6	1.6	1	1.2	3.1	86
(Tech. Iden)	1.9	1.2	1.2	1.5	2.2	1.6	1.7	1.2	3.2	2.7	1	3	0	1.9	1.2	1	1	1.5	2.3	2	1	1.4	3.1	2.7	1	2.9	0	1.9	1	1	1	1.5	2.2	2.4	1.7	1.4	3.1	2.7	1	2.9	0	1.87	1.5	1.2	1.1	1.5	2.2	2.4	2	1.4	3.1	88
(Tech Deve)	2	2	2	3.1	3	2.4	2.5	1.4	1.4	1.6	0.9	1	2	0	1.5	2	2	3.1	2.8	2	2	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.1	3	2.5	2.5	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.1	3	2.5	2	1.5	1.4	97
(Mang comp)	3.1	1.9	1.8	3	2	2	0	1.5	2.2	2.4	1.2	1	1	2.8	3	2	1	0	1.9	2	2	0	1.7	2.3	2	1.4	1.8	2.9	0	2	2	2.8	3.3	1.1	3.1	2.2	2.1	2.3	2	1.4	1.9	2.86	0	1.8	2.9	3.3	1.2	3.2	2	2.1	2.4	99
(Fac)	2.1	1.6	2.7	1.6	1.7	1.4	1.7	3.1	1.4	1.6	2	2	2	1.8	0	1	3	1.9	1.7	2	2	1.6	1.4	1.1	1.6	1.3	1.1	1.9	2	0	3	2.6	1.9	1.4	1.3	2.5	1.3	1.1	1.5	1.4	1.1	1.89	1.9	0	2.6	2.6	1.9	1.4	1	2.7	1.4	87
(Org. Poten)	1.2	1.2	0	1.6	1.5	1.6	2	1.5	1.5	2.6	1.2	2	2	1.6	1.7	3	1	2.2	1.5	1	0	1.2	2.1	1.1	1.5	1.4	1.1	1.6	2	3	0	3.4	1.8	1.4	1.5	2.8	1.5	1.2	1.5	1.5	1.2	1.63	2.1	2.7	0	3.3	1.9	1.4	1	2.8	1.5	84
(Pers. Skil)	3.1	3	3.1	1.6	1.2	1.6	3	1.7	2	0	1.7	1	1	2.6	2	1	1	2	1.2	1	2	1.5	0	1.5	1.6	1.4	1.2	2.6	3	4	3	0	1.8	1.4	1.8	3.1	2	1.5	1.6	1.4	2	2.61	3.1	3.6	3.1	0	1.9	1.4	2	3.1	2	97
(Str Tech)	2	1.2	1.6	1.5	1.6	2.3	1.5	1.5	1.1	1.6	1.9	0	3	2.6	1.7	1	1	3	1.6	1	2	1.2	2.9	1.5	1.2	1.2	1.4	2.6	2	2	2	1.9	0	2.5	2.1	1.5	1.1	1.5	1.2	1.2	1.5	2.69	2.1	1.9	1.6	1.8	0	2.7	2	1.5	1.1	85
(Corp Tech Stra)	1.7	1.1	2.1	1.5	2.2	1.6	1.2	0	1.7	2.2	1.4	3	0	2.2	1.2	1	1	1.6	2.3	1	3	1.4	1.6	1.7	2	1.7	1.9	2.2	1	2	2	2.1	2.9	0	2	1.7	1.7	1.7	2	1.7	1.9	2.12	3.2	1.2	1.2	2	2.5	0	0	1.5	1.4	84
(Corport Bus Strat)	3	1.4	1.2	3.1	3	1.6	1.7	1.6	1.3	2.7	0	1	2	2.6	1.4	1	1	1.6	2.8	3	1	1.5	3.1	2.4	1.3	1.2	1.5	2.6	3	1	1	2	2.4	1.4	0	1.5	1.4	2.5	1.1	1.2	1.5	2.59	3.1	1.2	1.2	2	2.5	1.4	0	1.5	1.4	89
(Tech Alli)	1.9	1.2	2.7	1.6	2.2	2.4	2.5	1.6	2.1	1.6	1.2	3	3	1.6	3	1	1	1.6	1.5	1	1	1.4	2.9	1.6	1.7	1.1	1.4	1.6	2	3	3	2.9	2	1.6	1.7	0	2.1	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	1.1	1.6	2	0	2.1	94
(Desor. Cap)	1.8	2	2	3.1	3	2	2.5	1.5	1.4	1.6	1.1	1	2	0	3	2	2	2.5	3.4	1	2	2.2	2.2	2.4	2	1.4	1.9	2.9	0	2	2	2.8	3.3	1.1	3.2	2.2	2.2	2.4	2	1.4	1.9	2.86	1.7	1.2	1.5	1.6	1.7	1.6	2	1.7	0	99
	103	87	88	105	101	84	92	85	91	89	68	75	84	98	93	86	84	102	100	84	93	84	94	88	73	72	80	101	95	91	88	106	102	80	93	89	92	88	72	73	82	101	111	86	86	106	89	93	80	87	89	

Table 5.29 Total Average matrix $T_{(Sub-Criteria)}$ (38 group)

The list of Abbreviation used for this Matrix is in Appendix F

Total Average Sub-criteria Matrix (T_Sub) (38 Focus Group)	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(Int & Ext Kno)	(R&D.Corp)	(Ext Net)	(Know. Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Poten)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)	
(K.cre)	0	2	1.8	2.8	3.2	1.1	3.1	2.1	2.1	2.3	1.9	1	2	2.8	0	2	2	2.9	3.2	1	3	2	2.1	2.3	2	1.8	1.9	1.3	2	3	0	2.8	3.2	1.1	3.1	2	2.1	2.3	1.9	1.3	1.8	2.8	2	1.7	2.8	3.2	1.2	3.1	2	2	2.3	106
(K.Acq)	1.8	0	2.5	2.5	1.8	1.3	1.3	2.3	1.3	1.1	1.4	1	1	1.8	1.8	0	3	2.5	1.8	1	1	2.7	1.3	1.1	0	2.5	1.6	1.3	1	2	2	2.5	1.8	1.3	1.3	2.4	1.3	1.1	1.5	1.3	1.1	1.9	1.8	0	2.6	2.5	1.8	1.3	1	2.6	1.3	81
(Int Kno Port)	1.9	2.6	0	3.2	1.8	1.3	1.4	2.7	1.5	1.1	1.5	1	1	1.6	1.9	3	0	3.2	1.8	1	1	2.7	1.5	1.1	2.6	0	1.5	1.5	1	2	2	3.2	1.8	1.3	1.5	2.8	1.5	1.1	1.4	1.5	1.2	1.6	2	2.6	0	3.3	1.8	1.3	1	2.8	1.5	86
(K.shar)	3	3.5	3	0	1.8	1.3	1.6	3	1.9	1.4	1.6	1	1	2.5	3	3	3	0	1.8	1	2	3	1.9	1.5	3.5	3	1.6	1.3	1	3	3	0	1.8	1.3	1.7	3.1	1.9	1.4	1.6	1.3	1.2	2.5	3	3.5	3	0	1.8	1.3	2	3	1.9	101
(K.Imp)	2	1.8	1.6	1.8	0	2.7	2.1	1.4	1.1	1.4	1.2	1	1	2.6	2	2	2	1.8	0	3	2	1.4	1.1	1.4	1.8	1.6	1.2	1.2	1	3	2	1.8	0	2.4	2.1	1.4	1.1	1.4	1.2	1.2	1.4	2.6	2	1.8	1.6	1.7	0	2.7	2	1.5	1.1	81
(K.tran)	1.1	1.6	2	2	2.8	0	1.9	1.6	1.6	1.6	1.9	2	2	2	1.2	2	2	2.1	2.8	0	2	1.7	1.7	1.7	1.7	2.1	1.9	1.7	2	2	1	2.1	2.8	0	1.9	1.7	1.7	1.7	1.9	1.7	1.8	2.1	3	1.2	1.2	1.9	2.4	1.3	0	1.4	1.3	86
(cult)	3	1.2	1.2	1.9	2.4	1.3	0	1.4	1.3	2.4	1.2	1	1	2.5	3	1	1	1.9	2.4	1	0	1.4	1.3	2.3	1.2	1.2	1.2	1.2	1	3	3	1.9	2.3	1.3	0	1.4	1.3	2.4	1.2	1.2	1.4	2.5	3	1.2	1.2	1.9	2.4	1.3	0	1.4	1.3	81
(stru)	1.9	2.9	2.7	2.9	1.9	1.6	1.7	0	2.1	1.6	1.7	1	1	1.6	1.9	3	3	2.9	1.8	2	2	0	2	1.6	2.9	2.6	1.7	1.1	1	2	2	2.9	1.9	1.6	1.7	0	2	1.6	1.6	1.1	1.3	1.6	1.9	2.9	2.6	2.9	1.8	1.6	2	0	2	92
(Tech)	1.6	1.2	1.4	1.6	1.6	1.6	1.9	1.6	0	2.6	1.8	2	2	1.6	1.6	1	1	1.6	1.6	2	2	1.6	0	2.6	1.2	1.4	1.8	1.6	2	2	2	1.6	1.7	1.6	1.9	1.6	0	2.6	1.8	1.7	2.1	1.6	1.7	1.2	1.4	1.6	1.7	1.6	2	1.6	0	79
(Peop)	1.9	1.1	1.2	1.6	1.4	2.1	2.9	1.2	2.8	0	1.3	2	2	1.6	1.9	1	1	1.6	1.4	2	3	1.2	2.8	0	1.1	1.2	1.3	1.8	2	2	2	1.6	1.4	2.2	2.9	1.2	2.8	0	1.3	1.8	2.1	1.6	1.9	1.1	1.2	1.6	1.5	2.1	3	1.2	2.8	85
(Lead& Supp)	1.7	1.3	1.1	1.6	1.2	1.6	1.4	1.4	1.6	1.6	0	1	1	1.3	1.7	1	1	1.6	1.2	2	1	1.4	1.6	1.6	1.3	1.1	0	1.3	1	1	2	1.6	1.2	1.6	1.4	1.4	1.6	1.6	0	1.3	1.1	1.3	1.6	1.3	1.1	1.6	1.2	1.6	1	1.4	1.6	67
(org. Lear)	1.2	1.1	1.3	1.4	1.6	1.6	1.2	1.2	3	2.1	1.2	0	3	2	1.2	1	1	1.4	1.6	2	1	1.2	3	2.1	1.1	1.3	1.2	0	3	2	1	1.4	1.6	1.6	1.2	1.2	3	2.2	1.2	0	3.4	2	1.2	1.1	1.3	1.4	1.6	1.6	1	1.2	3	80
(Succ. Rate)	1.4	1.2	1.2	1.4	2.1	2.3	1.6	1.3	3	2.6	1	3	0	1.8	1.4	1	1	1.4	2.1	2	2	1.3	3	2.6	1.2	1.1	1	2.8	0	2	1	1.4	2.2	2.3	1.7	1.3	3	2.6	1	2.8	0	1.8	1.4	1.2	1.1	1.4	2.2	2.3	2	1.3	3	87
(R&D Exper)	2.9	1.9	1.9	3	2.9	1.9	2.4	1.5	1.3	1.6	0.8	1	2	0	2.9	2	2	3	2.8	2	2	1.4	1.3	1.6	1.9	1.9	0.8	1.4	2	0	3	3	2.9	2.4	2.4	1.5	1.3	1.6	0.8	1.5	1.7	0	2.9	1.9	1.9	3	2.9	2.4	2	1.5	1.3	97
(Code)	1.8	2	1.8	2.8	3.2	1.1	3.1	2.1	2.1	2.3	1.8	1	2	2.8	0	2	2	2.2	3.2	1	3	2	2.1	2.3	2	1.8	1.9	1.3	2	3	0	2.7	3.2	1.1	3	2.1	2.1	2.3	2	1.3	1.8	2.8	2	1.7	2	3.2	1.1	3	2	2	2.3	106
(Pers)	1.9	0	2.5	2.5	1.8	1.3	1.3	2.5	1.3	1.1	1.4	1	1	1.8	0	0	3	2.5	1.8	1	1	2.7	1.3	1.1	0	2.5	1.6	1.3	1	2	2	2.5	1.8	1.3	1.3	2.4	1.3	1.1	1.5	1.3	1.1	1.9	1.8	0	2.5	2.5	1.8	1.3	1	2.6	1.3	79
(Ext)	3	2.6	0	3.2	1.8	1.3	1.4	2.6	1.4	1.1	1.5	1	1	1.6	1.8	3	0	3.2	1.8	1	1	2.7	1.4	1.1	2.6	0	1.5	1.4	1	2	2	3.2	1.8	1.3	1.5	2.8	1.4	1.1	1.4	1.5	1.2	1.6	2	2.6	0	3.2	1.8	1.3	1	2.7	1.4	87
(Inter)	2	3.4	3	0	1.8	1.3	1.7	3	1.9	1.4	1.6	1	1	2.5	1.9	4	3	0	1.8	1	2	3	1.9	1.5	3.5	3	1.6	1.3	1	3	3	0	1.8	1.3	1.7	3.1	1.9	1.4	1.6	1.3	1.9	2.5	3	3.5	3	0	1.8	1.3	2	3	1.9	100
(Tech .Tran)	1.2	1.8	1.6	1.8	0	2.6	2.1	1.4	1.1	1.4	1.1	1	1	2.6	3	2	2	1.8	0	3	2	1.4	1.1	1.4	1.8	1.6	1.1	1.2	1	3	2	1.8	0	2.4	2.1	1.4	1.1	1.4	1.2	1.2	1.4	2.6	2	1.8	1.6	1.7	0	2.6	2	1.4	1.1	81
(Dec.Mak)	3	1.6	2	2.1	2.8	0	1.9	1.6	1.6	1.6	1.9	2	2	2	2	2	2	2.1	2.7	0	2	1.7	1.7	1.7	1.7	2.1	1.9	1.7	2	2	1	2	2.8	0	1.9	1.7	1.7	1.7	1.9	1.7	1.8	2	3	1.2	1.2	1.9	2.4	1.3	0	1.4	1.3	88
(In. Op Inn)	1.9	1.2	1.2	1.9	2.4	1.3	0	1.4	1.3	2.4	1.1	1	1	2.5	1.2	1	1	1.9	2.4	1	0	1.4	1.3	2.3	1.2	1.2	1.2	1.2	1	3	3	1.9	2.3	1.3	0	1.4	1.3	2.4	1.2	1.2	1.4	2.5	3	1.2	1.2	1.9	2.4	1.3	0	1.4	1.3	78
(Proj. mang)	1.6	2.9	2.6	2.9	1.9	1.6	1.7	0	2	1.6	1.7	1	1	1.6	3	3	3	2.9	1.8	2	2	0	2	1.6	2.8	2.6	1.7	1.1	1	2	2	2.8	1.9	1.6	1.7	0	2	1.6	1.6	1.1	1.3	1.6	1.9	2.9	2.6	2.9	1.8	1.6	2	0	2	92
(Inn. com)	1.9	1.2	1.4	1.6	1.6	1.6	1.9	1.6	0	2.6	1.8	2	2	1.6	1.9	1	1	1.6	1.7	2	2	1.6	0	2.6	1.1	1.4	1.8	1.6	2	2	2	1.6	1.7	1.6	1.9	1.6	0	2.6	1.8	1.6	2.1	1.6	1.6	1.2	1.4	1.6	1.7	1.6	2	1.6	0	80
(Rate Int)	1.6	1.1	1.2	1.6	1.4	2.1	2.9	1.1	2.8	0	1.3	2	2	1.6	1.6	1	1	1.6	1.5	2	3	1.2	2.8	0	1.1	1.1	1.3	1.8	2	2	2	1.6	1.4	2.1	2.8	1.2	2.8	0	1.3	1.8	2.1	1.6	1.9	1.1	1.2	1.5	1.4	2.1	3	1.2	2.7	84
(Int & Ext Kno)	3	0	2.6	2.5	1.8	1.2	1.3	2.1	1.3	1.1	1.4	1	1	1.8	0	0	3	2.6	1.8	1	3	2.6	1.3	1.1	0	2.5	1.6	1.3	1	2	2	2.5	1.8	1.3	1.3	2.4	1.3	1.2	1.5	1.3	1.1	1.9	1.7	0	2.5	2.5	1.8	1.3	1	2.6	1.3	82
(R&D.Corp)	2	2.6	0	3.2	1.8	1.3	1.4	2.5	1.4	1.1	1.5	1	1	1.6	1.8	3	0	3.2	1.7	1	1	2.7	1.4	1.1	2.6	0	1.5	1.5	1	2	2	3.2	1.8	1.3	1.5	2.8	1.4	1.1	1.4	1.5	1.2	1.6	2	2.6	0	3.2	1.8	1.3	1	2.6	1.4	85
(Ext Net)	1.2	1.3	1.1	1.6	1.2	1.6	1.4	1.4	1.6	1.6	0	1	1	1.3	1.9	1	1	1.6	1.2	2	1	1.4	1.6	1.6	1.3	1.1	0	1.3	1	1	2	1.6	1.2	1.6	1.4	1.4	1.6	1.6	0	1.3	1.1	1.3	1.6	1.3	1.1	1.6	1.2	1.6	1	1.4	1.6	67
(Know .Inc)	1.4	1.1	1.3	1.4	1.6	1.6	1.2	1.2	3	2.1	1.2	0	3	2	1.6	1	1	1.4	1.6	2	1	1.2	3	2.1	1.1	1.3	1.2	0	3	2	1	1.4	1.6	1.6	1.2	1.2	3	2.2	1.2	0	3.4	2	1.2	1.1	1.3	1.4	1.5	1.6	1	1.1	3	81
(Rad Inn)	2.9	1.1	1.2	1.4	2.1	2.3	1.6	1.3	3	2.6	1	3	0	1.8	1.2	1	1	1.4	2.2	2	2	1.3	3	2.6	1.2	1.1	1	2.8	0	2	1	1.4	2.1	2.2	1.7	1.3	3	2.6	1	2.8	0	1.8	1.4	1.1	1.1	1.4	2.1	2.3	2	1.3	3	88
(Abso. Cap)	1.8	1.9	1.9	3	2.9	1.9	2.4	1.4	1.3	1.6	0.8	1	2	0	1.4	2	2	3	2.8	2	2	1.4	1.3	1.6	1.9	1.9	0.8	1.4	2	0	3	3	2.9	2.3	2.2	1.4	1.3	1.6	0.8	1.4	1.7	0	2.9	1.9	1.9	3	2.9	2.4	2	1.5	1.3	94
(R&D Empo)	1.9	2	1.8	2.8	3.2	1.9	3.1	1.4	2.1	2.3	1.9	1	2	2.8	2.9	2	2	2.4	3.2	1	2	2.1	2.1	2.3	2	1.8	1.9	1.3	2	3	0	2.7	3.2	1.1	3.1	2	2.1	2.3	2	1.3	1.8	2.8	2	1.6	2	3.2	1.1	3.1	2	2	2.3	108
(Tech Tren)	1.2	3.4	3	0	1.8	1.3	1.6	2.6	1.9	1.4	1.6	1	1	2.5	1.9	4	3	0	1.8	1	1	3	1.9	1.5	3.5	3	1.6	1.3	1	3	3	0	1.8	1.3	1.7	3.1	1.9	1.4	1.6	1.3	1.2	2.5	3.1	3.5	3	0	1.8	1.3	2	3	1.9	97
(Inno. per)	3	1.8	1.6	1.8	0	1.3	2.1	3	1.1	1.4	1.1	1	1	2.6	3	2	2	1.8	0	3	2	1.4	1.1	1.4	1.8	1.6	1.1	1.2	1	3	2	1.8	0	2.4	2.1	1.4	1.1	1.4	1.2	1.2	1.4	2.6	2	1.8	1.6	1.7	0	2.6	2	1.4	1.1	82
(Inov Str& ini)	1.9	1.6	2	2.1	2.8	2.6	1.9	1.4	1.6	1.6	1.9	2	2	2.1	2	2	2	2	2.7	0	2	1.7	1.7	1.7	1.7	2	1.9	1.7	2	2	1	2.1	2.8	0	1.9	1.7	1.7	1.7	1.9	1.7	1.8	2	3	1.2	1.2	1.9	2.4	1.3	0	1.4	1.3	90
(Org.Str)	1.6	1.2	1.2	1.9	2.4	0	0	1.6	1.3	2.4	1.1	1	1	2.5	1.2	1	1	1.9	2.4	1	2	1.4	1.3	2.3	1.1	1.2	1.2	1.2	1	3	3	1.9	2.3	1.3	0	1.4	1.3	2.4	1.2	1.2	1.4	2.5	3	1.2	1.1	1.9	2.4	1.3	0	1.4	1.3	78
(Tech. Acq)	1.9	2.9	2.6	2.9	1.9	1.3	1.7	1.4	2.1	1.6	1.6	1	1	1.6	3	3	3	2.9	1.8	2	0	0	2	1.6	2.9	2.6	1.7	1.1	1	2	2	2.9	1.9	1.6	1.7	0	2.1	1.6	1.6	1.1	1.3	1.6	1.9	2.9	2.6	2.9	1.8	1.6	2	0	2	92
(Tech. Expo)	1.7	1.2	1.5	1.6	1.6	1.6	1.9	0	0	2.6	1.8	2	2	1.6	1.9	1	1	1.6	1.7	2	2	1.6	0	2.6	1.1	1.4	1.8	1.6	2	2	2	1.6	1.7	1.6	1.9	1.6	0	2.6	1.8	1.6	2.2	1.6	1.6	1.2	1.4	1.6	1.6	1.6	2	1.6	0	77
(Tech. Pro)	1.2	1.1	1.2	1.6	1.4	1.6	2.9	1.6	2.8	0	1.3	2	2	1.6	1.6	1	1	1.6	1.5	2	2	1.2	2.8	0	1.1	1.1	1.3	1.8	2	2	2	1.6	1.4	2.1	2.9	1.2	2.8	0	1.3	1.8	2	1.6	1.9	1.1	1.1	1.5	1.4	2.1	3	1.2	2.7	83
(Tech. lear)	1.5	1.3	1.1	1.6	1.2	2.1	1.4	1.1	1.6	1.6	0	1	1	1.3	1.9	1	1	1.6	1.2	2	3	1.4	1.6	1.6	1.3	1.1	0	1.3	1	1	2	1.6	1.1	1.6	1.4	1.4	1.6	1.6	0	1.3	1.1	1.3	1.6	1.3	1.1	1.6	1.2	1.6	1	1.4	1.6	69
(Tech. Sele)	2.9	1.1	1.3	1.4	1.6	1.6	1.2	1.4	3	2.1	1.2	0	3	2	1.6	1	1	1.4	1.6	2	1	1.2	3	2.1	1.1	1.3	1.2	0	3	2	1	1.4	1.6	1.6	1.2	1.2	3	2.2	1.2	0	3.4	2	1.2	1.1	1.3	1.4	1.6	1.6	1	1.1	3	83
(Tech. Iden)	1.8	1.2	1.2	1.4	2.1	1.6	1.6	1.2	3.1	2.6	1	3	0	1.8	1.2	1	1	1.4	2.2	2	1	1.3	3	2.6	1.2	1.1	1	2.8	0	2	1	1.4	2.1	2.3	1.7	1.3	3	2.6	1	2.8	0	1.8	1.4	1.2	1.1	1.4	2.1	2.3	2	1.3	3	85
(Tech Deve)	1.9	1.9	1.9	3	2.9	2.3	2.4	1.3	1.3	1.6	0.8	1	2	0	1.4	2	2	3	2.7	2	2	1.4	1.3	1.6	1.9	1.9	0.8	1.4	2	0	3	3	2.9	2.4	2.4	1.4	1.3	1.6	0.8	1.4	1.7	0	2.9	1.9	1.9	3	2.9	2.4	2	1.4	1.3	94
(Mang comp)	3	1.8	1.8	2.9	1.9	1.9	0	1.4	2.1	2.3	1.2	1	1	2.7	2.9	2	1	0	1.8	2	2	0	1.7	2.3	2	1.8	1.9	1.3	2	3	0	2.7	3.2	1.1	3	2.1	2.1	2.2	2	1.3	1.8	2.8	0	1.7	2.8	3.2	1.1	3.1	2	2	2.3	96
(Fac)	2	1.6	2.6	1.6	1.6	1.4	1.6	3	1.3	1.6	1.9	2	2	1.8	0	1	3	1.8	1.7	2	2	1.6	1.3	1.1	0	2.5	1.6	1.3	1	2	2	2.5	1.8	1.3	1.3	2.4	1.3	1.1	1.5	1.3	1.1	1.8	1.8	0	2.6	2.5	1.8	1.3	1	2.6	1.3	84
(Org. Poten)	1.2	1.2	0	1.6	1.4	1.6	1.9	1.4	1.4	2.5	1.1	2	2	1.6	1.6	3	1	2.1	1.4	1	0	1.2	2	1.1	2.6	0	1.5	1.4	1	2	2	3.2	1.8	1.3	1.4	2.7	1.4	1.2	1.4	1.5	1.2	1.6	2	2.6	0	3.2	1.8	1.3	1	2.7	1.4	81
(Pers. Skil)	3	2.9	3	1.6	1.2	1.6	2.9	1.6	1.9	0	1.6	1	1	2.5	1.9	1	1	1.9	1.2	1	2	1.4	0	1.5	3.5	3	1.6	1.3	1	3	3	0	1.8	1.3	1.7	3	1.9	1.4	1.6	1.3	1.9	2.5	3	3.5	3	0	1.8	1.3	2	3	1.9	93
(Str Tech)	1.9	1.2	1.6	1.4	1.6	2.2	1.4	1.4	1.1	1.6	1.8	0	3	2.5	1.6	1	1	2.9	1.6	1	2	1.2	2.8	1.4	1.8	1.6	1.1	1.2	1	3	2	1.8	0	2.4	2.1	1.4	1.1	1.4	1.2	1.2	1.4	2.6	2	1.8	1.6	1.8	0	2.6	2	1.4	1.1	82
(Corp Tech Stra)	1.6	1.1	2	1.4	2.2	1.6	1.2	0	1.6	2.1	1.3	3	0	2.1	1.2	1	1	1.5	2.2	1	3	1.3	1.6	1.7	1.6	2	1.9	1.7	2	2	1	2	2.8	0	1.9	1.6	1.6	1.6	1.9	1.6	1.8	2	3	1.2	1.2	1.9	2.4	0	0	1.4	1.3	81
(Corport Bus Strat)	2.9	1.3	1.2	3	2.9	1.6	1.6	1.6	1.3	2.6	0	1	2	2.5	1.4	1	1	1.6	2.7	3	1	1.4	3	2.4	1.2	1.2	1.2	1.1	1	3	3	1.9	2.3	1.3	0	1.4	1.3	2.4	1.1	1.2	1.4	2.5	3	1.2	1.2	1.9	2.4	1.3	0	1.4	1.3	86
(Tech Alli)	1.8	1.1	2.6	1.6	2.2	2.3	2.4	1.5	2	1.6	1.1	3	3	1.6	2.9	1	1	1.6	1.5	1	1	1.4	2.8	1.6	2.8	2.6	1.7	1.1	1	2	2	2.8	1.9	1.6	1.6	0	2.1	1.6	1.6	1.1	1.3	1.6	1.9	2.9	2.6	2.9	1.1	1.6	2	0	2	91
(Desor. Cap)	1.8	1.9	1.9	3	2.9	1.9	2.4	1.4	1.3	1.6	1.1	1	2	0	2.9	2	2	2.4	3.3	1	2	2.1	2.1	2.3	2	1.8	1.9	1.3	2	3	0	2.7	3.2	1.1	3.1	2.1	2.1	2.3	1.9	1.3	1.8	2.8	1.7	1.2	1.4	1.6	1.7	1.6	2	1.6	0	96
	100	84	85	101	98	81	89	82	88	86	66	72	81	94	90	83	81	98	97	81	90	81	91	85	88	85	70	70	77	97	92	103	98	77	90	86	89	85	70	70	79	98	107	84	83	103	86	90	77	84	86	

Table 5.30 Normalized initial direct-relation ***T*** *(Sub- Criteria)* The list of Abbreviation used for this Matrix is in Appendix F

Normalized initial direct-relation T (Sub- Criteria)	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(Int & Ext Kno)	(R&D.Corp)	(Ext Net)	(Know .Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Poten)	(Pers. Skill)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)
(K.cre)	0	0.019	0.02	0.03	0.03	0.01	0.029	0.019	0.02	0.021	0.018	0.01	0.017	0.03	0	0.02	0.016	0.03	0.03	0.01	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0	0.02	0.02	0.03	0.03	0.01	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.026	0.019	0.016	0.03	0.03	0.01	0.03	0.02	0.02	0.021
(K.Acq)	0.02	0	0.02	0.02	0.02	0.01	0.012	0.022	0.012	0.01	0.014	0.01	0.011	0.02	0.017	0	0.023	0.02	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0	0.02	0.02	0.02	0.012	0.01	0.02	0.013	0.01	0.01	0.01	0.01	0.018	0.017	0	0.02	0.02	0.02	0.01	0.01	0.02	0.012
(Int Kno Port)	0.02	0.024	0	0.03	0.02	0.01	0.013	0.025	0.014	0.01	0.014	0.01	0.01	0.01	0.018	0.02	0	0.03	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0	0.03	0.02	0.012	0.01	0.03	0.014	0.01	0.01	0.01	0.01	0.015	0.019	0.024	0	0.03	0.02	0.01	0.01	0.03	0.014
(K.shar)	0.03	0.032	0.03	0	0.02	0.01	0.015	0.028	0.018	0.013	0.014	0.01	0.01	0.02	0.028	0.03	0.028	0	0.02	0.01	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0	0.02	0.012	0.02	0.03	0.018	0.01	0.01	0.01	0.01	0.024	0.028	0.033	0.03	0	0.02	0.01	0.02	0.03	0.018
(K.Imp)	0.02	0.017	0.01	0.02	0	0.02	0.02	0.013	0.01	0.013	0.011	0.01	0.013	0.02	0.019	0.02	0.015	0.02	0	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0	0.023	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.024	0.019	0.017	0.01	0.02	0	0.02	0.02	0.01	0.01
(K.tran)	0.01	0.015	0.02	0.02	0.03	0	0.018	0.015	0.015	0.015	0.018	0.02	0.017	0.02	0.011	0.02	0.019	0.02	0.03	0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0	0.02	0.02	0.016	0.02	0.02	0.02	0.02	0.019	0.028	0.011	0.01	0.02	0.02	0.01	0	0.01	0.012
(cult)	0.03	0.011	0.01	0.02	0.02	0.01	0	0.013	0.012	0.022	0.011	0.01	0.013	0.02	0.028	0.01	0.011	0.02	0.02	0.01	0	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.02	0.012	0	0.01	0.012	0.02	0.01	0.01	0.01	0.024	0.028	0.011	0.01	0.02	0.02	0.01	0	0.01	0.012
(stru)	0.02	0.027	0.02	0.03	0.02	0.01	0.016	0	0.019	0.015	0.016	0.01	0.012	0.01	0.018	0.03	0.024	0.03	0.02	0.01	0.02	0	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.02	0.03	0.02	0.015	0.02	0	0.019	0.01	0.02	0.01	0.01	0.015	0.018	0.027	0.02	0.03	0.02	0.01	0.02	0	0.019
(Tech)	0.02	0.011	0.01	0.01	0.02	0.01	0.018	0.015	0	0.024	0.017	0.02	0.02	0.01	0.015	0.01	0.013	0.01	0.02	0.01	0.02	0.01	0	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.015	0.02	0.01	0	0.02	0.02	0.02	0.02	0.015	0.015	0.011	0.01	0.01	0.02	0.01	0.02	0.01	0
(Peop)	0.02	0.01	0.01	0.01	0.01	0.02	0.027	0.011	0.026	0	0.012	0.02	0.019	0.01	0.018	0.01	0.011	0.01	0.01	0.02	0.03	0.01	0.03	0	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.026	0	0.01	0.02	0.02	0.015	0.018	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.026
(Lead& Supp)	0.02	0.012	0.01	0.01	0.01	0.01	0.013	0.013	0.015	0.015	0	0.01	0.01	0.01	0.015	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.015	0.01	0.01	0.015	0.01	0	0.01	0.01	0.012	0.015	0.012	0.01	0.01	0.01	0.01	0.01	0.01	0.015
(org. Lear)	0.01	0.01	0.01	0.01	0.01	0.01	0.011	0.011	0.028	0.02	0.011	0	0.031	0.02	0.011	0.01	0.012	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.015	0.01	0.01	0.028	0.02	0.01	0	0.03	0.019	0.011	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.028
(Succ. Rate)	0.01	0.011	0.01	0.01	0.02	0.02	0.015	0.012	0.028	0.024	0.009	0.03	0	0.02	0.013	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.03	0.02	0.01	0.03	0	0.02	0.01	0.01	0.01	0.01	0.02	0.021	0.02	0.01	0.028	0.02	0.01	0.03	0	0.017	0.013	0.011	0.01	0.01	0.02	0.02	0.02	0.01	0.028
(R&D Exper)	0.03	0.018	0.02	0.03	0.03	0.02	0.022	0.014	0.012	0.015	0.008	0.01	0.015	0	0.027	0.02	0.018	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0	0.03	0.02	0.02	0.03	0.03	0.023	0.02	0.01	0.012	0.01	0.01	0.01	0.02	0	0.027	0.018	0.02	0.03	0.03	0.02	0.02	0.01	0.012
(Code)	0.02	0.019	0.02	0.03	0.03	0.01	0.029	0.02	0.02	0.021	0.017	0.01	0.017	0.03	0	0.02	0.016	0.02	0.03	0.01	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0	0.02	0.02	0.03	0.03	0.01	0.03	0.02	0.019	0.02	0.02	0.01	0.02	0.026	0.019	0.016	0.02	0.03	0.01	0.03	0.02	0.02	0.021
(Pers)	0.02	0	0.02	0.02	0.02	0.01	0.013	0.023	0.012	0.01	0.013	0.01	0.011	0.02	0	0	0.024	0.02	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0	0.02	0.02	0.02	0.012	0.01	0.02	0.012	0.01	0.01	0.01	0.01	0.018	0.017	0	0.02	0.02	0.02	0.01	0.01	0.02	0.012
(Ext)	0.03	0.024	0	0.03	0.02	0.01	0.013	0.025	0.013	0.01	0.014	0.01	0.01	0.01	0.017	0.02	0	0.03	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0	0.03	0.02	0.012	0.01	0.03	0.013	0.01	0.01	0.01	0.01	0.015	0.019	0.024	0	0.03	0.02	0.01	0.01	0.03	0.013
(Inter)	0.02	0.032	0.03	0	0.02	0.01	0.015	0.028	0.018	0.013	0.015	0.01	0.01	0.02	0.018	0.03	0.028	0	0.02	0.01	0.02	0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0	0.02	0.012	0.02	0.03	0.018	0.01	0.01	0.01	0.02	0.024	0.028	0.032	0.03	0	0.02	0.01	0.02	0.03	0.018
(Tech .Tran)	0.01	0.017	0.01	0.02	0	0.02	0.02	0.013	0.01	0.013	0.011	0.01	0.013	0.02	0.028	0.02	0.015	0.02	0	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0	0.022	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.025	0.019	0.017	0.01	0.02	0	0.02	0.02	0.01	0.01
(Dec.Mak)	0.03	0.015	0.02	0.02	0.03	0	0.018	0.015	0.015	0.015	0.018	0.01	0.017	0.02	0.019	0.02	0.019	0.02	0.03	0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0	0.02	0.02	0.016	0.02	0.02	0.02	0.02	0.019	0.028	0.011	0.01	0.02	0.02	0.01	0	0.01	0.012
(In. Op Inn)	0.02	0.011	0.01	0.02	0.02	0.01	0	0.013	0.012	0.022	0.01	0.01	0.013	0.02	0.011	0.01	0.011	0.02	0.02	0.01	0	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.02	0.012	0	0.01	0.012	0.02	0.01	0.01	0.01	0.023	0.028	0.011	0.01	0.02	0.02	0.01	0	0.01	0.012
(Proj. mang)	0.02	0.027	0.02	0.03	0.02	0.01	0.015	0	0.019	0.015	0.015	0.01	0.012	0.01	0.028	0.03	0.024	0.03	0.02	0.01	0.02	0	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.02	0.03	0.02	0.015	0.02	0	0.019	0.01	0.02	0.01	0.01	0.015	0.018	0.027	0.02	0.03	0.02	0.01	0.02	0	0.019
(Inn. com)	0.02	0.011	0.01	0.01	0.02	0.01	0.018	0.015	0	0.024	0.017	0.02	0.02	0.01	0.018	0.01	0.013	0.01	0.02	0.01	0.02	0.01	0	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.015	0.02	0.01	0	0.02	0.02	0.02	0.02	0.015	0.015	0.011	0.01	0.01	0.02	0.01	0.02	0.01	0
(Rate Int)	0.02	0.01	0.01	0.02	0.01	0.02	0.027	0.011	0.026	0	0.012	0.02	0.019	0.01	0.015	0.01	0.011	0.01	0.01	0.02	0.03	0.01	0.03	0	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.026	0	0.01	0.02	0.02	0.015	0.018	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.025
(Int & Ext Kno)	0.01	0.012	0.01	0.01	0.01	0.01	0.013	0.013	0.015	0.015	0	0.01	0.01	0.01	0.018	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.015	0.01	0.01	0.015	0.01	0	0.01	0.01	0.012	0.015	0.012	0.01	0.01	0.01	0.01	0.01	0.01	0.015
(R&D.Corp)	0.01	0.01	0.01	0.01	0.01	0.01	0.011	0.011	0.028	0.02	0.011	0	0.031	0.02	0.015	0.01	0.012	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.015	0.01	0.01	0.028	0.02	0.01	0	0.03	0.019	0.011	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.028
(Ext Net)	0.03	0.011	0.01	0.01	0.02	0.02	0.015	0.012	0.028	0.024	0.009	0.03	0	0.02	0.011	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.03	0.02	0.01	0.03	0	0.02	0.01	0.01	0.01	0.01	0.02	0.021	0.02	0.01	0.028	0.02	0.01	0.03	0	0.017	0.013	0.011	0.01	0.01	0.02	0.02	0.01	0.01	0.028
(Know .Inc)	0.02	0.018	0.02	0.03	0.03	0.02	0.022	0.013	0.012	0.015	0.008	0.01	0.015	0	0.013	0.02	0.018	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0	0.03	0.02	0.02	0.03	0.03	0.022	0.02	0.01	0.012	0.01	0.01	0.01	0.02	0	0.027	0.018	0.02	0.03	0.03	0.02	0.02	0.01	0.012
(Rad Inn)	0.02	0.019	0.02	0.02	0.03	0.02	0.029	0.014	0.02	0.021	0.017	0.01	0.017	0.03	0.027	0.02	0.016	0.02	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0	0.02	0.02	0.02	0.03	0.01	0.03	0.02	0.019	0.02	0.02	0.01	0.02	0.026	0.019	0.014	0.02	0.03	0.01	0.03	0.02	0.02	0.019
(Abso. Cap)	0.03	0	0.02	0.02	0.02	0.01	0.012	0.019	0.012	0.011	0.013	0.01	0.011	0.02	0	0	0.024	0.02	0.02	0.01	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0	0.02	0.02	0.02	0.012	0.01	0.02	0.012	0.01	0.01	0.01	0.01	0.018	0.016	0	0.02	0.02	0.02	0.01	0.01	0.02	0.012
(R&D Empo)	0.02	0.024	0	0.03	0.02	0.01	0.013	0.023	0.013	0.01	0.014	0.01	0.01	0.01	0.017	0.02	0	0.03	0.02	0.01	0.01	0.03	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0	0.03	0.02	0.012	0.01	0.03	0.013	0.01	0.01	0.01	0.01	0.015	0.019	0.024	0	0.03	0.02	0.01	0.01	0.02	0.013
(Tech Tren)	0.01	0.032	0.03	0	0.02	0.01	0.015	0.024	0.018	0.013	0.015	0.01	0.01	0.02	0.018	0.03	0.028	0	0.02	0.01	0.01	0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0	0.02	0.012	0.02	0.03	0.018	0.01	0.01	0.01	0.01	0.024	0.029	0.033	0.03	0	0.02	0.01	0.02	0.03	0.018
(Inno. per)	0.03	0.017	0.01	0.02	0	0.01	0.02	0.028	0.01	0.013	0.01	0.01	0.013	0.02	0.028	0.02	0.015	0.02	0	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0	0.023	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.025	0.019	0.017	0.01	0.02	0	0.02	0.02	0.01	0.01
(Inov Str& ini)	0.02	0.015	0.02	0.02	0.03	0.02	0.018	0.013	0.015	0.015	0.018	0.02	0.017	0.02	0.019	0.02	0.019	0.02	0.03	0	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0	0.02	0.02	0.016	0.02	0.02	0.02	0.02	0.019	0.028	0.011	0.01	0.02	0.02	0.01	0	0.01	0.012
(Org.Str)	0.02	0.011	0.01	0.02	0.02	0	0	0.015	0.012	0.022	0.01	0.01	0.013	0.02	0.011	0.01	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.02	0.012	0	0.01	0.012	0.02	0.01	0.01	0.01	0.024	0.028	0.011	0.01	0.02	0.02	0.01	0	0.01	0.012
(Tech. Acq)	0.02	0.027	0.02	0.03	0.02	0.01	0.015	0.013	0.019	0.015	0.015	0.01	0.012	0.01	0.028	0.03	0.024	0.03	0.02	0.01	0	0	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.02	0.03	0.02	0.015	0.02	0	0.02	0.01	0.02	0.01	0.01	0.015	0.018	0.027	0.02	0.03	0.02	0.01	0.02	0	0.019
(Tech. Expo)	0.02	0.011	0.01	0.01	0.02	0.01	0.018	0	0	0.024	0.017	0.02	0.02	0.01	0.018	0.01	0.013	0.01	0.02	0.01	0.02	0.01	0	0.02	0.02	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.02	0.015	0.02	0.01	0	0.02	0.02	0.02	0.02	0.015	0.015	0.011	0.01	0.01	0.02	0.01	0.02	0.01	0
(Tech. Pro)	0.01	0.01	0.01	0.01	0.01	0.01	0.027	0.015	0.026	0	0.012	0.02	0.019	0.01	0.015	0.01	0.011	0.01	0.01	0.02	0.02	0.01	0.03	0	0.01	0.02	0.02	0.01	0.02	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.026	0	0.01	0.02	0.02	0.015	0.018	0.01	0.01	0.01	0.01	0.02	0.03	0.01	0.025
(Tech. lear)	0.01	0.012	0.01	0.01	0.01	0.02	0.013	0.011	0.015	0.015	0	0.01	0.011	0.01	0.018	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.01	0.01	0	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.015	0.01	0.01	0.015	0.01	0	0.01	0.01	0.012	0.015	0.012	0.01	0.01	0.01	0.01	0.01	0.01	0.015
(Tech. Sele)	0.03	0.01	0.01	0.01	0.01	0.01	0.011	0.013	0.028	0.02	0.011	0	0.031	0.02	0.015	0.01	0.012	0.01	0.01	0.01	0.01	0.01	0.03	0.02	0.01	0	0.03	0.02	0.01	0.01	0.01	0.01	0.01	0.015	0.01	0.01	0.028	0.02	0.01	0	0.03	0.019	0.011	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.028
(Tech. Iden)	0.02	0.011	0.01	0.01	0.02	0.01	0.015	0.011	0.029	0.024	0.009	0.03	0	0.02	0.011	0.01	0.01	0.01	0.02	0.02	0.01	0.01	0.03	0.02	0.01	0.03	0	0.02	0.01	0.01	0.01	0.01	0.02	0.021	0.02	0.01	0.028	0.02	0.01	0.03	0	0.017	0.013	0.011	0.01	0.01	0.02	0.02	0.02	0.01	0.028
(Tech Deve)	0.02	0.018	0.02	0.03	0.03	0.02	0.022	0.012	0.012	0.015	0.008	0.01	0.015	0	0.013	0.02	0.018	0.03	0.03	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0	0.03	0.02	0.02	0.03	0.03	0.022	0.02	0.01	0.012	0.01	0.01	0.01	0.02	0	0.027	0.018	0.02	0.03	0.03	0.02	0.02	0.01	0.012
(Mang comp)	0.03	0.017	0.02	0.03	0.02	0.02	0	0.013	0.02	0.022	0.011	0.01	0.012	0.03	0.027	0.02	0.01	0	0.02	0.02	0.02	0	0.02	0.02	0.02	0.01	0.02	0.03	0	0.02	0.02	0.02	0.03	0.01	0.03	0.02	0.019	0.02	0.02	0.01	0.02	0.026	0	0.016	0.03	0.03	0.01	0.03	0.02	0.02	0.021
(Fac)	0.02	0.015	0.02	0.01	0.02	0.01	0.015	0.028	0.012	0.015	0.018	0.02	0.02	0.02	0	0.01	0.024	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0	0.02	0.02	0.02	0.012	0.01	0.02	0.012	0.01	0.01	0.01	0.01	0.017	0.017	0	0.02	0.02	0.02	0.01	0.01	0.02	0.012
(Org. Poten)	0.01	0.011	0	0.01	0.01	0.01	0.018	0.013	0.013	0.024	0.011	0.02	0.019	0.01	0.015	0.03	0.013	0.02	0.01	0.01	0	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0	0.03	0.02	0.012	0.01	0.03	0.013	0.01	0.01	0.01	0.01	0.015	0.019	0.024	0	0.03	0.02	0.01	0.01	0.03	0.013
(Pers. Skil)	0.03	0.027	0.03	0.01	0.01	0.01	0.027	0.015	0.018	0	0.015	0.01	0.011	0.02	0.018	0.01	0.011	0.02	0.01	0.01	0.02	0.01	0	0.01	0.01	0.01	0.01	0.02	0.03	0.03	0.03	0	0.02	0.012	0.02	0.03	0.018	0.01	0.01	0.01	0.02	0.024	0.028	0.032	0.03	0	0.02	0.01	0.02	0.03	0.018
(Str Tech)	0.02	0.011	0.01	0.01	0.01	0.02	0.013	0.013	0.01	0.015	0.017	0	0.031	0.02	0.015	0.01	0.01	0.03	0.01	0.01	0.02	0.01	0.03	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.02	0	0.022	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.024	0.019	0.017	0.01	0.02	0	0.02	0.02	0.01	0.01
(Corp Tech Stra)	0.02	0.01	0.02	0.01	0.02	0.01	0.011	0	0.015	0.02	0.012	0.03	0	0.02	0.011	0.01	0.012	0.01	0.02	0.01	0.03	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.02	0.02	0.03	0	0.02	0.02	0.015	0.02	0.02	0.02	0.02	0.019	0.028	0.011	0.01	0.02	0.02	0	0	0.01	0.012
(Corport Bus Strat)	0.03	0.012	0.01	0.03	0.03	0.01	0.015	0.015	0.012	0.024	0	0.01	0.015	0.02	0.013	0.01	0.01	0.01	0.03	0.02	0.01	0.01	0.03	0.02	0.01	0.01	0.01	0.02	0.03	0.01	0.01	0.02	0.02	0.012	0	0.01	0.012	0.02	0.01	0.01	0.01	0.023	0.028	0.011	0.01	0.02	0.02	0.01	0	0.01	0.012
(Tech Alli)	0.02	0.01	0.02	0.01	0.02	0.02	0.022	0.014	0.019	0.015	0.01	0.03	0.031	0.01	0.027	0.01	0.012	0.01	0.01	0.01	0.01	0.01	0.03	0.01	0.02	0.01	0.01	0.01	0.02	0.03	0.02	0.03	0.02	0.015	0.02	0	0.019	0.01	0.02	0.01	0.01	0.015	0.018	0.027	0.02	0.03	0.01	0.01	0.02	0	0.019
(Desor. Cap)	0.02	0.018	0.02	0.03	0.03	0.02	0.022	0.013	0.012	0.015	0.01	0.01	0.015	0	0.027	0.02	0.016	0.02	0.03	0.01	0.02	0.02	0.02	0.02	0.02	0.01	0.02	0.03	0	0.02	0.02	0.02	0.03	0.01	0.03	0.02	0.02	0.02	0.02	0.01	0.02	0.026	0.015	0.011	0.01	0.01	0.02	0.01	0.02	0.02	0

Estimation of the full direct and indirect influence matrix is obtained by employing by following Equation 3.4 which is already presented in chapter 3.

$$T = X\left(I - X^k\right)(I - X)^{-1}$$

$$T = X(I - X)^{-1} \text{ when } \lim_{k\to\infty} X^k = [0]_{n\times x} \qquad 5.1$$

Where $\boldsymbol{T} = [t_{ij}]_{n\times n}$, $i, j = 1,2,...,n$. In addition, the method presents each row sum and column sum of matrix $\boldsymbol{T}$ shows in Equation 3.5

$$r = (r_i)_{n\times 1} = \left[\sum_{j=1}^{n} t_{ij}\right]_{n\times 1} \text{ or} \qquad 5.2$$

$$c = (c_i)_{n\times 1} = \left[\sum_{i=1}^{n} t_{ij}\right]_{n\times 1}$$

From equation 5.1 and 5.2, the $r_i$use to represents the row sum of the i^{th}row of the matrix $T_{\ (Sub\text{-}Criteria)}$.. While, c_j represents column sum of the j^{th} column of the matrix $T_{\ (Sub\text{-}Criteria)}$.. $R_{\ (row)}$ + $C_{\ (Column)}$ shows that the degree of strength of influence delivers and received. In simple words, R $_{(row)}$ + C $_{(Column)}$ represent the degree of significant control of i used to carry during addressing the problem. Similarly if R $_{(row)}$ - C $_{(Column)}$ is positive in nature than it used to translate as factor *i* is going to affect other factors, if R $_{(row)}$ - C $_{(Column)}$ is negative in nature than it used to represent that factor *i* is being influenced by other factors. Therefore, the cause and effect among the $T_{\ (Sub\text{-}Criteria)}$ is shown in Table 5.31.

To minimize the minor effects, it is necessary to establish the specific threshold value 'α' which filters out the insignificant results appears in Matrix *T*. It is essential to isolate the relation structure of the elements. As verifying a matrix *T*, each factor in matrix *T* uses to illustrate the specific information. To reduce the complexity for researchers and decision makers a set the specific threshold value allow scaling the influence level. The threshold value can formulate by using Equation 3.6. Therefore, the Total relation matrix T $_{(Sub\text{- }Criteria)}$ with α value is shown in Table 5.32

Table 5.31 Total relation matrix ***T*** *(Sub- Criteria)* The list of Abbreviation used for this Matrix is in Appendix F

Total Rational Matric $T_{(Sub-Criteria)}$	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(Int & Ext Kno)	(R&D.Corp)	(Ext Net)	(Know .Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. pot)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)	
(K.cre)	0.09	0.1	0.1	0.1	0.12	0.09	0.112	0.097	0.1	0.1	0.08	0.08	0.091	0.11	0.086	0.1	0.093	0.12	0.12	0.09	0.11	0.1	0.1	0.1	0.08	0.08	0.09	0.12	0.09	0.1	0.1	0.12	0.12	0.083	0.11	0.1	0.101	0.1	0.08	0.08	0.09	0.118	0.121	0.096	0.11	0.13	0.09	0.11	0.09	0.1	0.1	5.127
(K.Acq)	0.09	0.06	0.09	0.1	0.09	0.07	0.079	0.083	0.08	0.07	0.06	0.07	0.07	0.09	0.085	0.06	0.084	0.1	0.09	0.07	0.08	0.08	0.08	0.07	0.07	0.06	0.07	0.09	0.09	0.07	0.09	0.1	0.09	0.069	0.08	0.09	0.077	0.07	0.07	0.06	0.07	0.09	0.097	0.065	0.09	0.1	0.08	0.08	0.07	0.09	0.07	4.03
(Int Kno Port)	0.1	0.09	0.07	0.1	0.09	0.08	0.084	0.09	0.08	0.08	0.07	0.07	0.073	0.09	0.089	0.09	0.066	0.11	0.09	0.08	0.08	0.09	0.08	0.08	0.07	0.07	0.07	0.09	0.09	0.09	0.07	0.11	0.09	0.073	0.09	0.09	0.082	0.08	0.07	0.07	0.07	0.092	0.104	0.091	0.07	0.11	0.08	0.08	0.07	0.09	0.08	4.281
(K.shar)	0.12	0.11	0.11	0.1	0.11	0.08	0.097	0.103	0.1	0.09	0.08	0.08	0.083	0.11	0.11	0.11	0.102	0.09	0.1	0.09	0.1	0.1	0.1	0.09	0.08	0.08	0.08	0.11	0.11	0.11	0.11	0.1	0.11	0.082	0.1	0.11	0.097	0.09	0.08	0.08	0.08	0.112	0.125	0.109	0.11	0.1	0.09	0.1	0.09	0.11	0.09	4.955
(K.Imp)	0.09	0.08	0.08	0.1	0.07	0.08	0.085	0.074	0.07	0.08	0.06	0.06	0.072	0.09	0.085	0.08	0.075	0.09	0.07	0.08	0.09	0.07	0.08	0.08	0.06	0.06	0.07	0.1	0.09	0.08	0.08	0.09	0.07	0.078	0.09	0.08	0.075	0.08	0.06	0.06	0.07	0.096	0.099	0.079	0.08	0.09	0.06	0.09	0.08	0.08	0.07	4.007
(K.tran)	0.09	0.08	0.09	0.1	0.1	0.06	0.086	0.079	0.08	0.08	0.07	0.07	0.078	0.09	0.081	0.08	0.082	0.09	0.1	0.06	0.09	0.08	0.08	0.08	0.07	0.07	0.08	0.09	0.08	0.08	0.08	0.1	0.1	0.06	0.09	0.08	0.083	0.08	0.07	0.07	0.08	0.094	0.11	0.077	0.08	0.1	0.09	0.08	0.06	0.08	0.08	4.194
(cult)	0.1	0.07	0.08	0.1	0.09	0.07	0.068	0.075	0.08	0.08	0.06	0.06	0.073	0.09	0.096	0.07	0.072	0.09	0.09	0.07	0.07	0.07	0.08	0.08	0.06	0.06	0.07	0.1	0.1	0.08	0.08	0.09	0.1	0.07	0.07	0.08	0.078	0.08	0.06	0.06	0.07	0.096	0.108	0.075	0.07	0.09	0.08	0.08	0.06	0.08	0.08	4.05
(stru)	0.1	0.1	0.1	0.1	0.1	0.08	0.089	0.07	0.09	0.08	0.07	0.07	0.078	0.09	0.092	0.1	0.092	0.11	0.1	0.08	0.09	0.07	0.09	0.08	0.07	0.07	0.07	0.1	0.09	0.1	0.09	0.11	0.1	0.078	0.09	0.07	0.09	0.08	0.07	0.07	0.08	0.096	0.107	0.097	0.09	0.11	0.09	0.09	0.08	0.07	0.09	4.495
(Tech)	0.09	0.07	0.07	0.1	0.08	0.07	0.082	0.073	0.06	0.08	0.06	0.07	0.077	0.08	0.08	0.07	0.071	0.08	0.08	0.07	0.08	0.07	0.06	0.08	0.07	0.07	0.07	0.08	0.08	0.07	0.07	0.09	0.09	0.07	0.08	0.08	0.063	0.08	0.07	0.07	0.08	0.084	0.092	0.071	0.07	0.09	0.08	0.08	0.07	0.08	0.06	3.882
(Peop)	0.09	0.08	0.08	0.1	0.09	0.08	0.095	0.073	0.09	0.07	0.06	0.07	0.08	0.09	0.087	0.07	0.073	0.09	0.09	0.08	0.1	0.07	0.09	0.07	0.07	0.07	0.08	0.09	0.09	0.08	0.08	0.09	0.09	0.078	0.1	0.08	0.092	0.07	0.07	0.07	0.08	0.09	0.101	0.074	0.08	0.09	0.08	0.09	0.09	0.08	0.09	4.165
(Lead& Supp)	0.08	0.06	0.06	0.1	0.07	0.06	0.068	0.064	0.07	0.07	0.04	0.06	0.059	0.07	0.071	0.06	0.06	0.07	0.07	0.06	0.07	0.06	0.07	0.07	0.04	0.05	0.06	0.07	0.07	0.07	0.06	0.08	0.07	0.061	0.07	0.07	0.068	0.07	0.04	0.06	0.06	0.073	0.081	0.064	0.06	0.08	0.06	0.07	0.06	0.07	0.07	3.331
(org. Lear)	0.08	0.07	0.07	0.1	0.09	0.07	0.076	0.07	0.09	0.08	0.06	0.05	0.088	0.09	0.077	0.07	0.071	0.08	0.08	0.07	0.08	0.07	0.09	0.08	0.06	0.05	0.09	0.09	0.08	0.07	0.07	0.09	0.09	0.071	0.08	0.07	0.091	0.08	0.06	0.05	0.09	0.089	0.089	0.071	0.07	0.09	0.08	0.08	0.07	0.07	0.09	3.939
(Succ. Rate)	0.09	0.08	0.08	0.1	0.09	0.08	0.085	0.076	0.09	0.09	0.06	0.08	0.063	0.09	0.084	0.08	0.073	0.09	0.09	0.08	0.09	0.07	0.1	0.09	0.06	0.08	0.06	0.09	0.08	0.08	0.08	0.09	0.1	0.081	0.09	0.08	0.095	0.09	0.06	0.08	0.06	0.093	0.097	0.076	0.08	0.09	0.09	0.09	0.08	0.08	0.09	4.223
(R&D Exper)	0.12	0.09	0.09	0.1	0.11	0.09	0.101	0.087	0.09	0.09	0.07	0.08	0.085	0.09	0.107	0.09	0.09	0.11	0.11	0.09	0.1	0.09	0.09	0.09	0.07	0.07	0.08	0.09	0.11	0.1	0.09	0.12	0.11	0.089	0.1	0.09	0.089	0.09	0.07	0.08	0.08	0.088	0.122	0.093	0.09	0.12	0.1	0.1	0.09	0.09	0.09	4.792
(Code)	0.11	0.1	0.1	0.1	0.12	0.09	0.113	0.097	0.1	0.1	0.08	0.08	0.091	0.11	0.086	0.1	0.093	0.11	0.12	0.09	0.11	0.1	0.1	0.1	0.08	0.08	0.09	0.12	0.09	0.1	0.1	0.12	0.12	0.083	0.11	0.1	0.101	0.1	0.08	0.08	0.09	0.118	0.121	0.096	0.1	0.13	0.09	0.11	0.09	0.1	0.1	5.135
(Pers)	0.09	0.06	0.09	0.1	0.09	0.07	0.077	0.083	0.07	0.07	0.06	0.06	0.069	0.09	0.067	0.06	0.082	0.09	0.09	0.07	0.08	0.08	0.08	0.07	0.07	0.06	0.06	0.09	0.08	0.07	0.09	0.1	0.09	0.068	0.08	0.09	0.076	0.07	0.06	0.06	0.07	0.088	0.095	0.064	0.08	0.1	0.08	0.08	0.07	0.09	0.07	3.932
(Ext)	0.11	0.09	0.07	0.1	0.09	0.08	0.084	0.09	0.08	0.08	0.07	0.07	0.073	0.09	0.088	0.09	0.066	0.11	0.09	0.08	0.08	0.09	0.08	0.08	0.07	0.07	0.07	0.09	0.09	0.1	0.07	0.11	0.09	0.073	0.09	0.09	0.083	0.08	0.07	0.07	0.07	0.093	0.105	0.092	0.07	0.11	0.08	0.08	0.08	0.09	0.08	4.309
(Inter)	0.11	0.11	0.1	0.1	0.1	0.08	0.095	0.102	0.09	0.09	0.07	0.08	0.082	0.11	0.099	0.11	0.101	0.09	0.1	0.09	0.1	0.1	0.1	0.09	0.08	0.07	0.08	0.11	0.11	0.11	0.1	0.09	0.11	0.081	0.1	0.11	0.095	0.09	0.08	0.08	0.09	0.11	0.124	0.107	0.1	0.09	0.09	0.09	0.09	0.1	0.09	4.869
(Tech .Tran)	0.08	0.08	0.08	0.1	0.07	0.08	0.085	0.074	0.07	0.08	0.06	0.06	0.072	0.09	0.094	0.08	0.075	0.09	0.07	0.08	0.09	0.07	0.08	0.08	0.06	0.06	0.07	0.09	0.09	0.08	0.08	0.09	0.07	0.078	0.09	0.08	0.075	0.08	0.06	0.06	0.07	0.096	0.099	0.079	0.08	0.09	0.06	0.09	0.08	0.08	0.07	3.998
(Dec.Mak)	0.11	0.08	0.09	0.1	0.1	0.06	0.089	0.081	0.08	0.08	0.07	0.07	0.08	0.09	0.091	0.08	0.084	0.1	0.1	0.07	0.09	0.08	0.09	0.08	0.07	0.07	0.08	0.1	0.08	0.09	0.09	0.1	0.1	0.062	0.09	0.08	0.085	0.08	0.07	0.07	0.08	0.097	0.113	0.079	0.08	0.1	0.09	0.09	0.06	0.08	0.08	4.337
(In. Op Inn)	0.09	0.07	0.07	0.1	0.09	0.07	0.065	0.072	0.07	0.08	0.06	0.06	0.07	0.09	0.076	0.07	0.069	0.09	0.09	0.07	0.07	0.07	0.08	0.08	0.06	0.06	0.07	0.09	0.09	0.07	0.07	0.09	0.09	0.068	0.07	0.08	0.075	0.08	0.06	0.06	0.07	0.093	0.104	0.072	0.07	0.09	0.08	0.08	0.06	0.07	0.07	3.876
(Proj. mang)	0.1	0.1	0.1	0.1	0.1	0.08	0.09	0.07	0.09	0.08	0.07	0.07	0.078	0.09	0.102	0.1	0.092	0.11	0.1	0.08	0.09	0.07	0.09	0.08	0.07	0.07	0.08	0.1	0.09	0.1	0.1	0.11	0.1	0.078	0.09	0.07	0.091	0.08	0.07	0.07	0.08	0.096	0.108	0.097	0.09	0.11	0.09	0.09	0.08	0.07	0.09	4.517
(Inn. com)	0.09	0.07	0.07	0.1	0.08	0.07	0.082	0.073	0.06	0.08	0.06	0.07	0.077	0.08	0.083	0.07	0.071	0.08	0.08	0.07	0.08	0.07	0.06	0.08	0.07	0.07	0.07	0.08	0.08	0.07	0.07	0.09	0.09	0.07	0.08	0.08	0.064	0.08	0.07	0.07	0.08	0.085	0.093	0.072	0.07	0.09	0.08	0.08	0.07	0.08	0.06	3.901
(Rate Int)	0.09	0.07	0.08	0.1	0.09	0.08	0.094	0.072	0.09	0.07	0.06	0.07	0.079	0.09	0.084	0.07	0.073	0.09	0.09	0.08	0.09	0.07	0.09	0.07	0.07	0.07	0.08	0.09	0.09	0.08	0.08	0.09	0.09	0.077	0.09	0.08	0.091	0.07	0.07	0.07	0.08	0.089	0.1	0.074	0.07	0.09	0.08	0.09	0.08	0.08	0.09	4.113
(Int & Ext Kno)	0.07	0.06	0.06	0.1	0.07	0.06	0.068	0.064	0.07	0.07	0.04	0.06	0.059	0.07	0.073	0.06	0.06	0.07	0.07	0.06	0.07	0.06	0.07	0.07	0.04	0.05	0.06	0.07	0.07	0.07	0.06	0.08	0.07	0.061	0.07	0.07	0.068	0.07	0.04	0.06	0.06	0.072	0.081	0.064	0.06	0.08	0.06	0.07	0.06	0.07	0.07	3.316
(R&D.Corp)	0.09	0.07	0.07	0.1	0.09	0.07	0.077	0.071	0.09	0.08	0.06	0.05	0.089	0.09	0.081	0.07	0.071	0.08	0.08	0.07	0.08	0.07	0.09	0.08	0.06	0.05	0.09	0.09	0.08	0.07	0.07	0.09	0.09	0.071	0.08	0.07	0.091	0.08	0.06	0.05	0.09	0.09	0.089	0.071	0.07	0.09	0.08	0.08	0.07	0.07	0.09	3.966
(Ext Net)	0.11	0.08	0.08	0.1	0.1	0.08	0.086	0.077	0.1	0.09	0.06	0.08	0.064	0.09	0.082	0.08	0.074	0.09	0.1	0.09	0.09	0.08	0.1	0.09	0.06	0.08	0.06	0.09	0.09	0.08	0.08	0.09	0.1	0.081	0.09	0.08	0.096	0.09	0.06	0.08	0.06	0.094	0.098	0.077	0.08	0.09	0.09	0.09	0.08	0.08	0.09	4.281
(Know .Inc)	0.1	0.09	0.09	0.1	0.11	0.09	0.098	0.084	0.09	0.09	0.06	0.07	0.083	0.08	0.09	0.09	0.087	0.11	0.11	0.09	0.1	0.08	0.09	0.09	0.07	0.07	0.08	0.08	0.11	0.09	0.09	0.11	0.11	0.086	0.1	0.09	0.086	0.09	0.07	0.07	0.08	0.085	0.119	0.09	0.09	0.11	0.1	0.1	0.09	0.09	0.08	4.62
(Rad Inn)	0.11	0.1	0.1	0.1	0.12	0.1	0.115	0.093	0.1	0.1	0.08	0.08	0.093	0.12	0.114	0.1	0.095	0.12	0.12	0.09	0.11	0.1	0.1	0.1	0.09	0.08	0.09	0.12	0.09	0.11	0.1	0.12	0.12	0.084	0.12	0.1	0.103	0.1	0.09	0.08	0.09	0.12	0.123	0.096	0.1	0.13	0.09	0.12	0.09	0.1	0.1	5.247
(Abso. Cap)	0.1	0.06	0.09	0.1	0.09	0.07	0.079	0.081	0.08	0.07	0.06	0.07	0.07	0.09	0.068	0.06	0.084	0.1	0.09	0.07	0.09	0.08	0.08	0.07	0.07	0.06	0.07	0.09	0.09	0.07	0.09	0.1	0.09	0.069	0.08	0.09	0.077	0.07	0.07	0.06	0.07	0.09	0.097	0.065	0.09	0.1	0.08	0.08	0.07	0.09	0.08	4.042
(R&D Empo)	0.1	0.09	0.07	0.1	0.09	0.07	0.083	0.088	0.08	0.08	0.07	0.07	0.072	0.09	0.087	0.09	0.065	0.11	0.09	0.08	0.08	0.09	0.08	0.08	0.07	0.07	0.07	0.09	0.09	0.09	0.07	0.11	0.09	0.072	0.08	0.09	0.081	0.08	0.07	0.07	0.07	0.091	0.103	0.091	0.07	0.11	0.08	0.08	0.07	0.09	0.08	4.232
(Tech Tren)	0.1	0.11	0.1	0.1	0.1	0.08	0.093	0.097	0.09	0.09	0.07	0.07	0.08	0.11	0.097	0.11	0.099	0.09	0.1	0.08	0.09	0.1	0.1	0.09	0.08	0.07	0.08	0.11	0.11	0.11	0.1	0.09	0.1	0.079	0.1	0.1	0.094	0.09	0.08	0.07	0.08	0.108	0.122	0.106	0.1	0.09	0.09	0.09	0.08	0.1	0.09	4.761
(Inno. per)	0.1	0.08	0.08	0.1	0.07	0.07	0.087	0.09	0.08	0.08	0.06	0.06	0.073	0.09	0.096	0.08	0.076	0.09	0.07	0.08	0.08	0.07	0.08	0.08	0.06	0.06	0.07	0.1	0.09	0.08	0.08	0.09	0.08	0.08	0.09	0.08	0.076	0.08	0.06	0.06	0.07	0.098	0.101	0.081	0.08	0.09	0.07	0.09	0.08	0.08	0.07	4.095
(Inov Str& ini)	0.1	0.08	0.09	0.1	0.1	0.09	0.09	0.08	0.08	0.08	0.07	0.07	0.081	0.1	0.093	0.08	0.085	0.1	0.1	0.07	0.09	0.08	0.09	0.08	0.07	0.07	0.08	0.1	0.09	0.09	0.09	0.1	0.1	0.063	0.09	0.09	0.086	0.08	0.07	0.07	0.08	0.098	0.115	0.08	0.08	0.1	0.09	0.09	0.06	0.08	0.08	4.405
(Org.Str)	0.09	0.07	0.07	0.1	0.09	0.06	0.064	0.074	0.07	0.08	0.06	0.06	0.07	0.09	0.076	0.07	0.069	0.09	0.09	0.07	0.08	0.07	0.08	0.08	0.06	0.06	0.07	0.09	0.09	0.07	0.07	0.09	0.09	0.068	0.07	0.08	0.075	0.08	0.06	0.06	0.07	0.093	0.104	0.072	0.07	0.09	0.08	0.08	0.06	0.07	0.07	3.876
(Tech. Acq)	0.1	0.1	0.1	0.1	0.1	0.08	0.09	0.083	0.09	0.08	0.07	0.07	0.078	0.09	0.103	0.1	0.093	0.11	0.1	0.08	0.08	0.07	0.09	0.08	0.07	0.07	0.08	0.1	0.09	0.1	0.1	0.11	0.1	0.078	0.09	0.07	0.092	0.08	0.07	0.07	0.08	0.096	0.108	0.098	0.09	0.11	0.09	0.09	0.08	0.07	0.09	4.534
(Tech. Expo)	0.08	0.07	0.07	0.1	0.08	0.07	0.08	0.057	0.06	0.08	0.06	0.07	0.075	0.08	0.081	0.07	0.069	0.08	0.08	0.07	0.08	0.07	0.06	0.08	0.07	0.06	0.07	0.08	0.08	0.07	0.07	0.09	0.08	0.068	0.08	0.07	0.062	0.08	0.07	0.06	0.07	0.083	0.09	0.07	0.07	0.09	0.07	0.08	0.07	0.07	0.06	3.793
(Tech. Pro)	0.09	0.07	0.07	0.1	0.09	0.07	0.092	0.075	0.09	0.06	0.06	0.07	0.078	0.08	0.083	0.07	0.071	0.09	0.09	0.08	0.08	0.07	0.09	0.06	0.06	0.07	0.08	0.09	0.09	0.08	0.07	0.09	0.09	0.076	0.09	0.08	0.09	0.06	0.06	0.07	0.08	0.088	0.098	0.072	0.07	0.09	0.08	0.09	0.08	0.07	0.09	4.036
(Tech. lear)	0.08	0.07	0.06	0.1	0.07	0.07	0.069	0.062	0.07	0.07	0.04	0.06	0.061	0.07	0.075	0.07	0.062	0.08	0.07	0.07	0.08	0.06	0.07	0.07	0.04	0.06	0.06	0.07	0.07	0.07	0.06	0.08	0.07	0.062	0.07	0.07	0.069	0.07	0.04	0.06	0.06	0.074	0.083	0.065	0.06	0.08	0.06	0.07	0.06	0.07	0.07	3.414
(Tech. Sele)	0.1	0.07	0.08	0.1	0.09	0.08	0.079	0.075	0.09	0.08	0.06	0.05	0.089	0.09	0.083	0.07	0.073	0.09	0.09	0.08	0.08	0.07	0.09	0.08	0.06	0.05	0.09	0.09	0.08	0.08	0.08	0.09	0.09	0.072	0.08	0.08	0.093	0.08	0.06	0.05	0.09	0.092	0.091	0.073	0.08	0.09	0.08	0.08	0.07	0.07	0.09	4.074
(Tech. Iden)	0.09	0.08	0.08	0.1	0.09	0.08	0.083	0.073	0.09	0.09	0.06	0.08	0.062	0.09	0.081	0.07	0.072	0.09	0.09	0.08	0.08	0.07	0.1	0.09	0.06	0.08	0.06	0.09	0.08	0.08	0.08	0.09	0.09	0.08	0.09	0.08	0.094	0.09	0.06	0.08	0.06	0.092	0.095	0.075	0.07	0.09	0.08	0.09	0.07	0.08	0.09	4.154
(Tech Deve)	0.1	0.09	0.09	0.1	0.11	0.09	0.097	0.083	0.09	0.09	0.06	0.07	0.082	0.08	0.09	0.09	0.087	0.11	0.11	0.09	0.09	0.08	0.09	0.09	0.07	0.07	0.08	0.08	0.11	0.09	0.09	0.11	0.11	0.087	0.1	0.09	0.086	0.09	0.07	0.07	0.08	0.085	0.119	0.09	0.09	0.11	0.1	0.1	0.09	0.09	0.08	4.61
(Mang Comp)	0.11	0.09	0.09	0.1	0.1	0.09	0.078	0.085	0.09	0.09	0.07	0.07	0.081	0.11	0.104	0.09	0.08	0.08	0.1	0.09	0.1	0.07	0.09	0.09	0.08	0.07	0.08	0.11	0.08	0.1	0.09	0.11	0.11	0.076	0.11	0.09	0.094	0.09	0.08	0.07	0.08	0.109	0.093	0.089	0.1	0.12	0.08	0.11	0.09	0.09	0.09	4.683
(Fac)	0.09	0.08	0.09	0.1	0.09	0.07	0.083	0.091	0.08	0.08	0.07	0.07	0.08	0.09	0.07	0.08	0.086	0.09	0.09	0.08	0.09	0.08	0.08	0.07	0.07	0.06	0.07	0.09	0.09	0.07	0.09	0.1	0.09	0.071	0.08	0.09	0.078	0.07	0.07	0.07	0.07	0.091	0.099	0.066	0.09	0.1	0.08	0.08	0.07	0.09	0.08	4.132
(Org. Poten)	0.08	0.07	0.06	0.1	0.08	0.07	0.083	0.074	0.08	0.09	0.06	0.07	0.078	0.08	0.082	0.09	0.073	0.09	0.08	0.07	0.07	0.07	0.08	0.07	0.07	0.06	0.07	0.09	0.09	0.09	0.06	0.1	0.09	0.069	0.08	0.09	0.077	0.07	0.06	0.07	0.07	0.087	0.098	0.086	0.06	0.1	0.08	0.08	0.07	0.09	0.08	3.991
(Pers. Skil)	0.11	0.1	0.1	0.1	0.09	0.08	0.102	0.085	0.09	0.07	0.07	0.07	0.078	0.1	0.094	0.08	0.08	0.1	0.09	0.08	0.09	0.08	0.08	0.09	0.07	0.07	0.08	0.11	0.11	0.11	0.1	0.09	0.1	0.077	0.09	0.1	0.092	0.08	0.07	0.07	0.08	0.106	0.119	0.104	0.1	0.09	0.09	0.09	0.08	0.1	0.09	4.602
(Str Tech)	0.09	0.07	0.08	0.1	0.09	0.08	0.08	0.075	0.07	0.08	0.07	0.05	0.09	0.09	0.082	0.07	0.071	0.1	0.09	0.07	0.09	0.07	0.09	0.08	0.06	0.06	0.07	0.1	0.09	0.08	0.08	0.09	0.07	0.079	0.09	0.08	0.075	0.08	0.06	0.06	0.07	0.097	0.1	0.08	0.08	0.09	0.06	0.09	0.08	0.08	0.07	4.065
(Corp Tech Stra)	0.09	0.07	0.08	0.1	0.09	0.07	0.075	0.06	0.08	0.08	0.06	0.08	0.058	0.09	0.077	0.07	0.071	0.08	0.09	0.07	0.09	0.07	0.08	0.08	0.07	0.07	0.07	0.09	0.08	0.08	0.08	0.09	0.1	0.056	0.08	0.08	0.078	0.08	0.07	0.07	0.07	0.09	0.106	0.072	0.07	0.09	0.08	0.07	0.06	0.08	0.07	3.946
(Corport Bus Strat)	0.11	0.08	0.08	0.1	0.1	0.08	0.086	0.08	0.08	0.09	0.05	0.07	0.078	0.1	0.085	0.08	0.075	0.09	0.1	0.09	0.09	0.08	0.1	0.09	0.07	0.07	0.07	0.1	0.1	0.08	0.08	0.1	0.1	0.073	0.07	0.08	0.081	0.09	0.07	0.07	0.08	0.101	0.113	0.078	0.08	0.1	0.09	0.08	0.06	0.08	0.08	4.293
(Tech Alli)	0.1	0.08	0.09	0.1	0.1	0.09	0.096	0.082	0.09	0.08	0.07	0.08	0.096	0.09	0.101	0.08	0.079	0.09	0.09	0.08	0.09	0.08	0.1	0.08	0.07	0.07	0.07	0.09	0.09	0.1	0.09	0.11	0.1	0.077	0.09	0.07	0.091	0.08	0.07	0.07	0.08	0.095	0.106	0.096	0.09	0.11	0.08	0.09	0.08	0.07	0.09	4.475
(Desor. Cap)	0.1	0.09	0.09	0.1	0.11	0.09	0.098	0.084	0.09	0.09	0.07	0.07	0.083	0.08	0.104	0.09	0.086	0.11	0.11	0.08	0.1	0.09	0.1	0.09	0.08	0.07	0.08	0.11	0.08	0.1	0.09	0.11	0.11	0.076	0.11	0.09	0.094	0.09	0.08	0.07	0.08	0.11	0.108	0.084	0.09	0.1	0.09	0.09	0.08	0.09	0.07	4.658
	4.91	4.18	4.24	5	4.78	3.95	4.394	4.048	4.26	4.17	3.26	3.53	3.924	4.65	4.45	4.14	4.006	4.8	4.72	4.01	4.43	3.98	4.38	4.17	3.47	3.43	3.75	4.79	4.54	4.37	4.21	5.02	4.85	3.773	4.47	4.26	4.299	4.17	3.45	3.46	3.86	4.809	5.294	4.162	4.16	5.03	4.19	4.45	3.82	4.2	4.15	

Table 5.32 Threshold value α: 0.083386. The values were marked when higher than the threshold value

Threshold value α: 0.083386	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(Int & Ext Kno)	(R&D.Corp)	(Ext Net)	(Know. Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org Poten)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)
(K.cre)	0.095	0.1	0.098	0.1205	0.121	0.086	0.112	0.097	0.1	0.1006	0.08	0.08	0.091	0.115	0.0861	0.0985	0.093	0.1182	0.1194	0.09	0.113	0.095	0.103	0.101	0.084	0.078	0.088	0.117	0.089	0.103	0.098	0.122	0.122	0.083	0.113	0.101	0.101	0.101	0.084	0.079	0.091	0.118	0.121	0.096	0.106	0.125	0.091	0.113	0.092	0.1	0.1
(K.Acq)	0.091	0.06	0.087	0.0982	0.088	0.072	0.079	0.083	0.077	0.0726	0.063	0.065	0.07	0.087	0.0849	0.0642	0.084	0.0958	0.0874	0.072	0.079	0.085	0.078	0.073	0.067	0.064	0.066	0.09	0.086	0.068	0.087	0.099	0.09	0.069	0.08	0.087	0.077	0.073	0.066	0.064	0.068	0.09	0.097	0.065	0.087	0.099	0.08	0.08	0.07	0.088	0.075
(Int Kno Port)	0.097	0.09	0.07	0.1089	0.093	0.075	0.084	0.09	0.082	0.0763	0.066	0.07	0.073	0.09	0.0894	0.0907	0.066	0.1062	0.092	0.076	0.084	0.089	0.083	0.077	0.07	0.068	0.07	0.092	0.091	0.095	0.07	0.11	0.094	0.073	0.085	0.094	0.082	0.077	0.069	0.069	0.073	0.092	0.104	0.091	0.069	0.11	0.083	0.083	0.075	0.093	0.08
(K.shar)	0.119	0.11	0.106	0.0942	0.106	0.085	0.097	0.103	0.096	0.0906	0.075	0.077	0.083	0.109	0.1098	0.1088	0.102	0.0909	0.1043	0.087	0.097	0.102	0.099	0.091	0.079	0.075	0.08	0.112	0.111	0.113	0.106	0.096	0.107	0.082	0.099	0.107	0.097	0.09	0.079	0.076	0.082	0.112	0.125	0.109	0.105	0.096	0.094	0.095	0.087	0.106	0.094
(K.Imp)	0.093	0.08	0.078	0.0916	0.073	0.083	0.085	0.074	0.074	0.0752	0.06	0.063	0.072	0.094	0.0851	0.0782	0.075	0.0888	0.0721	0.084	0.086	0.073	0.076	0.076	0.063	0.062	0.07	0.095	0.087	0.082	0.078	0.092	0.074	0.078	0.086	0.078	0.075	0.076	0.063	0.063	0.071	0.096	0.099	0.079	0.077	0.092	0.064	0.091	0.076	0.077	0.072
(K.tran)	0.088	0.08	0.085	0.0966	0.099	0.062	0.086	0.079	0.082	0.0802	0.069	0.07	0.078	0.092	0.0813	0.0805	0.082	0.094	0.0986	0.064	0.087	0.078	0.084	0.081	0.072	0.069	0.075	0.094	0.083	0.085	0.085	0.098	0.101	0.06	0.088	0.083	0.083	0.081	0.072	0.07	0.077	0.094	0.11	0.077	0.076	0.097	0.087	0.083	0.061	0.079	0.077
(cult)	0.102	0.07	0.076	0.0932	0.095	0.073	0.068	0.075	0.077	0.0848	0.06	0.064	0.073	0.094	0.0956	0.0737	0.072	0.0906	0.0937	0.073	0.068	0.074	0.079	0.084	0.064	0.063	0.07	0.096	0.096	0.078	0.075	0.094	0.095	0.07	0.07	0.078	0.078	0.085	0.063	0.064	0.072	0.096	0.108	0.075	0.075	0.094	0.085	0.081	0.06	0.077	0.076
(stru)	0.101	0.1	0.096	0.1099	0.098	0.081	0.089	0.07	0.09	0.0841	0.071	0.069	0.078	0.093	0.092	0.0964	0.092	0.1073	0.0962	0.082	0.09	0.069	0.092	0.084	0.074	0.068	0.075	0.095	0.095	0.1	0.095	0.111	0.099	0.078	0.091	0.074	0.09	0.084	0.073	0.068	0.077	0.096	0.107	0.097	0.094	0.111	0.087	0.089	0.08	0.073	0.088
(Tech)	0.086	0.07	0.075	0.0863	0.084	0.072	0.082	0.073	0.063	0.0842	0.064	0.066	0.077	0.082	0.0797	0.0707	0.071	0.0839	0.0835	0.073	0.082	0.072	0.065	0.084	0.067	0.065	0.074	0.084	0.081	0.074	0.074	0.087	0.086	0.07	0.083	0.076	0.063	0.084	0.066	0.066	0.076	0.084	0.092	0.071	0.074	0.087	0.076	0.079	0.073	0.075	0.061
(Peop)	0.095	0.08	0.077	0.0918	0.089	0.081	0.095	0.073	0.091	0.0664	0.063	0.072	0.08	0.087	0.0873	0.0743	0.073	0.089	0.0878	0.082	0.096	0.073	0.093	0.067	0.067	0.07	0.078	0.09	0.088	0.078	0.076	0.092	0.09	0.078	0.096	0.078	0.092	0.066	0.066	0.071	0.079	0.09	0.101	0.074	0.075	0.093	0.079	0.089	0.085	0.076	0.089
(Lead& Supp)	0.077	0.06	0.063	0.0764	0.071	0.064	0.068	0.064	0.068	0.0665	0.041	0.056	0.059	0.071	0.0707	0.0639	0.06	0.0743	0.0703	0.064	0.069	0.063	0.069	0.067	0.044	0.055	0.057	0.072	0.072	0.067	0.063	0.077	0.072	0.061	0.069	0.067	0.068	0.066	0.044	0.055	0.059	0.073	0.081	0.064	0.062	0.077	0.063	0.07	0.061	0.066	0.066
(org. Lear)	0.083	0.07	0.074	0.0862	0.085	0.073	0.076	0.07	0.09	0.0812	0.059	0.053	0.088	0.087	0.0769	0.0708	0.071	0.0839	0.0843	0.074	0.076	0.07	0.092	0.081	0.062	0.052	0.086	0.089	0.078	0.074	0.074	0.087	0.086	0.071	0.078	0.074	0.091	0.082	0.062	0.052	0.087	0.089	0.089	0.071	0.073	0.087	0.077	0.08	0.068	0.072	0.088
(Succ. Rate)	0.091	0.08	0.078	0.0915	0.095	0.084	0.085	0.076	0.095	0.0897	0.061	0.081	0.063	0.09	0.084	0.076	0.073	0.0889	0.0941	0.084	0.086	0.075	0.097	0.09	0.064	0.079	0.061	0.092	0.085	0.08	0.076	0.092	0.096	0.081	0.087	0.079	0.095	0.09	0.064	0.08	0.063	0.093	0.097	0.076	0.076	0.092	0.086	0.091	0.076	0.078	0.093
(R&D Exper)	0.115	0.09	0.094	0.1163	0.112	0.088	0.101	0.087	0.089	0.0892	0.067	0.076	0.085	0.085	0.1067	0.0925	0.09	0.1132	0.1103	0.094	0.102	0.085	0.091	0.089	0.071	0.075	0.082	0.088	0.108	0.097	0.094	0.117	0.113	0.089	0.102	0.091	0.089	0.089	0.07	0.075	0.085	0.088	0.122	0.093	0.093	0.118	0.101	0.102	0.09	0.09	0.087
(Code)	0.111	0.1	0.098	0.1207	0.121	0.086	0.113	0.097	0.101	0.1008	0.079	0.08	0.091	0.115	0.086	0.0985	0.093	0.1124	0.1197	0.09	0.113	0.095	0.103	0.101	0.084	0.078	0.088	0.118	0.089	0.103	0.098	0.121	0.122	0.083	0.113	0.101	0.101	0.101	0.084	0.079	0.091	0.118	0.121	0.096	0.099	0.125	0.091	0.113	0.092	0.1	0.1
(Pers)	0.09	0.06	0.086	0.0962	0.086	0.07	0.077	0.083	0.075	0.0713	0.061	0.064	0.069	0.085	0.0668	0.0627	0.082	0.0941	0.0854	0.071	0.077	0.083	0.076	0.071	0.066	0.062	0.065	0.087	0.084	0.066	0.085	0.097	0.088	0.068	0.078	0.085	0.076	0.071	0.065	0.063	0.067	0.088	0.095	0.064	0.085	0.097	0.078	0.078	0.069	0.086	0.073
(Ext)	0.107	0.09	0.071	0.109	0.094	0.076	0.084	0.09	0.082	0.0768	0.067	0.07	0.073	0.09	0.0884	0.0906	0.066	0.1068	0.0925	0.077	0.085	0.089	0.084	0.077	0.07	0.068	0.07	0.092	0.091	0.095	0.07	0.11	0.095	0.073	0.086	0.095	0.083	0.077	0.069	0.069	0.073	0.093	0.105	0.092	0.07	0.11	0.084	0.084	0.075	0.093	0.08
(Inter)	0.108	0.11	0.105	0.0924	0.104	0.084	0.095	0.102	0.095	0.0889	0.074	0.076	0.082	0.107	0.0987	0.1076	0.101	0.0892	0.1025	0.085	0.096	0.1	0.097	0.089	0.078	0.074	0.079	0.11	0.11	0.111	0.104	0.094	0.105	0.081	0.097	0.106	0.095	0.089	0.078	0.075	0.088	0.11	0.124	0.107	0.104	0.094	0.093	0.093	0.085	0.104	0.093
(Tech .Tran)	0.084	0.08	0.078	0.0914	0.073	0.083	0.085	0.074	0.074	0.0753	0.059	0.063	0.072	0.093	0.094	0.0778	0.075	0.0886	0.0719	0.083	0.086	0.073	0.075	0.076	0.063	0.063	0.069	0.095	0.087	0.082	0.078	0.092	0.074	0.078	0.086	0.077	0.075	0.076	0.063	0.063	0.071	0.096	0.099	0.079	0.077	0.092	0.064	0.09	0.076	0.076	0.072
(Dec.Mak)	0.107	0.08	0.088	0.0998	0.102	0.064	0.089	0.081	0.084	0.0824	0.071	0.072	0.08	0.095	0.0913	0.083	0.084	0.0968	0.1012	0.066	0.09	0.08	0.086	0.083	0.074	0.071	0.077	0.097	0.085	0.087	0.087	0.1	0.104	0.062	0.091	0.085	0.085	0.083	0.074	0.071	0.079	0.097	0.113	0.079	0.079	0.1	0.089	0.085	0.063	0.082	0.08
(In. Op Inn)	0.089	0.07	0.073	0.0898	0.091	0.07	0.065	0.072	0.074	0.0817	0.058	0.062	0.07	0.091	0.0762	0.071	0.069	0.0873	0.0903	0.071	0.065	0.071	0.076	0.082	0.061	0.061	0.068	0.093	0.093	0.075	0.072	0.091	0.092	0.068	0.066	0.075	0.075	0.082	0.061	0.061	0.07	0.093	0.104	0.072	0.072	0.091	0.082	0.078	0.057	0.074	0.073
(Proj. mang)	0.098	0.1	0.096	0.1104	0.098	0.081	0.09	0.07	0.09	0.0845	0.071	0.07	0.078	0.094	0.1023	0.0968	0.092	0.1077	0.0966	0.082	0.091	0.069	0.092	0.085	0.074	0.068	0.075	0.096	0.095	0.1	0.095	0.11	0.1	0.078	0.091	0.074	0.091	0.084	0.074	0.069	0.077	0.096	0.108	0.097	0.095	0.111	0.088	0.089	0.08	0.073	0.088
(Inn. com)	0.089	0.07	0.075	0.0867	0.085	0.072	0.082	0.073	0.063	0.0841	0.064	0.067	0.077	0.083	0.0827	0.0709	0.071	0.0843	0.0841	0.073	0.083	0.072	0.065	0.084	0.067	0.065	0.074	0.084	0.082	0.074	0.074	0.087	0.086	0.07	0.083	0.076	0.064	0.084	0.067	0.066	0.076	0.085	0.093	0.072	0.074	0.088	0.076	0.08	0.074	0.075	0.062
(Rate Int)	0.091	0.07	0.076	0.0912	0.088	0.08	0.094	0.072	0.09	0.0655	0.062	0.071	0.079	0.086	0.0837	0.0733	0.073	0.088	0.0868	0.081	0.095	0.072	0.093	0.066	0.066	0.069	0.077	0.089	0.088	0.077	0.075	0.091	0.088	0.077	0.094	0.076	0.091	0.066	0.066	0.07	0.079	0.089	0.1	0.074	0.074	0.091	0.078	0.088	0.085	0.075	0.088
(Int & Ext Kno)	0.072	0.06	0.063	0.0761	0.071	0.063	0.068	0.064	0.067	0.0662	0.041	0.056	0.059	0.07	0.0732	0.0636	0.06	0.074	0.07	0.064	0.068	0.063	0.069	0.066	0.044	0.055	0.057	0.072	0.072	0.067	0.063	0.077	0.071	0.061	0.069	0.066	0.068	0.066	0.043	0.055	0.058	0.072	0.081	0.064	0.062	0.077	0.063	0.07	0.061	0.065	0.066
(R&D.Corp)	0.086	0.07	0.075	0.0867	0.086	0.074	0.077	0.071	0.091	0.0816	0.06	0.054	0.089	0.087	0.0812	0.0714	0.071	0.0844	0.085	0.074	0.077	0.07	0.093	0.082	0.062	0.052	0.086	0.09	0.078	0.075	0.074	0.087	0.087	0.071	0.078	0.074	0.091	0.082	0.062	0.053	0.088	0.09	0.089	0.071	0.074	0.087	0.077	0.081	0.068	0.073	0.089
(Ext Net)	0.105	0.08	0.079	0.0924	0.096	0.084	0.086	0.077	0.096	0.0903	0.062	0.081	0.064	0.091	0.0824	0.077	0.074	0.0901	0.0962	0.085	0.087	0.076	0.098	0.091	0.065	0.08	0.062	0.094	0.085	0.081	0.077	0.093	0.097	0.081	0.088	0.08	0.096	0.091	0.065	0.08	0.063	0.094	0.098	0.077	0.077	0.093	0.087	0.092	0.076	0.079	0.094
(Know .Inc)	0.102	0.09	0.092	0.1129	0.109	0.086	0.098	0.084	0.086	0.0863	0.065	0.074	0.083	0.082	0.0901	0.0898	0.087	0.1101	0.107	0.091	0.099	0.082	0.088	0.086	0.068	0.072	0.08	0.084	0.105	0.094	0.091	0.114	0.11	0.086	0.097	0.088	0.086	0.086	0.068	0.073	0.082	0.085	0.119	0.09	0.09	0.114	0.099	0.099	0.088	0.087	0.084
(Rad Inn)	0.114	0.1	0.1	0.1219	0.123	0.095	0.115	0.093	0.103	0.1025	0.081	0.082	0.093	0.117	0.1144	0.1005	0.095	0.1164	0.121	0.091	0.109	0.098	0.105	0.103	0.086	0.079	0.09	0.118	0.09	0.105	0.099	0.122	0.125	0.084	0.116	0.103	0.103	0.103	0.086	0.08	0.092	0.12	0.123	0.096	0.101	0.128	0.093	0.116	0.094	0.102	0.1
(Abso. Cap)	0.102	0.06	0.088	0.0982	0.088	0.071	0.079	0.081	0.077	0.0734	0.063	0.065	0.07	0.087	0.0684	0.0643	0.084	0.0964	0.0874	0.072	0.095	0.084	0.078	0.073	0.067	0.064	0.067	0.09	0.086	0.068	0.087	0.099	0.09	0.069	0.08	0.087	0.077	0.074	0.066	0.064	0.068	0.09	0.097	0.065	0.087	0.099	0.08	0.079	0.07	0.088	0.075
(R&D Empo)	0.097	0.09	0.069	0.1076	0.092	0.074	0.083	0.088	0.081	0.0756	0.066	0.069	0.072	0.089	0.0873	0.0895	0.065	0.1052	0.0905	0.075	0.082	0.088	0.082	0.076	0.069	0.067	0.069	0.091	0.09	0.094	0.069	0.109	0.093	0.072	0.084	0.093	0.081	0.076	0.068	0.068	0.072	0.091	0.103	0.091	0.068	0.109	0.083	0.083	0.074	0.091	0.079
(Tech Tren)	0.098	0.11	0.103	0.0903	0.102	0.083	0.093	0.097	0.093	0.0873	0.073	0.075	0.08	0.105	0.097	0.1059	0.099	0.0872	0.1005	0.084	0.092	0.099	0.095	0.088	0.077	0.073	0.077	0.108	0.108	0.109	0.103	0.092	0.103	0.079	0.095	0.104	0.094	0.087	0.076	0.074	0.079	0.108	0.122	0.106	0.102	0.092	0.091	0.091	0.084	0.103	0.091
(Inno. per)	0.103	0.08	0.08	0.0934	0.075	0.072	0.087	0.09	0.075	0.0769	0.061	0.064	0.073	0.095	0.0956	0.0793	0.076	0.0906	0.0737	0.085	0.084	0.074	0.077	0.077	0.064	0.063	0.071	0.097	0.088	0.084	0.08	0.094	0.076	0.08	0.088	0.079	0.076	0.077	0.064	0.064	0.072	0.098	0.101	0.081	0.079	0.094	0.065	0.092	0.077	0.078	0.074
(Inov Str& ini)	0.099	0.08	0.089	0.1011	0.104	0.09	0.09	0.08	0.085	0.0835	0.072	0.073	0.081	0.096	0.0925	0.0838	0.085	0.0979	0.1023	0.066	0.093	0.081	0.087	0.084	0.075	0.072	0.078	0.098	0.086	0.088	0.088	0.102	0.105	0.063	0.092	0.086	0.086	0.084	0.075	0.072	0.08	0.098	0.115	0.08	0.08	0.101	0.09	0.086	0.064	0.083	0.081
(Org.Str)	0.086	0.07	0.073	0.0898	0.091	0.058	0.064	0.074	0.074	0.0817	0.058	0.062	0.07	0.091	0.076	0.0709	0.069	0.0873	0.0903	0.071	0.083	0.071	0.076	0.082	0.061	0.06	0.068	0.093	0.094	0.074	0.072	0.091	0.092	0.068	0.066	0.075	0.075	0.082	0.061	0.061	0.069	0.093	0.104	0.072	0.072	0.091	0.082	0.078	0.057	0.074	0.073
(Tech. Acq)	0.101	0.1	0.096	0.1109	0.099	0.079	0.09	0.083	0.091	0.0846	0.071	0.07	0.078	0.094	0.1027	0.0973	0.093	0.1081	0.0968	0.082	0.076	0.069	0.092	0.085	0.075	0.068	0.075	0.096	0.095	0.101	0.096	0.112	0.1	0.078	0.092	0.074	0.092	0.085	0.074	0.069	0.077	0.096	0.108	0.098	0.095	0.112	0.088	0.09	0.081	0.073	0.089
(Tech. Expo)	0.085	0.07	0.073	0.0846	0.083	0.071	0.08	0.057	0.061	0.0825	0.063	0.065	0.075	0.081	0.0809	0.0689	0.069	0.0822	0.0821	0.071	0.079	0.071	0.063	0.083	0.066	0.064	0.073	0.082	0.08	0.072	0.073	0.085	0.084	0.068	0.081	0.075	0.062	0.082	0.065	0.064	0.075	0.083	0.09	0.07	0.072	0.086	0.075	0.078	0.072	0.074	0.06
(Tech. Pro)	0.086	0.07	0.075	0.0896	0.086	0.074	0.092	0.075	0.089	0.0643	0.061	0.07	0.078	0.085	0.0826	0.0723	0.071	0.0866	0.0853	0.08	0.084	0.071	0.091	0.064	0.065	0.069	0.076	0.087	0.086	0.076	0.074	0.09	0.087	0.076	0.094	0.075	0.09	0.064	0.065	0.069	0.077	0.088	0.098	0.072	0.073	0.09	0.077	0.086	0.084	0.074	0.087
(Tech. lear)	0.076	0.07	0.065	0.0782	0.072	0.07	0.069	0.062	0.069	0.0678	0.042	0.057	0.061	0.072	0.0747	0.0651	0.062	0.0757	0.0719	0.066	0.083	0.064	0.07	0.068	0.045	0.056	0.059	0.074	0.074	0.068	0.064	0.079	0.073	0.062	0.07	0.068	0.069	0.068	0.045	0.056	0.06	0.074	0.083	0.065	0.063	0.079	0.065	0.071	0.062	0.067	0.067
(Tech. Sele)	0.101	0.07	0.077	0.0886	0.088	0.075	0.079	0.075	0.093	0.0833	0.061	0.055	0.089	0.089	0.0827	0.0734	0.073	0.0864	0.0871	0.076	0.081	0.072	0.094	0.084	0.064	0.053	0.088	0.092	0.08	0.076	0.076	0.089	0.089	0.072	0.08	0.076	0.093	0.084	0.064	0.054	0.089	0.092	0.091	0.073	0.075	0.09	0.079	0.083	0.07	0.074	0.091
(Tech. Iden)	0.093	0.08	0.077	0.0899	0.094	0.076	0.083	0.073	0.094	0.0883	0.06	0.08	0.062	0.089	0.0805	0.075	0.072	0.0876	0.0936	0.083	0.08	0.074	0.096	0.089	0.063	0.078	0.06	0.091	0.083	0.078	0.075	0.091	0.095	0.08	0.085	0.078	0.094	0.088	0.063	0.079	0.062	0.092	0.095	0.075	0.075	0.091	0.084	0.09	0.075	0.077	0.092
(Tech Deve)	0.103	0.09	0.091	0.1127	0.109	0.089	0.097	0.083	0.086	0.0861	0.065	0.074	0.082	0.082	0.09	0.0896	0.087	0.11	0.1059	0.091	0.091	0.082	0.088	0.086	0.068	0.072	0.08	0.084	0.105	0.094	0.091	0.114	0.11	0.087	0.099	0.088	0.086	0.086	0.068	0.073	0.082	0.085	0.119	0.09	0.09	0.114	0.098	0.099	0.087	0.087	0.084
(Mang Comp)	0.114	0.09	0.091	0.1137	0.102	0.087	0.078	0.085	0.094	0.0941	0.068	0.072	0.081	0.106	0.1041	0.0878	0.08	0.0842	0.0995	0.091	0.1	0.07	0.092	0.094	0.079	0.072	0.082	0.109	0.08	0.095	0.09	0.113	0.115	0.076	0.107	0.094	0.094	0.093	0.079	0.073	0.084	0.109	0.093	0.089	0.099	0.117	0.084	0.106	0.086	0.093	0.093
(Fac)	0.095	0.08	0.089	0.0914	0.089	0.074	0.083	0.091	0.078	0.0786	0.068	0.07	0.08	0.088	0.0697	0.0755	0.086	0.0912	0.088	0.084	0.086	0.076	0.08	0.074	0.068	0.065	0.068	0.091	0.087	0.069	0.088	0.101	0.091	0.071	0.081	0.088	0.078	0.074	0.067	0.065	0.07	0.091	0.099	0.066	0.088	0.101	0.081	0.081	0.071	0.089	0.076
(Org. Poten)	0.085	0.07	0.065	0.0883	0.085	0.074	0.083	0.074	0.077	0.0853	0.06	0.069	0.078	0.084	0.0816	0.0883	0.073	0.0903	0.0835	0.072	0.066	0.07	0.084	0.072	0.066	0.064	0.066	0.086	0.086	0.089	0.064	0.104	0.089	0.069	0.08	0.089	0.077	0.073	0.065	0.065	0.069	0.087	0.098	0.086	0.064	0.104	0.079	0.079	0.071	0.088	0.075
(Pers. Skil)	0.113	0.1	0.101	0.1014	0.094	0.082	0.102	0.085	0.091	0.072	0.071	0.073	0.078	0.103	0.0944	0.0816	0.08	0.1015	0.0927	0.081	0.092	0.082	0.075	0.086	0.074	0.071	0.075	0.106	0.106	0.107	0.1	0.088	0.101	0.077	0.093	0.102	0.092	0.085	0.074	0.071	0.084	0.106	0.119	0.104	0.1	0.089	0.089	0.089	0.082	0.1	0.089
(Str Tech)	0.092	0.07	0.079	0.0888	0.088	0.081	0.08	0.075	0.075	0.0781	0.066	0.054	0.09	0.094	0.0822	0.0732	0.071	0.0996	0.087	0.073	0.086	0.072	0.092	0.077	0.063	0.064	0.069	0.096	0.088	0.083	0.079	0.093	0.075	0.079	0.087	0.078	0.075	0.077	0.063	0.064	0.072	0.097	0.1	0.08	0.078	0.093	0.065	0.092	0.077	0.077	0.073
(Corp Tech Stra)	0.087	0.07	0.081	0.0864	0.09	0.073	0.075	0.06	0.078	0.0807	0.06	0.077	0.058	0.088	0.0769	0.0732	0.071	0.0848	0.0893	0.071	0.092	0.071	0.079	0.077	0.069	0.066	0.072	0.09	0.078	0.08	0.081	0.093	0.097	0.056	0.084	0.078	0.078	0.076	0.069	0.066	0.074	0.09	0.106	0.072	0.072	0.092	0.083	0.066	0.057	0.075	0.073
(Corport Bus Strat)	0.106	0.08	0.08	0.1075	0.104	0.079	0.086	0.08	0.08	0.0904	0.053	0.07	0.078	0.098	0.0849	0.0772	0.075	0.0915	0.1006	0.088	0.085	0.077	0.098	0.089	0.067	0.066	0.074	0.1	0.1	0.082	0.079	0.098	0.099	0.073	0.073	0.082	0.081	0.089	0.066	0.066	0.075	0.101	0.113	0.078	0.078	0.099	0.089	0.085	0.063	0.081	0.079
(Tech Alli)	0.099	0.08	0.095	0.0977	0.1	0.088	0.096	0.082	0.09	0.0844	0.065	0.084	0.096	0.093	0.1007	0.0805	0.079	0.0947	0.0924	0.079	0.085	0.08	0.098	0.084	0.074	0.068	0.075	0.095	0.094	0.099	0.095	0.11	0.099	0.077	0.09	0.072	0.091	0.084	0.073	0.068	0.077	0.095	0.106	0.096	0.094	0.111	0.08	0.089	0.079	0.071	0.088
(Desor. Cap)	0.102	0.09	0.092	0.1138	0.109	0.087	0.098	0.084	0.086	0.0868	0.067	0.074	0.083	0.082	0.1042	0.0912	0.086	0.1055	0.1116	0.082	0.099	0.089	0.096	0.094	0.078	0.072	0.082	0.109	0.08	0.095	0.09	0.112	0.114	0.076	0.106	0.094	0.094	0.093	0.078	0.072	0.084	0.11	0.108	0.084	0.086	0.102	0.088	0.092	0.085	0.088	0.072

. In simple words, R (row) + C (Column) represent the degree of significant control of *i* used to carry during addressing the problem. Similarly if R (row) - C (Column) is positive in nature than it used to translate as factor *i* is going to affect other factors, if R (row) - C (Column) is negative in nature than it used to represent that factor *i* is being influenced by other factors. In case of KM capability, the overall influences given and received among ***T** (Criteria)* and ***T** (Sub-Criteria)* Therefore, the cause and effect among is shown Table 5.33

Table 5.33 Overall influences given and received among ***T** (Criteria)* and ***T** (Sub-Criteria)* Total Average matrix

T(*Sub-Criteria*)	**R(row)**	**C(Column)**	**R(row)+ C(Column)**	**Rank**	**R(row)- C(Column)**	**Rank**
KM process capability **T(*Criteria*)**	9.985223	10.93184	20.917058	9	-0.946613	9
Knowledge Creation	5.126536	4.90933	10.035870	1	0.2172015	19
Knowledge Acquisition	4.02973	4.1846	8.2143333	34	-0.154876	32
Intellectual Knowledge Portfolio	4.28062	4.23949	8.5201134	19	0.041131	23
Knowledge Sharing	4.95476	4.96322	9.9179816	3	-0.008462	26
Knowledge Implementation	4.0069	4.77816	8.7850583	15	-0.771253	51
Knowledge Transfer	4.19393	3.95349	8.1474195	38	0.240437	18
KM.Infra. capability **T(*Criteria*)**	10.42267	10.85479	21.27745	7	-0.43211	8
Culture	4.04964	4.39398	8.443612	21	-0.3443	40
Structure	4.49452	4.04838	8.542892	18	0.44614	10
Technology	3.88152	4.25891	8.14043	40	-0.3774	41
People	4.16536	4.1655	8.330851	27	-0.0001	25
Role of Leadership & Support	3.33143	3.26481	6.596246	51	0.06662	22
Organizational Learning	3.93941	3.5269	7.466315	47	0.41251	11
KM Strate. capability **T(*Criteria*)**	10.81352	10.81541	21.628927	5	-0.001894	5
Success rate of R&D products	4.22336	3.92383	8.147191	39	0.29953	14
R&D Expenditure	4.7924	4.65372	9.446113	9	0.13868	20
Codification	5.13501	4.45036	9.585365	8	0.68465	2
Personalization	3.93196	4.13738	8.06934	43	-0.2054	37
External knowledge source	4.30893	4.00588	8.314813	28	0.30305	13
Internal Knowledge source	4.86949	4.79967	9.669163	6	0.06982	21

In case of IM capability, the overall influences given and received among ***T** (Criteria)* and ***T** (Sub-Criteria)* Therefore, the cause and effect among is shown Table 5.34

Table 5.34 Summary of the influences given and received among criteria and sub-criteria

T(*Sub-Criteria*)	**R(row)**	**C(Column)**	**R(row)+ C(Column)**	**Rank**	**R(row)- C(Column)**	**Rank**
I.M Process Cap **T(*Criteria*)**	11.0936	10.6894	21.783099	4	0.404280	3
Technology Transfer	3.99763	4.71549	8.71312	16	-0.7179	49
Decision Making Process	4.33691	4.01047	8.34738	25	0.32644	12
Open Innovation	3.87581	4.4279	8.303709	29	-0.5521	46
Project Management	4.51725	3.97936	8.496606	20	0.53789	6
Innovativeness Compatibility	3.90073	4.38281	8.283543	31	-0.4821	43
Rate of Introduction New Product	4.11305	4.1699	8.282944	32	-0.0568	29
Internal & External Knowledge Sharing	3.31595	3.47217	6.788117	50	-0.1562	33
R&D Corporation	3.96648	3.42688	7.393356	48	0.5396	5
I.M infra Cap **T(*Criteria*)**	10.4268	10.8251	21.252053	8	-0.398314	7
External Networking	4.28058	3.75357	8.034154	44	0.527	7
knowledge incentives	4.62029	4.78727	9.407557	11	-0.167	34
Radical Innovation	5.24719	4.53671	9.783903	4	0.71048	1
Absorptive capacity	4.04177	4.36731	8.409074	23	-0.3255	39
R&D Employee	4.23177	4.20838	8.44015	22	0.02338	24
I.M Strate Cap **T(*Criteria*)**	10.5922	10.7375	21.329805	6	-0.145284	6
Technology Trends	4.76054	5.01937	9.779905	5	-0.2588	38
Innovative Performance	4.09507	4.84538	8.940453	12	-0.7503	50
Innovation strategies and initiatives	4.4054	3.77324	8.178643	36	0.63216	3
Organizational strategy	3.8763	4.46595	8.34225	26	-0.5897	47

In case of TM capability, the overall influences given and received among ***T*** ***(Criteria)*** and ***T*** ***(Sub-Criteria)*** Therefore, the cause and effect among is shown Table 5.35

Table 5.35 Summary of the influences given and received among criteria and sub-criteria

T(*Sub-Criteria*)	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	Rank	$R_{(row)}-C_{(Column)}$	Rank
T.M Process Cap **T(*Criteria*)**	11.7753	11.1122	22.8876	1	0.663082	1
Technology Acquisition	4.53437	4.26201	8.79638	14	0.27236	17
Technology Exploitation	3.79301	4.2993	8.092317	42	-0.5063	45
Technology Protection	4.03635	4.16669	8.203035	35	-0.1303	31
Technology Learning	3.41398	3.45193	6.86591	49	-0.0379	28
Technology Selection	4.07431	3.45553	7.529841	46	0.61878	4
Technology identification	4.15359	3.86317	8.016761	45	0.29043	15
Technology development	4.60978	4.80904	9.418817	10	-0.1993	36
T.M Infra Cap **T(*Criteria*)**	11.1663	10.8469	22.0133	3	0.3193936	4
Management Competency	4.6825	5.29434	9.976846	2	-0.6118	48
Facility and Equipment	4.13246	4.16199	8.294453	30	-0.0295	27
Organization Potential	3.99141	4.16359	8.155003	37	-0.1722	35
Personal Skill	4.60219	5.02952	9.631714	7	-0.4273	42
T.M Start Cap **T(*Criteria*)**	11.5227	10.9853	22.5081	2	0.537467	2
Strategic Technology Road Mapping	4.06501	4.18949	8.254502	33	-0.1245	30
Corporate Technology Strategy	3.94634	4.44706	8.393402	24	-0.5007	44
Corporate Business Strategy	4.29305	3.82349	8.116534	41	0.46956	9
Technology Alliance Strategy	4.47457	4.19524	8.669809	17	0.27932	16
Desorptive Capacity	4.65839	4.14736	8.805755	13	0.51103	8

The findings are discussed as follows. At first account, according to the total influence matrix produce from DEMATEL technique. In case of criteria, the degree of importance among them is shown in Table 5.33 to 5.35 TM processes Capability (22.887622) > TM strategic capability (22.5081) > TM infrastructure capability (22.0133) > IM process capability (21.783099) > KM strategic capability (21.628927) > IM strategic capability (21.329805) > KM infrastructure capability (21.27745) > IM infrastructure capability (21.252053) > KM process capability (20.917058). Contrary to the importance of individual criteria, the net interrelationship among criteria, TM process capability (0.663082) > TM Strategic capability (0.537467) > IM process capability (0.404280) > TM infrastructure capability (0.3193936) > KM strategic capability (-0.001894) > IM Strategic capability (-0.145284) > IM infrastructure capability (-0.398314) > KM infrastructure capability (-0.43211) > KM process capability (-0.946613)

In case of sub-criteria, the degree of importance among them is shown in Table 5.33 to 5.35(K.cre) 10.03587 > (Mang Comp) 9.976846 > (K.shar) 9.917982 > (Rad Inn) 9.783903 >(Tech Tren) 9.779905 >(Inter) 9.669163 >(Pers. Skil) 9.631714 > (Code) 9.585365 >(R&D Exper) 9.446113 > (Tech Deve) 9.418817 > (Know .Inc) 9.407557 > (Inno. per) 8.940453 >(Desor. Cap) 8.805755 > (Tech. Acq) 8.79638 >(K.Imp) 8.785058 > (Tech .Tran) 8.71312 > (Tech Alli) 8.669809 >(stru) 8.542892 >(Int Kno Port) 8.520113 > (Proj. mang) 8.496606 > (cult) 8.443612 > (R&D Empo) 8.44015 > (Abso. Cap) 8.409074 > (Corp Tech Stra) 8.393402 > Dec.Mak)8.34738 > (Org.Str)8.342253 >(Peop) 8.330851 > (Ext) 8.314813 > (In. Op Inn) 8.303709 >(Fac) 8.294453 > (Inn. com) 8.283543 > (Rate Int) 8.282944 > (Str Tech) 8.254502 >(K.Acq) 8.214333 > (Tech. Pro) 8.203035 > (Inov Str& ini) 8.178643 > (Org. poten) 8.155003 >(K.tran) 8.14742 >(Succ. Rate) 8.147191 >(Tech) 8.14043 >(Corport Bus Strat) 8.116534 >(Tech. Expo) 8.092317 > (Pers) 8.06934 > (Ext Net) 8.034154> (Tech. Iden) 8.016761 >(Tech. Sele) 7.529841 >(org. Lear) 7.466315 > (R&D.Corp) 7.393356 >(Tech. lear) 6.86591 > (Int & Ext Kno) 6.788117 >(Lead& Supp) 6.596246

Contrary to the importance of individual criteria the interrelationship among sub-criteria Rad Inn (0.710484), Code (0.684652), Inov Str& ini (0.632157), Tech. Sele (0.618779), R&D.Corp (0.539597), Proj. Mang (0.537887), Ext Net (0.527004), Desor. Cap (0.511034), Corport Bus Strat (0.469564), stru (0.44614), org. Lear (0.412506),Dec.Mak(0.326441),Ext(0.303051),Succ.Rate(0.299526),Tech.Iden(0.290427),Tech.Alli(0.279324),Tech.Acq(0.272357),K.tran (0.240437), K.cre (0.217202), R&D Exper (0.13868), Inter (0.069823), Lead&Supp (0.066624), Int Kno Port (0.041131), R&D Empo (0.023383), Peop(-0.00014), K.shar(-0.00846), Fac(-0.02953), Tech. Lear(-0.03794), Rate Int(-0.05685), Str Tech(-0.12447), Tech. Pro (-0.13034),K.Acq(-0.15488), Int & Ext Kno(-0.15622) Know .Inc(-0.16699), Org. Pot(-0.17218), Tech Deve(-0.19926), Pers(-0.20541),Tech Tren(-0.25883), Abso. Cap (-0.32554), cult (-

0.34434), Tech (-0.37739), Pers. Skil (-0.42733), Inn. Com (-0.48209), Corp Tech Stra (-0.50072), Tech. Expo(-0.50629), In. Op Inn(-0.5521), Org.Str (-0.58965) Mang Comp(-0.61184), Tech .Tran(-0.71786), Inno. Per (-0.75032), K.Imp (-0.77125).

In term of criteria more improvement required to made on the Technology Management process capability that leads R&D toward the progressive and productive outcome more or less there is various other factors also involve for further up gradation. But, in case of technology management process capability public firms requires more emphasis on identification, selection, technological acquisition, technological exploitation and protection of the technology. These resources were considered as backbone mechanism behind value addition invisibly to organizational inputs

The influential significance within the Sub-criteria related to KM process capability Table 5.36

Table 5.36 Influential significance within KM Process Capability ***($T_{Sub\text{-}Criteria}$)***

	K.Cr	K.Aq	IIN KP	K.Sh	K.Im	K.Tr	
K.Cr	0.09454	0.099455	0.09809	0.1205	0.12066	0.08609	0.09454
K.Aq	0.09068	0.064873	0.08730	0.0982	0.08822	0.07171	0.09068
IN.KP	0.09670	0.091944	0.07016	0.10885	0.09306	0.07535	0.09670
K.Sh	0.11885	0.109208	0.10636	0.09416	0.10581	0.08492	0.11885
K.Im	0.09275	0.079578	0.07846	0.09157	0.07306	0.08332	0.09275
K.Tr	0.08773	0.080909	0.08529	0.09657	0.09949	0.06242	0.08773
	0.09454	0.099455	0.09809	0.12051	0.12066	0.08609	0.09454

A positive value for R $_{(row)}$ - C $_{(Column)}$ reflects the situation in which the sub-criterion influenced other sub-criteria, as compared to that it gets affected by other sub-criteria, which put sub-criteria in question that it need to prioritizes for further improvement. For instance, *knowledge transfer* as sub-criteria has the highest R $_{(row)}$ - C $_{(Column)}$ positive value (0.049) it reflects the strong influence on other sub-criteria's. On the other hand, *knowledge implementations* have very low R $_{(row)}$ - C $_{(Column)}$ value (-0.082) as sub-criteria, thus it has vulnerable to influence is show in Table 5.37.

Therefore, the priority can be ordered. The priority configuration can be represented as K.Tr > K.Cr > IN.KP> K.Sh> K.Aq> K.Tr

Table 5.37 Sum of the columns and row from the total-influence matrix ***T*** ***(Sub-Criteria)***

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+ C_{(Column)}$	$R_{(row)}- C_{(Column)}$	
K.Cr	0.61936	0.58128	1.2006	0.038	Cause
K.Aq	0.501	0.52597	1.027	-0.025	Affected
IN.KP	0.53609	0.5257	1.0618	0.01	Cause
K.Sh	0.61933	0.60988	1.2292	0.009	Cause
K.Im	0.49877	0.58033	1.0791	-0.082	Affected
K.Tr	0.51244	0.46383	0.9763	0.049	Cause

Similarly, the influential significance within the Sub-criteria related to KM infrastructure capabilities is shown in Table 5.38

Table 5.38 Influential significance within K.M Infrastructure Capability ***T*** ***(Sub-Criteria)***

	Cul	Str	Tec	Peop	Ro.Le	Or. L	
Cul	0.0679	0.0748	0.0771	0.0848	0.0604	0.0641	0.4293
Str	0.0894	0.0695	0.0897	0.0840	0.0707	0.0692	0.4729
Tec	0.0816	0.0731	0.0629	0.0841	0.0637	0.0664	0.4321
Peop	0.0945	0.0733	0.0913	0.0663	0.0630	0.071684	0.46035
Ro.Le	0.06833	0.06380	0.06759	0.06645	0.041179	0.056228	0.36358
Or.L	0.07616	0.07033	0.09030	0.08119	0.059058	0.053194	0.43024
	0.47813	0.42495	0.47901	0.46709	0.35838	0.38099	

The sub-criteria for KM infrastructure capability has reflected numbers of space for further improvement. From Table 5.39 *organization learning* has a highest positive value of $R_{(row)}$ - $C_{(Column)}$ (0.049) such a positive value implies a strong influence on other sub-criteria. On the other hand, *organizational culture* reflects very low $R_{(row)}$ - $C_{(Column)}$ value (-0.049) thus it has been susceptible for further influence. Therefore, the improvement priorities can be ordered from *organization learning* as the highest priority while *organizational culture* corresponds to low precedence for further improvement. The priority configuration can be represented as Or.L > Str > Ro.Le > Peop> Tec> Cul

Table 5.39 Sum of the columns and row from the total-influence matrix ***T*** ***(Sub-Criteria)***

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	$R_{(row)}-C_{(Column)}$	
Cul	0.42933	0.47814	0.9075	-0.049	Affected
Str	0.4729	0.42496	0.8979	0.048	Cause
Tec	0.43216	0.47901	0.9112	-0.047	Affected
Peop	0.46035	0.46709	0.9274	-0.007	Affected
Ro.Le	0.36358	0.35838	0.722	0.005	Cause
Or.L	0.43025	0.38099	0.8112	0.049	Cause

Similarly, the influential significance within the Sub-criteria related to KM Strategic capabilities is shown in Table 5.40

Table 5.40 Influential significance within KM Strategic Capability ***T*** ***(Sub-Criteria)***

	Suc.R	R&D.Exp	Code	Pers	Exter.kn	Inter.Kn	
Suc.R	0.06344	0.0900	0.0840	0.07603	0.07329	0.08891	0.47578
R&D.Exp	0.08524	0.0853	0.1066	0.09252	0.08995	0.11324	0.57297
Code	0.09119	0.1148	0.0860	0.09849	0.09330	0.11244	0.59631
Pers	0.06870	0.0852	0.0667	0.06265	0.08234	0.09408	0.45986
Exter.kn	0.07307	0.0901	0.0884	0.09058	0.06635	0.10678	0.51533
Inter.Kn	0.08158	0.1071	0.0986	0.10756	0.10084	0.08922	0.58507
	0.46325	0.5728	0.53059	0.52785	0.50610	0.60469	

Similarly, From Table 5.41 *Codification* has a highest positive value of $R_{(row)} - C_{(Column)}$ (0.0657235) such a positive value implies a strong influence on other sub-criteria. While, Personification shows very low $R_{(row)} - C_{(Column)}$ (-0.068) it has vulnerable to influence. Therefore, the improvement priorities can be ordered from *Codification* as highest priority for further improvement to *Personification* low priority for further improvement. The priority configuration can be represent as Code > Suc.R > Exter.kn > R&D.Exp > Inter.Kn > Pers

Table 5.41 Sum of the columns and row from the total-influence matrix ***T*** ***(Sub-Criteria)***

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	$R_{(row)}-C_{(Column)}$	
Suc.R	0.47578	0.46325	0.939	0.013	Cause
R&D.Exp	0.57297	0.57285	1.1458	0.00011	Cause
Code	0.59631	0.53059	1.1269	0.0657235	Cause
Pers	0.45987	0.52785	0.9877	-0.068	Affected
Exter.kn	0.51534	0.5061	1.0214	0.009	Cause
Inter.Kn	0.58508	0.6047	1.1898	-0.02	Affected

In case of IM process capability, the Influential significance within sub-criteria is shown in Table 5.42

Table 5.42 Influential significance within IM Process Capability ***T*** ***(Sub-Criteria)***

	Tech.Tran	Dec.Ma.Pr	Open. Inn	Proj.Man	Innov.Comp	Rate of In	Inter&Ext	R&D Cop	
Tech.Tran	0.07	0.083	0.0858	0.0731	0.0754	0.075	0.0627	0.0626	0.590
Dec.Ma.Pr	0.10	0.065	0.0899	0.0799	0.0862	0.082	0.0739	0.0708	0.650
Open. Inn	0.09	0.070	0.0651	0.0706	0.0757	0.081	0.0614	0.0605	0.576
Proj.Man	0.09	0.082	0.0908	0.0688	0.0919	0.08	0.0742	0.0680	0.657
Innov.Comp	0.08	0.073	0.0825	0.0721	0.0649	0.084	0.0669	0.0652	0.593
Rate of In	0.08	0.081	0.0946	0.0722	0.0926	0.065	0.0658	0.0694	0.628
Inter&Ext	0.07	0.064	0.0682	0.0625	0.0688	0.066	0.0436	0.0547	0.498
R&D Cop	0.08	0.074	0.0769	0.0701	0.0926	0.081	0.0624	0.0521	0.595
	0.68	0.595	0.6542	0.5696	0.6485	0.623	0.5112	0.503	

From Table 5.43 *R&D Corporation* has the highest positive value of $R_{(row)}$ - $C_{(Column)}$ (0.091928) such positive value illustrates the strong influence on other sub-criteria. While, *Technology Transfer* show very low $R_{(row)}$ - $C_{(Column)}$ (-0.09497) it has susceptible to influence. Therefore, the improvement priorities can be ordered from *R&D Corporation* as the highest priority for improvement to *Technology Transfer* low priority for further improvement. The priority configuration can be represented as R&D Cop > Proj.Man > Dec.Ma.Pr > Rate of In > Inter&Ext > Innov.Comp> Open. Inn> Tech.Tran

Table 5.43 Sum of the columns and row from the total-influence matrix ***T*** ***(Sub-Criteria)***

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	$R_{(row)}-C_{(Column)}$	
Tech.Tran	0.590822	0.685790384	1.277	-0.09497	Affected
Dec.Ma.Pr	0.650824	0.595560223	1.246	0.055264	Cause
Open. Inn	0.576401	0.654221464	1.231	-0.07782	Affected
Proj.Man	0.657285	0.56966301	1.227	0.087622	Cause
Innov.Comp	0.593825	0.648526567	1.242	-0.0547	Affected
Rate of In	0.628596	0.623189743	1.252	0.005407	Cause
Inter&Ext	0.498534	0.511264278	1.01	-0.01273	Affected
R&D Cop	0.59556	0.503631849	1.099	0.091928	Cause

In case of IM infrastructure capability, the Influential significance within sub-criteria is shown in Table 5.44

Table 5.44 Influential significance within I.M Infrastructure Capability ***T*** ***(Sub-Criteria)***

	Ext.Net	Kno.Inc	Rad. In	Abs. Cap	R&D Emp	
Ext.Net	0.0618	0.09352	0.08532	0.08052	0.0774	0.398
Kno.Inc	0.07958	0.08429	0.10538	0.09404	0.0911	0.454
Rad. In	0.09003	0.11814	0.09002	0.10504	0.0990	0.502
Abs. Cap	0.06653	0.08982	0.08598	0.06818	0.0869	0.397
R&D Emp	0.06920	0.09073	0.09020	0.09386	0.0688	0.4128
	0.367157	0.476527	0.456922	0.441671	0.42346	

From Table 5.44 *Radical Innovation* has the highest positive value of R (row) - C (Column) (0.0453472) such a positive value illustrates the strong influence on other sub-criteria. While, *Absorptive capacity* show very low R (row) - C (Column) (-0.0441448) it has susceptible to influence, Therefore, the improvement priorities can be ordered from *Radical Innovation* as the highest priority for improvement to *Absorptive capacity* low as the priority for further improvement. The priority configuration can be representing Rad. In > Ext.Net > R&D EMP > Kno.Inc > Abs.Cap

Table 5.45 Sum of the columns and row from the total-influence matrix T *(Sub-Criteria)*

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	$R_{(row)}-C_{(Column)}$	
Ext.Net	0.398834	0.36787	0.766704	0.030963883	Cause
Kno.Inc	0.454704	0.479726	0.934429	-0.025022286	Affected
Rad. In	0.508648	0.457794	0.966442	0.050853567	Cause
Abs. Cap	0.397734	0.442546	0.840281	-0.044812172	Affected
R&D Emp	0.413101	0.425084	0.838186	-0.011982993	Affected

In case of IM Strategic Capability, the Influential significance within sub-criteria is shown in Table 5.46

Table 5.46 Influential significance with in IM Strategic Capability **T** ***(Sub-Criteria)***

	Tech.Tran	In.Pr	In. Str	Or Str	
Tech.Tran	0.091948	0.103059	0.079487	0.095162	0.369657
In.Pr	0.094249	0.076034	0.079694	0.087956	0.337934
In. Str	0.101541	0.104917	0.062754	0.091796	0.361007
Or Str	0.090564	0.091657	0.067735	0.066095	0.316051
	0.378302	0.375668	0.289671	0.341009	

From Table 5.47 *Innovation, strategies and initiatives* have the highest positive value of R (row) - C (Column) (0.0713367) such a positive value illustrates the strong influence on other sub-criteria. While, *Innovative Performance* show very low R (row) - C (Column) (-0.0377339) it has susceptible to influence.Therefore, the improvement priorities can be ordered from *Innovation strategies and initiatives* as the highest priority for rectification to Innovative Performance as low priority for further improvement. The priority configuration can be representing In. STR > Tech.Tren > Or Str > In.Pr

Table 5.47 Sum of the columns and row from the total-influence matrix T *(Sub-Criteria)*

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	$R_{(row)}-C_{(Column)}$	
Tech.Tran	0.36966	0.378301846	0.747959	-0.0086444	Affected
In.Pr	0.33793	0.375667611	0.713601	-0.0377339	Affected
In. Str	0.36101	0.289670777	0.650678	0.0713367	Cause
Or Str	0.31605	0.341009248	0.65706	-0.0249583	Affected

In case of TM Process Capability, the Influential significance within sub-criteria is shown in Table 5.48

Table 5.48 Influential significance with in TM Process Capability **T** ***(Sub-Criteria)***

	Tech Acq	Tech Exp	Tech Pro	Tech lear	Tech Sel	Tech Id	Tec De	
Tech Acq	0.0743	0.092	0.0846	0.074	0.069	0.08	0.1	0.567124
Tech Exp	0.0748	0.062	0.0824	0.065	0.064	0.07	0.08	0.505903
Tech Pro	0.0752	0.09	0.0644	0.065	0.069	0.08	0.09	0.528105
Tech lear	0.0677	0.069	0.0678	0.045	0.056	0.06	0.07	0.439342
Tech Sel	0.0759	0.093	0.0841	0.064	0.054	0.09	0.09	0.552278
Tech Id	0.078	0.094	0.0884	0.063	0.079	0.06	0.09	0.555575
Tec De	0.0878	0.086	0.0862	0.068	0.073	0.08	0.08	0.56736
	0.5338	0.587	0.558	0.443	0.464	0.52	0.61	

From Table 5.49 *Technology Selection* has the highest positive value of $R_{(row)} - C_{(Column)}$ (0.0885) such a positive value illustrates the strong influence on other sub-criteria. While, *Technology Exploitation* show very low $R_{(row)} - C_{(Column)}$ (-0.08073) it has susceptible to influence. Therefore, the improvement priorities can be ordered from *Technology Selection* as the highest priority for rectification to *Technology Exploitation* as low priority for further improvement. The priority configuration can be representing In. Tech Sel > Tech Id > Tech Acq >Tech Lear > Tech Pro > Tec De> Tech Exp

Table 5.49 Sum of the columns and row from the total-influence matrix **T** ***(Sub-Criteria)***

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+ C_{(Column)}$	$R_{(row)}- C_{(Column)}$	
Tech Acq	0.5671238	0.534	1.274787	0.03335	Cause
Tech Exp	0.5059031	0.587	1.249882	-0.0807	Affected
Tech Pro	0.5281054	0.558	1.251143	-0.0299	Affected
Tech lear	0.4393423	0.443	1.016002	-0.0039	Affected
Tech Sel	0.5522778	0.464	1.197225	0.08851	Cause
Tech Id	0.5555753	0.522	1.230504	0.03381	Cause
Tec De	0.56736	0.608	1.342066	-0.0411	Affected

In case of TM Infrastructure Capability, the Influential significance within sub-criteria is shown in Table 5.50

Table 5.50 Influential significance with in TM Infrastructure Capability ***T*** ***(Sub-Criteria)***

	Man.Cap	Fac&Eq	Org.Cap	Per.Ski	
Man.Cap	0.093	0.0889	0.099	0.117	0.4
Fac&Eq	0.099	0.0659	0.088	0.101	0.35
Org.Cap	0.098	0.0864	0.064	0.104	0.35
Per.Ski	0.119	0.1037	0.1	0.089	0.41
	0.409	0.3448	0.35	0.411	

Table 5.51 shows that *Facility and Equipment* have the highest positive value of R (row) - C (Column) (0.009008) such a positive value illustrates the strong influence on other sub-criteria. While, *Management capability* show very low R (row) - C (Column) (-0.010333) it has susceptible to influence. Therefore, the improvement priorities can be ordered from Facility *and Equipment* as the highest priority for rectification to *Management capability* as low priority for further improvement. The priority configuration can be representing In. Fac&Eq > Org.poten > Per.Ski > Man.Comp

Table 5.51 Sum of the columns and row from the total-influence matrix ***T*** ***(Sub-Criteria)***

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	$R_{(row)}-C_{(Column)}$	
Man.Comp	0.3984686	0.409	0.80727	-0.01033319	Affected
Fac&Eq	0.353832	0.345	0.698656	0.00900805	Cause
Org.Pont	0.3517403	0.35	0.702057	0.0014237	Cause
Per.Ski	0.4108618	0.411	0.821822	-9.8559E-05	Cause

In case of TM Infrastructure Capability, the Influential significance within sub-criteria is shown in Table 5.52

Table 5.52 Influential significance with in T.M Strategic Capability ***T*** ***(Sub-Criteria)***

	St.Tec	Corp.Tec	Corp. Bus	Tech.Alli	Des.Cap	
St.Tec	0.0646	0.092	0.077	0.08	0.07	0.38355
Corp.Tec	0.0834	0.066	0.057	0.08	0.07	0.355391
Corp. Bus	0.089	0.085	0.063	0.08	0.08	0.395819
Tech.Alli	0.08	0.089	0.079	0.07	0.09	0.407361
Des.Cap	0.088	0.092	0.085	0.09	0.07	0.425167
	0.405	0.424	0.361	0.39	0.39	

In a similar way From Table 5.53 *Desorptive capacity* has a highest positive value of $R_{(row)} - C_{(Column)}$ (0.039848) such a positive value illustrates the strong influence on other sub-criteria. While, *corporate Technology Strategy* show very low $R_{(row)} - C_{(Column)}$ (-0.06818677) it has susceptible to influence.

Therefore, the improvement priorities can be ordered from *Technology Alliance* as the highest priority for rectification to *corporate Technology Strategy* as low priority for further improvement. The priority configuration can be representing In. Des.Cap > Corp. Bus> Tech.Alli > St.Tec> Corp.Tec

Table 5.53 Sum of the columns and row from the total-influence matrix ***T*** ***(Sub-Criteria)***

	$R_{(row)}$	$C_{(Column)}$	$R_{(row)}+C_{(Column)}$	$R_{(row)}-C_{(Column)}$	
St.Tec	0.383549	0.405	0.788513	-0.02141381	Affected
Corp.Tec	0.355391	0.424	0.77897	-0.06818677	Affected
Corp. Bus	0.395818	0.361	0.756378	0.03525895	Cause
Tech.Alli	0.407361	0.393	0.800228	0.01449362	Cause
Des.Cap	0.425166	0.385	0.810485	0.039848	Cause

5.6.1 Finding the Influential Weight of Criteria Using the DANP

DANP can satisfy the interrelationship among characteristics of variables involve in developing criteria‘s or dimensions, and its ease to construct a relationship that replicates those features with transformative system. After measuring the interrelationship among the criteria and sub-criteria that involve to contributes on R&D resulted from DEMATEL is shows in Table (5.33-5.35), the DANP techniques are then used to acquire the sub-criteria relative influence weights subsequently applied ANP procedure. The interrelation among the criteria and sub-criteria can be clarified from the unweighted supermatrix. But to assess the influence of all the sub-criteria and criteria simultaneously, it is necessary to construct the weighted supermatrix, the limits of which can be applied to measure the global weighted matrix for all the criteria and sub- criteria. For unweighted supermatrix at first, the total influential matrices for sub-criteria need to normalize and then transpose of the normalized influential matrix consider as unweighted matrix. While on the other hand, similar steps would take for criteria matrix only criteria matrix need to get normalized. At last, for weighted supermatrix the transpose of normalized sub-criteria matrix multiple with criteria normalized matrix $\boldsymbol{W}^{\propto} = \boldsymbol{T_D}^{\propto} \times (T_c^{\propto})'$. Some pre-normalized method required to carry further steps forward. Therefore, normalized initial direct-relation T **(Criteria)** and T **(Sub-Criteria)** is shown in Table 5.54 -5.56

Table 5.54 Normalized Total influential Matrix $T\propto$ (Sub- The list of Abbreviation used for this Matrix is in Appendix F

Normalized Total influential Matrix $T\propto$ (Sub-Criteria)	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(R&D.Corp)	(Ext Net)	(Know. Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Pot)	(Pers. Skill)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)
(K.cre)	0.1526	0.1606	0.158	0.195	0.1948	0.139	0.2	0.17	0.18	0.177	0.1401	0.141	0.152	0.19	0.143	0.16	0.15	0.196	0.1527	0.11	0.14	0.1	0.131	0.13	0.1	0.179	0.237	0.18	0.208	0.1971	0.28	0.2775	0.188	0.26	0.15	0.15	0.149	0.125	0.117	0.135	0.17474	0.27	0.215	0.2361	0.279	0.18	0.2281	0.186	0.201	0.201
(K.Acq)	0.181	0.1295	0.174	0.196	0.1761	0.143	0.18	0.188	0.17	0.166	0.1432	0.149	0.145	0.179	0.175	0.13	0.17	0.197	0.1446	0.12	0.13	0.1	0.129	0.12	0.105	0.167	0.226	0.22	0.172	0.219	0.29	0.2657	0.205	0.24	0.17	0.147	0.139	0.125	0.122	0.13	0.17171	0.279	0.187	0.2489	0.2854	0.2	0.2029	0.179	0.223	0.191
(Int Kno Port)	0.1804	0.1715	0.131	0.203	0.1736	0.141	0.18	0.193	0.17	0.163	0.1416	0.149	0.142	0.174	0.174	0.18	0.13	0.206	0.1439	0.12	0.13	0.1	0.13	0.12	0.106	0.168	0.22	0.22	0.227	0.167	0.3	0.2603	0.201	0.24	0.17	0.148	0.138	0.124	0.124	0.131	0.16576	0.277	0.244	0.1847	0.2937	0.2	0.2011	0.18	0.224	0.193
(K.shar)	0.1919	0.1763	0.172	0.152	0.1709	0.137	0.18	0.191	0.18	0.168	0.1395	0.144	0.137	0.18	0.182	0.18	0.17	0.151	0.1421	0.12	0.13	0.1	0.134	0.12	0.103	0.154	0.214	0.21	0.216	0.2028	0.25	0.2787	0.214	0.26	0.17	0.151	0.14	0.123	0.118	0.127	0.17413	0.287	0.25	0.2417	0.2207	0.2	0.1997	0.183	0.222	0.198
(K.Imp)	0.186	0.1596	0.157	0.184	0.1465	0.167	0.2	0.172	0.17	0.174	0.1385	0.147	0.146	0.19	0.173	0.16	0.15	0.18	0.1217	0.14	0.15	0.1	0.128	0.13	0.105	0.169	0.231	0.21	0.2	0.1894	0.28	0.2244	0.236	0.26	0.15	0.143	0.146	0.121	0.121	0.137	0.18411	0.285	0.227	0.222	0.2652	0.17	0.2393	0.2	0.202	0.19
(K.tran)	0.1712	0.1579	0.166	0.188	0.1942	0.122	0.19	0.169	0.18	0.172	0.1477	0.15	0.154	0.181	0.16	0.16	0.16	0.185	0.1558	0.1	0.14	0.1	0.133	0.13	0.109	0.179	0.223	0.2	0.2	0.2014	0.28	0.2908	0.174	0.25	0.15	0.148	0.145	0.128	0.125	0.138	0.16875	0.307	0.213	0.2121	0.2682	0.23	0.2131	0.157	0.205	0.199
(cult)	0.1989	0.1459	0.148	0.182	0.1843	0.142	0.16	0.174	0.18	0.198	0.1408	0.149	0.146	0.189	0.192	0.15	0.14	0.182	0.1565	0.12	0.11	0.1	0.132	0.14	0.105	0.17	0.231	0.23	0.187	0.1812	0.29	0.2895	0.213	0.21	0.15	0.145	0.159	0.118	0.118	0.134	0.17958	0.307	0.212	0.2129	0.2684	0.22	0.2142	0.158	0.204	0.2
(stru)	0.173	0.1671	0.165	0.189	0.1681	0.138	0.19	0.147	0.19	0.178	0.1497	0.147	0.139	0.167	0.165	0.17	0.16	0.192	0.147	0.13	0.14	0.1	0.14	0.13	0.104	0.163	0.207	0.21	0.218	0.2064	0.29	0.2622	0.205	0.24	0.13	0.161	0.149	0.13	0.121	0.137	0.17023	0.262	0.236	0.2304	0.2711	0.21	0.2137	0.191	0.175	0.211
(Tech)	0.1818	0.1505	0.157	0.182	0.1777	0.152	0.19	0.169	0.15	0.195	0.1476	0.154	0.165	0.177	0.172	0.15	0.15	0.181	0.1412	0.12	0.14	0.1	0.109	0.14	0.11	0.191	0.217	0.21	0.191	0.1913	0.27	0.2644	0.214	0.25	0.15	0.123	0.163	0.129	0.127	0.147	0.16355	0.284	0.22	0.2266	0.2692	0.21	0.2173	0.201	0.205	0.168
(Peop)	0.1863	0.148	0.151	0.181	0.1745	0.159	0.21	0.159	0.2	0.144	0.1371	0.156	0.163	0.178	0.178	0.15	0.15	0.181	0.1381	0.13	0.15	0.1	0.147	0.1	0.11	0.19	0.219	0.22	0.19	0.1857	0.26	0.2517	0.22	0.27	0.14	0.17	0.123	0.122	0.13	0.146	0.16596	0.294	0.217	0.2197	0.2697	0.19	0.212	0.204	0.182	0.214
(Lead& Supp)	0.1844	0.1555	0.152	0.184	0.1703	0.153	0.19	0.175	0.19	0.183	0.1133	0.155	0.148	0.177	0.177	0.16	0.15	0.186	0.1404	0.13	0.14	0.1	0.138	0.13	0.11	0.173	0.218	0.22	0.202	0.1899	0.28	0.2563	0.22	0.25	0.15	0.158	0.154	0.101	0.128	0.136	0.16818	0.285	0.225	0.2186	0.2707	0.19	0.2146	0.187	0.201	0.203
(org. Lear)	0.1761	0.1508	0.157	0.182	0.1796	0.154	0.18	0.163	0.21	0.189	0.1373	0.124	0.185	0.182	0.161	0.15	0.15	0.176	0.1423	0.13	0.13	0.1	0.156	0.14	0.087	0.214	0.222	0.19	0.185	0.1843	0.27	0.2679	0.22	0.24	0.14	0.169	0.152	0.115	0.097	0.163	0.16622	0.278	0.222	0.2284	0.2714	0.2	0.2085	0.176	0.187	0.229
(Succ. Rate)	0.1761	0.1484	0.151	0.178	0.1844	0.163	0.17	0.155	0.19	0.184	0.1252	0.166	0.133	0.189	0.177	0.16	0.15	0.187	0.1406	0.13	0.13	0.1	0.145	0.13	0.118	0.155	0.234	0.21	0.202	0.194	0.26	0.2709	0.227	0.24	0.14	0.169	0.159	0.113	0.141	0.111	0.16471	0.285	0.223	0.2218	0.2705	0.2	0.2158	0.179	0.184	0.219
(R&D Exper)	0.1857	0.1509	0.152	0.188	0.1811	0.143	0.2	0.171	0.17	0.175	0.1316	0.15	0.149	0.149	0.186	0.16	0.16	0.198	0.1539	0.13	0.14	0.1	0.127	0.12	0.104	0.175	0.187	0.23	0.207	0.2003	0.28	0.2686	0.212	0.24	0.15	0.152	0.152	0.12	0.128	0.144	0.1497	0.287	0.219	0.2187	0.2759	0.22	0.2174	0.192	0.191	0.184
(Code)	0.1745	0.1563	0.154	0.189	0.19	0.136	0.2	0.17	0.18	0.176	0.1387	0.141	0.153	0.193	0.144	0.17	0.16	0.189	0.1528	0.11	0.14	0.1	0.131	0.13	0.1	0.178	0.237	0.18	0.208	0.1974	0.28	0.2785	0.189	0.26	0.15	0.15	0.149	0.125	0.117	0.134	0.17473	0.274	0.218	0.2245	0.2839	0.18	0.2281	0.186	0.201	0.202
(Pers)	0.1831	0.1287	0.174	0.196	0.1754	0.143	0.18	0.192	0.17	0.165	0.1423	0.148	0.149	0.185	0.145	0.14	0.18	0.205	0.1443	0.12	0.13	0.1	0.129	0.12	0.105	0.167	0.225	0.22	0.171	0.2198	0.29	0.2654	0.205	0.24	0.17	0.147	0.138	0.126	0.122	0.13	0.1713	0.279	0.187	0.2489	0.2855	0.2	0.2025	0.179	0.224	0.191
(Ext)	0.1953	0.1682	0.129	0.199	0.1709	0.138	0.18	0.192	0.17	0.164	0.1419	0.149	0.142	0.175	0.172	0.18	0.13	0.207	0.144	0.12	0.13	0.1	0.13	0.12	0.106	0.168	0.22	0.22	0.228	0.1672	0.3	0.2606	0.201	0.24	0.17	0.148	0.138	0.124	0.124	0.131	0.16591	0.278	0.244	0.1853	0.293	0.2	0.2018	0.18	0.223	0.193
(Inter)	0.1804	0.179	0.174	0.154	0.1732	0.139	0.18	0.191	0.18	0.167	0.14	0.144	0.139	0.183	0.169	0.18	0.17	0.152	0.1419	0.12	0.13	0.1	0.135	0.12	0.103	0.153	0.214	0.21	0.216	0.2027	0.25	0.2786	0.215	0.26	0.17	0.149	0.138	0.121	0.117	0.137	0.17225	0.288	0.25	0.2418	0.2198	0.2	0.1993	0.182	0.222	0.198
(Tech .Tran)	0.1724	0.1624	0.16	0.187	0.1489	0.17	0.2	0.171	0.17	0.175	0.138	0.147	0.143	0.187	0.188	0.16	0.15	0.177	0.1217	0.14	0.15	0.1	0.128	0.13	0.106	0.169	0.231	0.21	0.2	0.1895	0.28	0.2246	0.236	0.26	0.15	0.143	0.145	0.121	0.121	0.136	0.18458	0.285	0.228	0.2221	0.265	0.17	0.2381	0.2	0.202	0.191
(Dec.Mak)	0.1973	0.1525	0.161	0.183	0.188	0.118	0.19	0.169	0.18	0.172	0.1477	0.15	0.151	0.179	0.172	0.16	0.16	0.183	0.1554	0.1	0.14	0.1	0.133	0.13	0.109	0.179	0.224	0.2	0.2	0.2018	0.28	0.2905	0.174	0.25	0.15	0.148	0.144	0.128	0.124	0.138	0.16919	0.306	0.213	0.2127	0.2684	0.22	0.2136	0.158	0.205	0.2
(In. Op Inn)	0.1833	0.1485	0.15	0.185	0.1882	0.145	0.16	0.174	0.18	0.198	0.1403	0.15	0.151	0.195	0.164	0.15	0.15	0.188	0.1567	0.12	0.11	0.1	0.131	0.14	0.105	0.169	0.231	0.23	0.187	0.1806	0.29	0.2899	0.214	0.21	0.15	0.145	0.159	0.118	0.118	0.135	0.17966	0.308	0.212	0.2117	0.2681	0.23	0.2138	0.157	0.204	0.2
(Proj. mang)	0.169	0.1681	0.165	0.19	0.1692	0.139	0.19	0.147	0.19	0.178	0.149	0.147	0.137	0.164	0.179	0.17	0.16	0.189	0.1469	0.13	0.14	0.1	0.14	0.13	0.103	0.163	0.208	0.21	0.216	0.207	0.29	0.2631	0.206	0.24	0.13	0.161	0.149	0.13	0.121	0.137	0.1703	0.262	0.236	0.2302	0.2713	0.21	0.2139	0.191	0.175	0.211
(Inn. com)	0.1864	0.1497	0.156	0.181	0.1767	0.151	0.19	0.169	0.15	0.194	0.1476	0.154	0.164	0.177	0.177	0.15	0.15	0.18	0.1416	0.12	0.14	0.1	0.109	0.14	0.11	0.191	0.217	0.21	0.191	0.1912	0.27	0.2644	0.214	0.25	0.15	0.123	0.163	0.129	0.127	0.147	0.16383	0.284	0.22	0.2263	0.2694	0.21	0.2173	0.201	0.205	0.168
(Rate Int)	0.1817	0.1485	0.152	0.182	0.1751	0.161	0.21	0.159	0.2	0.144	0.137	0.156	0.164	0.179	0.173	0.15	0.15	0.182	0.138	0.13	0.15	0.1	0.147	0.1	0.111	0.19	0.219	0.22	0.19	0.1851	0.26	0.252	0.22	0.27	0.14	0.17	0.122	0.122	0.13	0.147	0.16597	0.294	0.217	0.2196	0.2691	0.19	0.2122	0.204	0.182	0.212
(Int & Ext Kno)	0.1762	0.1571	0.154	0.186	0.1724	0.155	0.19	0.176	0.19	0.183	0.1132	0.155	0.147	0.175	0.183	0.16	0.15	0.185	0.1405	0.13	0.14	0.1	0.138	0.13	0.11	0.172	0.218	0.22	0.202	0.1902	0.28	0.2564	0.22	0.25	0.15	0.158	0.154	0.101	0.128	0.136	0.16789	0.285	0.225	0.2185	0.2708	0.19	0.2148	0.187	0.201	0.203
(R&D.Corp)	0.1796	0.1502	0.156	0.181	0.179	0.154	0.18	0.163	0.21	0.188	0.1377	0.124	0.183	0.18	0.168	0.15	0.15	0.174	0.1427	0.13	0.13	0.1	0.156	0.14	0.088	0.214	0.222	0.19	0.185	0.1845	0.27	0.2681	0.22	0.24	0.14	0.169	0.152	0.116	0.097	0.162	0.16635	0.278	0.222	0.2287	0.2715	0.2	0.2088	0.177	0.187	0.229
(Ext Net)	0.1967	0.1446	0.147	0.173	0.1802	0.158	0.17	0.156	0.19	0.184	0.1254	0.166	0.134	0.19	0.172	0.16	0.15	0.188	0.142	0.13	0.13	0.1	0.144	0.13	0.118	0.155	0.235	0.21	0.202	0.1943	0.26	0.2709	0.226	0.24	0.14	0.169	0.159	0.114	0.141	0.112	0.16494	0.284	0.222	0.2227	0.2706	0.2	0.2162	0.178	0.184	0.219
(Know .Inc)	0.1722	0.1533	0.155	0.191	0.1839	0.145	0.2	0.171	0.17	0.175	0.1313	0.15	0.153	0.152	0.166	0.17	0.16	0.203	0.1542	0.13	0.14	0.1	0.127	0.12	0.104	0.175	0.186	0.23	0.207	0.2005	0.28	0.2702	0.211	0.24	0.15	0.152	0.152	0.12	0.128	0.144	0.14899	0.287	0.219	0.2185	0.2757	0.22	0.2169	0.192	0.191	0.184
(Rad Inn)	0.1745	0.1543	0.152	0.186	0.1873	0.146	0.2	0.162	0.18	0.178	0.1407	0.142	0.146	0.184	0.18	0.16	0.15	0.183	0.1528	0.12	0.14	0.1	0.132	0.13	0.1	0.179	0.235	0.18	0.209	0.1971	0.27	0.279	0.189	0.26	0.15	0.15	0.149	0.125	0.116	0.134	0.17479	0.275	0.215	0.2252	0.2851	0.18	0.2296	0.187	0.202	0.198
(Abso. Cap)	0.1993	0.1269	0.171	0.192	0.1729	0.138	0.18	0.184	0.18	0.168	0.1431	0.149	0.149	0.185	0.145	0.14	0.18	0.205	0.1408	0.12	0.15	0.1	0.126	0.12	0.103	0.167	0.226	0.22	0.172	0.2188	0.29	0.2659	0.205	0.24	0.17	0.146	0.14	0.125	0.122	0.13	0.17165	0.278	0.188	0.2493	0.2853	0.2	0.2027	0.179	0.224	0.191
(R&D Empo)	0.1822	0.1712	0.13	0.202	0.1735	0.14	0.18	0.19	0.17	0.164	0.1424	0.149	0.142	0.175	0.172	0.18	0.13	0.207	0.1435	0.12	0.13	0.1	0.13	0.12	0.107	0.168	0.22	0.22	0.227	0.1668	0.3	0.2604	0.201	0.24	0.17	0.148	0.138	0.124	0.124	0.131	0.16577	0.278	0.244	0.1846	0.293	0.2	0.2016	0.181	0.223	0.193
(Tech Tren)	0.1689	0.1817	0.177	0.155	0.1752	0.142	0.18	0.187	0.18	0.169	0.1406	0.145	0.139	0.183	0.169	0.18	0.17	0.152	0.1422	0.12	0.13	0.1	0.135	0.12	0.103	0.153	0.213	0.21	0.216	0.2032	0.25	0.2788	0.215	0.26	0.17	0.151	0.14	0.122	0.118	0.127	0.17416	0.289	0.251	0.2417	0.2185	0.2	0.1987	0.182	0.223	0.198
(Inno. per)	0.2047	0.1611	0.159	0.185	0.1481	0.142	0.19	0.198	0.17	0.169	0.1334	0.142	0.143	0.186	0.187	0.16	0.15	0.178	0.1232	0.14	0.14	0.1	0.129	0.13	0.106	0.169	0.23	0.21	0.2	0.1897	0.28	0.225	0.236	0.26	0.15	0.143	0.145	0.121	0.121	0.136	0.18443	0.285	0.228	0.2227	0.2648	0.17	0.2384	0.2	0.201	0.191
(Inov Str& ini)	0.1744	0.1485	0.157	0.179	0.1833	0.158	0.19	0.166	0.18	0.173	0.1482	0.151	0.151	0.179	0.172	0.16	0.16	0.182	0.1549	0.1	0.14	0.1	0.132	0.13	0.109	0.179	0.224	0.2	0.2	0.2012	0.28	0.2906	0.174	0.25	0.15	0.148	0.144	0.128	0.125	0.138	0.16893	0.306	0.213	0.2126	0.2685	0.22	0.2134	0.158	0.205	0.2
(Org.Str)	0.1832	0.1533	0.155	0.191	0.1939	0.124	0.16	0.178	0.18	0.197	0.1397	0.15	0.151	0.196	0.164	0.15	0.15	0.188	0.1521	0.12	0.14	0.1	0.127	0.14	0.102	0.17	0.231	0.23	0.185	0.1807	0.29	0.29	0.214	0.21	0.15	0.145	0.159	0.118	0.119	0.134	0.17986	0.308	0.212	0.2112	0.2682	0.23	0.2139	0.157	0.203	0.2
(Tech. Acq)	0.1735	0.168	0.165	0.19	0.1687	0.135	0.18	0.17	0.19	0.173	0.1449	0.143	0.137	0.164	0.179	0.17	0.16	0.189	0.1503	0.13	0.12	0.1	0.143	0.13	0.106	0.163	0.208	0.2	0.218	0.2065	0.29	0.262	0.205	0.24	0.13	0.162	0.149	0.13	0.121	0.137	0.17007	0.262	0.237	0.2302	0.2715	0.21	0.2139	0.192	0.175	0.211
(Tech. Expo)	0.1821	0.1501	0.157	0.181	0.1779	0.152	0.2	0.14	0.15	0.201	0.1528	0.16	0.164	0.177	0.177	0.15	0.15	0.18	0.1419	0.12	0.14	0.1	0.109	0.14	0.111	0.191	0.217	0.21	0.191	0.1912	0.27	0.2644	0.214	0.25	0.15	0.122	0.163	0.129	0.127	0.147	0.16357	0.284	0.22	0.2266	0.2695	0.21	0.2175	0.201	0.206	0.167
(Tech. Pro)	0.1772	0.1513	0.155	0.185	0.1782	0.153	0.2	0.166	0.2	0.142	0.1358	0.155	0.164	0.179	0.174	0.15	0.15	0.182	0.1398	0.13	0.14	0.1	0.15	0.11	0.112	0.19	0.219	0.22	0.19	0.1851	0.26	0.2506	0.22	0.27	0.14	0.17	0.122	0.122	0.131	0.147	0.16578	0.294	0.217	0.2193	0.2692	0.19	0.2116	0.205	0.182	0.213
(Tech. lear)	0.1786	0.154	0.151	0.183	0.1694	0.164	0.19	0.169	0.19	0.184	0.1146	0.156	0.149	0.176	0.182	0.16	0.15	0.185	0.1371	0.12	0.16	0.1	0.134	0.13	0.107	0.173	0.218	0.22	0.201	0.1897	0.28	0.2566	0.219	0.25	0.15	0.158	0.154	0.102	0.128	0.136	0.1678	0.286	0.225	0.2185	0.2709	0.19	0.2145	0.187	0.201	0.203
(Tech. Sele)	0.2014	0.1468	0.152	0.176	0.1744	0.149	0.18	0.168	0.21	0.187	0.1361	0.124	0.181	0.181	0.167	0.15	0.15	0.175	0.1424	0.12	0.13	0.1	0.154	0.14	0.087	0.213	0.223	0.19	0.185	0.1847	0.27	0.2684	0.219	0.24	0.14	0.169	0.152	0.116	0.098	0.162	0.16651	0.278	0.222	0.2286	0.272	0.2	0.2089	0.177	0.188	0.228
(Tech. Iden)	0.1839	0.1492	0.152	0.178	0.1859	0.151	0.17	0.153	0.2	0.184	0.1253	0.167	0.134	0.19	0.173	0.16	0.15	0.188	0.1425	0.13	0.12	0.1	0.146	0.14	0.119	0.155	0.235	0.21	0.202	0.1942	0.26	0.2704	0.227	0.24	0.14	0.17	0.159	0.113	0.142	0.111	0.16474	0.284	0.223	0.2226	0.2704	0.2	0.216	0.179	0.184	0.219
(Tech Deve)	0.1728	0.1521	0.154	0.189	0.1825	0.15	0.2	0.169	0.17	0.176	0.1318	0.15	0.152	0.151	0.166	0.17	0.16	0.203	0.1547	0.13	0.13	0.1	0.128	0.13	0.105	0.175	0.185	0.23	0.207	0.2006	0.28	0.2685	0.212	0.24	0.15	0.152	0.152	0.12	0.128	0.144	0.14895	0.287	0.219	0.2186	0.2755	0.22	0.2174	0.192	0.191	0.184
(Mang Comp)	0.1905	0.1508	0.152	0.191	0.1703	0.145	0.16	0.172	0.19	0.192	0.1381	0.147	0.148	0.196	0.191	0.16	0.15	0.155	0.1427	0.13	0.14	0.1	0.131	0.13	0.104	0.18	0.239	0.17	0.209	0.1978	0.27	0.28	0.186	0.26	0.15	0.15	0.149	0.125	0.116	0.134	0.17464	0.235	0.223	0.2479	0.2945	0.18	0.2294	0.186	0.201	0.202
(Fac)	0.1828	0.1551	0.172	0.176	0.1713	0.142	0.18	0.193	0.17	0.168	0.146	0.149	0.163	0.18	0.142	0.15	0.18	0.186	0.1419	0.13	0.14	0.1	0.129	0.12	0.105	0.168	0.226	0.22	0.171	0.2186	0.29	0.2656	0.205	0.24	0.17	0.147	0.139	0.125	0.123	0.13	0.17049	0.279	0.186	0.2485	0.286	0.2	0.2028	0.179	0.223	0.192
(Org. Pote)	0.1802	0.1566	0.138	0.188	0.1802	0.157	0.19	0.165	0.17	0.19	0.1328	0.155	0.157	0.17	0.165	0.18	0.15	0.182	0.1445	0.12	0.11	0.1	0.146	0.12	0.111	0.169	0.22	0.22	0.228	0.164	0.31	0.2597	0.201	0.23	0.17	0.148	0.139	0.124	0.124	0.131	0.16524	0.278	0.246	0.1809	0.2954	0.2	0.2008	0.18	0.224	0.193
(Pers. Skil)	0.1907	0.1675	0.171	0.172	0.1593	0.14	0.21	0.173	0.18	0.146	0.1437	0.148	0.145	0.191	0.175	0.15	0.15	0.188	0.1419	0.12	0.14	0.1	0.115	0.13	0.109	0.152	0.214	0.21	0.217	0.2032	0.25	0.2809	0.215	0.26	0.17	0.149	0.138	0.121	0.117	0.137	0.17277	0.289	0.252	0.2433	0.2154	0.2	0.1984	0.182	0.224	0.198
(Str Tech)	0.1834	0.1483	0.157	0.176	0.1746	0.16	0.19	0.175	0.17	0.182	0.1549	0.127	0.176	0.184	0.161	0.14	0.14	0.195	0.1419	0.12	0.14	0.1	0.15	0.13	0.104	0.167	0.231	0.21	0.2	0.1895	0.28	0.2236	0.237	0.26	0.15	0.143	0.146	0.121	0.121	0.136	0.18418	0.285	0.228	0.2222	0.2644	0.17	0.239	0.201	0.202	0.19
(Corp Tech Stra)	0.1786	0.1469	0.166	0.177	0.1834	0.149	0.17	0.139	0.18	0.187	0.1397	0.179	0.129	0.195	0.17	0.16	0.16	0.188	0.1454	0.12	0.15	0.1	0.128	0.13	0.107	0.181	0.224	0.19	0.199	0.2015	0.28	0.2928	0.171	0.25	0.15	0.148	0.144	0.129	0.124	0.139	0.16924	0.309	0.211	0.2112	0.2684	0.23	0.1863	0.161	0.212	0.207
(Corport Bus Strat)	0.1907	0.1442	0.143	0.194	0.1865	0.142	0.19	0.173	0.17	0.197	0.1152	0.152	0.155	0.195	0.168	0.15	0.15	0.181	0.1501	0.13	0.13	0.1	0.146	0.13	0.098	0.17	0.231	0.23	0.188	0.1816	0.29	0.2889	0.213	0.21	0.15	0.145	0.158	0.118	0.118	0.135	0.17956	0.307	0.213	0.2126	0.2679	0.22	0.2139	0.158	0.204	0.199
(Tech Alli)	0.1766	0.1439	0.17	0.175	0.1786	0.157	0.19	0.164	0.18	0.168	0.13	0.168	0.176	0.17	0.185	0.15	0.15	0.174	0.1397	0.12	0.13	0.1	0.149	0.13	0.102	0.164	0.208	0.2	0.217	0.207	0.29	0.2636	0.206	0.24	0.13	0.162	0.15	0.13	0.121	0.137	0.16988	0.261	0.237	0.23	0.2719	0.2	0.2183	0.194	0.175	0.216
(Desor. Cap)	0.1713	0.1532	0.155	0.191	0.184	0.146	0.2	0.17	0.17	0.175	0.1343	0.15	0.15	0.148	0.189	0.17	0.16	0.191	0.1546	0.11	0.14	0.1	0.132	0.13	0.1	0.179	0.24	0.18	0.208	0.1974	0.27	0.2789	0.187	0.26	0.15	0.15	0.149	0.125	0.116	0.134	0.17544	0.285	0.221	0.2265	0.2679	0.21	0.2166	0.199	0.208	0.17

Table 5.55 Total influential Matrix $T_{\textbf{(Criteria)}}$

	KM Proc Cap	KM Infra Cap	KM Strat Cap	IM Proc Cap	I.M infra Cap	IM Strat Cap	TM Process Cap	TM Infra Cap	TM Strat Cap	
KM process Cap	1	1.1	1.1	1	1.1	1	1	1.1	1.1	9.99
KM Infra Cap	1.2	1.1	1.2	1	1.2	1	1	1.2	1.2	10.4
KM Strate Cap	1.2	1.2	1.1	1	1.2	1	1	1.2	1.2	10.8
IM Process Cap	1.3	1.2	1.2	1	1.2	1	1	1.2	1.3	11.1
IM infra Cap	1.2	1.2	1.2	1	1.1	1	1	1.2	1.2	10.4
IM Strate Cap	1.2	1.2	1.2	1	1.2	1	1	1.2	1.2	10.6
TM Process Cap	1.3	1.3	1.3	1	1.3	1	1	1.3	1.3	11.8
TM Infra Cap	1.3	1.3	1.2	1	1.3	1	1	1.1	1.3	11.2
TM Start Cap	1.3	1.3	1.3	1	1.3	1	1	1.3	1.2	11.5
	10.9	10.8	10.8	10.69	10.8	10.7	11.1	10.85	10.99	

Some pre-normalized method required to carry further steps forward. Therefore, normalized initial direct-relation $T^{\propto}_{\textbf{(Criteria)}}$ is shown in Table 5.56.

Table 5.56 Normalized Total influential Matrix $T^{\propto}$ (Criteria)

Total Relationship Matrix(T_ Criteria)	KM process Cap	KM Infra Cap	KM Strate Cap	IM Process Cap	IM infra Cap	IIM Strate Cap	TM Process Cap	TM Infra Cap	TM Start Cap
KM process Cap	0.1	0.11	0.1	0.11	0.111	0.11	0.11	0.113	0.1
KM Infra Cap	0.1	0.10	0.1	0.11	0.11	0.1	0.11	0.114	0.1
KM Strate Cap	0.1	0.11	0.1	0.11	0.112	0.1	0.11	0.113	0.1
IM Process Cap	0.1	0.11	0.1	0.10	0.111	0.1	0.11	0.11	0.1
IM infra Cap	0.1	0.11	0.1	0.11	0.101	0.11	0.11	0.113	0.1
IM Strate Cap	0.1	0.11	0.1	0.11	0.11	0.10	0.11	0.114	0.1
TM Process Cap	0.1	0.11	0.1	0.11	0.113	0.11	0.10	0.112	0.1
TM Infra Cap	0.1	0.11	0.1	0.11	0.112	0.11	0.11	0.102	0.1
TM Start Cap	0.1	0.11	0.1	0.11	0.112	0.11	0.11	0.111	0.1

Before, weighted supermatrix the transpose of normalized sub-criteria is shown in Table 5.57 At last, for weighted supermatrix, The transpose of normalized sub-criteria matrix multiple with criteria normalized matrix $\boldsymbol{W}^{\propto} = \boldsymbol{T_D}^{\propto} \times (T_C{}^{\propto})'$. Some pre-normalized method required to carry further steps forward is shown in Table 5.58

Table 5.57 Transpose of Normalized sub-criteria Matrix "Un-Weighted Super Matrix" ($T^{\propto}$ (Sub-Criteria))

Transpose of Normalized sub-criteria Matrix "Un-Weighted Super Matrix" ($T^{\propto}$ (Sub-Criteria))	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)
(K.cre)	0.1526	0.181	0.18	0.192	0.186	0.171	0.2	0.173	0.18	0.186	0.1844	0.176	0.176	0.186	0.175	0.18	0.2	0.18
(K.Acq)	0.1606	0.1295	0.172	0.176	0.1596	0.158	0.15	0.167	0.15	0.148	0.1555	0.151	0.148	0.151	0.156	0.13	0.17	0.179
(Int Kno Port)	0.1584	0.1743	0.131	0.172	0.1573	0.166	0.15	0.165	0.16	0.151	0.1524	0.157	0.151	0.152	0.154	0.17	0.13	0.174
(K.shar)	0.1946	0.196	0.203	0.152	0.1836	0.188	0.18	0.189	0.18	0.181	0.184	0.182	0.178	0.188	0.189	0.2	0.2	0.154
(K.Imp)	0.1948	0.1761	0.174	0.171	0.1465	0.194	0.18	0.168	0.18	0.175	0.1703	0.18	0.184	0.181	0.19	0.18	0.17	0.173
(K.tran)	0.139	0.1431	0.141	0.137	0.1671	0.122	0.14	0.138	0.15	0.159	0.1532	0.154	0.163	0.143	0.136	0.14	0.14	0.139
(cult)	0.1969	0.1796	0.179	0.179	0.1975	0.185	0.16	0.189	0.19	0.205	0.1879	0.177	0.174	0.198	0.197	0.18	0.18	0.179
(stru)	0.1696	0.1885	0.193	0.191	0.1717	0.169	0.17	0.147	0.17	0.159	0.1755	0.163	0.155	0.171	0.17	0.19	0.19	0.191
(Tech)	0.1763	0.1746	0.175	0.178	0.1715	0.176	0.18	0.19	0.15	0.198	0.1859	0.21	0.195	0.174	0.177	0.17	0.17	0.178
(Peop)	0.1766	0.1656	0.163	0.168	0.1743	0.172	0.2	0.178	0.19	0.144	0.1828	0.189	0.184	0.175	0.176	0.17	0.16	0.167
(Lead& Supp)	0.1401	0.1432	0.142	0.14	0.1385	0.148	0.14	0.15	0.15	0.137	0.1133	0.137	0.125	0.132	0.139	0.14	0.14	0.14
(org. Lear)	0.1406	0.1485	0.149	0.144	0.1466	0.15	0.15	0.147	0.15	0.156	0.1547	0.124	0.166	0.15	0.141	0.15	0.15	0.144
(Succ. Rate)	0.1517	0.1446	0.142	0.137	0.1457	0.154	0.15	0.139	0.16	0.163	0.1484	0.185	0.133	0.149	0.153	0.15	0.14	0.139
(R&D Exper)	0.1903	0.1794	0.174	0.18	0.1902	0.181	0.19	0.167	0.18	0.178	0.1767	0.182	0.189	0.149	0.193	0.19	0.17	0.183
(Code)	0.1431	0.1746	0.174	0.182	0.1729	0.16	0.19	0.165	0.17	0.178	0.1772	0.161	0.177	0.186	0.144	0.15	0.17	0.169
(Pers)	0.1636	0.1321	0.176	0.18	0.1587	0.159	0.15	0.173	0.15	0.151	0.1603	0.148	0.16	0.161	0.165	0.14	0.18	0.184
(Ext)	0.1549	0.1721	0.128	0.169	0.1522	0.161	0.14	0.164	0.15	0.149	0.1512	0.149	0.154	0.157	0.156	0.18	0.13	0.172
(Inter)	0.1964	0.1972	0.206	0.151	0.1803	0.185	0.18	0.192	0.18	0.181	0.1862	0.176	0.187	0.198	0.189	0.2	0.21	0.152
(Tech .Tran)	0.1527	0.1446	0.144	0.142	0.1217	0.156	0.16	0.147	0.14	0.138	0.1404	0.142	0.141	0.154	0.153	0.14	0.14	0.142
(Dec.Mak)	0.1146	0.1198	0.119	0.118	0.1413	0.101	0.12	0.125	0.12	0.13	0.1286	0.125	0.126	0.131	0.115	0.12	0.12	0.118
(In. Op Inn)	0.144	0.1301	0.132	0.133	0.1455	0.138	0.11	0.138	0.14	0.15	0.1371	0.129	0.128	0.142	0.144	0.13	0.13	0.133
(Proj. mang)	0.1216	0.1403	0.139	0.138	0.1237	0.123	0.12	0.105	0.12	0.115	0.1256	0.118	0.112	0.119	0.121	0.14	0.14	0.139
(Inn. com)	0.1312	0.1291	0.13	0.134	0.1278	0.133	0.13	0.14	0.11	0.147	0.1381	0.156	0.145	0.127	0.131	0.13	0.13	0.135
(Rate Int)	0.1286	0.1205	0.12	0.124	0.1282	0.128	0.14	0.129	0.14	0.105	0.133	0.138	0.134	0.125	0.129	0.12	0.12	0.124
(Int & Ext Kno)	0.1075	0.1106	0.109	0.108	0.1065	0.114	0.11	0.113	0.11	0.105	0.0876	0.105	0.096	0.099	0.108	0.11	0.11	0.108
(R&D.Corp)	0.0997	0.1051	0.106	0.103	0.1052	0.109	0.1	0.104	0.11	0.11	0.1097	0.087	0.118	0.104	0.1	0.11	0.11	0.103
(Ext Net)	0.1786	0.1673	0.168	0.154	0.169	0.179	0.17	0.163	0.19	0.19	0.1725	0.214	0.155	0.175	0.178	0.17	0.17	0.153
(Know .Inc)	0.2369	0.2264	0.22	0.214	0.2307	0.223	0.23	0.207	0.22	0.219	0.218	0.222	0.234	0.187	0.237	0.22	0.22	0.214
(Rad Inn)	0.1794	0.2155	0.218	0.213	0.2113	0.197	0.23	0.206	0.21	0.216	0.2176	0.194	0.215	0.23	0.179	0.22	0.22	0.214
(Abso. Cap)	0.2081	0.1717	0.227	0.216	0.1995	0.2	0.19	0.218	0.19	0.19	0.2019	0.185	0.202	0.207	0.208	0.17	0.23	0.216
(R&D Empo)	0.1971	0.219	0.167	0.203	0.1894	0.201	0.18	0.206	0.19	0.186	0.1899	0.184	0.194	0.2	0.197	0.22	0.17	0.203
(Tech Tren)	0.2762	0.2939	0.303	0.25	0.2788	0.281	0.29	0.293	0.27	0.259	0.2761	0.27	0.259	0.277	0.275	0.29	0.3	0.249
(Inno. per)	0.2775	0.2657	0.26	0.279	0.2244	0.291	0.29	0.262	0.26	0.252	0.2563	0.268	0.271	0.269	0.279	0.27	0.26	0.279
(Inov Str& ini)	0.1884	0.2047	0.201	0.214	0.2359	0.174	0.21	0.205	0.21	0.22	0.2196	0.22	0.227	0.212	0.189	0.21	0.2	0.215
(Org.Str)	0.2579	0.2357	0.236	0.257	0.2609	0.254	0.21	0.24	0.25	0.269	0.2479	0.242	0.243	0.242	0.258	0.24	0.24	0.257
(Tech. Acq)	0.1497	0.1656	0.169	0.167	0.149	0.148	0.15	0.131	0.15	0.143	0.1543	0.137	0.14	0.155	0.15	0.17	0.17	0.165
(Tech. Expo)	0.1505	0.147	0.148	0.151	0.1431	0.148	0.14	0.161	0.12	0.17	0.1581	0.169	0.169	0.152	0.15	0.15	0.15	0.149
(Tech. Pro)	0.1494	0.1386	0.138	0.14	0.1456	0.145	0.16	0.149	0.16	0.123	0.1542	0.152	0.159	0.152	0.149	0.14	0.14	0.138
(Tech. lear)	0.1245	0.1254	0.124	0.123	0.1211	0.128	0.12	0.13	0.13	0.122	0.1011	0.115	0.113	0.12	0.125	0.13	0.12	0.121
(Tech. Sele)	0.1167	0.1218	0.124	0.118	0.1206	0.125	0.12	0.121	0.13	0.13	0.1283	0.097	0.141	0.128	0.117	0.12	0.12	0.117
(Tech. Iden)	0.1345	0.1299	0.131	0.127	0.1366	0.138	0.13	0.137	0.15	0.146	0.1358	0.163	0.111	0.144	0.134	0.13	0.13	0.137
(Tech Deve)	0.1747	0.1717	0.166	0.174	0.1841	0.169	0.18	0.17	0.16	0.166	0.1682	0.166	0.165	0.15	0.175	0.17	0.17	0.172
(Mang Comp)	0.2699	0.2789	0.277	0.287	0.2854	0.307	0.31	0.262	0.28	0.294	0.2855	0.278	0.285	0.287	0.274	0.28	0.28	0.288
(Fac)	0.215	0.1869	0.244	0.25	0.2273	0.213	0.21	0.236	0.22	0.217	0.2252	0.222	0.223	0.219	0.218	0.19	0.24	0.25
(Org. Pote)	0.2361	0.2489	0.185	0.242	0.222	0.212	0.21	0.23	0.23	0.22	0.2186	0.228	0.222	0.219	0.224	0.25	0.19	0.242
(Pers. Skil)	0.279	0.2854	0.294	0.221	0.2652	0.268	0.27	0.271	0.27	0.27	0.2707	0.271	0.271	0.276	0.284	0.29	0.29	0.22
(Str Tech)	0.1838	0.2031	0.201	0.198	0.1688	0.225	0.22	0.21	0.21	0.189	0.1942	0.198	0.203	0.215	0.183	0.2	0.2	0.198
(Corp Tech Stra)	0.2281	0.2029	0.201	0.2	0.2393	0.213	0.21	0.214	0.22	0.212	0.2146	0.208	0.216	0.217	0.228	0.2	0.2	0.199
(Corport Bus Strat)	0.186	0.1794	0.18	0.183	0.2	0.157	0.16	0.191	0.2	0.204	0.1873	0.176	0.179	0.192	0.186	0.18	0.18	0.182
(Tech Alli)	0.2007	0.2233	0.224	0.222	0.2017	0.205	0.2	0.175	0.21	0.182	0.2011	0.187	0.184	0.191	0.201	0.22	0.22	0.222
(Desor. Cap)	0.2015	0.1913	0.193	0.198	0.1902	0.199	0.2	0.211	0.17	0.214	0.2029	0.229	0.219	0.184	0.202	0.19	0.19	0.198

Transpose of Normalized sub-criteria Matrix "Un-Weighted Super Matrix" ($T^{\propto}$ (Sub-Criteria))	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(R&D.Corp)	(Ext Net)	(Know .Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)
(K.cre)	0.1724	0.2	0.18	0.2	0.186	0.18	0.18	0.197	0.172	0.17	0.199	0.1822	0.17	0.2047	0.174	0.18
(K.Acq)	0.1624	0.15	0.15	0.2	0.15	0.15	0.15	0.145	0.153	0.15	0.127	0.1712	0.18	0.1611	0.149	0.15
(Int Kno Port)	0.16	0.16	0.15	0.2	0.156	0.15	0.156	0.147	0.155	0.15	0.171	0.1305	0.18	0.1585	0.157	0.16
(K.shar)	0.1868	0.18	0.18	0.2	0.181	0.18	0.181	0.173	0.191	0.19	0.192	0.2024	0.16	0.1852	0.179	0.19
(K.Imp)	0.1489	0.19	0.19	0.2	0.177	0.18	0.179	0.18	0.184	0.19	0.173	0.1735	0.18	0.1481	0.183	0.19
(K.tran)	0.1696	0.12	0.14	0.1	0.151	0.16	0.154	0.158	0.145	0.15	0.138	0.1402	0.14	0.1424	0.158	0.12
(cult)	0.1976	0.19	0.16	0.2	0.189	0.21	0.177	0.175	0.198	0.2	0.18	0.1799	0.18	0.1916	0.186	0.16
(stru)	0.1714	0.17	0.17	0.1	0.169	0.16	0.163	0.156	0.171	0.16	0.184	0.1904	0.19	0.1979	0.166	0.18
(Tech)	0.1714	0.18	0.18	0.2	0.146	0.2	0.21	0.195	0.174	0.18	0.175	0.1747	0.18	0.1662	0.176	0.18
(Peop)	0.1749	0.17	0.2	0.2	0.194	0.14	0.188	0.184	0.175	0.18	0.168	0.164	0.17	0.1692	0.173	0.2
(Lead& Supp)	0.138	0.15	0.14	0.1	0.148	0.14	0.138	0.125	0.131	0.14	0.143	0.1424	0.14	0.1334	0.148	0.14
(org. Lear)	0.1466	0.15	0.15	0.1	0.154	0.16	0.124	0.166	0.15	0.14	0.149	0.1487	0.14	0.1417	0.151	0.14
(Succ. Rate)	0.1431	0.15	0.15	0.1	0.164	0.16	0.183	0.134	0.153	0.15	0.149	0.1416	0.14	0.1431	0.151	0.15
(R&D Exper)	0.1866	0.18	0.2	0.2	0.177	0.18	0.18	0.19	0.152	0.18	0.185	0.1747	0.18	0.1862	0.179	0.2
(Code)	0.1879	0.17	0.16	0.2	0.177	0.17	0.168	0.172	0.166	0.18	0.145	0.1719	0.17	0.1875	0.172	0.16
(Pers)	0.1554	0.16	0.15	0.2	0.151	0.15	0.147	0.161	0.166	0.16	0.137	0.1763	0.18	0.1555	0.156	0.15
(Ext)	0.1499	0.16	0.15	0.2	0.151	0.15	0.147	0.155	0.161	0.15	0.178	0.1283	0.17	0.15	0.159	0.15
(Inter)	0.177	0.18	0.19	0.2	0.18	0.18	0.174	0.188	0.203	0.18	0.205	0.2072	0.15	0.1777	0.182	0.19
(Tech .Tran)	0.1217	0.16	0.16	0.1	0.142	0.14	0.143	0.142	0.154	0.15	0.141	0.1435	0.14	0.1232	0.155	0.15
(Dec.Mak)	0.1412	0.1	0.12	0.1	0.123	0.13	0.125	0.126	0.131	0.12	0.116	0.1193	0.12	0.1413	0.101	0.12
(In. Op Inn)	0.1454	0.14	0.11	0.1	0.139	0.15	0.129	0.128	0.142	0.14	0.152	0.1306	0.13	0.1399	0.14	0.14
(Proj. mang)	0.1237	0.12	0.12	0.1	0.121	0.11	0.118	0.112	0.119	0.12	0.136	0.1397	0.14	0.1244	0.123	0.12
(Inn. com)	0.1277	0.13	0.13	0.1	0.109	0.15	0.156	0.144	0.127	0.13	0.126	0.1303	0.13	0.1288	0.132	0.13
(Rate Int)	0.1282	0.13	0.14	0.1	0.142	0.1	0.137	0.134	0.125	0.13	0.118	0.1205	0.12	0.1293	0.127	0.14
(Int & Ext Kno)	0.1062	0.11	0.11	0.1	0.113	0.1	0.105	0.096	0.098	0.11	0.108	0.1093	0.11	0.1072	0.113	0.1
(R&D.Corp)	0.106	0.11	0.11	0.1	0.11	0.11	0.088	0.118	0.104	0.1	0.103	0.1069	0.1	0.1059	0.109	0.1
(Ext Net)	0.1686	0.18	0.17	0.2	0.191	0.19	0.214	0.155	0.175	0.18	0.167	0.1676	0.15	0.1693	0.179	0.17
(Know .Inc)	0.2306	0.22	0.23	0.2	0.217	0.22	0.222	0.235	0.186	0.24	0.226	0.2198	0.21	0.2303	0.224	0.23
(Rad Inn)	0.2115	0.2	0.23	0.2	0.21	0.22	0.194	0.214	0.232	0.18	0.216	0.2185	0.21	0.2106	0.196	0.23
(Abso. Cap)	0.1998	0.2	0.19	0.2	0.191	0.19	0.185	0.202	0.207	0.21	0.172	0.2273	0.22	0.2001	0.2	0.18
(R&D Empo)	0.1895	0.2	0.18	0.2	0.191	0.19	0.185	0.194	0.2	0.2	0.219	0.1668	0.2	0.1897	0.201	0.18
(Tech Tren)	0.2791	0.28	0.29	0.3	0.268	0.26	0.27	0.26	0.279	0.27	0.294	0.3035	0.25	0.2789	0.281	0.29
(Inno. per)	0.2246	0.29	0.29	0.3	0.264	0.25	0.268	0.271	0.27	0.28	0.266	0.2604	0.28	0.225	0.291	0.29
(Inov Str& ini)	0.2357	0.17	0.21	0.2	0.214	0.22	0.22	0.226	0.211	0.19	0.205	0.2005	0.22	0.2358	0.174	0.21
(Org.Str)	0.2607	0.25	0.21	0.2	0.254	0.27	0.242	0.244	0.239	0.26	0.235	0.2356	0.26	0.2603	0.254	0.21
(Tech. Acq)	0.1487	0.15	0.15	0.1	0.148	0.14	0.137	0.141	0.155	0.15	0.165	0.1696	0.17	0.1485	0.148	0.15
(Tech. Expo)	0.1433	0.15	0.14	0.2	0.123	0.17	0.169	0.169	0.152	0.15	0.146	0.1479	0.15	0.1433	0.148	0.14
(Tech. Pro)	0.1455	0.14	0.16	0.1	0.163	0.12	0.152	0.159	0.152	0.15	0.14	0.1378	0.14	0.1454	0.144	0.16
(Tech. lear)	0.121	0.13	0.12	0.1	0.129	0.12	0.116	0.114	0.12	0.13	0.125	0.1238	0.12	0.1212	0.128	0.12
(Tech. Sele)	0.1206	0.12	0.12	0.1	0.127	0.13	0.097	0.141	0.128	0.12	0.122	0.1241	0.12	0.1208	0.125	0.12
(Tech. Iden)	0.1364	0.14	0.13	0.1	0.147	0.15	0.162	0.112	0.144	0.13	0.13	0.131	0.13	0.1363	0.138	0.13
(Tech Deve)	0.1846	0.17	0.18	0.2	0.164	0.17	0.166	0.165	0.149	0.17	0.172	0.1658	0.17	0.1844	0.169	0.18
(Mang Comp)	0.2853	0.31	0.31	0.3	0.284	0.29	0.278	0.284	0.287	0.27	0.278	0.2781	0.29	0.2846	0.306	0.31
(Fac)	0.2276	0.21	0.21	0.2	0.22	0.22	0.222	0.222	0.219	0.22	0.188	0.2444	0.25	0.2278	0.213	0.21
(Org. Pote)	0.2221	0.21	0.21	0.2	0.226	0.22	0.229	0.223	0.218	0.23	0.249	0.1846	0.24	0.2227	0.213	0.21
(Pers. Skil)	0.265	0.27	0.27	0.3	0.269	0.27	0.271	0.271	0.276	0.29	0.285	0.293	0.22	0.2648	0.268	0.27
(Str Tech)	0.1691	0.22	0.23	0.2	0.208	0.19	0.198	0.202	0.216	0.18	0.203	0.202	0.2	0.1691	0.224	0.23
(Corp Tech Stra)	0.2381	0.21	0.21	0.2	0.217	0.21	0.209	0.216	0.217	0.23	0.203	0.2016	0.2	0.2384	0.213	0.21
(Corport Bus Strat)	0.2003	0.16	0.16	0.2	0.201	0.2	0.177	0.178	0.192	0.19	0.179	0.181	0.18	0.2004	0.158	0.16
(Tech Alli)	0.2019	0.2	0.2	0.2	0.205	0.18	0.187	0.184	0.191	0.2	0.224	0.2227	0.22	0.201	0.205	0.2
(Desor. Cap)	0.1906	0.2	0.2	0.2	0.168	0.21	0.229	0.219	0.184	0.2	0.191	0.1927	0.2	0.1911	0.2	0.2

Transpose of Normalized sub-criteria Matrix "Un-Weighted Super Matrix" ($T^{\propto}$ (Sub-Criteria))	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Pote)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)
(K.cre)	0.17	0.182	0.177	0.179	0.201	0.184	0.17281	0.191	0.183	0.1802	0.1907	0.18	0.1786	0.191	0.177	0.171
(K.Acq)	0.17	0.15	0.151	0.154	0.147	0.149	0.15211	0.151	0.155	0.1566	0.1675	0.15	0.1469	0.144	0.144	0.153
(Int Kno Port)	0.16	0.157	0.155	0.151	0.152	0.152	0.15356	0.152	0.172	0.1379	0.1711	0.16	0.1658	0.143	0.17	0.155
(K.shar)	0.19	0.181	0.185	0.183	0.176	0.178	0.18923	0.191	0.176	0.1882	0.1719	0.18	0.1765	0.194	0.175	0.191
(K.Imp)	0.17	0.178	0.178	0.169	0.174	0.186	0.1825	0.17	0.171	0.1802	0.1593	0.17	0.1834	0.187	0.179	0.184
(K.tran)	0.14	0.152	0.153	0.164	0.149	0.151	0.14979	0.145	0.142	0.1569	0.1396	0.16	0.1488	0.142	0.157	0.146
(cult)	0.18	0.196	0.204	0.189	0.177	0.174	0.19883	0.159	0.177	0.186	0.2068	0.19	0.1749	0.188	0.191	0.198
(stru)	0.17	0.14	0.166	0.169	0.168	0.153	0.16896	0.172	0.193	0.1653	0.1726	0.17	0.1394	0.173	0.164	0.17
(Tech)	0.19	0.15	0.197	0.187	0.208	0.196	0.1746	0.192	0.167	0.1712	0.1837	0.17	0.1799	0.175	0.179	0.173
(Peop)	0.17	0.201	0.142	0.184	0.187	0.184	0.17565	0.192	0.168	0.1902	0.1457	0.18	0.1872	0.197	0.168	0.175
(Lead& Supp)	0.14	0.153	0.136	0.115	0.136	0.125	0.13184	0.138	0.146	0.1328	0.1437	0.15	0.1397	0.115	0.13	0.134
(org. Lear)	0.14	0.16	0.155	0.156	0.124	0.167	0.15012	0.147	0.149	0.1546	0.1475	0.13	0.1789	0.152	0.168	0.15
(Succ. Rate)	0.14	0.164	0.164	0.149	0.181	0.134	0.15234	0.148	0.163	0.1569	0.1455	0.18	0.129	0.155	0.176	0.15
(R&D Exper)	0.16	0.177	0.179	0.176	0.181	0.19	0.15137	0.196	0.18	0.1699	0.1914	0.18	0.195	0.195	0.17	0.148
(Code)	0.18	0.177	0.174	0.182	0.167	0.173	0.16635	0.191	0.142	0.1646	0.1751	0.16	0.17	0.168	0.185	0.189
(Pers)	0.17	0.151	0.152	0.159	0.148	0.161	0.1656	0.162	0.154	0.1782	0.1513	0.14	0.1619	0.153	0.148	0.165
(Ext)	0.16	0.151	0.15	0.15	0.148	0.155	0.16114	0.148	0.175	0.1482	0.1484	0.14	0.1564	0.149	0.146	0.156
(Inter)	0.19	0.18	0.182	0.185	0.175	0.188	0.20319	0.155	0.186	0.1822	0.1883	0.2	0.1877	0.181	0.174	0.191
(Tech .Tran)	0.15	0.142	0.14	0.137	0.142	0.143	0.15468	0.143	0.142	0.1445	0.1419	0.14	0.1454	0.15	0.14	0.155
(Dec.Mak)	0.13	0.123	0.132	0.125	0.124	0.127	0.13255	0.131	0.135	0.1245	0.1242	0.12	0.1162	0.132	0.12	0.114
(In. Op Inn)	0.12	0.136	0.138	0.159	0.133	0.122	0.13363	0.144	0.138	0.1148	0.1403	0.14	0.1501	0.127	0.129	0.138
(Proj. mang)	0.11	0.122	0.116	0.122	0.117	0.112	0.12003	0.1	0.122	0.1213	0.125	0.12	0.1154	0.115	0.121	0.124
(Inn. com)	0.14	0.109	0.15	0.134	0.154	0.146	0.12813	0.131	0.129	0.1457	0.1152	0.15	0.1285	0.146	0.149	0.132
(Rate Int)	0.13	0.143	0.106	0.13	0.137	0.135	0.12609	0.134	0.12	0.1248	0.1309	0.13	0.1253	0.132	0.128	0.13
(Int & Ext Kno)	0.12	0.113	0.106	0.086	0.105	0.096	0.09968	0.113	0.11	0.1137	0.114	0.1	0.1121	0.1	0.112	0.108
(R&D.Corp)	0.11	0.111	0.112	0.107	0.087	0.119	0.10521	0.104	0.105	0.1106	0.1086	0.1	0.1069	0.098	0.102	0.1
(Ext Net)	0.16	0.191	0.19	0.173	0.213	0.155	0.17536	0.18	0.168	0.1685	0.152	0.17	0.1807	0.17	0.164	0.179
(Know .Inc)	0.21	0.217	0.219	0.218	0.223	0.235	0.18539	0.239	0.226	0.22	0.2137	0.23	0.2244	0.231	0.208	0.24
(Rad Inn)	0.2	0.21	0.216	0.217	0.194	0.215	0.23171	0.175	0.217	0.2192	0.2138	0.21	0.1944	0.23	0.205	0.175
(Abso. Cap)	0.22	0.191	0.19	0.201	0.185	0.202	0.20699	0.209	0.171	0.2283	0.2172	0.2	0.1989	0.188	0.217	0.208
(R&D Empo)	0.21	0.191	0.185	0.19	0.185	0.194	0.20055	0.198	0.219	0.164	0.2032	0.19	0.2015	0.182	0.207	0.197
(Tech Tren)	0.29	0.267	0.259	0.276	0.27	0.259	0.27749	0.275	0.294	0.3051	0.246	0.28	0.2815	0.286	0.292	0.274
(Inno. per)	0.26	0.264	0.251	0.257	0.268	0.27	0.26851	0.28	0.266	0.2597	0.2809	0.22	0.2928	0.289	0.264	0.279
(Inov Str& ini)	0.2	0.214	0.22	0.219	0.219	0.227	0.21188	0.186	0.205	0.2006	0.2149	0.24	0.1708	0.213	0.206	0.187
(Org.Str)	0.24	0.255	0.27	0.248	0.242	0.244	0.24212	0.26	0.235	0.2346	0.2582	0.26	0.2549	0.213	0.239	0.26
(Tech. Acq)	0.13	0.148	0.142	0.154	0.137	0.14	0.15479	0.151	0.166	0.1692	0.1659	0.15	0.1471	0.146	0.129	0.15
(Tech. Expo)	0.16	0.122	0.17	0.158	0.169	0.17	0.15207	0.15	0.147	0.1477	0.1493	0.14	0.1477	0.145	0.162	0.15
(Tech. Pro)	0.15	0.163	0.122	0.154	0.152	0.159	0.15195	0.149	0.139	0.1387	0.1382	0.15	0.1439	0.158	0.15	0.149
(Tech. lear)	0.13	0.129	0.122	0.102	0.116	0.113	0.11976	0.125	0.125	0.1238	0.1207	0.12	0.129	0.118	0.13	0.125
(Tech. Sele)	0.12	0.127	0.131	0.128	0.098	0.142	0.12842	0.116	0.123	0.1244	0.1166	0.12	0.1236	0.118	0.121	0.116
(Tech. Iden)	0.14	0.147	0.147	0.136	0.162	0.111	0.14405	0.134	0.13	0.1308	0.1365	0.14	0.1394	0.135	0.137	0.134
(Tech Deve)	0.17	0.164	0.166	0.168	0.167	0.165	0.14895	0.175	0.17	0.1652	0.1728	0.18	0.1692	0.18	0.17	0.175
(Mang Comp)	0.26	0.284	0.294	0.286	0.278	0.284	0.28726	0.235	0.279	0.2781	0.2888	0.29	0.3093	0.307	0.261	0.285
(Fac)	0.24	0.22	0.217	0.225	0.222	0.223	0.21868	0.223	0.186	0.2455	0.2525	0.23	0.211	0.213	0.237	0.221
(Org. Pote)	0.23	0.227	0.219	0.219	0.229	0.223	0.21855	0.248	0.248	0.1809	0.2433	0.22	0.2112	0.213	0.23	0.227
(Pers. Skil)	0.27	0.269	0.269	0.271	0.272	0.27	0.27551	0.294	0.286	0.2954	0.2154	0.26	0.2684	0.268	0.272	0.268
(Str Tech)	0.21	0.208	0.189	0.195	0.199	0.202	0.21627	0.182	0.204	0.2017	0.1979	0.17	0.2346	0.225	0.196	0.207
(Corp Tech Stra)	0.21	0.217	0.212	0.215	0.209	0.216	0.2174	0.229	0.203	0.2008	0.1984	0.24	0.1863	0.214	0.218	0.217
(Corport Bus Strat)	0.19	0.201	0.205	0.187	0.177	0.179	0.19187	0.186	0.179	0.1804	0.1816	0.2	0.1607	0.158	0.194	0.199
(Tech Alli)	0.17	0.206	0.182	0.201	0.188	0.184	0.19053	0.201	0.223	0.2243	0.2238	0.2	0.2118	0.204	0.175	0.208
(Desor. Cap)	0.21	0.167	0.213	0.203	0.228	0.219	0.18393	0.202	0.192	0.1927	0.1982	0.19	0.2066	0.199	0.216	0.17

Table 5.58 Weighted Super Matrix $\boldsymbol{W} = \boldsymbol{T}^{\infty}{}_{(Criteria)} \times (T^{\infty}{}_{(Sub\text{-}Criteria)})'$

Weighted Super Matrix $W\infty = T^{\infty}_{(criteria)} \times (T^{\infty}_{(sub\text{-}criteria)})'$	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(R&D.Corp)
(K.cre)	0.0155	0.0183	0.018	0.019	0.0188	0.017	0.02	0.019	0.02	0.021	0.0207	0.02	0.02	0.021	0.02	0.02	0.02	0.02	0.0194	0.02	0.02	0	0.021	0.02	0.02
(K.Acq)	0.0163	0.0131	0.017	0.018	0.0162	0.016	0.02	0.019	0.02	0.017	0.0175	0.017	0.017	0.017	0.018	0.01	0.02	0.02	0.0183	0.02	0.02	0	0.017	0.02	0.017
(Int Kno Port)	0.016	0.0176	0.013	0.017	0.0159	0.017	0.02	0.019	0.02	0.017	0.0171	0.018	0.017	0.017	0.017	0.02	0.01	0.02	0.018	0.02	0.02	0	0.018	0.02	0.018
(K.shar)	0.0197	0.0198	0.021	0.015	0.0186	0.019	0.02	0.021	0.02	0.02	0.0207	0.02	0.02	0.021	0.021	0.02	0.02	0.017	0.021	0.02	0.02	0	0.02	0.02	0.02
(K.Imp)	0.0197	0.0178	0.018	0.017	0.0148	0.02	0.02	0.019	0.02	0.02	0.0191	0.02	0.021	0.02	0.021	0.02	0.02	0.019	0.0167	0.02	0.02	0	0.02	0.02	0.02
(K.tran)	0.0141	0.0145	0.014	0.014	0.0169	0.012	0.02	0.016	0.02	0.018	0.0172	0.017	0.018	0.016	0.015	0.02	0.02	0.016	0.0191	0.01	0.02	0	0.017	0.02	0.017
(cult)	0.022	0.0201	0.02	0.02	0.0221	0.021	0.02	0.019	0.02	0.021	0.0191	0.018	0.02	0.022	0.022	0.02	0.02	0.02	0.0222	0.02	0.02	0	0.021	0.02	0.02
(stru)	0.019	0.0211	0.022	0.021	0.0192	0.019	0.02	0.015	0.02	0.016	0.0178	0.017	0.017	0.019	0.019	0.02	0.02	0.021	0.0193	0.02	0.02	0	0.019	0.02	0.018
(Tech)	0.0197	0.0195	0.02	0.02	0.0192	0.02	0.02	0.019	0.01	0.02	0.0189	0.021	0.022	0.02	0.02	0.02	0.02	0.02	0.0193	0.02	0.02	0	0.016	0.02	0.024
(Peop)	0.0197	0.0185	0.018	0.019	0.0195	0.019	0.02	0.018	0.02	0.015	0.0185	0.019	0.021	0.02	0.02	0.02	0.02	0.019	0.0196	0.02	0.02	0	0.022	0.02	0.021
(Lead& Supp)	0.0157	0.016	0.016	0.016	0.0155	0.017	0.01	0.015	0.01	0.014	0.0115	0.014	0.014	0.015	0.016	0.02	0.02	0.016	0.0155	0.02	0.02	0	0.017	0.02	0.015
(org. Lear)	0.0157	0.0166	0.017	0.016	0.0164	0.017	0.02	0.015	0.02	0.016	0.0157	0.013	0.019	0.017	0.016	0.02	0.02	0.016	0.0165	0.02	0.02	0	0.017	0.02	0.014
(Succ. Rate)	0.017	0.0162	0.016	0.015	0.0163	0.017	0.02	0.016	0.02	0.019	0.017	0.021	0.013	0.015	0.015	0.02	0.01	0.014	0.016	0.02	0.02	0	0.018	0.02	0.02
(R&D Exper)	0.0213	0.0201	0.019	0.02	0.0213	0.02	0.02	0.019	0.02	0.02	0.0202	0.021	0.019	0.015	0.019	0.02	0.02	0.019	0.0208	0.02	0.02	0	0.02	0.02	0.02
(Code)	0.016	0.0195	0.019	0.02	0.0194	0.018	0.02	0.019	0.02	0.02	0.0203	0.018	0.018	0.019	0.015	0.01	0.02	0.017	0.021	0.02	0.02	0	0.02	0.02	0.019
(Pers)	0.0183	0.0148	0.02	0.02	0.0178	0.018	0.02	0.02	0.02	0.017	0.0183	0.017	0.016	0.016	0.017	0.01	0.02	0.019	0.0173	0.02	0.02	0	0.017	0.02	0.016
(Ext)	0.0173	0.0193	0.014	0.019	0.017	0.018	0.02	0.019	0.02	0.017	0.0173	0.017	0.016	0.016	0.016	0.02	0.01	0.017	0.0167	0.02	0.02	0	0.017	0.02	0.016
(Inter)	0.022	0.0221	0.023	0.017	0.0202	0.021	0.02	0.022	0.02	0.021	0.0213	0.02	0.019	0.02	0.019	0.02	0.02	0.015	0.0198	0.02	0.02	0	0.02	0.02	0.019
(Tech .Tran)	0.0172	0.0163	0.016	0.016	0.0137	0.018	0.11	0.112	0.11	0.112	0.1123	0.112	0.016	0.017	0.017	0.02	0.02	0.016	0.0124	0.02	0.02	0	0.014	0.01	0.015
(Dec.Mak)	0.0129	0.0135	0.013	0.013	0.0159	0.011	0.11	0.112	0.11	0.112	0.1123	0.112	0.014	0.015	0.013	0.01	0.01	0.013	0.0144	0.01	0.01	0	0.013	0.01	0.013
(In. Op Inn)	0.0162	0.0146	0.015	0.015	0.0164	0.016	0.11	0.112	0.11	0.112	0.1123	0.112	0.014	0.016	0.016	0.01	0.01	0.015	0.0148	0.01	0.01	0	0.014	0.02	0.013
(Proj. mang)	0.0137	0.0158	0.016	0.016	0.0139	0.014	0.11	0.112	0.11	0.112	0.1123	0.112	0.012	0.013	0.014	0.02	0.02	0.015	0.0126	0.01	0.01	0	0.012	0.01	0.012
(Inn. com)	0.0148	0.0145	0.015	0.015	0.0144	0.015	0.11	0.112	0.11	0.112	0.1123	0.112	0.016	0.014	0.015	0.01	0.01	0.015	0.013	0.01	0.01	0	0.011	0.01	0.016
(Rate Int)	0.0145	0.0136	0.014	0.014	0.0144	0.014	0.11	0.112	0.11	0.112	0.1123	0.112	0.015	0.014	0.014	0.01	0.01	0.014	0.0131	0.01	0.01	0	0.014	0.01	0.014
(Int & Ext Kno)	0.0121	0.0124	0.012	0.012	0.012	0.013	0.11	0.112	0.11	0.112	0.1123	0.112	0.011	0.011	0.012	0.01	0.01	0.012	0.0108	0.01	0.01	0	0.011	0.01	0.011
(R&D.Corp)	0.0112	0.0118	0.012	0.012	0.0118	0.012	0.11	0.112	0.11	0.112	0.1123	0.112	0.013	0.012	0.011	0.01	0.01	0.011	0.0108	0.01	0.01	0	0.011	0.01	0.009
(Ext Net)	0.0201	0.0188	0.019	0.017	0.019	0.02	0.02	0.018	0.02	0.021	0.0193	0.024	0.017	0.02	0.02	0.02	0.02	0.017	0.0189	0.02	0.02	0	0.021	0.02	0.024
(Know .Inc)	0.0267	0.0255	0.025	0.024	0.026	0.025	0.03	0.023	0.02	0.025	0.0244	0.025	0.026	0.021	0.026	0.03	0.02	0.024	0.0259	0.03	0.03	0	0.024	0.02	0.025
(Rad Inn)	0.0202	0.0243	0.025	0.024	0.0238	0.022	0.03	0.023	0.02	0.024	0.0244	0.022	0.024	0.026	0.02	0.02	0.02	0.024	0.0238	0.02	0.03	0	0.024	0.02	0.022
(Abso. Cap)	0.0234	0.0193	0.026	0.024	0.0225	0.023	0.02	0.024	0.02	0.021	0.0226	0.021	0.022	0.023	0.023	0.02	0.03	0.024	0.0224	0.02	0.02	0	0.021	0.02	0.021
(R&D Empo)	0.0222	0.0246	0.019	0.023	0.0213	0.023	0.02	0.023	0.02	0.021	0.0213	0.021	0.022	0.022	0.022	0.02	0.02	0.023	0.0213	0.02	0.02	0	0.021	0.02	0.021
(Tech Tren)	0.0202	0.019	0.019	0.017	0.0192	0.02	0.02	0.018	0.02	0.021	0.0193	0.024	0.029	0.031	0.031	0.03	0.03	0.028	0.0312	0.03	0.03	0	0.03	0.03	0.03
(Inno. per)	0.0268	0.0257	0.025	0.024	0.0261	0.025	0.03	0.023	0.02	0.024	0.0244	0.025	0.03	0.03	0.031	0.03	0.03	0.031	0.0251	0.03	0.03	0	0.03	0.03	0.03
(Inov Str& ini)	0.0203	0.0244	0.025	0.024	0.0239	0.022	0.03	0.023	0.02	0.024	0.0243	0.022	0.025	0.024	0.021	0.02	0.02	0.024	0.0263	0.02	0.02	0	0.024	0.02	0.025
(Org.Str)	0.0236	0.0195	0.026	0.024	0.0226	0.023	0.02	0.024	0.02	0.021	0.0226	0.021	0.027	0.027	0.029	0.03	0.03	0.029	0.0291	0.03	0.02	0	0.028	0.03	0.027
(Tech. Acq)	0.0166	0.0183	0.019	0.018	0.0165	0.016	0.02	0.015	0.02	0.016	0.0171	0.015	0.016	0.017	0.017	0.02	0.02	0.019	0.017	0.02	0.02	0	0.017	0.02	0.016
(Tech. Expo)	0.0167	0.0163	0.016	0.017	0.0158	0.016	0.02	0.018	0.01	0.019	0.0175	0.019	0.019	0.017	0.017	0.02	0.02	0.017	0.0164	0.02	0.02	0	0.014	0.02	0.019
(Tech. Pro)	0.0165	0.0153	0.015	0.016	0.0161	0.016	0.02	0.017	0.02	0.014	0.0171	0.017	0.018	0.017	0.017	0.02	0.02	0.016	0.0166	0.02	0.02	0	0.019	0.01	0.017
(Tech. lear)	0.0138	0.0139	0.014	0.014	0.0134	0.014	0.01	0.014	0.01	0.014	0.0112	0.013	0.013	0.014	0.014	0.01	0.01	0.014	0.0138	0.01	0.01	0	0.015	0.01	0.013
(Tech. Sele)	0.0129	0.0135	0.014	0.013	0.0133	0.014	0.01	0.013	0.01	0.014	0.0142	0.011	0.016	0.014	0.013	0.01	0.01	0.013	0.0138	0.01	0.01	0	0.015	0.01	0.011
(Tech. Iden)	0.0149	0.0144	0.014	0.014	0.0151	0.015	0.01	0.015	0.02	0.016	0.0151	0.018	0.013	0.016	0.015	0.01	0.01	0.015	0.0156	0.02	0.02	0	0.017	0.02	0.019
(Tech Deve)	0.0193	0.019	0.018	0.019	0.0204	0.019	0.02	0.019	0.02	0.018	0.0186	0.018	0.019	0.017	0.02	0.02	0.02	0.019	0.0211	0.02	0.02	0	0.019	0.02	0.019
(Mang Comp)	0.03	0.031	0.031	0.032	0.0318	0.034	0.03	0.03	0.03	0.033	0.0322	0.031	0.032	0.032	0.031	0.03	0.03	0.032	0.032	0.03	0.03	0	0.032	0.03	0.031
(Fac)	0.0239	0.0208	0.027	0.028	0.0253	0.024	0.02	0.027	0.02	0.024	0.0254	0.025	0.025	0.024	0.024	0.02	0.03	0.028	0.0255	0.02	0.02	0	0.025	0.02	0.025
(Org. Pot)	0.0263	0.0277	0.021	0.027	0.0247	0.024	0.02	0.026	0.03	0.025	0.0246	0.026	0.025	0.024	0.025	0.03	0.02	0.027	0.0249	0.02	0.02	0	0.025	0.02	0.026
(Pers. Skil)	0.031	0.0318	0.033	0.025	0.0295	0.03	0.03	0.031	0.03	0.03	0.0305	0.031	0.03	0.031	0.032	0.03	0.03	0.025	0.0297	0.03	0.03	0	0.03	0.03	0.03
(Str Tech)	0.0208	0.0229	0.023	0.022	0.0191	0.025	0.03	0.023	0.02	0.021	0.0217	0.022	0.023	0.024	0.02	0.02	0.02	0.022	0.0194	0.03	0.03	0	0.024	0.02	0.023
(Corp Tech Stra)	0.0258	0.0229	0.023	0.023	0.027	0.024	0.02	0.024	0.02	0.024	0.024	0.023	0.024	0.024	0.025	0.02	0.02	0.022	0.0273	0.02	0.02	0	0.025	0.02	0.024
(Corport Bus Strat)	0.021	0.0203	0.02	0.021	0.0226	0.018	0.02	0.021	0.02	0.023	0.021	0.02	0.02	0.021	0.021	0.02	0.02	0.02	0.023	0.02	0.02	0	0.023	0.02	0.02
(Tech Alli)	0.0227	0.0252	0.025	0.025	0.0228	0.023	0.02	0.02	0.02	0.02	0.0225	0.021	0.02	0.021	0.022	0.02	0.02	0.025	0.0232	0.02	0.02	0	0.024	0.02	0.021
(Desor. Cap)	0.0228	0.0216	0.022	0.022	0.0215	0.023	0.02	0.024	0.02	0.024	0.0227	0.026	0.024	0.02	0.022	0.02	0.02	0.022	0.0219	0.02	0.02	0	0.019	0.02	0.026

Weighted Super Matrix $W\infty = T^{\infty}_{(criteria)} \times (T^{\infty}_{(sub\text{-}criteria)})'$	(Ext Net)	(Know .Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Pot)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)
(K.cre)	0.022	0.019	0.02	0.022	0.0204	0.02	0.0229	0.019	0.02	0.02	0.021	0.02	0.02	0.023	0.021	0.0195	0.022	0.021	0.0205	0.0217	0.02	0.02	0.021	0.02	0.019
(K.Acq)	0.016	0.017	0.02	0.014	0.0191	0.02	0.018	0.017	0.02	0.02	0.017	0.017	0.017	0.017	0.017	0.01716	0.017	0.018	0.0178	0.019	0.02	0.0164	0.016	0.016	0.017
(Int Kno Port)	0.016	0.017	0.02	0.019	0.0146	0.02	0.0177	0.018	0.02	0.02	0.018	0.017	0.017	0.017	0.017	0.01733	0.017	0.02	0.0157	0.0194	0.02	0.0186	0.016	0.019	0.017
(K.shar)	0.019	0.021	0.02	0.021	0.0226	0.02	0.0207	0.02	0.02	0.02	0.02	0.021	0.021	0.02	0.02	0.02135	0.022	0.02	0.0214	0.0195	0.02	0.0198	0.022	0.02	0.021
(K.Imp)	0.02	0.021	0.02	0.019	0.0194	0.02	0.0165	0.02	0.02	0.02	0.02	0.02	0.019	0.02	0.021	0.02059	0.019	0.019	0.0205	0.0181	0.02	0.0205	0.021	0.02	0.021
(K.tran)	0.018	0.016	0.02	0.015	0.0157	0.02	0.0159	0.018	0.01	0.02	0.017	0.017	0.018	0.017	0.017	0.0169	0.017	0.016	0.0178	0.0159	0.02	0.0167	0.016	0.018	0.016
(cult)	0.02	0.022	0.02	0.02	0.0202	0.02	0.0213	0.021	0.02	0.02	0.022	0.023	0.021	0.02	0.02	0.0223	0.018	0.02	0.0212	0.0236	0.02	0.0197	0.021	0.021	0.022
(stru)	0.017	0.019	0.02	0.021	0.0213	0.02	0.022	0.018	0.02	0.02	0.016	0.019	0.019	0.019	0.017	0.01895	0.02	0.022	0.0189	0.0197	0.02	0.0157	0.019	0.018	0.019
(Tech)	0.022	0.02	0.02	0.02	0.0196	0.02	0.0185	0.02	0.02	0.02	0.017	0.022	0.021	0.023	0.022	0.01958	0.022	0.019	0.0195	0.021	0.02	0.0202	0.02	0.02	0.019
(Peop)	0.021	0.02	0.02	0.019	0.0184	0.02	0.0188	0.019	0.02	0.02	0.023	0.016	0.021	0.021	0.021	0.0197	0.022	0.019	0.0217	0.0166	0.02	0.021	0.022	0.019	0.02
(Lead& Supp)	0.014	0.015	0.02	0.016	0.016	0.02	0.0148	0.016	0.02	0.02	0.017	0.015	0.013	0.015	0.014	0.01479	0.016	0.017	0.0151	0.0164	0.02	0.0157	0.013	0.015	0.015
(org. Lear)	0.019	0.017	0.02	0.017	0.0167	0.02	0.0158	0.017	0.02	0.02	0.018	0.017	0.017	0.014	0.019	0.01684	0.017	0.017	0.0176	0.0168	0.01	0.0201	0.017	0.019	0.017
(Succ. Rate)	0.015	0.017	0.02	0.017	0.0159	0.02	0.0159	0.017	0.02	0.02	0.018	0.018	0.017	0.02	0.015	0.01704	0.017	0.018	0.0177	0.0164	0.02	0.0145	0.017	0.02	0.017
(R&D Exper)	0.021	0.017	0.02	0.021	0.0196	0.02	0.0207	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.021	0.01693	0.022	0.02	0.0192	0.0216	0.02	0.022	0.022	0.019	0.017
(Code)	0.019	0.019	0.02	0.016	0.0193	0.02	0.0208	0.019	0.02	0.02	0.02	0.019	0.02	0.019	0.019	0.0186	0.022	0.016	0.0186	0.0198	0.02	0.0192	0.019	0.021	0.021
(Pers)	0.018	0.019	0.02	0.015	0.0198	0.02	0.0173	0.017	0.02	0.02	0.017	0.017	0.018	0.017	0.018	0.01852	0.018	0.017	0.0201	0.0171	0.02	0.0183	0.017	0.017	0.019
(Ext)	0.017	0.018	0.02	0.02	0.0144	0.02	0.0167	0.018	0.02	0.02	0.017	0.017	0.017	0.017	0.017	0.01802	0.017	0.02	0.0168	0.0168	0.02	0.0176	0.017	0.016	0.018
(Inter)	0.021	0.023	0.02	0.023	0.0233	0.02	0.0198	0.02	0.02	0.02	0.02	0.02	0.021	0.02	0.021	0.02272	0.018	0.021	0.0206	0.0213	0.02	0.0212	0.02	0.02	0.022
(Tech .Tran)	0.016	0.017	0.02	0.016	0.0161	0.02	0.0137	0.017	0.02	0.02	0.016	0.016	0.015	0.016	0.016	0.01744	0.016	0.016	0.0165	0.0162	0.02	0.0163	0.017	0.016	0.017
(Dec.Mak)	0.014	0.015	0.01	0.013	0.0134	0.01	0.0157	0.011	0.01	0.01	0.014	0.015	0.014	0.014	0.014	0.01494	0.015	0.015	0.0142	0.0141	0.01	0.0131	0.015	0.013	0.013
(In. Op Inn)	0.014	0.016	0.02	0.017	0.0146	0.01	0.0155	0.016	0.02	0.01	0.015	0.016	0.018	0.015	0.014	0.01506	0.016	0.016	0.0131	0.016	0.02	0.0169	0.014	0.014	0.015
(Proj. mang)	0.013	0.013	0.01	0.015	0.0156	0.02	0.0138	0.014	0.01	0.01	0.014	0.013	0.014	0.013	0.013	0.01353	0.011	0.014	0.0138	0.0142	0.01	0.013	0.013	0.014	0.014
(Inn. com)	0.016	0.014	0.01	0.014	0.0146	0.02	0.0143	0.015	0.01	0.02	0.012	0.017	0.015	0.017	0.016	0.01445	0.015	0.015	0.0166	0.0131	0.02	0.0144	0.016	0.017	0.015
(Rate Int)	0.015	0.014	0.01	0.013	0.0135	0.01	0.0144	0.014	0.02	0.01	0.016	0.012	0.015	0.015	0.015	0.01422	0.015	0.014	0.0142	0.0149	0.01	0.0141	0.015	0.014	0.015
(Int & Ext Kno)	0.011	0.011	0.01	0.012	0.0122	0.01	0.0119	0.013	0.01	0.01	0.013	0.012	0.01	0.012	0.011	0.01124	0.013	0.013	0.013	0.013	0.01	0.0126	0.011	0.013	0.012
(R&D.Corp)	0.013	0.012	0.01	0.011	0.012	0.01	0.0118	0.012	0.01	0.01	0.012	0.013	0.012	0.01	0.013	0.01186	0.012	0.012	0.0126	0.0124	0.01	0.012	0.011	0.011	0.011
(Ext Net)	0.016	0.018	0.02	0.017	0.017	0.02	0.0191	0.02	0.02	0.02	0.021	0.021	0.019	0.024	0.017	0.01968	0.02	0.019	0.0191	0.0173	0.02	0.0202	0.019	0.018	0.02
(Know .Inc)	0.024	0.019	0.02	0.023	0.0223	0.02	0.0259	0.025	0.03	0.02	0.024	0.025	0.024	0.025	0.026	0.0208	0.027	0.026	0.025	0.0243	0.03	0.0251	0.026	0.023	0.027
(Rad Inn)	0.022	0.024	0.02	0.022	0.0222	0.02	0.0237	0.022	0.03	0.02	0.024	0.024	0.024	0.022	0.024	0.026	0.02	0.025	0.0249	0.0243	0.02	0.0218	0.026	0.023	0.02
(Abso. Cap)	0.021	0.021	0.02	0.017	0.0231	0.02	0.0225	0.023	0.02	0.02	0.021	0.021	0.023	0.021	0.023	0.02322	0.024	0.019	0.0259	0.0247	0.02	0.0223	0.021	0.024	0.023
(R&D Empo)	0.02	0.02	0.02	0.022	0.0169	0.02	0.0213	0.023	0.02	0.02	0.021	0.021	0.021	0.021	0.022	0.0225	0.022	0.025	0.0186	0.0231	0.02	0.0226	0.02	0.023	0.022
(Tech Tren)	0.029	0.031	0.03	0.033	0.0339	0.03	0.0282	0.028	0.03	0.03	0.03	0.029	0.031	0.03	0.029	0.03104	0.031	0.034	0.035	0.0282	0.03	0.0315	0.032	0.033	0.031
(Inno. per)	0.03	0.03	0.03	0.03	0.0291	0.03	0.0228	0.029	0.03	0.03	0.03	0.028	0.029	0.03	0.03	0.03004	0.032	0.03	0.0298	0.0322	0.02	0.0327	0.032	0.029	0.031
(Inov Str& ini)	0.025	0.024	0.02	0.023	0.0224	0.02	0.0239	0.018	0.02	0.02	0.024	0.025	0.025	0.025	0.025	0.0237	0.021	0.023	0.023	0.0246	0.03	0.0191	0.024	0.023	0.021
(Org.Str)	0.027	0.027	0.03	0.026	0.0263	0.03	0.0264	0.026	0.02	0.03	0.028	0.03	0.028	0.027	0.027	0.02708	0.03	0.027	0.0269	0.0296	0.03	0.0285	0.024	0.027	0.029
(Tech. Acq)	0.016	0.018	0.02	0.019	0.0193	0.02	0.0169	0.017	0.02	0.01	0.015	0.014	0.016	0.014	0.014	0.01567	0.017	0.019	0.019	0.0186	0.02	0.0162	0.016	0.014	0.017
(Tech. Expo)	0.019	0.017	0.02	0.017	0.0168	0.02	0.0163	0.017	0.02	0.02	0.012	0.017	0.016	0.017	0.017	0.0154	0.017	0.016	0.0166	0.0168	0.02	0.0163	0.016	0.018	0.017
(Tech. Pro)	0.018	0.017	0.02	0.016	0.0157	0.02	0.0165	0.016	0.02	0.02	0.016	0.012	0.016	0.015	0.016	0.01538	0.017	0.016	0.0156	0.0155	0.02	0.0159	0.017	0.017	0.016
(Tech. lear)	0.013	0.014	0.01	0.014	0.0141	0.01	0.0138	0.015	0.01	0.01	0.013	0.012	0.01	0.012	0.011	0.01212	0.014	0.014	0.0139	0.0136	0.01	0.0142	0.013	0.014	0.014
(Tech. Sele)	0.016	0.015	0.01	0.014	0.0141	0.01	0.0137	0.014	0.01	0.01	0.013	0.013	0.013	0.01	0.014	0.013	0.013	0.014	0.014	0.0131	0.01	0.0136	0.013	0.013	0.013
(Tech. Iden)	0.013	0.016	0.02	0.015	0.0149	0.01	0.0155	0.016	0.02	0.01	0.015	0.015	0.014	0.016	0.011	0.01458	0.015	0.015	0.0147	0.0153	0.02	0.0154	0.015	0.015	0.015
(Tech Deve)	0.019	0.017	0.02	0.02	0.0189	0.02	0.0209	0.019	0.02	0.02	0.017	0.017	0.017	0.017	0.017	0.01508	0.02	0.019	0.0186	0.0194	0.02	0.0187	0.02	0.019	0.019
(Mang Comp)	0.032	0.032	0.03	0.031	0.0314	0.03	0.0322	0.035	0.03	0.03	0.032	0.033	0.032	0.031	0.032	0.03248	0.024	0.029	0.0284	0.0295	0.03	0.0344	0.034	0.029	0.032
(Fac)	0.025	0.025	0.02	0.021	0.0276	0.03	0.0258	0.024	0.02	0.03	0.025	0.025	0.025	0.025	0.025	0.02472	0.023	0.019	0.0251	0.0258	0.03	0.0235	0.024	0.026	0.025
(Org. Pot)	0.025	0.025	0.03	0.028	0.0208	0.03	0.0252	0.024	0.02	0.03	0.026	0.025	0.025	0.026	0.025	0.02471	0.025	0.025	0.0185	0.0249	0.02	0.0235	0.024	0.026	0.025
(Pers. Skil)	0.031	0.031	0.03	0.032	0.0331	0.02	0.0299	0.03	0.03	0.03	0.03	0.03	0.031	0.031	0.031	0.03115	0.03	0.029	0.0302	0.022	0.03	0.0299	0.03	0.03	0.03
(Str Tech)	0.023	0.024	0.02	0.023	0.0227	0.02	0.019	0.025	0.03	0.02	0.023	0.021	0.022	0.022	0.023	0.0242	0.02	0.023	0.0225	0.0221	0.02	0.0237	0.023	0.02	0.021
(Corp Tech Stra)	0.024	0.024	0.03	0.023	0.0227	0.02	0.0268	0.024	0.02	0.02	0.024	0.024	0.024	0.023	0.024	0.02433	0.026	0.023	0.0224	0.0222	0.02	0.0188	0.022	0.022	0.022
(Corport Bus Strat)	0.02	0.022	0.02	0.02	0.0204	0.02	0.0225	0.018	0.02	0.02	0.023	0.023	0.021	0.02	0.02	0.02147	0.021	0.02	0.0202	0.0203	0.02	0.0162	0.016	0.02	0.02
(Tech Alli)	0.021	0.021	0.02	0.025	0.025	0.03	0.0226	0.023	0.02	0.02	0.023	0.02	0.023	0.021	0.021	0.02132	0.022	0.025	0.025	0.025	0.02	0.0214	0.021	0.018	0.021
(Desor. Cap)	0.025	0.021	0.02	0.022	0.0217	0.02	0.0215	0.022	0.02	0.02	0.019	0.024	0.023	0.026	0.025	0.02058	0.023	0.021	0.0215	0.0221	0.02	0.0208	0.02	0.022	0.017

In order to create most precise weights for the concerned criteria are formulated by using pair-wise comparison of the unweighted super matrices, the limiting power of the weighted supermatrix is achieved is shown in Table 5.59, and

Table 5.59 Influential weights by stable matrix of DANP when power $\lim_{\theta\to\infty}(W^*_{Stable\ matrix})^\theta$

$\lim_{\theta\to\infty}(W^*_{Stable\ matrix})^\theta$	**Stable matrix**
Knowledge Creation	0.021366482
Knowledge Acquisition	0.018331038
Intellectual Knowledge Portfolio	0.018596176
Knowledge Sharing	0.021481339
Knowledge Implementation	0.020689195
Knowledge Transfer	0.017477966
Culture	0.017629256
Structure	0.019240313
Technology	0.019786602
People	0.02160632
Role of Leadership & Support	0.015852068
Organizational Learning	0.016717911
Success rate of R&D products	0.015038582
R&D Expenditure	0.020694122
Codification	0.019404846
Personalization	0.017710483
External Knowledge Source	0.017129161
Internal Knowledge Source	0.020446506
Technology Transfer	0.013958564
Decision Making Process	0.015942745
Open Innovation	0.016367277
Project Management	0.014166057
Innovativeness compatibility	0.014568272
Rate of Introduction New Product	0.01462377
Internal & External Knowledge Sharing	0.012377231
R&D cooperation	0.012357182
External Networking	0.017307008
knowledge incentives	0.025383864
Radical Innovation	0.023295642
Absorptive capacity	0.0220755
R&D Employee	0.021298132
Technology Trends	0.026759543

Table 5.59 Continued

$\lim_{\theta \to \infty} (W^{*}_{Stable\ matrix})^{\theta}$	**Stable matrix**
Innovative Performance	0.029803396
Innovation strategies and initiatives	0.023346047
Organization strategy	0.0276401
Technology Acquisition	0.01483629
Technology Exploitation	0.017922845
Technology Protection	0.016681599
Technology Learning	0.014768769
Technology Selection	0.01384275
Management Competency	0.015394291
Facility and Equipment	0.018788719
Organization potential	0.025566641
Personal Skill	0.024388788
Strategic Technology Road Mapping	0.026931401
Corporate Technology Strategy	0.031692392
Corporate Business Strategy	0.018549302
Technology Alliance Strategy	0.025678614
Desorptive Capacity	0.021840791
Strategic Technology Road Mapping	0.021925541

The steady –state condition that indicates appropriate weight along with local and global weight of each criterion based on several sub-criteria is shown in Table 5.60

Table 5.60 Overall Local and global weights of criteria related.

	Local Weight (DANP)	**Global Weight (DANP)**	**RANK**
KM Process Capability	0.117942		3
Knowledge Creation	0.181160624	0.021366482	17
Knowledge Acquisition	0.155423914	0.018331038	29
Intellectual Knowledge Portfolio	0.157671953	0.018596176	27
Knowledge Sharing	0.182134468	0.021481339	16
Knowledge Implementation	0.175418093	0.020689195	21
Knowledge Transfer	0.148190947	0.017477966	33
KM Infrastructure Capability	0.110832469		5
Culture	0.159062194	0.017629256	32
Structure	0.17359816	0.019240313	25
Technology	0.178527123	0.019786602	23

Table 5.60 Continued

	Local Weight (DANP)	**Global Weight (DANP)**	**RANK**
People	0.19494576	0.02160632	15
Role of Leadership & Support	0.143027289	0.015852068	40
Organizational Learning	0.150839474	0.016717911	36
KM Strategic Capability	0.110424		6
Success rate of R&D products	0.1361898	0.015038582	42
R&D Expenditure	0.187406529	0.020694122	20
Codification	0.175730813	0.019404846	24
Personalization	0.160386608	0.017710483	31
External Knowledge Source	0.155122141	0.017129161	35
Internal Knowledge Source	0.185164109	0.020446506	22
IM Process Capability	1.1015236		1
Technology Transfer	0.136843414	0.013958564	48
Decision Making Process	0.15629542	0.015942745	39
Open Innovation	0.160457342	0.016367277	38
Project Management (monitoring)	0.13887758	0.014166057	47
Innovativeness compatibility	0.142820713	0.014568272	46
Rate of Introduction New Product	0.143364791	0.01462377	45
Internal & External Knowledge Sharing	0.12134074	0.012377231	50
R&D cooperation	0.101523606	0.012357182	51
IM Infrastructure Capability	0.121717328		2
External Networking	0.142190174	0.017307008	34
knowledge incentives	0.208547662	0.025383864	8
Radical Innovation	0.191391336	0.023295642	11
Absorptive capacity	0.181366942	0.0220755	12
R&D Employee	0.17498028	0.021298132	18
IM Strategic Capability	0.1075490		9
Technology Trends	0.24881237	0.026759543	5
Innovative Performance	0.27711436	0.029803396	2
Innovation strategies and initiatives	0.217073411	0.023346047	10
Organization strategy	0.256999859	0.0276401	3

Table 5.60 Continued

	Local Weight (DANP)	Global Weight (DANP)	RANK
TM Process Capability	0.11223526232409		4
Technology Acquisition	0.132189208	0.01483629	43
Technology Exploitation	0.159689964	0.017922845	30
Technology Protection	0.148630638	0.016681599	37
Technology Learning	0.131587599	0.014768769	44
Technology Selection	0.123336904	0.01384275	49
Technology identification	0.137160913	0.015394291	41
Technology development	0.167404774	0.018788719	26
TM Infrastructure Capability	0.10857922		8
Management Competency	0.235465317	0.025566641	7
Facility and Equipment	0.224617447	0.024388788	9
Organization Potential	0.248034577	0.026931401	4
Personal Skill	0.291882659	0.031692392	1
TM Strategic Capability	0.1087200		7
Strategic Technology Road Mapping	0.170615334	0.018549302	28
Corporate Technology Strategy	0.236190308	0.025678614	6
Corporate Business Strategy	0.200890252	0.021840791	14
Technology Alliance Strategy	0.20166978	0.021925541	13
Desorptive Capacity	0.190634326	0.020725767	19

5.6.2 Discussion on DANP Findings

The outcomes are discussed as follows. From Table 5.60, the significant priorities among criteria weight are From Table 5.60, the significant priorities among criteria weight are: IM process capability (local weight= 1.1015236) is consider as most important capability to priorities first followed by, IM infrastructure capability (local weight= 0.121717328), KM process capability (local weight= 0.117942195), TM process capability (local weight= 0.112235262), KM infrastructure capability (local weight= 0.110832469), KM strategic capability (local weight= 0.110423699), TM strategic capability (local weight= 0.108720014), TM infrastructure capability (local weight= 0.108579222), IM strategic capability (local weight= 0.107549086). In case of sub-criteria, the situation is different Personal skill (global weight =0.0316932) has considered being the highest factor to its intensity in regard to its precedence with other sub-criteria , From Table 5.60, Researcher extracts the top ten sub-criteria Innovative performance (global weight =0.02980339), Organizational strategy (global weight = 0.02764), Technology trends (global weight = 0.0267595), Corporate Technology strategy (global weight = 0.025678), Management competency (global weight = 0.025566), Knowledge incentives (global weight = 0.0253838), Facility equipment (global weight= 0.0243887), Innovation strategies and incentives (global weight = 0.023346047). After formulating the degree of importance and the net casual relationship among capabilities, DANP techniques, used to obtain the weights of the nine criteria based on 51 sub-criteria

The outcome of global weight priority represents the *Personal skill'* as highest factor that requires maximum improvement that leads progressive management for R&D among the public sector organization. There are various other factor also involve as stakeholder in fixing '*Personal skill'* hence it used as sub-criteria for TM infrastructure pillar specifically dealing with R&D function. Comprehensive improvement of adequate skills may allow individuals to contribute to generating creative technological ability as throughput R&D function and consider as significant steps toward the policy-making process. Majority of sub-criteria belong to TM infrastructure capability required extensive restructuring in case of R&D in Pakistan Public Organization.

Innovative performance is at number second in priority list with Influential weights (0.02980339) and considers factor for R&D in public organization that requires improvement as an indicator of IM strategic capability. Innovative performance relied on two factors that also need to address for further development. The first one purely belongs to organizational financial performance which comprises market value in shape of share price, leftover revenue in the form of profit and capital return on investment in percentage. The second factor stressed on organization market value such as share prices which entirely indicates organization progress. The 'Organizational strategy third on the list as shown in Table 5.60 as the source of improvement required during *selection of organizational strategy*. That consider as the strategic tool that used to enables strategic alignment at organizational level and allows R&D for crafting prosperous innovation mechanism.

Organizational potential fourth in the list as shown in Table 5.60 and consider for further improvement in order to retain organizational strength that were more aligned with R&D function to access New Product Development NPD and R&D proficiency

Technology trends five on the list as shown in Table 5.60 and consider as for further improvement since it is strategic instrument to drive IM strategic capability allow firms to predict relevant technological methods for their future development and estimate future trends. Corporate Technology Strategy sixth on the list as shown in table 5.60 allow further improvement required in shape of identifying technological strategies at all level with in the corporations for long term technological planning for example: which technologies acceptable for business advancement, and what potential competences were required for competitive advantages

5.6.3 Comparing Result with Some Studies to Bridge The Theoretical Gap

Pisano and Figgie (2016a) suggested the general relationship in between knowledge and technology management to address the complex technological environment. Such a relationship depends on redesigning cross-functional communication within the organization and external collaboration along with changing approach for existing capabilities related to technology management. However, such collaboration is unable to disclose the resources that drive these capabilities. In similar way, some of earlier studies for instance:

Park and Kim (2005a) proposed the model in which knowledge Management and R&D strictly addressing knowledge management process capability as the source for R&D ignoring other influential capabilities which may imply the useful relation with R&D.

Hanninen (2007) represents four kind of knowledge-based innovation syndromes, more focus on draw the relationship in between the knowledge and innovation management for high tech firms. He proposed the model for technology intense firms that enables capabilities based perspective related to knowledge-based innovation for end users. However, the impact of various dimension related to innovation management were missing. He also points out the need of complementary resources related to technological capability that requires for developing technological products for specific market.

Motohashi (2007) represents a relationship among factors that involve in searching technological opportunity, market condition and capabilities related to develop innovation policy. He draws the causes and consequences during the recent R&D collaboration among Japanese pharmaceutical firms. From his findings, the technology opportunity as driving factors that belongs technology management can be induced with market condition and innovation policy factors. However, various factors were ignored that drive capabilities belongs to technology management, which helps to discover abundant knowledge for screening new drugs R&D.

Maine and Garnsey (2007) proposed an open system model by developing relationship among factors related to R&D collaboration, capital investment to acquire technology management capabilities and complementary assets to recognize the advance material venture. Such relationship helps decision makers to get better under the uncertainty in a commercial environment for high tech material firms. However, there are numbers of dimensions related to technology management were ignored that allow comprehensive access to complementary asset for commercializing their innovations.

Murovec and Prodan (2009a) were more focus on a positive relation among knowledge, technology absorptive capacity with R&D. However, such relationship somehow ignoring potential outcome which belongs to capabilities that were required to manage the innovation at an organizational level.

Karlsson et al. (2011) utilize that knowledge, innovation, and technology as an essential construct for economic growth but limiting the capabilities perspective related to knowledge, innovation and technology management with their involvement without realization positive impact on R&D.

Moffett et al. (2010) developed a knowledge-based model for a firm’s internal learning by illustrating dimensions that were applicable through strong R&D practices which play significant role in the innovation process. However, these dimensions undermine various technological capabilities which allow firms to confront variating market trends. As observed from the previous theories, there are very few studies which discuss capabilities related to "knowledge, innovation and technology management" with their significance on R&D. Besides, some studies considered a particular draw some relation in between the knowledge, innovation and technology management and R&D with individual context, but no research has regarded as the relations among three concepts together with their casual influence on R&D. Therefore, because of this gap in the literature, this study have explored and developed relationship between these supporting management disciplines their significance on R&D.

5.7 Summary

The primary objective of chapter is to argue the process of refining and validating capabilities that explore from systematic review based on Focus Group Discussion (FGD) technique. The outcome of focus group discussion becomes the initial step to address second and third research question by applying DANP (DEMATEL based ANP) in order to determine the interrelationship among these capabilities and prioritizes with respect to their influence.

- The focus group study has the primary goal to rectify capabilities related to the knowledge, innovation, and technology management discipline that were influencing R&D by merely emphasizing on a country-specific context. The three essential management supporting discipline (i.e., knowledge management, innovation management, technology management) gather from the literature review become initial scope for focus group discussion
- After completion of first session, the outcome from expert's consensus would develop a pre-determined model fit to the characteristic related to R&D in Public organizations of Pakistan. The experts were responsible for approving the model relevant to address the research problem.
- Outcome of focus group discussion draw conceptual orientation based on three dimensions that used to contributes their significance on R&D. Therefore, DANP technique were applied to measure contributing impact among dimensions, criteria's and sub-criteria's with respect to their interrelationship.

DANP technique allows researcher, an in-depth configuration to map interrelations between capabilities. Also, priorities them according to their interrelated significance. For in-depth discussion, same panel of experts were invited for second session. Now, the experts approved model was used for further discussion in case of developing interrelationship and prioritization among capabilities. Therefore, closed-ended questionnaires were step up to gauge interrelationship among criteria and sub-criteria

CHAPTER 6

CONCLUSION

6.1 Introduction

This chapter summarizes the critical findings after applying of two-stage methodical tool based on 'Focus Group Discussion and DANP (DEMATEL-Based ANP)' technique with a view of 'Exploring capabilities belong to supporting management discipline that contributes to R&D in Public Organization'. This chapter begins with the answer to the research question and then proceeds to address the overarching research objectives. This followed by a discussion regarding contribution (a) Focus group discussion, (b) Applying DANP in case of R&D in Pakistan Public Sector organizations, and (c) contribution towards R&D research. Finally, the research limitation and future research direction are presented

6.2 Addressing the research questions

As previously discussed in chapter three, this research designed is to rectify the dynamic of R&D. In doing so, the research was accomplished and validated subsequently in four-step: a literature review on R&D to specify the general relationship in between Knowledge, Innovation, and Technology management and R&D literature as supporting management discipline. In order to classify the capabilities related to "Knowledge, Innovation and Technology Management" a systematic review (PRISMA with Co-word Analysis) were performed to trace the criteria' and sub-criteria belongs to these capabilities. Focus group discussion and DANP (DEMATEL Based ANP) case was drawn from Pakistan Public Organization.

At first, the research has presented an answer for the first question "(i.e. '*how to classify the capabilities related to supporting management discipline that contributes to R&D*?')". Through a systematic literature review including theories and literatures from both developed and developing countries, allow researcher to identify 101 factors-classified into three dimensions along with nine criteria driven by 89 sub-criteria – consider as supporting management discipline for R&D in public organization. However, the comprehensive set of gathered capabilities needs to be refined with suitable orientation related to country-specific by the number of experts in the same field.

DEMATEL technique was applied to determine the interrelationship among criteria and sub-criteria to answer the second research question (i.e., *How to determine if there is any relationship among these capabilities in case of Pakistan*?). While, DANP technique used to answer third research question *(How to prioritize these capabilities that involve at R&D in public organization based on their interdependency in case of Pakistan*) – The outcome of 39 focus group discussion (FGD) ultimately developed country specific conceptual orientation, that is suitable for R&D in public organizations of Pakistan. In case of exploring, the interrelationship among capabilities related to supporting discipline. The outcome of FGD helps the researcher to construct DANP questionnaire, in order to explore the casual impact among capabilities

The findings are discussed as follows. At first account, according to the total influence matrix produce from DEMATEL technique. In case of criteria, the degree of importance among them is shown in Table 5.33 to 5.35 TM processes Capability (22.887622) > TM strategic capability (22.5081) > TM infrastructure capability (22.0133) > IM process capability (21.783099) > KM strategic capability (21.628927) >IM strategic capability (21.329805) > KM infrastructure capability (21.27745) > IM infrastructure capability (21.252053) > KM process capability (20.917058). Contrary to the importance of individual criteria, the net interrelationship among these criteria are follow as: TM process capability (0.663082) > TM Strategic capability (0.537467) > IM process capability (0.404280) > TM infrastructure capability (0.3193936) > KM strategic capability (-0.001894) > IM Strategic capability (-0.145284) > IM infrastructure capability (-0.398314) > KM infrastructure capability (-0.43211) > KM process capability (-0.946613)

In case of sub-criteria, the degree of importance among them is shown in Table 5.33 to 5.35(K.cre) 10.03587 > (Mang Comp) 9.976846 > (K.shar) 9.917982 > (Rad Inn) 9.783903 >(Tech Tren) 9.779905 >(Inter) 9.669163 >(Pers. Skil) 9.631714 > (Code) 9.585365 >(R&D Exper) 9.446113 > (Tech Deve) 9.418817 > (Know .Inc) 9.407557 > (Inno. per) 8.940453 >(Desor. Cap) 8.805755 > (Tech. Acq) 8.79638 >(K.Imp) 8.785058 > (Tech .Tran) 8.71312 > (Tech Alli) 8.669809 >(stru) 8.542892 >(Int Kno Port) 8.520113 > (Proj. mang) 8.496606 > (cult) 8.443612 > (R&D Empo) 8.44015 > (Abso. Cap) 8.409074 > (Corp Tech Stra) 8.393402 > Dec.Mak)8.34738 > (Org.Str)8.342253 >(Peop) 8.330851 > (Ext) 8.314813 > (In. Op Inn) 8.303709 >(Fac) 8.294453 > (Inn. com) 8.283543 > (Rate Int) 8.282944 > (Str Tech) 8.254502 >(K.Acq) 8.214333 > (Tech. Pro) 8.203035 > (Inov Str& ini) 8.178643 > (Org. poten) 8.155003 >(K.tran) 8.14742 >(Succ. Rate) 8.147191 >(Tech) 8.14043 >(Corport Bus Strat) 8.116534 >(Tech. Expo) 8.092317 > (Pers) 8.06934 > (Ext Net) 8.034154> (Tech. Iden) 8.016761 >(Tech. Sele) 7.529841 >(org. Lear) 7.466315 > (R&D.Corp) 7.393356 >(Tech. lear) 6.86591 > (Int & Ext Kno) 6.788117 >(Lead& Supp) 6.596246. Contrary to the importance of individual criteria the interrelationship among sub-criteria's are follow as: Rad Inn (0.710484), Code (0.684652), Inov Str& ini (0.632157), Tech. Sele (0.618779), R&D.Corp (0.539597), Proj. Mang (0.537887), Ext Net (0.527004), Desor. Cap (0.511034), Corport Bus Strat(0.469564),stru(0.44614),org.Lear(0.412506),Dec.Mak(0.326441),Ext(0.303051),Succ.Rate(0.299526),Tech.Iden(0.290427),Tech.Alli(0.279324),Tech.Acq(0.272357),K.tran (0.240437), K.cre (0.217202), R&D Exper (0.13868), Inter (0.069823), Lead&Supp (0.066624), Int Kno Port (0.041131), R&D Empo (0.023383), Peop(-0.00014), K.shar(-0.00846), Fac(-0.02953), Tech. Lear(-0.03794), Rate Int(-0.05685), Str Tech(-0.12447), Tech. Pro (-0.13034),K.Acq(-0.15488), Int & Ext Kno(-0.15622) Know .Inc(-0.16699), Org. Poten(-0.17218), Tech Deve(-0.19926), Pers(-0.20541),Tech Tren(-0.25883), Abso. Cap (-0.32554), cult (-0.34434), Tech (-0.37739), Pers. Skil (-0.42733), Inn. Com (-0.48209), Corp Tech Stra (-0.50072), Tech. Expo(-0.50629), In. Op Inn(-0.5521), Org.Str (-0.58965) Mang Comp(-0.61184), Tech .Tran(-0.71786), Inno. Per(-0.75032), K.Imp (-0.77125).

After formulating the degree of importance and the net casual relationship among capabilities, DANP techniques, used to obtain the weights of the nine criteria based on 51 sub-criteria, that allows the researcher to answer the third research question *("How to prioritize these capabilities that involve at R&D in public organization based on their interdependency in case of Pakistan?"*); also it leads to an overall result.

The outcomes are discussed as follows. From Table 5.60, the significant priorities among criteria weight are: IM process capability (local weight= 1.1015236) is consider as most important capability to priorities first followed by, IM infrastructure capability (local weight= 0.121717328), KM process capability (local weight= 0.117942195), TM process capability (local weight= 0.112235262), KM infrastructure capability (local weight= 0.110832469), KM strategic capability (local weight= 0.110423699), TM strategic capability (local weight= 0.108720014), TM infrastructure capability (local weight= 0.108579222), IM strategic capability (local weight= 0.107549086). In case of sub-criteria, the situation is different Personal skill (global weight =0.0316932) has considered being the highest factor to its intensity in regard to its precedence with other sub-criteria , From Table 5.60, Researcher extracts the top ten sub-criteria Innovative performance (global weight =0.02980339), Organizational strategy (global weight = 0.02764), Technology trends (global weight = 0.0267595), Corporate Technology strategy (global weight = 0.025678), Management competency (global weight = 0.025566), Knowledge incentives (global weight = 0.0253838), Facility equipment (global weight= 0.0243887), Innovation strategies and incentives (global weight = 0.023346047). At present situation, the researcher aware that testing previous theories enables positive effects on - Prioritizing KM, IM and TM capabilities with respect to their contribution to R&D is defiantly for the success of R&D in Public Organization.

6.3 Contribution to the Body of knowledge

The core outcome of this research are: (a) a set of supporting management capabilities that share the boundaries with R&D is drive from extensive literature review; (b) a methodological framework which assists in structuring a management model; (c) DANP-based framework for devising the most relevant orientation for future R&D field in case of Pakistan Public organizations, the research makes three main contributions such as: to the chosen country (Pakistan), to the developing economies and in research domain belong to knowledge, innovation, and technology management. Firstly, the DANP-based model arranges the capabilities belong to supporting management discipline that contributes multiple dimensional significance to public R&D based on criteria's that devising an appropriate orientation useful for R&D in the Public organization. These dimensions were influences R&D in Public organizations based on criteria for conceiving a proper orientation which is constructive for R&D in Public organizations. It provides valuable decision making compared to the technique that used to portray decision making based on intuition. For examples, endorsing innovation-related or technology related projects without prioritizing the impact of projects on innovation or technology that diffuses with organizational resources. This becomes more critical in case of R&D in Pakistan Public organization when they were facing resource allocation issues

6.3.1 Theoretical Contribution

This research offers some Theoretical relevance that relate three aspects of supporting management disciplines based on conceptual development (Cetindamar, 2009; Unsal & Cetindamar, 2015). Firstly, this study adds to associate new ideas in order to rectify ongoing current debate within the same scope. The second is to combine streams of existing theoretical concepts with same research domain that were previously disconnected. The third contribution is to initiates the research domain outside the main research scope. The fourth contribution is to create concepts from "blue sky thinking." The critical research finding is to authenticate, extend and confront the previous outcome into R&D literature. The significant result also contributes new conceptual insights into how supporting management discipline contributes their significance on R&D is perceived from researcher aspects.

The current contributions of this research to the body of knowledge will improve our perspective of what capabilities related to supporting management tool (Knowledge, innovation, and Technology Management) influence R&D competitiveness, the impact of these capabilities in-shape of processes, infrastructure, and strategies effects on R&D. By offering, the empirical evidence related to impact that how different capabilities of knowledge, innovation and technology management contribute their influence on R&D as a competitive tool; some contribution to the literature related to R&D with academic and practical relevance were discuss below:

This research adds to the body of knowledge by offering an integrated framework that enables the capabilities of three disciplines to achieve effective R&D competitiveness.

At first, this study employing knowledge management as a catalyst to R&D and argues sufficient criteria's for capabilities related to knowledge management under R&D scope. This study portrays theoretically relationship among criteria's for these capabilities that were necessary for decision makers and signifies that how capabilities that belongs to knowledge management become core element during policy making to enhance R&D competitiveness

Secondly, this research adds to establish logical connectivity among processes, infrastructure, and strategies as a capabilities related to technology management. That considered previously as single sources toward retaining R&D competitiveness. However, previous studies were theoretically avoiding the potential criteria for technology management capabilities. This signifies technology management as the dimension which describes supporting management discipline rules in context of infrastructural, processes, and strategic perspective, and evaluates the relationship among these criteria's for developing appropriate policy to improve R&D competitiveness

Thirdly, this study theoretically contributes by drawing relationship among the criteria's and sub-criteria that drive innovation management as influential entity that contributes as supporting agent to R&D. Such influence helps R&D policy makers to draw general specification related to significance of innovation management that add some value to national innovation system.

6.3.2 Practical Contributions

In practical term, this research contributes an existing body of knowledge by proposing the methodological model, which portrays guideline that allows systematically organized R&D to attract foreign investment with international investors to lend their investment.

In addition to the organization level, the research also contributes to national level (i.e. Pakistan) as tool for adding suitable value to developing national innovation policy. Other than R&D in Public organizations, this model also adapts to design new network model that includes organizational-specific factors with all dimensions of public organization taken into account. The present researcher argues that selecting proper R&D orientations for public R&D organizations helps to narrate cohesive and strong national innovation system. This is a worthy outcome since the majority of governmental funds fall in public organization.

Firstly, this study adds some practical significance related to effectiveness of capabilities related to knowledge management contributes to R&D in public organization. This research provides the better understanding on how multicriteria related to knowledge management capabilities that can helps adjust the science and technology policy align to National level. Such contribution offers a retainable path to adopt the dynamic changes towards technological and innovative trends.

Secondly, this research study will contribute towards some aspects of innovation management that used as relevant dimension that shares its influence with R&D in the Public organization. Since the exceptional role of R&D in Public, organization could offer retainable national innovation mechanism. Such mechanism enables sustainable competitiveness and capacity building for R&D in public organization. This research enables complete relevant capabilities related to multicriteria guideline for innovation management. This research highlights useful parameters that were used to drive these criteria for effective innovation mechanism.

Thirdly, this study represents in-depth analysis to identify the capabilities related to Technology management to explore certain aspects of R&D. Since technology, management plays a crucial role in developing a national innovation policy. Therefore under such landscape, this study evaluates supportive concepts and related theories that utilize to explore the uncover features related to technology management

The complicated and monolithic character of the R&D in public sector organization specifically among developing countries always confronts complex political bureaucracy due to financial deficiencies; make R&D in public organizations ineffective. This study aims to undertake the necessary steps toward finding the new guideline for reorganizing the capabilities belongs to supporting management discipline that and finding their significance on R&D in public organizations.

Since, this research study has essential focus based on developing country. Therefore, this research might be useful for other low privilege countries where state driven R&D model plays a crucial role in developing national science policy. The methodological technique in this research studies is perceived to have a standard dimension to facilitate as an instrument how to assess the interrelationship among knowledge, innovation and technology management capabilities. Since experience experts will appraise this research belongs to the broad research domain associated with S&T (science and technology) in Pakistan, the capabilities somehow fit the environment of R&D in Pakistani public firms. Furthermore, this study can involve in improving supporting management capabilities for the public organization. Additionally, these capabilities could facilitate to create unified National innovation mechanism. In general terms, beside the R&D other functions of public organization could adopt the proposed model in systematically way depends upon their existing requirements. In practical node, this study used to formulate the most suitable orientation for future national innovation policy because factors arranged in the model were expected to be fit to R&D in Pakistan Public organizations.

6.4 Limitation

This research posse's number of limitations. Since, it could be arguable that identification of criteria's and sub-criteria based on extensive systematic review with the bibliometric technique known as co-word analysis. The co-word analysis sketch the postulations on research article keywords comprise a sufficient narration of its content or the adequate associations that paper recognized between problems. But unable to draw complete characteristics of research which is based on comprehensive overview of abstract

It could be arguable that the implementation of the illustrative model may not country specific. That allows evaluating the significance of DANP-based Model in the cross-cultural setting; however, this research argues an in-depth analysis on adopting DANP- based network model specific to Pakistan that could provide enough interpretation

It could be argued that findings are based upon insufficient diverse data set. However, the research offers some of the standard dimensions for instance, the conceptual framework not only contributing to R&D research but also conceived as a generic adoption model. Also, the integrated approach is not new now. But the process through which they have been utilized to rectify the complication regarding multidisciplinary characteristic relate to R&D in public organization.

6.5 Future Recommendation

The research findings acknowledge numerous opportunities for future avenues since this research utilizing co-word analysis as bibliometric technique. This technique condenses substantial data sets that offer specific visualized pattern with the preservation of crucial information enclosed in the data. This information can also be improved for future research since substantial contribution of publication included in each year (From 2000 to 2017). Therefore, more improved analysis no need to require the data over comparatively long periods to produce the map. This allows researchers to analyze short terms variations within research fields.

This research faces specific limitation in case of co-word analysis, as visualization pattern includes title words and author keywords. Since the title words are less accurate, a higher coverage can be expected. Therefore, visualization on abstract words opens further research avenues where co-word mapping includes abstract words instead of title word that may improve the characterization of research fields.

There are few other recommendations for the future exploration: For instance, to enhance management perspective of R&D in the Public organization it has to be presented in the integrated form as Focus Group Discussion (FGD) and DANP Model. The illustrative model can be implemented to other functions as to resolves their core activities. In term of research exploration at the national level, the proposed conceptual model allows researchers and experts aspire to manage R&D in the Public organization. As R&D in public organizations of Pakistan somehow shares the similar social, background but for the multi-ethical environment further investigation required to confront diverse environment. The proposed model also leads toward future research in-shape of involving the factors from Privately-owned R&D for both developing and developed countries. Researchers and Experts related to R&D could ratify the range of influencing capabilities to acknowledge in the research that may further be refined and validated through same FGD and DANP technique with different countries with the different organizational setting.

6.6 Summary

In sum, the research has met the objectives to (a) Classify the capabilities related to supporting management discipline that contributes to R&D (b) Provide methodological framework to analyze the interrelationship among the capabilities related to supporting management discipline for R&D in Public Organizations of Pakistan (c) Prioritize the capabilities that involve at R&D in public organizations based on their interdependency in case of Pakistan. Although the research was limited to R&D in Public organization of Pakistan, it contributes to the body of knowledge at different levels: To the chosen country, to developing countries, and to knowledge, innovation and technology management research. In addition, the recommendations for generalizing the research findings to further research have been presented for the benefit of the future research

REFERENCES

Abbas, H. (2012). *Optimizing Research and Developement Performance using Knowledge Management* (PhD), University of engineering and technology, Taxila. (1-102)

Abetti, P. A. (1989). Linking technology and business strategy. *American Management Association*.

Abramo, D'Angelo, & Caprasecca. (2009). Allocative efficiency in public research funding: Can bibliometrics help? . *Research Policy, 38*(1), 206-215.

Accorsi, & Costa. (2008). Peer-to-peer systems consubstantiating the Ba concept. *Electronic Journal of Knowledge Management, 6*(1), 1-12.

Acocella. (2012). The focus groups in social research: advantages and disadvantages. *Quality & Quantity, 46*, 1125-1136.

Acs, Z. J., Audretsch. (1989). Patents as a measure of innovative activity. *Kyklos, 4*, 171–180.

Adams, Bessant, & Phelps. (2006). Innovation management measurement: A review. *International Journal of Management Reviews, 8*(1), 21-47.

Afza, & Nazir. (2007). Economic Competitiveness and Human Resource Development: An FDI Perspective. *Political Economy and Social Review, 45*(2), 167-180.

Agar, & MacDonald. (1995). Focus groups and ethnography. *Human Organization, 54*, 78–86.

Ahuja, G., Katila. (2001). Technological acquisition and the innovative performance of acquiring firms: a longitudinal study. *Strategic Management Journal, 22*, 197–220.

Akgün, Keskin, Byrne, & Aren. (2007). Emotional and Learning Capability and Their Impact on Product Innovativeness and Firm Performance. *Technovation, 27*(1), 501–513.

Akroush. (2006). Effects of marketing assets and capabilities on performance: an empirical investigation of banks operating in Jordan. *An empirical investigation of banks operating in Jordan", Jordan Journal of Business Administration, 2*(3), 440-463.

Aksnes, D. W., Foyn, F., Iversen, E., Solberg, E., Wendt, K., & Wilhelmsen, L. (2017). *Human resources Research and Development Technology Innovation*. Retrieved from Oslo, Norway www.forskningsradet.no/publikasjoner

Alasoini, Hanhike, Lahtonen, Ramstad, & Rouhiainen. (2006). *Learning networks as forums for knowledge creation: a new approach in the search for workplace innovation*. Paper presented at the Innovation Pressure International ProACT Conference 15-17 March, Tampere.

Alavi, & Leidner. (2001). Review: Knowledge management and knowledge management systems: conceptual foundations and research issues. *MIS Quarterly, 25*(1), 107-136.

Albaladejo, H. R. a. M. (2000). Determinants of Innovation Capability in Small UK Firms: An Empirical Analysis. *Eindhoven Centre for Innovation Studies, 200013*, 29.

Alberto Di Minin , J. Z., Peter Gammeltoft. (2012). Chinese foreign direct investment in R&D in Europe: A new model of R&D internationalization? *European Management Journal, 30*, 189-203.

Aleksandras Vytautas Rutkauskas, & Jurgita Raudeliūnienė, I. R. (2014). Integral knowledge, innovation and technology cluster formation nurturing the universal development sustainability in the context of globalization. *Economics and Sociology, 7*(4), 41-58.

Ali, Ullah, & Khan. (2009). Managing innovation and technology in developing countries. *arXiv*.

Ali, M., Egbetokun, A., & Memon, M. H. (2018). Human Capital, Social Capabilities and Economic Growth. *Economies*, *6*(2), 2-18.

Allen. (2004). 50 Years of Engineering Management through the Lens of the IEEE Transactions. *IEEE Transactions on Engineering Management, 51*(4), 391-395.

Allen, N. J., and Meyer. (1996). Affective, Continuance, and Normative Commitment to the Organization. *Journal of Vocational Behavior*, 252–276.

Allen, T. J. O. S. (2014). *Introduction. In: T. J. Allen & R. P. O'Shea (Eds.), Building Technology Transfer within Research Universities: An Entrepreneurial Approach* Cambridge: Cambridge University Press.

Alves, Zen, & Padula. (2011). Routines, capabilities and innovation in the Brazilian wine industry. *Journal of Technology Management and Innovation*, *6*(2), 128-144.

Amara, & landry. (2005). Sources of Information as Determinants of Novelty of Innovation in Manufacturing Firms: Evidence from the 1999 statistics Canada innovation Survey. *Technovation, 25*, 245-259.

Amidon. (1996). The challenge of fifth generation R&D. *Research Technology Management, 39*(4), 33-41.

Amsden, & Tschang. (2003a). A new approach to assessing the technological complexity of different categories of R&D (with examples from Singapore)'. *Research Policy, 32*, 553- 572.

Amsden, & Tschang. (2003b). A new approach to assessing the technological complexity of different categories of R&D (with examples from Singapore)'. *Research Policy, 32*, 553- 572.

Anadon, G. C. a. L. D. (2016). Improving Decision Making for Public R&D Investment in Energy: Utilizing Expert Elicitation in Parametric Models. *Cambridge Working Paper in Economics, 1682*(1), 1-54.

Andersson, U. (2003). Managing the Transfer of Capabilities within Multinational Corporations." *Scandinavian Journal of Management, 19*(4), 425–442.

Andreeva. (2012). A Does knowledge management really matter? Linking knowledge management practices, competitiveness, and economic performance. *Journal of Knowledge Management, 16*(4), 617-636.

Ang, & Chai. (2010). *Strategic heuristic and valuation of defence R&D investments: A real options approach*. Paper presented at the 5th IEEE International Conference on Management of Innovation and Technology.

Anil. (2006). Strategies for global R&D: a study of 31 companies reveals different models and approaches to the conduct of low-cost R&D around the world. *Research Technology Management, 49*(2), 48- 57.

Antikainen, M., M. Mäkipää, and M. Ahonen. (2010). Motivating and supporting collaboration in open innovation. *European Journal of Innovation Management, 13*(1), 100–119.

Antman, Lau, Kupelnick, Mosteller, & Chalmers. (1992). A comparison of results of meta-analyses of randomized control trials and recommendations of clinical experts Treatments for myocardial infarction. *JAMA, 268*, 240–248.

Antonio, Richard, Esther, & Tang. (2010). The impact of technological innovation capabilities on innovation performance. *Journal of Science and Technology Policy in China, 1*(2), 163 - 186.

Anwar-ul-Hassan, & Ansari, F. L. (2015). STI, policy *STI Voice Quarterly Newsletter, 1*(4).

Anwar-ul-Hassan Gilani , F. L. A. (2015). STI, policy *STI Voice Quarterly Newsletter, 1*(4).

Aoshima. (1994). *System-based improvement and knowledge transfer across multiple generations of product development projects. International motor vehicle program*. Cambridge: MIT Press.

Arabella Bhutto, P. I. R., Qazi Moinuddin Abr. (2012). Indicators for science and technology policy in Pakistan: Entering the science, technology and innovation paradigm. *Science and Public Policy, 39*.

Arasti, M. R., Khaleghi, M., & Noori, J. (2010). *The Linkage of Technology Strategy and Overall Strategy of Multi Business Diversified Groups: Literature Review and Theoritical Framework.* Paper presented at the Technology Management for Global Economic Growth (PICMET), 2010 Proceedings of PICMET '10:, Phuket, Thailand

Arber. (2001). *Desiging Samples. In: Gilbert N, ed*. London

Archibugi. (1992). Patenting as an indicator of technological innovation: a review. *Science and Public Policy, 6*, 357–358.

Archibugi, Filippetti, & Frenz. (2013). Economic crisis and innovation: Is destruction prevailing over accumulation *Research Policy, 42*(2), 303-314

Armbrecht, F. M. R., Chapas, R. B., Chappelow, C. C., Farris, G. F., Friga, P. N., Hartz, C. A., McIlvaine, M. E., & Whitwell, S. R. P. G. E. (2016). Knowledge Management in Research and Development. *Research-Technology Management, 42*(21).

Arora, Ceccagnoli, & Cohen. (2008). R&D and the patent premium. *International Journal of Industrial Organization, 26*(2), 1153–1179.

Arrau, G. P. (2015). *Knowledge Management in the context of developing countries: the case of Chile" paper given at the 16th European Conference in Knowledge Management. September 2015, University of Udine Italy,*. Paper presented at the European Conference in Knowledge Management. September 2015, University of Udine Italy, Udine, Italy.

Arvanitis, Kubli, & Woerter, a. (2008). University industry knowledge and technology transfer in Switzerland: What university scientists think about cooperation with private enterprises. *Research Policy, 37*(10), 1865–1883.

Audretsch, Bozeman, Combs, Feldman, Link, Siegel, Stephan, Tassey, & Wessner. (2002). The economics of science and technology. *Journal of Technology Transfer, 27*, 155- 203.

Aujirapongpan, Vadhanasindhu, Chandrachai, & Cooparat. (2010). Indicators for Knowledge Management Capability for KM Effectiveness. *The Journal of Information and Knowledge Management Systems, 40*(2), 183-203.

Aujirapongpan, S., Vadhanasindhu, P., Chandrachai A., and Cooparat, P. (2010). Indicators of Knowledge Management Capability for KM Effectiveness. *The Journal of Information and Knowledge Management Systems, 40*(2), 183-203.

Ayse Kaya Firat, W. L. W., Stuart Madnick (2008). Technological Forecasting – A Review. *Composite Information Systems Laboratory (CISL), Massachusetts Institute of Technology*.

Aziz, Harris, & Norhashim. (2011). University Research, Development & Commercialisation Management: A Malaysian Best Practice Case Study. *World Review of Business Research, 1*(2), 179-192.

Babelyte-Labanauske, K., & Nedzinskas, S. (2016). Dynamic capabilities and their impact on research organizations' r & d and innovation performance. *Journal of Modelling in Management, 12* (4), 603-630.

Baccarini, Salm, & Love. (2004). Management of risks in information technology projects. *Industrial Management & Data Systems, 104*(4), 286-295.

Bäck, I., & Kohtamäki, M. (2016). Joint Learning in Innovative R&D Collaboration. *Industry and Innovation*.

Badawy. (1998). Technology management education: alternatives models. *California Management Review, 40*(4), 94–116.

Baecker. (2006). The Form of the Firm. *Organization Science, 13*(1), 109-142.

Bakry. (2009). *The ecosystem of the knowledge society (in Arabic). Riyadh*. Retrieved from Saudi Arabia:

Bakry, & Alfantoukh. (2010). Toward building the knowledge culture. *International Journal of Knowledge Society Research, 1*(1), 46–64.

Ballot, Fakhfakh, & Taymaz. (2001). Firms' Human Capital, R&D and Performance: A Study on French and Swedish Firms. *Labour Economics, 8*(1), 443–462.

Bamfield. (2006). *Research and Development in the Chemical and Pharmaceutical Industry*. Weinheim: Wiley-VCH.

Bank, W. (2010). *Innovation Policy: A Guide for Developing Countries*: World Bank Publications.

Bank, W. (2018). Research and development expenditure. Retrieved from https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?view=map

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management Information Systems, 17*(1), 99–120.

Barry, Kosnik, & Turk. (1991). Effects of board and ownership structure on corporate R&D strategy. *Academy of Management Journal, 34*(1), 205- 214.

Barthélemy, J. a. Q. (2006). Complexity of outsourcing contracts and ex post transaction costs: an empirical investigation. *Journal of management studies, 43*, 1775–1797.

Bashir, Bakhtiar, & Gilani. (2018). Overcoming Challenge of R&D and Innovation Financing in Developing Countries: A Proposed Way Forward for Pakistan *Science, Technology and Development, 37*(3), 139-148.

Bashir, M., & Bashir, D. T. (2014). Science, Technologyand Innovation Indicators of Pakistan. *Pakistan Council for Science and Technology, Islamabad*.

Bayarcelik, E. B., & Tasal, F. (2012). Research and Development: Source of Economic Growth *Social and Behavioral Sciences, 58*(1), 744 – 753

Beers, C., & Zand, F. (2014). R&D Cooperation, Partner Diversity, and Innovation Performance: An Empirical Analysis. *The Journal of Product Innovation Management, 31*(2), 292–312.

Belderbos, Carree, & Lokshin. (2004). Cooperative R&D and Firm Performance. *Research Policy, 33*, 1477-1492.

Benn Lawson, D. S. (2001). Developing innovation capability in organisations: A dynamic capabilities approach. *International Journal of Innovation Management, 5*(3), 377-400.

Benn Lawson, D. S. (2001). Developing Innovation capability in Organization :A dynamic capbilities approach *International Journal of Innovation Management, 5*(3), 377-400.

Benner, M. (2003). Exploitation, exploration and process management: the productivity dilemma revisited. *The Academy of Management Review, 28*, 238-256.

Benner, M. (2002). Process management and technological innovation: A longitudinal study of the photography and paint industries. *Administrative Science Quarterly, 47*(4), 676-707.

Bes, D., & Kotler. (2011). *A bíblia da inovação: princípios fundamentais pata levar a cultura da inovação contínua às organizações*. São Paulo: Lua de papel.

Bessant, Lamming, Noke, & Phillips. (2005). Managing innovation beyond the steady state. *Technovation, 25*(12), 1366-1376.

Bessant, & Tidd. (2007). *Innovation and entrepreneurship*. NJ: John Wiley & Sons.

Bharadwaj, A. S. (2000). A resource-based perspective on information technology capability and firm performance: an empirical investigation. *MIS Quarterly*, 169-196.

Bhutto, Rashd, & Qazi. (2012). Indicators for science and technology policy in Pakistan: Entering the science, technology and innovation paradigm. *Science and Public Policy, 39*.

Black, & Boal. (1994). Strategic resources: Traits, configurations and paths to sustainable competitive advantage. *Strategic Management Journal, 15*, 131-148.

Blomqvist, Harkink, Drongelen, Kuittinen, & Ojanen. (2004a). *Challenges and possibilities for knowledge-based firms.* Paper presented at the International Engineering Management Conference, 2004.

Blomqvist, Harkink, Drongelen, Kuittinen, & Ojanen. (2004b). *Measuring Innovativeness - Challenges and possibilities for knowledge-based firms*. Paper presented at the International Engineering Management Conference.

Blomqvist, Harkink, K. D., Kuittinen, & Ojanen. (2004). *Measuring Innovativeness - Challenges and possibilities for knowledge-based firms* Paper presented at the International Engineering Management Conference.

Blomqvist, K., Harkink, E., Drongelen, K., Kuittinen, O., and Ojanen,. (2004). *Measuring Innovativeness – Challenges and possibilities for knowledge-based firms challenges and possibilities for knowledge-based firms.* Paper presented at the International Engineering Management Conference.

Bloor, Frankland, Thomas, & Robson. (2000). *Focus groups in social research.* London: Sage.

Bloor, Frankland, Thomas, & Robson. (2001). *Focus groups in social research 2nd Edition*. London: Sage Publications.

Blosch. (2001). Pragmatism and organizational knowledge management. *Knowledge and Process Management, 8*(1), 39-39.

Bolisani. (2000). Electronic communication and knowledge transfer. *International Journal of Technology Management, 20*(1-2), 116-133.

Börjesson, & Elmquist. (2011). Developing Innovation Capabilities : A Longitudinal Study of a Project at Volvo Cars. *Creativity and Innovation Management, 20*(3), 171-184.

Boscoianu, Prelipcean, & Lupan. (2017). Innovation enterprise as a vehicle for sustainable development – A general framework for the design of typical strategies based on enterprise systems engineering, dynamic capabilities, and option thinking. *Journal of Cleaner Production, 172,* 3498-3507.

Bounfour, A., & Miyagawa, T. (2014). *Intangibles, Market Failure and Innovation Performance*: Springer International Publishing.

Bowns, Bradley, Knee, William, & Williams. (2003). Measuring the economic benefits from R&D: improvements in the MMI model of the United Kingdom National Measurement System. *Research Policy, 32*(6), 991-1002.

Bowonder, & Miyake. (2000). Technology management: a knowledge ecology perspective *International Journal of Technology Management, 19*(7-8), 662-684.

Brennan, R., and P. W. Turnbull. (1999). Adaptive Behavior in Buyer–Supplier Relationships. *Industrial Marketing Management 28*(5), 481–495.

Brennenraedts, Bekkers, & Verspagen. (2006). *The different channels of university-industry knowledge transfer: Empirical evidence from Biomedical Engineering.* (PhD), Eindhoven, Netherlands.

Brockhoff. (1992). R&D cooperation between firms — A perceived transaction cost. *perspective. Management Science, 38*(4), 514–524.

Brockhoff. (2003). Exploring strategic R&D success factors. *Technology Analysis & Strategic Management,, 15*(3), 333- 348.

Brockhoff, K. (2017). The emergence of technology and innovation management. *Technology and Innovation, 19*(1), 461-480.

Browne, & Geiger. (2010). *The Executive Opinion Survey: The Business Executives' Insight into their Operating Environment*. Retrieved from Geneva:

Bruce, & Birchall. (2009). *Via expressa para o sucesso em inovação*. São Paulo.

Brunswicker, S., & Vanhaverbeke, W. (2014). Open innovation in small and mediumsized enterprises (SMEs): External knowledge sourcing strategies and internal organizational facilitators. *Journal of Small Business Management*.

Bruton, Dess, & Janney. (2007). Knowledge management in technology-focused firms in emerging economies caveats on capabilities, networks, and real options. *24*, 115-130.

Bryman. (2004). *Social research methods*. Oxford: Oxford University Press.

Bucheli, V. A., and F.A. Gonzalez. (2007). Technology monitoring software tool – VIGTECH. *Revista Avances en Sistemas e Informática*, *4*(1), 117–126.

Bukhamsin. (2015). *Investigating the Relationship between Organizational Innovation Capability and Firm Performance with Irish SMEs.* (MSc in Computing(Information and knowledge Management)), Dublin Institute of Technology

Burgelman, Maidique, & Wheelwright. (2001). *Strategic Management of Technology and Innovation.* New York, USA: McGraw-Hill.

Burgelman, R., Maidique, M.A., Wheelwright, S.C. (2004). *Strategic Management of Technology and Innovation*. New York: McGraw-Hill,.

Burton-Jones. (2000). *Cross Cultural management: A Knowledge management perspective*: Pretence Hall.

Byers, & Wilcox. (1991). Focus groups: a qualitative opportunity for researchers. . *Journal of Business Communication, 28*(1), 63-78.

Byrd, and, & Turner. (2000). An exploratory analysis of the information technology infrastructure flexibility construct. *Journal of Management Information Systems, 17*(1), 167-208.

Cabrales, Medina, Lavado, & Cabrera. (2008). Managing functional diversity, risk taking and incentives for teams to achieve radical innovations. *R&D Management, 38*(1), 35-50.

Cabrera. (2005). Fostering Knowledge Sharing Through People Management Practices. *International Journal of Human Resource Management, 16*, 720– 735.

Cabrera, Collins, & Salgado. (2006). Determinants of Individual Engagement in Knowledge Sharing. *International Journal of Human Resource Management, 17*, 245–264.

Cabrera, E. F., and Cabrera. (2005). Fostering Knowledge Sharing Through People Management Practices. *International Journal of Human Resource Management, 16*, 720– 735.

Calantone, R. J., Cavusgil, S.T. and Zhao, Y. . (2002). Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management,, 31*(6), 515-524.

Callon, M., Courtial, & Laville, F. (1991). Co-word analysis as a tool for describing the network of interactions between basic and technological research: The case of polymer chemistry. *Scientometrics, 22*(1), 1991.

Cambrosio, Limoges, Courtial, & Laville. (1993). Historical scientometrics? Mapping over 70 years of biological safety research with co-word analysis. *Scientometrics*, *27*(2), 119–143.

Camelo-Ordaz, C., García-Cruz, J., Sousa-Ginel, E., & Valle-Cabrera, R. (2011). The influence of human resource management on knowledge sharing and innovation in Spain: the mediating role of affective commitment. *The International Journal of Human Resource Management, 22*(7), 1442-1463.

Cantwell, J., & Zhang, Y. (2005). *Japan's R&D Internationalization and its Institutional Environment*: Gabler Verlag.

Carayannis, & Provance. (2008a). International Journal of Innovation and regional Development. *Measuring firm innovativeness: towards a composite innovation index built on firm innovative posture propensity and performance attributes, 1*(1), 90-107.

Carayannis, & Provance. (2008b). Measuring firm innovativeness: towards a composite innovation index built on firm innovative posture propensity and performance attributes. *Internation Journal of Innovation and regional Development, 1*(1), 90-107.

Carneiro. (2000). How does knowledge management influence innovation and competitiveness?. . *Journal of Knowledge Management, 4*(2), 87-98.

Carrillo, Robinson, Anumba, & Al-Ghassani. (2003). IMPaKT: a framework for linking knowledge management to business performance. *Electronic Journal of Knowledge Management, 1*(1), 1-12.

Castellacci, & Archibugi. (2008). The technology clubs: the distribution of knowledge across nations. *Research Policy, 37*, 1659- 1673.

Cetindamar, Phaal, & Probert. (2009). Understanding Technology Management as a Dynamic Capability: A Framework for Technology Management Activities. *Technovation*, *29*, 237-246.

Cetindamar, Phaal, & Probert. (2010). *Technology Management: Activities and Tools*: Palgrave Macmillan.

Cetindamar, Phaal, & Probert. (2016). *Technology Management: Activities and Tools*: 2nd Edition, Palgrave Macmillan.

Cetindamar, Phaal, & Probert. (2017). *Technology Management: Activities and Tools*: 3nd Edition, Palgrave Macmillan.

Cetindamar, D., Phaal, R., & Probert, D. (2009). Understanding Technology Management as a Dynamic Capability: A Framework for Technology Management Activities. *Technovation*, *29*, 237-246.

Cetindamara, D., Phaal, R., & Probert, D. (2009). Understanding technology management as a dynamic capability: A framework for technology management activities. *Technovation, 29*(4), 237–246.

Chan, I., and Chao, C. (2008). Knowledge management in small and medium-sized enterprises. *Communications of the ACM, 51*(4), 83-88.

Chandy, & Tellis. (2000). The Incumbent's Curse? Incumbency, Size, and Radical Product Innovation. *The Journal of Marketing, 64*(3), 1-17.

Chang, & Chuang. (2011). Social Capital and Individual Motivations on Knowledge Sharing: Participant Involvement as a Moderator. *Information & Management, 48*(1), 9–18.

Chang, & Gotcher. (2007). Safeguarding Investments and Creation of Transaction Value in Asymmetric International Subcontracting Relationships: The Role of Relationship Learning and Relational Capital. *Journal of World Business, 42*(4), 477–488.

Chang, K.-H., and D. F. Gotcher. (2007). Safeguarding Investments and Creation of Transaction Value in Asymmetric International Subcontracting Relationships: The Role of Relationship Learning and Relational Capital. *Journal of World Business, 42*(4), 477–488.

Chang, Y. a. H., M. (2012). Drivers of innovation ambidexterity in small- to medium-sized firms. *European Management Journal, 30*, 1-17.

Chanwoo Cho, Jong Ku Son and Sungjoo Lee. (2016). Comparative Analysis of R&D-Based Innovation Capabilities in SMEs to Design Innovation Policy. *Science and Public Policy*, 1–14.

Chen, Hsu, & Tzeng. (2011a). A balanced scorecard approach to establish a performance evaluation and relationship model for hot spring hotels based on a hybrid MCDM model combining DEMATEL and ANP *International Journal of Hospitality Management*, 908-932.

Chen, Hsu, & Tzeng. (2011b). A balanced scorecard approach to establish a performance evaluation and relationship model for hot spring hotels based on a hybrid MCDM model combining DEMATEL and ANP. *International Journal of Hospitality Management, 30* 908-932.

Chen, Lin, & Chuang. (2016). Closing the Skill Gap of Cloud CRM Application Services in Cloud Computing for Evaluating Big Data Solutions. *International Journal o f Geo-Information, 5*(227).

Cheng, Liou, & Chiu. (2017). A consistent fuzzy preference relations based ANP model for R&D project selection. *Sustainability, 9*(8).

Chesbrough. (2003a). The Era of Open Innovation. *MIT Sloan Management Review, 44*(3), 35-38

Chesbrough. (2003b). *Open Innovation – The New Imperative for Creating and Profiting from Technology* Retrieved from Boston

Chesbrough. (2003c). *Open innovation: the new imperative for creating and profiting from technology*. Retrieved from Cambridge, MA:

Chesbrough, & Crowther. (2006). Beyond high tech: early adopters of open innovation in other industries. *R&D Management, 36*(3), 229-236.

Chiara Franco, A. M. a. S. M. (2012). *Absorptive capacity, innovationcooperation and human-capital. Evidence from 3 European countries*. Retrieved from Seville (Spain):

Chiesa, Frattini, Lazzarotti, & Manzini. (2008a). Designing a performance measurement system for the research activities: A reference framework and an empirical study. *Journal of Engineering and Technology Management, 25*(3), 213-226.

Chiesa, Frattini, Lazzarotti, & Manzini. (2008b). Designing a performance measurement system for the research activities: A reference framework and an empirical study. *Journal of Engineering and Technology Management, 25*(3).

Chioncel, Veen, V. D., Wildemeersch, & Jarvis. (2003). The validity and reliability of focus groups as a research method in adult education. *International Journal of Lifelong Education*, *22*(5), 495-517.

Chiu. (2006). *Metro Manila Solid Waste Management and Circular Economy Promotion Study*. Retrieved from

Chiu, Chen, Shyu, & Tzeng. (2006). Marketing strategy based on customer behavior for the LCD-TV. *International Journal of Management Decision Making, 7*(2), 143-165.

Chiu, Tzeng, & Li. (2013). A new hybrid MCDM model combining DANP with VIKOR to improve e-store business. *Knowledge Based System, 37,* 48–61.

Choi, & Jong. (2010). Assessing the impact of knowledge management strategies announcements on the market value of the firms. . *Information and Management, 47*, 42–52.

Choi, H. (2003). An empirical investigation of knowledge management styles and their effect on corporate performance. *Information and Management, 40*(5), 403-417.

Choong, K. K. (2008). Intellectual capital: definitions, categorization and reporting models. *Journal of Intellectual Capital, 9*(4), 609-638.

Chou. (2002). *The Australian Growth Experience (1960-2000), R &D based, Human Capital-Based or Just Steady State Growth*.

Chou, Wang, & Tang. (2015). Exploring the determinants of knowledge adoption in virtual communities: A social influence perspective. *International Journal of Information Management, 35*(3), 364-376.

Chuang, Byrd, lewis, & Ford. (2005). Empirical study of relationship between It infrastucture flexibity *ACM Sigmis Database, 36*(3), 26-44.

Cirera, Xavier, Maloney, & William. (2017). *The Innovation Paradox : Developing-Country Capabilities and the Unrealized Promise of Technological Catch-Up*. Retrieved from Washington, DC: World Bank: https://openknowledge.worldbank.org/handle/10986/28341

Clark, & Fujimoto. (1991a). *Product development performance*

Boston (MA): Harvard Business School Press.

Clark, & Fujimoto. (1991b). *Product Development Performance: Strategy, Organization, and Management in the World Auto Industry*. Boston: Harvard Business School Press.

Clark, & Wheelwright. (1993). *Managing new product and processes development: Text and cases*. New York: Free Press.

Clark, K. (1989). What strategy can do for technology. *Harvard Business Review, 12*, 94–98.

Coates. (2001). On the future of technological forecasting. *Technological Forecasting and Social Change, 67*(1), 1-17.

Cohen, & Levinthal. (1989). Innovation and learning: The two faces of R&D. *Economic Journal of Operations Management, 99*, 569–596.

Cohen, & Levinthal. (1990a). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly, 35*(1), 128–152.

Cohen, & Levinthal. (1990b). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly, 35*, 128-152.

Collins. (2006). Opening Up the Innovation Process. *Engineering Management Journal, 16*(1), 14-17.

Colucci, E. (2008). On the Use of Focus Groups in Cross-Cultural Research. *Doing Cross-Cultural Research, 34*, 233-252.

Coombs, G. (1991). Cross-functional pay strategies in high technology firms'. *Compensation and Benefit Review, 23*(5), 40–48.

Cooper. (1983). A process model for industrial new product development. *IEEE Transactions on Engineering Management, 30*(1), 1983.

Cooper. (1985). The role of incubator organizations in the founding of growth-oriented firms. *Journal of Business Venturing, 1*(1), 75-86.

Cooper. (1998). A multidimensional approach to the adoption of innovation. *Management Decision, 36*(8), 493-502.

Cooper, & Kleinschmidt. (1995). Benchmarking firms' new product performance and practices. *IEEE Engineering Management review, 23*(3).

Cooper, & Schindler. (2008). *Business research methods*. Boston: McGraw-Hill.

Corbin, & Strauss. (2008). *Basics of qualitative research, techniques and procedures for developing grounded theory* Thousand Oaks: Sage Publications.

Corsaro, Cantu`, & Tunisini. (2012). Actors' Heterogeneity in Innovation Networks. *Industrial Marketing Management, 41*(5), 780–789.

Council, N. N. R. (1987). *Management of Technology: The Hidden Competitive Advantage,* . Washington, DC: National Academy Press.

Courtial, M. C., & Sigogneau. (1993). The use of patent titles for identifying the topics of invention and forecasting trends. *Scientometrics, 26*(2), 231–242.

Cozzarin. (2006). Performance measures for the socio-economic impact of government spending on R&D. *Scientometrics, 68*(1), 41-71.

Cozzarin. (2008a). Data and the measurement of R&D program impacts. *Evaluation and Program Planning, 31*(3), 284-298.

Crabtree, Yanoshik, Miller, & O'Connor. (1993). *Selecting individual or group interviews. Successful focus groups*.

Cristol, & Mellet. (2013). Développer une université d'entreprise: créer un levier de business development. *Sociales francaises, ESF Éditeur*.

Crossan, & Apaydin. (2010). A Multi-Dimensional Framework of Organizational Innovation A Systematic Review of the Literature. *Journal of management studies, 47*(6), 1154-1191.

Croteau, Solomon, Raymond, & Bergeron. (2001). *Organizational and technological infrastructures alignment*. Paper presented at the System Sciences, 2001. Proceedings of the 34th Annual Hawaii International Conference on system science Maui, HI, USA.

Croteau, A.-M., & Bergeron, F. (2001). An information technology trilogy: business strategy, technological deployment and organizational performance. *The Journal of Strategic Information Systems, 10*(2), 77–99.

Cuervo-Cazurra, & Asakawa, K. (2010). R&D Collaborations and Product Innovation. *Journal of Product Innovation Management, 27*(5), 673–689.

Culnan. (1986). The intellectual development of management information systems Management *Management Science, 32* 156–172.

Cummings. (2004). Work Groups, Structural Diversity, and Knowledge Sharing in a Global Organization. *Management Science, 50*(3), 352–364.

Cunningham, & Kwakkel. (2011). Innovation Forecasting: A case study of the management of engineering and technology literature. *Technological Forecasting & Social Change, 78*, 346-357.

Dachs, B., Ebersberger, B. and Pyka (2008). Why do Firms Co-operate for Innovation? A comparison of Austrian and Finnish CIS 3 results. *Journal of Foresight and Innovation Policy, 4*(3-4), 200-229.

Dahlander, L. G., D. M. (2010). How Open is Innovation? . *Research Policy, 39*,, 699-709.

Damanpour. (1991). Organizational innovation: a meta-analysis of effects of determinants and moderators. *The Academy of Management Journal, 34*, 555-590.

Damanpour, F. (1991). Organizational innovation: a meta-analysis of effects of determinants and moderators. *Academy of Management Journal, 34*, 555– 590.

Damanpour, F., Szabat, K.A., and Evan, W.M. (1989). The relationship between types of innovation and organizational performance. *Journal of Management Studies., 26*(6), 587-601.

Daniels, H., & Smits, M. (2005). *Portfolio Optimization as a Tool for Knowledge Management.* Paper presented at the Annual International Conference of the German Operations Research Society (GOR), Bremen.

Dasgupta, P.T (2011). Low Carbon Growth: An Indian Perspective on Sustainability and Technology Transfer. *Problems of Sustainable Development,, 6*, 65–74.

David, S. (2005). The Emerging Discipline of Knowledge Management. *Journal of Knowledge Management, 1*(2), 1-11.

Davies, N. J. (2000). Knowledge Management. *BT Technology Journal of, 18*(1), 62-63.

Deepika rohatgi, R. (2016). The Contribution of Various Government Policies and Schemes in Facilitating and Fostering an Inclusive, Innovative, Technology Enabled Stable Industrial Growth with Enhanced R&D Investments *Indian Natn Sci Acad*, 1-25.

Dell'Anno, D., & Del Giudice, M. (2015). Absorptive and desorptive capacity of actors within university-industry relations: does technology transfer matter? *Journal of Innovation and Entrepreneurship, 4*(1), 13.

DeLong, D. (1997). Building the knowledge-based organization: how culture drives knowledge behaviors Working paper In E. Y. Innovation (Ed.). Boston.

Denicolai, S., Ramirez, M., & Tidd, J. (2016). Overcoming the false dichotomy between internal R&D and external knowledge acquisition: Absorptive capacity dynamics over time. *Technological Forecasting & Social Change, 104*, 57-65.

Dennis, Flavin, & Davies. (1998). Online R&D management: the way forward. *R&D Management Review, 28*(1), 27-36.

DeSarbo, W. S., Benedetto, C. A., Song, M. and Sinha. (2005). 'Revisiting the miles and snow strategic framework: uncovering interrelationships between strategic types, capabilities, environmental uncertainty, and firm performance'. *Strategic Management Journal, 26*, 47–74.

Díaz-Díaz, Aguiar-Díaz, & Saá-Pérez, D. (2008). The Effect of Technological Knowledge Assets on Performance: The Innovative Choice in Spanish Firms. *Research Policy, 37*(9), 1515–1529.

Dilek Cetindamar, R. P., David Probert. (2009). Understanding technology management as a dynamic capability: A framework for technology management activities. *Technovation, 29*, 237–246.

Dilek Cetindamara, R. P., David R. Probert. (2016). Technology management as a profession and the challenges ahead. *Journal of Engineering and Technology Management, 41*, 1-13.

Dimitrios Kafetzopoulos, E. P. (2015). The impact of innovation capability on the performance of manufacturing companies: The Greek case. *Journal of Manufacturing Technology Management, 26*(1), 104 - 130.

Ding, Chowdhury, & Foo. (2001). Bibliometric cartography of information retrieval research by using co-word analysis. *Information Processing & Management, 37*(6), 817-842.

Dingyong, Yizhen, Long, & Zheng. (2009). *Application Research of Knowledge Management in R&D Enterprise Project Management*. Paper presented at the International Conference on Information Management, Innovation Management and Industrial Engineering.

Dodge, R., Dwyer, J., Witzeman, S., Neylon, S., & Taylor, S. (2017). The Role of Leadership in Innovation. *Research-Technology Management, 60*(3), 22-29.

Dodgson, Gann, & Salter. (2008). *The Management of Technological Innovation: Strategy and Practice.* . UK: Oxford University Press.

Doyle, & O'Connor. (2013). Innovation capacities in advanced economies: Relative performance of small open economies. *Research in International Business and Finance, 27*, 106–123.

Drejer. (1997). The Discipline of Management of Technology, Based on Considerations Related to Technology. *Technovation, 17*(5), 253–265.

Drejer. (2002). Towards a model for contingency of management of technology. *Technovation, 22*(6), 363-370.

Dutta, Lanvin, & Wunsch-Vincent. (2014). The Global Innovation Index 2014: The Human Factor in Innovation. Geneva. *World Intellectual Property Organization*.

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2015-2016). *The Global Innovation Index 2015 Effective Innovation Policies for Development*. Retrieved from

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2016a). *The Global Innovation Index 2015 Effective Innovation Policies for Development*. Retrieved from

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2016b). *The Global Innovation Index 2016: Winning with Global Innovation*. Retrieved from Geneva:

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2017). *The Global Innovation Index 2016-2017 Innovation Feeding the World*. Retrieved from www.wipo.int/edocs/pubdocs/en/wipo_gii_2015.pdf

Dutta, S., Lanvin, B., & Wunsch-Vincent, S. (2018). *Global innovation index 2018*. Retrieved from www.wipo.int/edocs/pubdocs/en/wipo_gii_2018.pdf

Echtelt, V., Wynstra, Weele, v., & Duysters. (2008). Managing Supplier Involvement in New Product Development: A Multiple-Case Study. *Journal of Product Innovation Management, 25* (2), 180–201.

Edgett, S. J. (2014). People: A Key to Innovation Capability *European Business Review*, 10-12.

Edler, Cameron, & Hajhashem. (2015). *The intersection of intellectual property rights and innovation policy making–a literature review*. Retrieved from Manchester:

Edler, Cunningham, Gök, & Shapira. (2016). *Handbook of Innovation Policy Impact*: Edward Elgar Publishing.

Edler, J., Cunningham, P., Gök, A., & Shapira, U. M. P. (2016). *Handbook of Innovation Policy Impact*: Edward Elgar Publishing, Incorporated.

Egbetokun, A., Oluwadare, A. J., Ajao, B. F., & Jegede, O. O. (2017). Innovation systems research: an agenda for developing countries. *Journal of Open Innovation: Technology, Market, and Complexity, 3*(25), 1-16.

Ehigie, & McAndrew. (2005). Innovation, diffusion and adoption of total quality management (TQM). *Management Decision, 43*(6), 925 - 940.

Ehrlenspiel, K., Kiewert, A., Lindemann. (2007). *Cost-effective development and construction: Cost Management in Integrated Product Development,* . Heidelberg: 6th edition Springer.

Einsehardt, & Martin. (2000). Dynamic capabilities: What are they. *Strategic Management Journa, 21*(10/11), 1105-1121.

Eisenhardt, & Martin. (2000). Dynamic capabilities: what are they? *Strategic Management Journal, 21*(10), 1105-1121.

Eisenhardt, K. M., and J.A. Martin. (2000). Dynamic capabilities: What are they. *Strategic Management Journal, 21*, 1105–1121.

Elahi, S. b., Kalantari, N., Azar, A., & Hassanzadeh, M. (2016). Impact of common innovation infrastructures on the national innovative performance: mediating role of knowledge and technology absorptive capacity. *Innovation Management Policy & Practice*.

Eldred, & McGrath. (1997a). Commercializing new technology-I. *Research-Technology Management, 40*(01).

Eldred, & McGrath. (1997b). Commercializing new technology-II. *Research-Technology Management, 40*(02).

Erasmus, R. (2005). *The impact of communities of practice (cop) on inter-firm alliance research teams.* (PhD), University of south africa south africa

Erciş, A., & Ünalan, M. (2016). Innovation: A comparative case study of Turkey and South Korea Aysel Ercişa , Musa Ünalanb. *Procedia - Social and Behavioral Sciences, 235*, 701 – 708.

Ernst. (2001). Patent applications and subsequent changes of performance: evidence from time-series cross-section analyses on the firm level. *Research Policy, 30*, 143–157.

Escher, J.-P. (2001). The Process of External Technology Exploitation as Part of Technology Marketing A Conceptual Framework *Management of Engineering and Technology, 2001., 1*, 241 - 242.

Eskandari, H., Sala-Diakanda, S., & Furterer. (2007). Enhancing the undergraduate industrial engineering curriculum, Defining desired characteristics and emerging topics. *Education & Training, 49*(1), 45-55.

Eugenia, Huang, & Lin, S. C. (2006). How R&D management practice affects innovation performance: An investigation of the high-tech industry in Taiwan. *Industrial Management & Data Systems, 106*(7).

Evangelista, G. P., F. Rapiti, D. Archibugi. (1997). Nature and impact of innovation in manufacturing: some evidence from the Italian innovation survey. *Research Policy, 26*, 521–536.

Fan, P. (2006). Technovation. *Catching up through developing innovation capability: evidence from China's telecom-equipment industry, 26*, 359-368.

Fang, S., Fang, C., Chou, S.M., Yang, and Tsai. (2011). Relationship Learning and Innovation: The Role of Relationship-Specific Memory. *Industrial Marketing Management, 40* (5), 743–753.

Fey, B. (2005). External Sources of Knowledge, Governance Mode, and R&D Performance. *Journal of Management, 31*, 597-621.

Fildes, R. (2006). The forecasting journals and their contribution to forecasting research: citation analysis and expert opinion. *International Journal of Forecasting, 22*(3), 415–432.

Filippov, S., & Mooi, H. (2010). Innovation project management: A research agenda. *Journal on Innovation and Sustainability. RISUS ISSN 2179-3565, 1*(1).

Fink, & Neumann. (2007). Gaining agility through IT personnel capabilities: The mediating role of IT infrastructure capabilities. *Journal of the Association for Information Systems, 8*(8), 440-462.

Fleischer, T. G. (2008). A. Making nanotechnology developments sustainable. A role for technology assessment? . *Journal of Cleaner Production, 16*(8-9), 889-898.

Floyd. (1997). Managing Technology for Corporate Success Gower.

Ford, D. P., and Chan, Y. E. (2003). Knowledge sharing in a multi-cultural setting: a case study. *Knowledge Management Research & Practice, 1*(1), 11-27.

Forsman, H. (2011). Innovation capacity and innovation development in small enterprises. A comparison between the manufacturing and service sectors. *Research Policy, 40*(5), 739-750.

Foss, Husted, & Michailova. (2010). Governing knowledge sharing in organizations: Levels of analysis, governance mechanisms, and research directions. *Journal of management studies, 47*(3), 455–482.

Foxley, A., & Stallings, B. (2016). *Innovation and Inclusion in Latin America: Strategies to Avoid the Middle Income Trap*: Palgrave Macmillan US.

Freel, M., & Jong, J. P. J. d. (2009). Market novelty, competence-seeking and innovation networking. *Technovation, 29*(12), 873-884.

Freeman, & Soete. (1997). *The Economics of Industrial Innovation*. Cambridge: MIT Press Book.

Freeman, C., Soete. (1997). *The Economics of Industrial Innovation*. Retrieved from London:

Gaillard. (2010). Measuring research and development in developing countries: main characteristics and implications for the Frascati manual. *Science, Technology and Society, 15*(1), 111.

Galende, & Fuente, d. l. (2003). Internal factors determining a firm's innovative behaviour. *Research Policy, 32*(5), 715-736.

Ganguly. (1999). *Business-Driven Research and Development: managing knowledge to create wealth*. England: Macmillan Publishers Ltd.

GarcÃa-Granero, A., Vega-Jurado, J., & Alegre-Vidal, J. (2014). Is R&D Enough to Take Advantage From External Knowledge? Focusing on Coordination Mechanisms. *Journal of Technology Management & Innovation, 9*(2).

Garcia-Hernandez. (2015). A Note on the Validity and Reliability of Multi-Criteria Decision Analysis for the Benefit-Risk Assessment of Medicines. *Global Data Science, 38*(11), 1049-1057.

Garcia, R. (2002). A critical look at technological innovation typology and innovativeness terminology: a literature review. *The Journal of Product Innovation Management and Policy, 19,* 110-132.

Garvin. (1993). Building a Learning Organization. *Harvard Business Review*, 78–91.

Gaynor. (1996). *Handbook of Technology Management*. New York: McGraw-Hill.

Gaynor, G. H. (1989). *Managing technology - Managers don't grow on trees.* Paper presented at the Proceedings of the Second International Conference on Engineering Management, Ontario, Canada.

Gebauer, Ren, Valtakoski, & Reynoso. (2012a). Service-Driven Manufacturing: Provision Evolution and Financial Impact of Services in Industrial Firms. *Journal of Service Management, 23*(1), 120–136.

Geffen, & Judd. (2004). Innovation through initiatives a framework for building new capabilities in public sector research organizations *Journal of Engineering and Technology Management*, *21*(4), 281-306.

Gendron, B. (1977). *Technology and the Human Condition* (Vol. 18): St. Martin's Press.

George, & Mallery. (2010). *SPSS for Windows Step by Step: A Simple Guide and Reference*. Boston: Pearson.

George, Zahra, & Wood. (2002). The effects of business–university alliances on innovative output and financial performance: a study of publicly traded biotechnology companies. *Journal Business Venturing, 17*, 577 – 609.

George, A. Z. (2002). Absorptive capacity: A review, reconceptualization, and extension. *Acad. Manag. Rev, 27*(2), 185-203,.

Gibson. (1981). *Managing Research and Development,* . New York, NY: John Wiley & Sons Inc.

Gilani, A.-u.-H. (2015). Science, Technology, Innovation. *STI Voice, 1*(3).

Gilani, A.-u.-H., & Ansari, F. L. (2015). STI, policy *STI Voice Quarterly Newsletter, 1*(4).

Gillingham, K., Newell, R. G., & Pizer, W. A. (2008). Modeling endogenous technological change for climate policy analysis. *Energy Economics, 30*(6), 2734-2753.

Ginsberg, A. (1998). Measuring and modeling changes in strategy: theoretical foundations and empirical directions. *Strategic Management Journal, 9*(6), 559–575.

Gloet, M. a. T., M. . (2004). Exploring the relationship between knowledge management practices and innovation performance. *Journal of Manufacturing Technology Management, 15*(5), 402-409.

Goedhuys, & Mytelka. (2005a). Measuring innovation: Making innovation surveys work for developing countries United Nations University. *Technology Policy Briefs, 4*(1), 1–12.

Goffin, & Mitchell. (2010). *Innovation management: Strategy and implementation using the Pentathlon framework*. Basingstoke Palgrave Macmillan.

Goh. (2005). Harnessing knowledge for innovation: an integrated management framework. *Journal of Knowledge Management, 9*(4), 6-18.

Gölcük, İ., & Baykasoğlu, A. (2016). An analysis of DEMATEL approaches for criteria interaction handling within ANP. *Expert Systems with Applications, 46*, 346-366.

Gold, Malhotra, & Segars. (2001). Knowledge management: an organizational capabilities perspective. *Journal of Management Information Systems, 18*(1), 185-214.

Gold, A., Malhotra, A & Segars. (2001). Knowledge management: an organizational capabilities perspective. *Journal of Management Information Systems, 18*(1), 185-214.

Gopalakrishnan, S. (2000). Unraveling the links between dimensions of innovation and organizational performance. *The Journal of High Technology Management Research, 11*(1), 137-153.

Grant. (1991). The resource based theory of competitive advantage: implications for strategy formulation. *Knowledge and strategy, 33*(3), 3-23.

Grant. (1996a). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science, 7*, 375-387.

Grant. (1996). Toward a knowledge-based theory of the firm. *Strategic Management Journal, 17*(2), 109-122.

Greenbaum. (1993). *The handbook for focus group research*. New York NY: Lexington Books.

Greener. (2009). *Public management : a critical text Basingstoke*: Palgrave Macmillan.

Gregory. (1995). Technology Management: A Process Approach. *Proceedings of the Institution of Mechanical Engineers, 209*, 347-356.

Griliches. (1990). Patent statistics as economic indicators: A survey. *Journal of Economic Literature, 28*(4), 1661-1707.

Grimpe, C., & Kaiser, U. (2010). Balancing Internal and External Knowledge Acquisition: The Gains and Pains from R&D Outsourcing. *Journal of management studies, 47*(8), 1484-1509.

Gro¨nroos, C., and P. Voima. (2013). Critical Service Logic: Making Sense of Value Creation and Co-Creation. *Journal of the Academy of Marketing Science*(41), 133–150.

Grossman, M. (2007). The emerging academic discipline of knowledge management. *Journal of Information Systems Education, 18*(1).

Grossmann. (2007). How to promote R&D-based growth? Publiceducation expenditure on scientists and engineers versus R&D subsidies. *Journal of Macroeconomics, 29*, 891–911.

Grupp. (1994.). The measurement of technical performance of innovations by technometrics and its impact on established technology indicators. *Research Policy, 23*, 175–193.

Gryszkiewicz, L., Giannopoulou, E. & Barlatier, P.-J. (2011). *Capabilities mapping approach for sustainable service-innovation management in knowledge-intensive organizations*. Paper presented at the XXII ISPIM Conference, Hamburg Germany.

Gudanowska, A. E. (2017). Modern Research Trends within Technology Management in the Light of Selected Publications. *Procedia Engineering*, *182*, 247 – 254.

Guimón, J., & Agapitova, N. (2013). Why should governments of developing countries invest in R&D and innovation? *African Journal of Business Management, 7*(12), 901-905.

Gulati, R. (1998). Alliances and networks. *Strategic Management Journal*, *19*(4), 293-317.

Gulati, R., Nohria, N., & Zaheer, A. (2000). Strategic networks. *Strategic Management Journal*, 203-215.

Gulati, R., & Singh, H. (1998). The architecture of cooperation: managing coordination costs and appropriation concerns in strategic alliances. *Administrative Science Quarterly*, *43* (4), 781-814.

Gunasekara. (2006). The generative and developmental roles of universities in regional innovation systems. *Science and Public Policy*, *33*(2), 137–150.

Gunsel, A., Siachou, E., & Acar, Z. (2011). Knowledge Management And Learning Capability To Enhance Organizational Innovativeness *7th International Strategic Management Conference* (Vol. 24): Procedia Social and Behavioral Sciences.

Günther Schuh, L. K. (2015). *Cybernetic Approach for Controlling Technology Management Activities*. Paper presented at the 48th CIRP Conference on manufacturing systems - CIRP CMS

Guo, C., Jiang, C. X., & Yang, Q. (2014). The Development of Organizational Capabilities and Corporate Entrepreneurial Processes: The Case of Chinese

Automobile Firms, Patent management in German high tech. *Thunderbird International Business Review*, *56*(6), 483-500.

Gutterman, A. S. (2016). *A Library of Resources for Growth-Oriented Entrepreneurs Definitions and Types of Entrepreneurship*. California: www.alangutterman.com.

Halicka, K. (2015). Forward-looking planning of technology development. *Business, Management and Education*, *13*(2), 308-320.

Hall. (2001). *The Educational Needs of Qualified Nurses Caring for Children Following Trauma*. University of Huddersfield.

Hall. (2011). *Innovation and Productivity*. Working Paper. National bureau of economic research.

Hall, B. H., Griliches, A. and. Hausman. (1986). Patents and R and D: Is there a lag? . *International Economic Review*, *27*(2), 265-283,.

Hamdani, K. (2014). Foreign Direct Investment and Technological Capabilities: The Relevance of the East Asian Experience for Pakistan. *The Lahore Journal of Economics, 19*, 267–281

Hammond, M. M., Neff, J., Farr, A. R. Schwall, and Zhao (2011). Predictors of individual-level innovation at work: A meta-analysis. *Psychology of Aesthetics, Creativity, & the Arts*, *5*90–105.

Haner. (2002). Innovation Quality - a conceptual framework. *International Journal of Production Economics*, *80*, 31-37.

Hanninen, S. (2007). The 'perfect technology syndrome': sources, consequences, and solutions'. *International Journal of Technology Management*, *39*(1), 33–48.

Haq, M. A., Dong, Y. J., Phulpoto, N. H., & Usman, M. (2014). Analysing National Innovation System of Pakistan. *Journal of Developing Countries Studies*, *4*, 133-139.

Hargrave, T., & Van de Ven, A. (2006). Collective action model of institutional innovation. *Academy of Management Review*, *31*, 864 – 888.

Harold Alvarez , P. I. (2015). Internal Capabilities and External Knowledge Sourcing for Product Innovation in LMT SMEs. *Journal of Innovation Management*, *3*(2), 55-70.

Harris. (2010). R&D under pressure: innovation lessons from Ireland. *Research Technology Management*, *53*(1), 35-39.

Hauser, & Zettelmeyer. (1996). *Evaluating and managing the tiers of R&D', working paper #145-96, The International Centre for Research on the Management of Technology*. Sloan School of Management,MIT. Cambridge, MA.

Hayashi. (2004). Building better teams. *MIT Sloan Management Review*, *45*(2), 5.

He-jiang, G. (2013). *Study on Knowledge Acquisition Affecting Technology Innovation Performance of Photovoltaic Enterprises-- Based on Mediating Effect of Technology Capability and Moderating Effect of Government Behaviors*. Paper presented at the 2013 International Conference on Management Science & Engineering(20th), Harbin, P.R.China.

Helble, Y., & Chong, L. C. (2004). The importance of internal and external R&D network linkages for R&D organisations: evidence from Singapore. *R&D Management, 34*(5), 605-612.

Henderson, & Cockburn. (1994). Measuring competence? Exploring firm effects in pharmaceutical research *Strategic Management Journal,, 15*(8), 63-84.

Hii, A. N. a. J. (1999). *The Innovative Capacity of Firms*. Retrieved from Cambridge Trumpington Street Cambridge:

Hill, & Rothaermel. (2003). The performance of incumbent firms in the face of radical technological innovation. *Academy of Management Review, 28*, 257-274.

Hippel, E. v. (1975). The dominant role of users in the scientific instrument innovation process. *Research Policy, 5*(3).

Hislop. (2003). Linking Human Resource Management and Knowledge Management via Commitment. A Review and Research Agenda. *Employee Relations, 25*, 182–202.

Hitt, Ireland, & Hoskisson. (2012). Strategic management: Competitiveness and globalization Cengage learning. *Independence*, 472.

Holden. (2002). *Cross Cultural Management: A knowledge management perspective* Pretence Hall

Hollenstein. (1996). A composite indicator of a firm's innovativeness –An empirical analysis based on survey data for swiss manufacturing. *Research Policy, 25*, 633-645.

Holm, D. B., Eriksson, K., & Johanson, J. (1999). Creating value through mutual commitment to business network relationships. *Strategic Management Journal*, 467-486.

Holsapple, C. W., & Singh, M. (2001). The knowledge chain model: Activities for competitiveness. *Expert Systems with Applications, 20*(77–98).

Hosni, F. a. (2010). *Effects of r&d implementation on the performance of publicly funded research in sultan qaboos university.* (Phd thesis), Cranfield University, Cranfield, UK.

Hosseinia, P. (2016). Social capital, knowledge sharing, and innovation capability: an empirical study of R&D teams in Iran. *Technology Analysis & Strategic Management, 28*(1), 96-113.

Howells. (2006). *Outsourcing for innovation: systems of innovation and the role of knowledge intermediaries'*. Cheltenham: Edward Elgar.

Howells, Gagliardi, & Malik. (2008). The growth and management of R&D outsourcing: evidence from UK pharmaceuticals'. *R&D Management, 38*, 205–219.

Hsiao, T.C. (1997). Capability development and management of R&D professionals in a developing context, Taiwan. *Technovation*, *10*(10), 569-581.

Hsu, H.Y. (2006). *Knowledge Management and Intellectual Capital'*. (PhD), Southern Illinois University Carbondale.

Hu, M.C., Hung, S.C., Hsien-Chen, & Tseng, Y.C. (2016). Determinants of university–industry research collaborations in Taiwan: The case of the National Tsing Hua University. *Research Evaluation Advance*, 1-15.

Huang, Chua, & Chiang. (2008). A fuzzy AHP application in government-sponsored R&D project selection. *Omega*, *36*(6), 1038-1052.

Huang, & Huang. (2007). Knowledge Sharing and KM Effectiveness in Technology R&D Teams: Transactive Memory System and Team-based Outcome Expectations Perspectives. *IEEE*, 2124-2128.

Huggins, Izushi, Davies, & Shougui. (2008). *World Knowledge Competitiveness Index, Centre for International Competitiveness*. Retrieved from Cardiff: http://www.cforic.org

Huikkola, Ylima¨ki, & Kohtama. (2013). Joint Learning in R&D Collaborations and the Facilitating Relational Practices *Industrial Marketing Management, 42*(7), 1167–1180.

Huizingh. (2011). Open Innovation: State of the Art and Future Perspective. *Technovation, 31*(1), 2-9.

Hung, S. W. a. T., R.H. . (2008). Factors affecting the choice of technology acquisition mode: an empirical analysis of the electronic firms of Japan, Korea and Taiwan. *Technovation, 28*, 551-563.

Hutchings, K., & Mohannak, K. (2007). *Knowledge Management in Developing Economies: A Cross-cultural and Institutional Approach*: Edward Elgar.

Huw Lloyd-Ellis, J. R. (2002). Twin Engines of Growth: Skills and Technology as Equal Partners in Balanced Growth. *Journal of Economic Growth,, 7*(2), 87-115.

Iaccarino. (2004). Mastering science in the South. *EMBO reports, 5*(5), 437- 441.

Iansiti, & West. (1997a). Technology integration. *Harvard Business Review, 75*(3).

Igel, & Numprasertcha. (2004). Knowledge Management in University R&D in Thailand. *International Engineering Management Conference*, 463-467.

İlkerGölcük, & AdilBaykasoğlu. (2016). An analysis of DEMATEL approaches for criteria interaction handling within ANP. *Expert Systems with Applications*, *46*, 346-366.

IMF. (2016). *World Economic Outlook: Subdued Demand: Symptoms and Remedies.* Retrieved from Washington: http://www.imf.org/external/am/2016/

Ingrid Robeyns. (2003). *The Capability Approach: An Interdisciplinary Introduction* (PhD), University of Amsterdam, Amsterdam.

Isabel, caprio, & Santos-arteaga. (2015). Technological assimilation and divergence in times of crisis. *Technological and Economic Development of Economy*, *22*(2), 254-273.

Jacobsson, Oskarsson, & Philipson. (1996). Indicators of technological activities – comparing educational, patent and R&D statistics in the case of Sweden. *Research Policy, 25*, 573-585.

Jacques, J., & Jolly, C. D. (1999). Technological management: expanding the perspective of management of technology. *Management Decision, 37*(8), 613 - 621.

Jain, K., Siddiquee, Q., & Singal, V. (2010). *Measurement of Innovativeness in an Organisation using AHP* Paper presented at the Technology Management for Global Economic Growth (PICMET), Proceedings of PICMET '1.

Jamali, M. C. K. (2012). National Science, Technology and Innovation Policy. *Pakistan Council for Science and Technology, Islamabad*, *1*(1), 1-62.

Jankowska, B., Matysek-Jędrych, A., & Mroczek-Dąbrowska, K. (2017). Efficiency of National Innovation Systems – Poland and Bulgaria in The Context of the Global Innovation Index. *Comparative Economic Research*, *20*(3), 2082-6737.

Jansen, J. J., Van den Bosch, F.A. and Volberda, H.W. (2006). Exploratory innovation, exploitative innovation, and performance: effects of organizational antecedents and environmental moderators. *Management Science*, *52*, 1661-1674.

Jasimuddin. (2012). *Knowledge Management: An Interdisciplinary Perspective*.

Jemala, M. (2012). Integration of Technology Management and its Developmet :Interlevel overlap and technology identification. *Acta oeconomica pragensia*, *5*(58-74).

Jeng, & Tzeng. (2012). Social influence on the use of Clinical Decision Support Systems: Revisiting the Unified Theory of Acceptance and Use of Technology by the fuzzy DEMATEL technique. *Computers and Industrial Engineering*, *62*, 819-828.

Jiann, & Gwo-Hshiung. (2011). An integrated, MCDM technique combined with DEMATEL for a novel clusterweighted with ANP method. *Expert Syst Appl*, *7*(2), 1417-1424.

Jiaoa, H., Zhoub, J., Gaoc, T., & Liud, X. (2016). The more interactions the better? The moderating effect of the interaction between local producers and users of knowledge on the relationship between R&D investment and regional innovation systems. *Technological Forecasting and Social Change, 101*.

Jimenez-Barrionuevo, M., Gacia-Morales, & Molina, M. (2011a). Validation of an instrument to measure absorptive capacity. *Technovation, 31*, 190-201.

Jimenez-Barrionuevo, M., Gacia-Morales, & Molina, M. (2011b). Validation of an instrument to measure absorptive capacity. *Technovation, 31*, 190–202.

Jin, & Zedtwitz, V. (2008). Technological capability development in China's mobile phone industry. *Technovation, 28*, 327-334.

Johannessen, Olaisen, & Olsen. (2001). Mismanagement of tacit knowledge: the importance of tacit knowledge, the danger of information technology. *International Journal of Information Management, 21*, 3-20

John Hagedoorn, M. C. (2003). Measuring innovative performance: is there an advantage in using multiple indicators. *Research Policy, 32* 1365–1379.

Jolly, & Nasiriyar. (2007). *Technology platform exploitation: Definition and research boundaries.* Paper presented at the Proceedings of the 16th International Association of Management of Technology Conference (IAMOT).

Jolly, J. (1999). Technological management: expanding the perspective of management of technology. *Management Decision, 37*(8), 613 - 621.

Jun Jin , M. Z. (2008). Technological capability development in China's mobile phone industry. *Technovation, 28*(6), 327-334.

Kafetzopoulos, D., & Psomas, E. (2015). The impact of innovation capability on the performance of manufacturing companies: The Greek case. *Journal of Manufacturing Technology Management, 26*(1), 104 - 130.

Kagohara, D., Meer, L. D., Ramdoss, S., Reilly, M., Lancioni, G., Davis, T., Rispoli, M., Lang, Marschik, P., Sutherland, D., A.Green, V., & Sigafoos, J. (2013). Using iPods® and iPads® in teaching programs for individuals with developmental disabilities: A systematic review. *Research in Developmental Disabilities, 34*(1), 147-156.

Kahn, & McGourty. (2009). *Performance management at R&D organizations. Practices and metrics from case examples*. Retrieved from Bedford, MA

Kaiser, C. (2010). Balancing Internal and External Knowledge Acquisition: The Gains and Pains from R&D Outsourcing. *Journal of management studies, 47*(8), 1483-1507.

Kalantaridis, C., Thurner, T., Bhaduri, S., Prause, G. K., & Ferreiro, M. d. F. (2013). Crossing Boundaries Knowledge, Technology and Innovation Flows across National Boundaries: Developing a Research Agenda. *Working Paper*, 13-11.

Kale, D. (2012b). Innovative capability development in the Indian pharmaceutical industry. *International Journal of Innovation and Technology Management,, 9*(2), 125.

Kalvarskaya. (2009, 6-9 December 2009). *Measurement and planning of the company's innovation capabilities.* Paper presented at the The Proceedings of the 2nd ISPIM Innovation Symposium, New York City,USA,.

Kamath, V., Rodrigues, L., & Desai, P. (2016). The significance of knowledge management, innovation on firm performance in the Indian manufacturing sectors: an empirical analysis. *International Journal of Business Excellence, 2016*(9), 2.

Kaplan, Robert, Norton, & P, D. (2004). *Strategy maps. Converting intangible assets into tangible outcomes. Boston*. MA: Harvard Business School Press

Karahanna, & Watson. (2006). Information systems leadership. *IEEE Transactions on Engineering Management, 53*(2), 171-176.

Karaveg, C., Thawesaengskulthai, N., & Chandrachai, A. (2016). R&D commercialization capability criteria: implications for project selection. *Journal of Management Development, 35*(3), 304-325.

Karki. (1996). Searching for bridges between disciplines: an author co-citation analysis on the research into scholarly communication. *Journal of Information Science, 22*(5), 323–334.

Karlsson. (2006). The internationalisation of corporate R&D: leveraging the changing geography of innovation. *Academic report, Swedish Institute for Growth Policy Studies.*

Karlsson, C., Johansson, B., & Norman, T. (2011). *Innovation, Technology and Knowledge*. Retrieved from The Royal Institute of technology:

Katić, A., Ćosić, I., Anđelić, G., & Raletić, S. (2012). Review of Competitiveness Indices that Use Knowledge as a Criterion. *Acta Polytechnica Hungarica, 5*(9).

Kavanagh, D. N. (2009). Innovation & project management – exploring the links. *PM World Today, 9*(4), 1-7.

Keeble, D., and F. Wilkinson. (1999). Collective learning and knowledge development in the evolution of regional clusters of high-technology smes in Europe. *Regional Studies, 33*(4), 295–303

Kelley, K., Clarke, B., & Sitzia, V.J. (2003). Good practice in the conduct and reporting or survey research *International Journal of Quality Health Care, 15*(3), 261-266.

Khalifa, & Liu. (2003). Determinants of successful knowledge management programs. *Electronic Journal on Knowledge Management, 1*(2), 103-112.

Khalil, & Tarek. (2000). *Management of technology. The key to competitiveness and wealth creation*. Boston,MA: McGraw-Hill.

Khan, J., & Khattak, N.R. (2013). The Significance of Research And Development For Economic Growth: The Case of Pakistan. *City University Research Journal, 3*(2), 175-186.

Khilji, S. E., Mroczkowski, T. and Bernstein (2006). From invention to innovation: toward developing an integrated innovation model for biotech firms. *Journal of Product Innovation Management, 23*, 528–540.

Khodakarami, & Chan. (2014). Exploring the role of customer relationship management (CRM) systems in customer knowledge creation. *Information & Management, 51*(1), 27-42.

Khurana, & Rosenthal. (1998). Towards holistic "front ends" in new product development. *Journal of Product Innovation Management, 15*(1), 57-74.

Kidd, J. B. (1998). Knowledge creation in Japanese manufacturing companies in Italy: reflection upon organizational learning. *Management Learning, 29*(2), 131–146.

Kim. (2014). Government R&D funding in economic downturns: Testing the varieties of capitalism conjecture. *Science and Public Policy, 41*, 107-118.

Kim, Kyun, S., Cho, H., & Khieu, H. (2014). Slack and R&D Strategy: The Effect of Slack on Internal R&D and External R&D, and Innovation. *Journal of Management Policy and Practice, 15*(2), 33.

Kim, Song, & Nerkar. (2012). Learning and innovation: Exploitation and exploration trade-offs. *Journal of Business Research, 65*(8), 1189-1194.

Kim, T., and G. Lee. (2012). A Modified and Extended Triandis Model for the Enablers–Process– Outcomes Relationship in Hotel Employees' Knowledge Sharing. *The Service Industries Journal, 32*(13), 2059–2090.

Kim, W., and Mauborgne, R. (1998). Procedural Justice, Strategic Decision Making and theKnowledge Economy. *Strategic Management Journal, 19*, 323–338.

Kirby, M. R. (2011). *A methodology for technology identification, evaluation, and selection in conceptual and preliminary aircraft design.* Georgia Institute of Technology.

Klappert. (2006). *System-forming technology controlling*. Shaker: Aachen

Kleinberg. (2002). *Bursty and hierarchical structure in streams.* Paper presented at the KDD '02 Proceedings of the eighth ACM SIGKDD international conference on Knowledge discovery and data mining.

Kleinberg. (2003). Bursty and hierarchical structure in streams. Data Mining and Knowledge Discovery. *Data Mining and Knowledge Discovery*, *7*(4), 373–397.

Klentien, & Kamnungwut. (2017). The learning organization in a small government unit: Case study of the center for academic services, srinakharinwirot university, thailand. *Advances in Intelligent Systems and Computing, 498*, 1275-1284.

Klincewicz. (2010). *Przypadek niebieskiego lasera* Uniwersytetu Warszawskiego, Wydawnictwo Naukowe Wydziału Zarządzania.

Kodanu. (1992). Technology fusion and the new research and development. *Harvara Business Review, 70*(4).

Kogut, B., and Zander, U. (1996). What Firms Do? Coordination, Identity, and Learning. *Organization Science, 7*(5), 502–518.

Kohtama¨ki, & Bourlakis. (2012). Antecedents of Relationship Learning in Supplier Partnerships from the Perspective of an Industrial Customer: The Direct Effects Model. *Journal of Business & Industrial Marketing, 27*, 299–310.

Kohtamäki, I.M. (2016). Joint Learning in Innovative R&D Collaboration. *Industry and Innovation*.

Kondratiuk-Nierodzińska, M. (2016.). Innovation capabilities in EU countries: have Central and Eastern European countries been catching up? *Journal of Business Economics and Management, 17*(5), 765-779.

Kostopoulos, Papalexandris, Papachroni, & Ioannou. (2011). Absorptive capacity, innovation, and financial performance. *Journal of Business Research, 64*, 1335–1343.

Kotnour, T. (2000). Organizational learning practices in the project management environment. *International Journal of Quality and Reliability Management, 17*(4-5), 393-406.

Kreuger. (1998). *Analyzing and reporting focus group results*. California: Sage.

Kriščiūnas, & Daugėlienė. (2006). The Assessment Models of Knowledge-Based Economy Penetration,. *Engineering Economics, 5*(50), 36-46

Kristensson, P., and Magnusson, P. R. (2010). Tuning users' innovativeness during ideation. *Creativity and Innovation Management, 19*, 147–159.

Krueger, & Casey. (2009). *Focus groups: a practical guide for applied research (4th ed.)*. Thousand Oaks, CA: Sage

Kumar. (2011). *Research methodology : a step-by-step guide for beginners*. London: SAGE.

Kuwada. (1998). Strategic Learning: The Continuous Side of Discontinuous Strategic Change. *Organization Science, 9* (6), 719–736.

Kwang, Pervaiz, & Zairi. (1999). Managing for quality through knowledge management. *Total Quality Management, 10*(5), 615-621.

Lanctot, A. (2000). Technology acquisition strategy in an internationally competitive environment. *Journal of International Management, 6*(3), 187-215.

Lane, P. J, Koka, B. R. and Pathak, S. (2006). The reification of absorptive capacity: a critical review and rejuvenation of the construct. *Academy of Management Review, 31*(4), 833–863.

Lanjouw, J.O., Schankerman. (1999). *The Quality of Ideas: Measuring Innovation with Multiple Indicators.* Retrieved from

Lau, Tang, & Yam. (2010). Effects of Supplier and Customer Integration on Product Innovation and Performance: Empirical Evidence in Hong Kong Manufacturers. *Journal of Product Innovation Management, 27*(5), 761-777.

Laurindo, A. (2016). Innovation management: A systematic literature analysis of the innovation management evolution. *Brazilian Journal of Operations & Production Management, 13*, 16-30.

Laursen, K. S. (2006). Open for innovation: The role of openness in explaining innovation performance among U.K. manufacturing firms. *Strategic Management Journal, 27*, 131–150.

Laursen, K. S. (2006). The Role of Openness in Explaining Innovation Performance among U.K. Manufacturing Firms. *Strategic Management Journal, 27*(2), 131-150.

Lawless, M. W. a. A., P.C. (1996). Generational technological change: effects of innovation and local rivalry on performance. *Academy of Management Journal, 39*(5), 1185-1217.

Lee. (2005). Human Capital and Productivity for Korea's Sustained Economic Growth. *Journal of Asian Economics, 16*, 663–687

Lee, & Choi. (2003). Knowledge management enablers, processes, and organizational performance: an integrative view and empirical examination. *Journal of Management Information Systems Research, 20*(1), 179-228.

Lee, & Lings. (2008). *Doing business research: a guide to theory and practice*. London: SAGE.

Lee, C. K., and Al-Hawamdeh. (2002). Factors impacting knowledge sharing. *Journal of Information and Knowledge Management, 1*, 49-56.

Lee, H. (2003). 'Knowledge management enablers, processes, and organizational performance: an integrative view and empirical examination. *Journal of Management Information Systems Research, 20*(1), 179-228.

Lee, W. (2015). The Relationship between Technology Planning Capability Enhancement, the Technology Roadmap, and Innovation. *International Journal of Innovation, Management and Technolog, 6*(1), 26-29.

Lee, W. I. (2013). Major Determinants for the Successful Implementation of Technology Roadmap in the Technology Intensive Organization: A Case of Smart Grid Roadmap in Korea. *Journal of Advanced Management Science, Vol. 1, No. 1, March, 1*(1), 112-117.

Lenz-cesar, & Heshmati. (2012). An econometric approach to identify determinants of cooperation for innovation among firms. *Applied Economics Letters, 19*, 227-235.

Leonard-Barton. (1992). Core capabilities and core rigidities. *Strategic Management Journal, 13*, 111-126.

Leonard-Barton. (1995). Wellsprings of knowledge - building and sustaining the sources of innovation. *Harvard Business School Press*.

Lerner, J., and Julie Wulf. (2007). Innovation and incentives: Evidence from corporate r&d. *The Review of Economics and Statistics, 89*(4), 634-644.

Lévêque, S., & Ménière. (2004). *The Economics of Patents and Copyright*: Berkeley Electronic Press.

Levin, D. Z., & Barnard, H. (2008). Technology management routines that matter to technology managers. *Int. J. Technology Management, 41*(1), 22-37.

Leydesdorff. (2006). *The knowledge-based economy: Modeled, measured, simulated*. Boca Raton: Universal Publishers.

Liao, Wang, Chuang, Shih, & Liu. (2010). Enhancing knowledge management for R&D innovation and firm performance: An integrative view. *African Journal of Business Management, 14*(4), 3026-3038.

Liao, C., Wang, H.Y., Chuang, S.H., Shih, M.L., & Liu, C.C. (2010). Enhancing knowledge management for R&D innovation and firm performance: An integrative view. *African Journal of Business Management, 14*(4), 3026-3038.

Liberati, Altman, Tetzlaff, Mulrow, Gøtzsche, & Ioannidis. (2009). The PRISMA Statement for Reporting Systematic Reviews and Meta-Analyses of Studies That Evaluate Health Care Interventions: Explanation and Elaboration. *PLoS Med, 6*(7).

Libing, & Rong. (2007). Analysis on Influence Factors of Knowledge Transfer within R&D Unit under Technological Innovation Perspective. *IEEE*.

Lichtenthaler. (2009). Absorptive Capacity, Environmental Turbulence, and the Complementarity of Organizational Learning Processes. *Academy of Management Journal,, 52*(4), 822-846.

Lichtenthaler. (2011). Open Innovation: Past Research, Current Debates and Future Directions. *Academy of Management Perspectives*, 75-93.

Lichtenthaler, & Ernst. (2007). External technology commercialization in large firm; result if a quantitative benchmarking study. *R and D Management*, *37*(5), 383-397.

Lichtenthaler, U., & Lichtenthaler, E. (2010). Technology Transfer across Organizational Boundaries: Absorptive Capacity and Desorptive Capacity. *California Management Review*, *53*(1), 154-170.

Lichtenthaler, U. L. (2010). Technology Transfer across Organizational Boundaries: Absorptive Capacity and Desorptive Capacity. *California Management Review*, *53*(1), 154-170.

Liebowitz. (2013). Developing metrics for determining knowledge management success: A fuzzy logic approach. *Information System Journal,*, *6*(2), 36-42.

Liebowitz, & Wilcox. (1997). Knowledge Management and Its Integrative Elements [Press release]

Liebowitz, J.S. (2000). Developing knowledge management metrics for measuring intellectual capital. *Journal of Intellectual Capital,*, *1*(1), 54–67.

Lilleoere, & Hansen, H. (2011). Knowledge-sharing enablers and barriers in pharmaceutical research and development. *Journal of Knowledge Management*, *15*, 53–70.

Lin. (2003). Technology transfer as technological learning: a source of competitive advantage for firms with limited R&D resources. *R&D Management*, *33*(3), 327-341.

Lin, Lee, & Hung. (2006). R&D intensity and commercialization orientation effect on financial performance. *Journal of Business Research*, *59*, 679-685.

Lin, & Tseg. (2005). Bridging the implementation gaps in the knowledge management system for enhancing corporate performance. *Expert Systems with Applications*, *29*, 163-173.

Linlin, & Hui. (2008). An Empirical Study on the Knowledge Management Elements of Research Team in University. *IEEE*.

Linstone, H. A. (2003). The 21st century: everyman as faust-technology, terrorism, and the multiple perspective approach. *Technological Forecasting and Social Change*, *70*(3), 283–296.

Liou. (2012). Developing an integrated model for the selection of strategic alliance partners in the airline industry. *Knowledge-Based Systems*, *28*, 59-67.

Liou, J. J. H., Lu, M.-T., Hu, S.-K., & Cheng, C.-H. (2017). A Hybrid MCDM Model for Improving the Electronic Health Record to Better Serve Client Needs. *Sustainability*, *9*(10), 1819.

Liu, Tzeng, & Lee. (2012). Improving tourism policy implementation The use of hybrid MCDM models *Tourism Management*, *33*, 413-426.

Liu, & Wan-Hsin. (2014). Relevance of Own R&D and Sources of Knowledge Transfer for Industrial Innovation in China. *The Developing Economies*, *52*(1), 1-25.

Lu, & Hung. (2011). Exploring the operating efficiency of Technology Development Programs by an intellectual capital perspective-A case study of Taiwan *Research Policy, 31*(8), 374-383.

Lu, M.T., Tzeng, G.-H., Hu, S.-K., & Yung-Chang-Lin. (2013). *Evaluating business-to-business m-commerce in smes by using mcdm approach*. Paper presented at the Proceedings of the International Symposium on the Analytic Hierarchy Process 2013.

Lu, M.-T., Tzeng, G.-H., & Tang, L.-L. (2013). Environmental Strategic Orientations for Improving Green Innovation Performance in Fuzzy Environment - Using New Fuzzy Hybrid MCDM Model. *International Journal of Fuzzy Systems, 15*(3).

Lundvall, Joseph, Chaminade, & Vang. (2009). *Handbook of innovation systems and developing countries* Northampton, UK: Edward Elgar.

Lundvall, B. Å., Joseph, K. J., Chaminade, C., & Vang, J. (2011). *Handbook of Innovation Systems and Developing Countries: Building Domestic Capabilities in a Global Setting*: Edward Elgar.

MacCormack, Verganti, & Iansiti. (2001). Developing products on “Internet Time”. *Management Science, 47*(1).

Maddan. (2009). *Measuring the impact of organizational culture factors on knowledge management implementation in the Jordanian telecommunication group (Orange): a case study.* (Master), Amman Arab University, Amman.

Madeira, L., Vick, T. E., & Nagano, M. S. (2013). Directions of scientific literature in knowledge management from the perspective of their relationships with innovation, information and technology management. *Transinformação, 25*(2).

Mah, J. S. (2015). R&D Promotion Policies of Developing Countries and Fairness in International Trade Relations. *Journal of Economic Issues,, 49*(1), 179-196.

Maine, E., & Garnsey, E. (2007). The commercialisation environment of advanced materials ventures. *International Journal of Technology Management, 39*(1-2), 49–71.

Malhotra. (2001). *Knowledge Management and Business Model Innovation*. Hershey,PA: Idea Group Publishing.

Maloney, W. (2014). Why don't poor countries do R&D? Retrieved from https://blogs.worldbank.org/developmenttalk/why-dont-poor-countries-do-rd

Mannan, H. (2013). Budget2013: Research and Development in Pakistan *The Express Tribune*.

Marinkovic, & Jakšić. (2014). *Government performance in technology and innovation management – the case of serbia*. Paper presented at the Symorg 2014, serbia.

Martin. (2004). Technology Roadmaps: Infrastructure for innovation. *Technological Forecasting & Social Change, 71*, 67-80.

Martin, M. (2015). Effectiveness of Business Innovation and R&D in Emerging Economies: The Evidence from Panel Data Analysis. *Journal of Economics, Business and Management, 4*(3), 440-446.

Martínez-Román, J. A., Gamero, J. & Tamayo, J.A. (2011). Analysis of innovation in SMEs using an innovative capability-based non-linear model: A study in the province of Seville *Technovation, 31*(9), 459-475.

Martino. (1993). *Technological Forecasting for Decision Making*. New York: McGraw-Hill.

Maskell, Pedersen, Petersen, & Dick-Nielsen. (2007). Learning paths to offshore outsourcing: from cost reduction to knowledge seeking. *Industry & Innovation, 14*(3), 239- 257.

Matear, Gray, & Garret. (2004). Market orientation, brand investment, new service development, market position and performance for service organizations. *International Journal of Service Industry Management, 15*(3), 284-301.

Mazurkiewicz, A., & Poteralska, B. (2017). Technology Transfer Barriers and Challenges Faced by R&D Organisations. *Procedia Engineering, 182*(1), 457 – 465.

McElroy. (2003). *The New Knowledge Management: Complexity, Learning and Sustainable Innovation*. Butterworth-Heinemann: Oxford:.

Mcevily, B., and A. Zaheer. (1999). Bridging Ties: A Source of Firm Heterogeneity in Competitive Capabilities. *Strategic Management Journal, 20*, 1133–1156.

McGrath, R. P. a. F. (2013). The Search for External Knowledge. *The Electronic Journal of Knowledge Management, 11*(2), 158-167.

Meade, N., & Islam, T. (2006). Modelling and forecasting the diffusion of innovation a 25-year review. *International Journal of Forecasting, 22*(3), 519–545.

Medcof. (1997). A taxonomy of internationally dispersed technology units and its application to management issues. *R&D Management, 27*(4), 301- 318.

Meesapawong, Rezgui, & Li. (2010). *Perceiving societal value as the core of innovation management in public research and development organizations*. Paper presented at the The 5th International Conference on Management of Innovation and Technology, Singapore.

Meesapawong, P. (2013). *Managing innovation in public research and development organisations using a combined Delphi and Analytic Hierarchy Process approach.* (PhD), Cardiff University.

Mei-Chih Hu, S.-C. H., Hsien-Chen L,Yung-Ching Tseng. (2016). Determinants of university–industry research collaborations in Taiwan: The case of the National Tsing Hua University. *Research Evaluation Advance*, 1-15.

Melián-González, Batista-Canino, & Sánchez-Medina. (2010). Identifying and assessing valuable resources and core capabilities in public organizations *International Review of Administrative Sciences, 7*(1), 97-114.

Merton, Fiske, & Kendall. (1956). *The focussed interview*. The Free Press.

Meuleman, & Maeseneire, D. (2012). Do R&D subsidies affect SMEs' access to external financing? *Research Policy, 41*(3), 580-591.

Meyer. (1993a). Management of an International Network of Industrial R&D Laboratories. *R&D Management, 23*(2), 109- 120.

Meyer. (1993b). The product family and the dynamics of core capability. *Sloan Management Review*.

Meyer, J., Stanley, D., Hercovitch, L., and Topolnytsky, L. (2002). 'Affective, Continuance and Normative Commitment to the Organizations: A Meta Analysis of Antecedents, Correlates and Consequences. *Journal of Vocational Behaviour, 61*, 20–25

Migdadi, M. (2005). *An integrative view and empirical examination of the relationships among knowledge management enablers,processes, and organizational performance in Australian enterprises* (PhD), University of Wollongong.

Miller. (1995a). Applying quality practices to R&D. *Research Technology Management*, 47-54.

Miller. (1995b). Broader mission for R&D. *Research Technology Management, 38*(6), 28-36.

Miller, & Morris. (1998). *Fourth generation R&D*. New York: Wiley.

Miller, W. L. (2014). *Generations of R&D and innovation management*: John Wiley & Sons.

Mills, & Smith. (2011). Knowledge management and organizational performance: A decomposed view. *Journal of Knowledge Management, 15*(1), 156-171.

Miron-Spektor, L. A. a. E. (2011). Organizational learning: From experience to knowledge. *Organization Science, 22*, 1123-1137.

Moenaert, & Souder. (1990). An information transfer model for integrating marketing and R&D personnel in new product development projects. *Journal of Product and Innovation Management, 7*, 91 - 107.

Moffett, M., Hazlett, & Shevlin. (2010). Developing a model of innovation implementation for UK SMEs: A path analysis and explanatory case analysis. *International Small Business Journal, 28*(3), 195–215.

Mohammadi, A., & Franzoni, C. (2014). Inventor's Knowledge Set as the Antecedent of Patent Importance. *Industry and Innovation, 21*(1), 65-87.

Mohammed, A., Elrehail, A. H., Ahmad, M., & Elçi, A. A. (2017). Knowledge management, decision-making style and organizational performanceGestión del conocimiento, estilo de toma de decisiones y desempeño organizacional. *Journal of Innovation & Knowledge*.

Moher, D., Shamseer, L., Clarke, M., Ghersi, D., Liberati, A., Petticrew, M., Shekelle, P., Stewart, L. A., & Group, P.-P. (2015). Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. *Systematic Reviews, 4*(1), 1. doi:10.1186/2046-4053-4-1

Mom, T. J. M., Oshri, I., & Volberda, H. W. (2012). The skills base of technology transfer professionals. *Technology Analysis & Strategic Management, 24*, 871–891.

Moorman, C., and A. S. Miner. (1997). The Impact of Organizational Memory on New Product Performance and Creativity. *Journal of Marketing Research 34*(1), 91–106.

Morgan. (1996). Focus groups. *Annual Review of Sociology, 22*(1), 129-152.

Morgan. (1998). *The focus group guide book.* London: Sage Publications.

Morgan, & Kreuger. (1998). *The focus group kit*. California: Sage.

Morrissey, M. T. A. (2005). Rethinking technology transfer. *Journal of Food Engineering, 67*, 135–145.

Motohashi, K. (2007). The changing autarky pharmaceutical R&D process: causes and consequences of growing R&D collaboration in Japanese firms. *International Journal of Technology Management & Innovation, 39*(1-2), 33–48.

Muhammad, & Bashir, T. (2014). *Science, technology and innovation indicators of pakistan*. Retrieved from Islamabad:

Muqadas, F., Rehman, M., Aslam, U., & Ur-Rahman, U.-. (2017). Exploring the challenges, trends and issues for knowledge sharing: A study on employees in public sector universities. *VINE Journal of Information and Knowledge Management Systems, 47*(1), 2-15.

Muralidar, & Santhanam. (1990). Using the analytic hierarchy process for information system project selection. *Information & Management, 1*(18), 87-95.

Murovec, & Prodan. (2009a). Absorptive capacity, its determinants, and influence on innovation output: Cross-cultural validation of the structural model. *Technovation, 29*, 859–872.

Murovec, & Prodan. (2009b). Absorptive capacity, its determinants, and influence on innovation output: Cross-cultural validation of the structural model. . *Technovation, 29*, 859–872.

Muzamil, M., & Naqshbandi. (2018). Knowledge-oriented leadership and open innovation: Role of knowledge management capability in France-based multinationals. *Internation Business Review, 27*(1), 701-713.

Nadzar, N. M., Bakri, A., & Ibrahim, R. (2017). A Bibliometric Mapping of Malaysian Publication By using Co-word Analysis *International Journal Advance Soft Computer Application 9*(3), 92-113.

Naqvi, I. B. (2011). National innovation system in a least developing country: the case of Pakistan. *International Journal Technology, Policy and Management, 11*(2), 139-152.

Naser, Mahdi, Amir, Hami, & Seyed. (2010). Strategic environment analysis using DEMATEL method through systematic approach. *Management science Engineering, 11*(2-3), 95-105.

Nazarko, J. (2013). Regional economic foresight. Methodology and research instruments.

Ndlela, & Toit. (2001). Establishing a knowledge management programme for competitive advantage in an enterprise. *International Journal of Information, 21*(2), 151-165

Nelson, & Winter. (1982). An Evolutionary Theory of Economic Change, Harvard University Press, Cambridge [Press release]

Nguyen, T., & Pham. (2017). *Knowledge Management Strategies, Imitation, and Innovation: An Empirical Study of Vietnamese Firms*. Vietnam.

Nicolás, & Cerdán. (2012). Strategic knowledge management, innovation and performance. *International Journal of Information Management, 31*(6), 502-509.

Nieto. (2002). From R&D management to knowledge management: an overview of studies on innovation management. *Technological Forecasting and Social Change, 70*(2), 135-161.

Nieto, M., & Santamaria, L. (2010). Technological Collaboration: Bridging the Innovation Gap between Small and Large Firms. *Journal of Small Business Management Decision, 48*(1), 44–69.

Niosi. (1999). Fourth generation R&D: from linear models to flexible innovation. *Journal of Business Research, 45*, 111- 117.

Niosi. (1999b). Fourth generation R&D: from linear models to flexible innovation. *Journal of Business Research, 45*, 111- 117.

Niosi, J. (2010). *Building national and regional innovation systems: Institutions for economic development.* Cheltenham, UK, Northampton, USA: Edward Elgar.

Nobelius. (2004). Towards the sixth generation of R&D management. *International Journal of Project Management, 22*, 369-375.

Nonaka, & Takeuchi. (1995a). The Knowledge-creating Company [Press release]

Nonaka, & Takeuchi. (1995b). The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation [Press release]

Nonaka, Toyama, & Konno. (2000). SECI, ba and leadership: A unified model of dynamic knowledge creation. *Long Range Planning, 33*, 5–34.

Nonaka, I., and Takeuchi, H (1995). The Knowledge Creating Company: How Japanese Companies Create the Dynamics of Innovation [Press release]

Nonaka, I., Toyama, R & Nagata, A (2000). A firm as a knowledge-creating entity: a new perspective on the theory of the firm. *Industrial and Corporate Change, 9*(1), 1-20.

Nordhaus, W. D. (2009). *The perils of the learning model for modeling endogenous technological change*. Retrieved from

Novak, & Bojnec. (2005). Human capital and economic growth by municipalities in Slovenia. *Managing Global Transitions, 3*(2), 157-177.

Nowotny, H., P. Scott, and M. Gibbons. (2003). Mode 2' revisited: the new production of knowledge – introduction. *Minerva, 41*(3), 179–194.

Numprasertchai, S., Kanchanasanpetch, P., & Numprasertchai, H. (2009). Knowledge creation and innovation capability in the public university *Int. J. Innovation and Learning, 6*(5), 560-570.

O.Nyumba, T., Wilson, K., Derrick, C. J., & Mukherjee, N. (2018). The use of focus group discussion methodology: Insights from two decades of application in conservation *British Ecological Journal, 9*(1), 20-32.

Oana Branzei a, I. V. (2006). Strategic pathways to product innovation capabilities in SMEs. *Journal of Business Venturing, 21*, 75 – 105.

OECD. (2005). *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*. Retrieved from Paris:

OECD. (2007a). *Innovation and Growth rationale for an Innovation strategy* Retrieved from https://www.oecd.org/science/inno/39374789.pdf

OECD. (2007b). Innovation and Growth: Rationale for an Innovative Strategy. *OECD Publishing*.

OECD. (2014) Science, Technology and Industry Outlook 2014. *OECD Publishing*. Paris.

OECD. (2015). *The Participation of Developing Countries in Global Value Chains: Implications for Trade and Trade-Related Policies*. Retrieved from

OECD. (2016). *Economic Outlook for Southeast Asia, China and India 2016: Enhancing Regional Ties*. Retrieved from Paris: http://dx.doi.org/10.1787/saeo-2016-en.

OECD. (2017). *A Decade of Social Protection Development in Selected Asian Countries*. Paris OECD Publishing.

OECD. (2018). *OECD Science, Technology and Innovation Outlook 2018*.

Oerlemans, Meeus, & Boekema. (1998). Do networks matter for innovation? The usefulness of the economic network approach in analysing innovation. *Tijdschrift voor Economische en Sociale, 89*, 298-309.

Ojasalo. (2003). Using market information in generating and selectingideas in new product development—Results from an empirical study oninnovations management in the software business. *The Business Review,Cambridge, 1*(1), 71–76.

Omer, A. M. (2013). *Obstacles to the Globalisation of Corporate Research and Development in Technologically Underdeveloped Countries.* (Doctor of Philosophy), Nottingham Trent University, Nottingham

OMITI. (2011, 5-6 May 2011). *Intellectual Asset Management for Sustainable Research.* Paper presented at the Proceedings of Sustainable Research and Innovation Conference., Nairobi, Kenya.

Oostrom, J. K., van der Linden, D., Born, M.P., & van der Molen, H.T. (2013). New technology in personnel selection: How recruiter characteristics affect the adoption of new selection technology. *Computers in Human Behavior, 29*(6), 2404-2415.

Oxman, & Guyatt. (1993). The science of reviewing research. *Annals of the New York Academy of Sciences, 703*, 133–124.

Pablo, Reay, Dewald, & Casebeer. (2007). Identifying, enabling and managing dynamic capabilities in the public sector. *Journal of management studies, 44*(5), 687-708.

Parikh. (2001). Knowledge management framework for High tech research and development. *Engineering Management Journal, 13*(3).

Park, & Kim. (2005a). Linkage between knowledge management and R&D management. *Journal of Knowledge Management, 9*(4), 34-44.

Park, & Kim. (2005b). Linkage between knowledge management and R&D management. *Journal of Knowledge Management, 9*(4), 34-44.

Park, Kim, & Kang. (2002). *On the design of workflow-based knowledge management system for R&D organization.* Paper presented at the IRMA International Conference, Seattle, WA.

Pavitt, K. (1990). What we know about the strategic management of technology. *Calif Manage Rev, 32*, 17–26.

Pavlou, & Sawy, E. (2006). From IT leveraging competence to competitive advantage in turbulent environments: the case of new product development. *Information Systems Research, 17*(3), 198-227.

Pellens, M., Peters, B., Rammer, C., & Licht, G. (2016). *Public investment in r&d in reaction to economic crises – a longitudinal study for oecd countries*. Retrieved from Valencia , Spain:

Pelz, & Andrews. (1966). *Scientists in organizations*. New York Wiley.

Penrose. (1959). *The Theory of the Growth of the Firm*. New York: John Wiley.

Penrose, E. (1959). *The theory of the growth of the firm*. New York: Wiley.

Pentland, B. T. (1995). The Social Epistemology of Organisational Knowledge Systems. *Accounting, Management & Information Technology, 5*(1), 1-21.

Peters, H. B. (2009). *Innovative Capability and Financing Constraints for Innovation More Money, More Innovation?* Paper presented at the European Corporation of Science and Technology

Petrylė, V. (2016). Does the global competitiveness index demonstrate the resilience of countries to economic crises. *ekonomika, 96*(6).

Phaal, Farrukh, & Probert. (2006). Technology Management Tools: Concept, Development and Application. *Technovation, 26*, 336-344.

Phaal, Paterson, & Probert. (1998). Technology Management in Manufacturing Business: Process and Practical Assessment. *Technovation, 18*(8), 541–589.

Phaal, R., Farrukh, C., & Probert, D. R. (2004). Technology Roadmapping - A Planning Framework for evolution and revolution. *Technological Forecasting & Social Change, 71*, 5-26.

Pianta, A. D. (1996). Measuring technological change through patents and innovation surveys. *Technovation, 16*(9), 146–145.

Piening. (2013). Dynamic capabilities in public organizations: A literature review and research agenda. *Public Management Review, 15*(2), 209-245.

Pilkington. (2008). Engineering management or management of technology? A bibliometric study of IEEE TEM. *International Journal of Management Science and Engineering Management, 3*(1), 63-70.

Pilkington, & Teichert. (2006). Management of technology: themes, concepts and relationships. *Technovation, 26*, 288-299.

Pilkington, A. (2014). *Technology Management: A Comprehensive Bibliometric Analysis* Paper presented at the 2014 IEEE International Technology Management Conference.

Pisano. (1990). The R&D boundaries of the firm: An empirical analysis. *Administrative Science Quarterly, 35*, 153–176.

Pisano, G., & Figgie, H. (2016a). Toward a prescriptive theory of dynamic capabilities: connecting strategic choice, learning, and competition. *Industrial and Corporate Change, 26*(5), 747-762.

Pisano, G., & Figgie, H. (2016b). Towards A Prescriptive Theory of Dynamic Capabilities Connecting Strategic Choice, Learning, and Competition *Harvard Business School*.

Pleschak, F., Ossenkopf. (2002). *Technology Assessment. In: Specht, D., Möhrle, M.G .. (eds.): Lexicon Technology Management*. Gabler, Wiesbaden.

Plessis. (2007). The role of knowledge management in Innovation. *Journal of knowledge Management Research & Practice, 11*(4), 20-29.

Pogrebnyakov, & Kristensen. (2011). Building innovation subsidiaries in emerging markets: The experience of Novo Nordisk. *Research Technology Management, 54*(4), 30-37.

Polit, & Beck. (2010a). *Essentials of nursing research : appraising evidence for nursing practice*. London: Lippincott Williams and Wilkins.

Polit, & Beck. (2010b). *Essentials of nursing research : appraising evidence for nursing practice : appraising evidence for nursing practice. London*. London: Lippincott Williams and Wilkins.

Popadiuk, S., and Chun Wei Choo. (2006). Innovation and knowledge creation: How are these concepts related. *International Journal of Information Management, 26*(4), 302-312.

Porter-Liebskind, J. (1996). Knowledge, strategy, and the theory of the firm. *Strategic Management Journal, 17*, 93–107.

Porter. (1985). *Competitive advantage: Creating and sustaining superior performance*. New York: The Free Press.

Porter. (2009). Competição on competition: estratégias competitivas essenciais. *Campus Elsevier Rio de Janeiro*.

Potgieter, A., Dube, T., & Rensleigh, C. (2013). Knowledge management awareness in a research and development facility: Investigating employee perceptions. *SA Journal of Information Management, 15*(2), 592.

Poyhonen, & Hamalainen. (2001). On the convergence of multiattribute weighting methods. *European Journal Operational Research, 129*, 569-585.

Prahalad, & Hamel. (1990). The core competence of the corporation. *Harvard Business Review, 68*(3), 79-91.

Prajogo, D. I. (2006). Relationships between innovation stimulus, innovation capacity, and innovation performance. *R&D Management, 36*(5), 499-515.

Preez, G. T., & Pistorius, C. W. I. Analyzing technological threats and opportunities in wireless data services. *Technological Forecasting and Social Change, 70* (1), 2003.

Prodan, A. C. S. I. (2008). How Internal and External Sources of Knowledge Contribute to Firms' Innovation Performanc. *Managing Global Transitions, 6*(3), 277-299.

Pufal, N., Zawislak, P. A., Alves, A. C., & Tello-Gamarra, J. (2014). Management Capability and the Paradox of the Organized Firm. *Strategic Management Quarterly, 2*(3&4), 47-69.

Pugh. (1991). *Total design: Integrated methods for successful product engineering*. Harlow: Addison Wesley.

Quinn, Anderson, & Finkelstein. (1996). Managing professional intellect: making the most of the best. *Harvard Business Review, 74* 71–80.

Quinn, & Mueller. (1963). Transferring research results to operations. *Harvard Business Review, 41* (1).

Qureshi, K. A. (2018). *Science Technology & Innovation Strategy* Retrieved from Pakistan council of Science and Technology, Islamabad

Raan, V., & Tijssen. (1993). The neural net of neural network research. *Scientometrics, 26*(1), 169–192.

Račinskaja, I.,& Verspagen, J. (2017). Role of Supporting Management Discipline Myth or Reality for R&D in Public Sector Firms among Developing Countries *Mediterraneo-Palermo, 7*(1), 77-81.

Raisch, S., Birkinshaw, J., Probst, G. and Tushman. (2009). Organizational ambidexterity: Balancing exploitation and exploration for sustained performance. *Organization Science, 20*(4), 685-695.

Ramzi, T., & Salah, A. B. (2018). The Determinants of Innovation Capacity in the Less Innovative Countries in the Euro-Mediterranean Region. *Journal of the Knowledge Economy, 9*(2), 526-543.

Rasa Laliene, A. S. (2014). *Development of R&D effectiveness assessment system in the research organizations*. Paper presented at the 19th International Scientific Conference; Economics and Management 2014, ICEM 2014, Riga, Latvia.

Reddy. (2011). *Global Innovation in Emerging Economies*. New York, NY: Routledge.

Redmond, & Curtis. (2009). Focus groups: principles and process. . *Nurse Researcher, 16*(3), 57-69.

Reichert, F. M., Beltrame, R. S., Corso, K. B., Trevisan, M., & Zawislak, P. A. (2011). Technological Capability's Predictor Variables. *Journal of Technology Management & Innovation, 6*(1), 14-25.

Reichstein, & Salter. (2006). Investigating the sources of process innovation among UK manufacturing firms. *Ind. Corporate Change,, 15*(4), 653-682.

Reuer, J. J., Zollo, M., & Singh, H. (2002). Post-formation dynamics in strategic alliances. *Strategic Management Journal, 23*, 135-151.

Rhéaume, L., & Gardoni, M. (2016). Strategy-making for innovation management and the development of corporate universities. *Int J Interact Des Manuf, 10*.

Richard Adams, A. A., Christina Öberg, . (2014). *Innovation management capabilities for start-ups and spin-offs: A literature review*. Paper presented at the IMP Conference, Bordeaux.

Riemschneider, B. (2018). 2018 global r&d funding forecast. *R&D Magazine*.

Rintamaa, & Aho-Mantila. (2011). Plant life management and modernisation: Research challenges in the EU. *Nuclear Engineering and Design, 241*(9), 3389-3394.

Rios, A. A. (2011). *The organization of R&D within firms: Measures, characteristics and consequences*. Retrieved from Massachusetts Avenue Cambridge:

Rizzi, Ponte, & Bonifacio. (2009). A new institutional reading of knowledge management technology adoption. *Journal of Knowledge Management, 13*(4), 75-85.

Rodan, & Galunic. (2004). More than network structure: How knowledge diversifies influences managerial performance and innovativeness. *Strategic Management Journal, 25*(6), 541-562

Rodriguez, J., & Wiengarten, F. (2017). The role of process innovativeness in the development of environmental innovativeness capability. *Journal of Cleaner Production, 142*(4), 2423-2434.

Rogers. (1996). The challenge of fifth generation R&D. *Research Technology Management, 39*(4), 33-41.

Rolstadås, Henriksen, & O'Sullivan. (2012). *Manufacturing Outsourcing: A Knowledge Perspective*: Springer London.

Rombach, D. A. (2007). *Research Collaborations Between Academia and Industry*. Paper presented at the International Conference on Software Engineering (FOSE'7).

Romer. (1990). Endogenous technological change. *The Journal of Political Economy, 98*(5), 71-102.

Romer, P. M. (1990). Endogenous Technological Change. *Journal of Political Economy, 98*(5), 71-102.

Roper, & Dundas. (2015). Knowledge stocks, knowledge flows and innovation: Evidence from matched patents and innovation panel data. *Research Policy, 44*(7), 1327-1340.

Rothaermel, & Hess. (2006). *The role of individual, firm, and network level effects in building capabilities*. Paper presented at the Academy of Management Best Conference Paper BPS.

Rothaermel, F. T., & Alexandre, M. T. (2009). Ambidexterity in technology sourcing: The moderating role of absorptive capacity. *Organization Science, 20*, 759-780.

Rothwell. (1994a). *Industrial innovation: success, strategy, trends*.

Rothwell. (1994b). Towards the fifth-generation innovation process. *International Market review, 11*(1), 7-31.

Rouse. (1998). R&D/Technology Management: A Framework for Putting Technology to Work. *IEEE Transactions on Systems Management and Cybernetics, 28*(4), 501-515.

Roussel, Saad, & Erickson. (1991). *Third generation R&D*. Boston.

Roussel, Sand, & Erickson. (1991). *Third generation R&D*. Boston, Massachusetts: Harvard Business School Press.

Rowlei. (2000). From learning organisation to knowledge entrepreneur. *Journal of Knowledge Management, 4*(1), 7-15.

Rozenfeld, Forcellini, Amaral, Toledo, Silva, & Alliprandini. (2006). Gestão de desenvolvimento de produtos: uma referência para a melhoria do processo. *Saraiva, São Paulo*.

Rush, H., Bessant, J., & Hobday, M. (2007). Assessing the technological capabilities of firms. *developing a policy tool R&D Management, 37*(3), 221–236.

Sáenz, J., Aramburu, N., & Blanco, C. E. (2012). Knowledge sharing and innovation in Spanish and Colombian high-tech firms. *Journal of Knowledge Management, 16*(6), 919-933.

Sagar, A. D., & van der Zwaan, B. (2006). Technological innovation in the energy sector: R&D, deployment, and learning-by-doing. *Energy Policy, 34*(17), 2601-2608. doi:http://dx.doi.org/10.1016/j.enpol.2005.04.012

Sahlman, K. (2010). *Elements of Strategic Technology Management.* Acta universitatis ouluensis, Finland.

Samson, & Gloet. (2014). Innovation capability in Australian manufacturing organisations: an exploratory study. *International Journal of Production Research, 21*(52), 6448-6466.

Sanchez , & Mahoney. (1996). Modularity, flexibility and knowledge management in product and organization design. *Strat. Manage. J, 17*, 63–76.

Santos, M, F., & Eisenhardt, K. M. (2005). Organizational boundaries and theories of organization. *Organization Science*, *16*(5), 491-508.

Satyanarayan, S., & Azumah, G. (2011). *Operationalisation of knowledge management practices in r&d activity in multinational organisations* Paper presented at the Proceedings of the 12th Management International Conference.

Saunders, Lewis, & Thornhill. (2009). *Research Methods for Business Students*. London: Prentice Hall.

Saunila, M. U., J. (2012). A conceptual framework for the measurement of innovation capability and its effects. *Baltic Journal of Management*, *7*(4).

Savory, C. (2009). Building knowledge translation capability into public-sector innovation processes. *Technology Analysis & Strategic Management*, *21*(2), 149-171,.

Sazali, & Raduan. (2011). *The Handbook of Inter Firm Technology Transfer: An Integrated Knowledge-Based View and Organizational Learning Perspective*. Germany: LAP LAMBERT Academic Publishing.

Schmidt, T. S., M.; Hoffmann, V. (2011, 6-8 April 2011). *Analyzing differential policy effects on innovative patterns of heterogeneous firms: the case of climate change and the electricity sector*. Paper presented at the A Proceedings of the DIME Final conference, Maastricht university.

Schreyögg, G., & Kliesch-Eberl, M. (2007). How dynamic can organizational Capabilities be? Towards a dual-process Model of capability dynamization. *Strategic Management Journal*, *28*, 913-933.

Schroeder, D. M. (1990). A dynamic perspective on the impact of process innovation upon competitive strategies. *Strategic Manag. J*, *11*(1), 25-41.

Schumpeter. (1984). *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. New York Oxford University Press.

Schwab, Sala-i-Martin, & Greenhill. (2011). *The global competitiveness report 2011–2012*. Retrieved from Geneva:

Schwab, K. (2016a). *The Global Competitiveness Report 2015–2016*. Retrieved from

Schwab, K. (2016b). *The Global Competitiveness Report (2015-2016)*. Retrieved from http://reports.weforum.org/global-competitiveness-report-2015-2016/

Schwab, K. (2018). *The Global Competitiveness Report 2018*. Retrieved from Geneva Switzerland:

Scott. (1998). Organizational knowledge and the internet. *Decis. Support. System*, *23*(1), 3-17.

Selnes, & Sallis. (2003). Promoting Relationship Learning. *Journal of Marketing, 67*(3), 80–95.

Şener, & Sarıdoğan. (2011). The effects of Science-Technology-Innovation on competitiveness and economic growth. *Procedia - Social and Behavioral Sciences, 24*, 815-828.

Serio, D., & Vasconcellos. (2009). Estratégia e competitividade empresarial: inovação e criação de valor. *Saraiva, São Paulo*, 364.

Serje Schmidt , A. B., Raquel Engelman, Maria Cristina Bohnenberger. (2016). The influence of innovation environments in R&D results. *Revista de Administração de Empresas, 51*(4), 397-408.

Shahab, M. (2015). Technology Achievement Index 2015: Mapping the Global Patterns of Technological Capacity in the Network Age. *Technological Forecasting & Social Change*.

Shahid, J. (2015, 10 Feb 2015). Top Science & Tech bureaucrat admits R&D not govt priority. *Dawn*.

Shahid, J. (2016). Govt urged to increase spending on R&D. *DAWN*

Shan, W., G Walker and B Koput (1994). Interfirm cooperation and startup innovation in the biotechnology industry. *Strategic Management Journal, 15*(5), 387–394.

Shane. (2000). Prior knowledge and the discovery of entrepreneurial opportunities. *Organization Science, 11*, 448–469

Shankar, Acharia, & Baveja. (2009). Soft-system knowledge management framework for new product development. *Journal of Knowledge Management, 13*(1), 135-153.

Shariq, S. Z. (1997). Knowledge Management: An Emerging Discipline. *Journal of Knowledge Management, 1*(1), 75-82.

Shen, Lin, & Tzeng. (2011). Combined DEMATEL techniques with novel MCDM for the organic light emitting diode technology selection. *Expert Systems with Applications, 38*, 1468-1481.

Sher, P. J., & Yang, P. Y. (2005). The effects of innovative capabilities and R&D clustering on firm performance: the evidence of Taiwan's semiconductor industry. *Technovation, 25*(1), 33-43.

Shu-hsien Liao, W.-C. F. a. C.-C. C. (2007). Knowledge sharing, absorptive capacity, and innovation capability: an empirical study of Taiwan's knowledgeintensive industries. *Journal of Information ScienceJournal of Information Science*, 1-20.

Shu-hsienLiao. (2005). Technology management methodologies and applications: A literature review from 1995 to 2003. *Technovation, 25*(4), 381-393.

Sigala, & Chalkiti. (2015). Knowledge management, social media and employee creativity. *International Journal of Hospitality Management, 45*, 44-58.

Silberglitt, Anton, Howell, & Wong. (2006). *The global technology revaluation 2020: Bio/Nano/Materials/Information trends, drivers, barriers, and social implications*. Retrieved from Santa Monica: http://tinyurl.com/theves

Silva, D. O., Bagno, R. B., & Salerno, M. S. (2014). Modelos para a gestão da inovação: revisão e análise da literatura. *Production, 24*(2), 477-490.

Silva, E. G. T. (2011). Does structure influence growth? A panel data econometric assessment of "relatively less developed" countries,. *Industrial and Corporate Change, 20*(2), 457–510.

Singal, K. J. Q. S. V. (2010). *Measurement of Innovativeness in an Organisation using AHP* Paper presented at the Technology Management for Global Economic Growth (PICMET), Proceedings of PICMET '1.

Sitzia, & Wood. (1998). Response Rate in Patient satisfication Research: An Analysis of 210 *Internation Journal Quality Health Care, 10*, 311-317.

Skilbeck, J. N. a. C., C.M. (1997). *A framework for evaluating technology management processes*. Paper presented at the PICMET '97, Portland.

Slocum, A., & Rubin, E. S. (2008). Understanding Radical Technology Innovation and its Application to CO2 Capture R&D: Interim Report, Volume One—Literature Review.

Smith, Busi, Ball, & Meer, V. D. (2008). Factors influencing an organisation's ability to manage innovation: a structured literature review and conceptual model. *International Journal of Innovation Management, 12*(4), 655-676.

smith, E., Lyles, & Tsang. (2008). Inter-organizational knowledge transfer: Current themes and future prospects. *Journal of management studies, 45*, 677-690.

Smith, T. (2006). *Knowledge management and its capabilities linked to the business strategy for organisational effectiveness.* (DBA), Nova Southeastern University

Song, Zhu, & Rundquist. (2014). Knowledge Transfer Mechanisms and Global R&D Operations in MNCs. *International Journal of Innovation and Technology Management, 11*(06).

Song, M., Droge, C., Hanvanich, S. and Calantone (2005). Marketing and technology resource complementarity: an analysis of their interaction effect in two environmental contexts. *Strategic Management Journal, 26*, 259-276.

Soo, C. W., Midgley, D. & Devinney. (2002). The process of knowledge creation in organizations. *Organization Science*, 1-42.

Spithoven, A., Clarysse, B., & Knockaert, M. (2011). Building absorptive capacity to organise inbound open innovation in traditional industries *Technovation, 31*(1), 10-21.

Stamboulis, Adamides, & Malakis. (2002). *Modeling the Product-Process R&D Dynamics* Paper presented at the International Conference of the System Dynamics Society.

Steele. (1989). *Managing Technology,The Strategic View*. New York:: McGraw-Hill.

Steels. (1993). *Corporate knowledge management*. Paper presented at the ISMICK '93, Compiegne France.

Stefan Güldenberg , K.-H. L. (2008). Strategy Processes in Research and Development Organisations:Why Knowledge Management is still more isolated than integrated *OKLC, 104*(1), 57-65.

Stern, J. G. a. S. (2003). *Assessing Australia's Innovative Capacity in the 21st Century*. Retrieved from Australia:

Stewart, & Shamdasani. (1990a). *Focus groups: Theory and Practice.* Newlay Park, CA Sage Publications.

Stewart, & Shamdasani. (1990b). *Theory and practice*. London: Sage Publications.

Stewart, Shamdasani, & Rook. (2007a). *Focus groups: theory and practice*. Newbury Park: Sage

Stewart, Shamdasani, & Rook. (2007b). *Focus groups: theory and practice* Newbury Park CA: Sage Publications.

Stewart, T. A. (1997). *Intellectual Capital, Currency/ Doubleday*. New York, NY.

Strebel. (2007). *Innovation and Technology Management*. Vienna.

Stuart. (2000). Interorganizational alliances and the performance of firms: a study of growth and innovation rates in a high-technology industry. *Strategic Management Journal, 21*, 791–811.

Stüer, C., Hüsig, S., & Biala, S. (2008). *How to Create and Sustain an Open and Radical Innovation Capability? An Empirical Case Study Analysing Ongoing Radical Innovation Projects at Vodafone R&D* Paper presented at the PICMET 2008 Proceedings, 27-31 July, Cape Town, South Africa.

Su, C. H., Tzeng, G.-H., & Hu, S.-K. (2015). Cloud e-learning service strategies for improving e-learning innovation performance in a fuzzy environment by using a new hybrid fuzzy multiple attribute decision-making model. *Interactive Learning Environments*.

Suárez, D. (2014). Persistence of innovation in unstable environments: Continuity and change in the firm's innovative behavior. *Research Policy, 43*(4), 726–736.

Subramanian, A. a. N., S. . (1996). Organizational innovativeness: exploring the relationship between organizational determinants of innovation, types of innovations, and measures of organizational performance. *International Journal of Management Science,, 24*(6), 631-647.

Sumsion. (1998). The Delphi Technique: An Adaptive Research Tool. *The British Journal of Occupational Therapy, 61*, 153-156.

Sun, & Hong. (2002). The alignment between manufacturing and business strategies: its influence on business performance. *Technovation, 22*, 699-705.

Sungjoo Lee, B. Y., Changyong Leed, Jinwoo Park. (2009). Business planning based on technological capabilities: Patent analysis for technology-driven roadmapping *Technological Forecasting and Social Change*, *76*(6), 769–786.

Suzana, R., and Kasim, R. . (2010). The Relationship of Knowledge Management Practices, Competencies and the Organizational Performance of Government Departments in Malaysia,. *International Journal of Human and Social Sciences, 5*(4), 219-225.

Svetina, A. C., & Prodan, I. (2008). How Internal and External Sources of Knowledge Contribute to Firms' Innovation Performance. *Managing Global Transitions, 6*(3), 277–299.

Swan, & Scarbrough. (2001). Knowledge management: Concepts and controversies. *Journal of management studies, 38*(7), 913-921.

Swan, J. N. (2000). *Linking knowledge management and innovation*. Paper presented at the European Conference on Information Systems, Vienna.

Tagliaventi, M. R., and Mattarelli. (2006). The Role of Networks of Practice, Value Sharing, and Operational Proximity in Knowledge Flows Between Professional Groups. *Human Relations, 59*, 291–319.

Talonen, T., & Hakkarainen, K. (2008). Strategies for Driving R&D and Technology Development. *Research-Technology Management*, *51*(5), 54-60.

Tamura, Nagata, & Akazawa. (2002). *Extraction and systems analysis of factors that prevent safety and security by structural models*. Paper presented at the In 1st SICE Annual Conference.

Tariq Mahmood Ali, T. B., Adiqa Kausar Kiani. (2015). Assessment of Technological Capabilities of OIC Countries. *Science Technology Society, 20*(1), 114-131.

Technology, I. A. F. M. O. (2007). Program guidelines for management of technology (MOT) graduate level academic institution certification. Retrieved from http://www.iamot.org/

Technology, S. a. (2007). *Information and Communication Technology & Research & Development and Innovation Strategy*. Retrieved from

Technology, T. F. o. M. o. (1987). *Management of Technology: The Hidden Competitive Advantage*. Washington, DC.

Teece. (2009). *Dynamic capabilities and strategic management Organizing for innovation and growth*. Oxford, New York: Oxford University Press.

Teece. (2010). Long Range Planning *Business models, business strategy and innovation*, *43*(2), 172–194.

Teece, Pisano, & Shuen. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal, 18*(7), 509-533.

Teece, D., & Pisano, G. (1994). The dynamic capabilities of firms: an introduction. *Industrial & Corporate Change, 3*(3), 537-556.

Teece, D., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509-533.

Teece, D., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509-533.

Teece, D. J. (2007). Explicating dynamic capabilities: the nature and microfoundations of (sustainable) enterprise performance. *Strategic Management Journal*, *28*, 1319-1350.

Teece, D. J. (2017). Towards a capability theory of (innovating) firms: implications for management and policy *Cambridge Journal of Economics*, *41*(1), 693–720.

Teresa, Eva, & Daniel. (2008a). A Balanced Scorecard framework for R&D. *European Journal of Innovation Management, 11*(2), 241-281.

Teresa, Eva, & Daniel. (2008b). A Balanced Scorecard framework for R&D. *European Journal of Innovation Management*, *11*(2), 241-281.

Thien A. Tran, T. D. (2008). A taxonomic review of methods and tools applied in technology assessment. *Technological Forecasting & Social Change*, *75*, 1396–1405.

Thomas. (1993). *New Product Development: Managing and forecasting for strategic success*. New York: John Wiley & Sons.

Tidd, Bessant, & Pavitt. (2005). *Managing innovation. Integrating technological, market and organizational change*. UK: John Wiley & Sons.

Tidd, J. (2001). Innovation management in context: environment, organization and performance. *International Journal of Management Reviews, 3*(3), 169-183.

Tieng, K., Jeenanunta, C., & Rittippant, N. (2016). *The influences of knowledge management on innovation within formal and non-formal R&D manufacturing firms, Thailand.* Paper presented at the 2016 IEEE International Conference on Management of Innovation and Technology (ICMIT), Thailand.

Tiwana. (2000). *The Knowledge Management Toolkit*. Englewood Cliffs NJ: Prentice-Hall.

Tobin. (1998). Networking your knowledge. *Management Review*, 46-48.

Tödtling, Lehner, & Kaufmann. (2008). Do different types of innovation rely on specific kinds of knowledge interactions? . *Technovation*.

Tomblin, M. S. (2010). Theory Development in Enterprise Systems and Organizational Learning. *Journal of Organizational Computing and Electronic Commerce, 20,* 398-416.

Trade, U. N. C. O., & Development. (2003). *Investment and Technology Policies for Competitiveness: Review of Successful Country Experiences*: UN.

Trajtenberg. (1990). A penny for your quotes: patent citations and the value of innovations. *Rand Journal of Economics, 21*, 172–187.

Tran, T. A. K. (2009). *Portland International Conference on Management of Engineering & Technology (PICMET 2009).* Paper presented at the Literature Review on Technology Transfer from Government Laboratories to Industry.

Trott. (2005). *Innovation management and new product development.* NJ:Financial Times Prentice Hall.

Trott, P. H. (2009). Why 'Open Innovation' is Old Wine in New Bottles. *International Journal of Innovation Management, 13*(4), 715-736.

Trygg. (1991). *Engineering design.* Chalmers University of Technology, Göteborg, Sweden.

Tsai, & Shih. (2004). The impact of marketing knowledge management among managers on marketing capabilities and business performance. *International Journal of Management, 21*(4).

Tsai, & Wang. (2004). R&D productivity and the spillover effects of high tech industry on traditional manufacturing sector: the case of Taiwan. *World Economy, 27*(10), 1555–1570.

Tsai, A. (2015). The effects of innovation by inter-organizational knowledge management. *Information Development, 32*(5), 1402-1416.

Tsang, M., Kung, L. S., Huang, H. L. H., & Tzeng, G. H. (2015). Evaluating the implementation of business-to-business m-commerce by SMEs based on a new hybrid MADM model. *Management Decision, 53*(2), 290 - 317.

Tseng. (2010). The correlation between organizational culture and knowledge conversion on corporate performance. *Journal of Knowledge Management, 14*(2), 269-284.

Tushman, & Reilly. (1999). Building ambidextrous organizations. *Health Forum J.*

Tzeng, & Huang. (2011). Combined DEMATEL technique with hybrid MCDM methods for creating the aspired intelligent global manufacturing & logistics systems. *Annals of Operations Research, 197*, 159-190.

UNCTAD. (2003). *Trade and development report, 2003: Capital accumulation, growth and structural change* Retrieved from Washington D.C, United States of America:

Unctad. (2014). *Science, Technology and Innovation (STI) for the Post-2015 Development Agenda*. Retrieved from Washington D.C, United States of America:

UNCTAD. (2017). *The Least Developed Countries Report* Retrieved from New York and Geneva,:

UNESCO. (2018). Gross Domestic Expenditure on R&D Retrieved from http://data.uis.unesco.org/Index.aspx?DataSetCode=SCN_DS&lang=en

Unsal, E., & Cetindamar, D. (2015). Technology management capability: Definition and its measurement. *European International Journal of Science and Technology*, *4*(2), 181-196.

Usman, K., & Liu, Z. (2015). Innovation Index Framework to Measure the Innovation Capacity and Efficiency of SAARC Countries. *European Journal of Social Sciences*, *46*(3), 325-338.

Utterback. (1970). Process of innovation – A study of origination and development of ideas for new scientific instruments. *IEEE Transactions on Aerospace and Electronic Systems*, *6*(5).

Van de Ven, A. H. (1986). Central Problems in the Management of Innovation. *Management Science*, *32*, 590–607.

Van De Vrande, V., Vanhaverbeke, W. & Gassmann. (2010). Broadening the Scope of Open Innovation: Past Research, Current State and Future Direction. *International Journal of Technology Management*, *5*(3/4), 221-235

Van Echtelt, F. E. A., Wynstra, A. J. van Weele, and Duysters. (2008). Managing Supplier Involvement in New Product Development: A Multiple-Case Study. *Journal of Product Innovation Management*, *25*(2), 180–201.

Van Eck, N. J., & Waltman, L. (2014). Visualizing bibliometric networks. In Y. Ding, R. Rousseau, & D. Wolfram (Eds.), Measuring scholarly impact: Methods and practice. *Springer*, 285–320.

Van Zyl, Amadi Echendu, & Bothma, a. T. J. D. (2007). Nine drivers of knowledge transfer between universities and industry R & D partners in South Africa. *South African J. Inf. Manag*, *9*.

Vega-Jurado, Gutierrez-Gracia, Fernandez-de-Lucio, & Manjarres-Henriquez. (2008). The effect of external and internal factors on firms' product innovation. *Research Policy*, *37*(4), 616-632.

Venters. (2010). Knowledge management technology-in-practice: a social constructionist analysis of the introduction and use of knowledge management systems. *Knowledge Management Research & Practice*, *8*(2), 161-172.

Veugelers. (1997). Internal R&D expenditures and external technology sourcing. *Research Policy, 26*, 303–315.

Vitola, L., & Erina, J. (2015). *R&D Expenditures by Higher Education Sector and Analysis of Performance Indicators of Baltic States.* Paper presented at the 20th International Scientific Conference Economics and Management - 2015 (ICEM-2015).

Volberda, Foss, & Lyles. (2010). Absorbing the Concept of Absorptive Capacity: How to Realize Its Potential in the Organization Field. *Organization Science,, 21*(4), 931-951.

Wade, & Hulland. (2004). Review: The resource-based view and information system research: Review, extension, and suggestions for future research. *MIS Quarterly, 28*(1), 107-142.

Wagner, S. M., and M. Hoegl. (2006). Involving Suppliers in Product Development: Insights from R&D Directors and Project Managers. *Industrial Marketing Management, 35*(8), 936–943.

Walsh. (1995). Managerial and Organizational Cognition: Notes from a Trip down Memory Lane. *Organization Science, 6*(3), 280–321.

Walter. (2003). Relationship-Specific Factors Influencing Supplier Involvement in Customer New Product Development. *Journal of Business Research, 56*(9), 721–733.

Wamae. (2009). Enhancing the role of knowledge and innovation for development. *International Journal of Technology Management & Sustainable Development, 8*(3), 199-220.

Wamae, W. (2009). Enhancing the role of knowledge and innovation for development. *International Journal of Technology Management and Sustainable Development,, 8*(3), 199–220.

Wang. (1993). Technology management in a dual world. *International Journal of Technology Management, 8*, 108-120.

Wang, Lu, & Chen. (2007a). Evaluating firm technological innovation capability under uncertainty. *Technovision*.

Wang, Lu, & Chen. (2007b). Evaluating firm technological innovation capability under uncertainty. *Technovision*.

Wang, Lu, & Chen. (2008). Evaluating firm technological innovation capability under uncertainty. *Technovation, 28*, 349-363.

Wang, & Tzeng. (2012). Brand marketing for creating brand value based on a MCDM model combining DEMATEL with ANP and VIKOR methods. *Expert Systems with Applications, 39*, 5600-5615.

Wang, C.-H., Lu, Y.-H., & Huang, C.-W. (2013). R&D, productivity, and market value: An empirical study from high-technology firms. *Omega, 41* 143–155.

Wang, C. H., Lu, L.Y. and Chen, C.B. (2007). Evaluating firm technological innovation capability under uncertainty. *Technovision*.

Wang, P., Zhu, F.-W., Song, H.-Y., & Zhang, J.-L. (2018). Visualizing the Academic Discipline of Knowledge Management. *Sustainability, 10*(3), 628.

Watanabe, K. A. A. M. T. C. (2007). Impact of Technology Assimilation on Investment Policy: Dynamic Optimization and Econometric Identification. *Journal of Optimization Theory and Applications, 134*(2), 321–338

WDI. (2016). World Bank national accounts data and OECD National Accounts data files Retrieved from http://data.worldbank.org/indicator/NE.GDI.FTOT.ZS

Weenen, V. d. H. a. F. d. L. V. (2004). Committed to share: commitment and CMC use as antecedents of knowledge sharing. *Knowledge and Process Management, 11*(2004), 13-24.

Weerd-Nederhof, & Drongelen., K.-v. (1994). *Part I: R&D management', Coursebook Managing the R&D Process, Enschede.*: The Netherlands: Twente Quality Centre

WEF. (2017). *The Global Competitiveness Report 2016–2017,*. Retrieved from Geneva:

Weick, K. E., K. M. Sutcliffe, and D. Obstfeld. (2005). Organizing and the Process of Sensemaking. *Organization Science 16*(4), 409–421.

Weisberg, R. (1999). *Creativity and knowledge:A challenge to theories. In Handbook of creativity,* . Cambridg: Cambridge University Press.

Wernerfelt. (1984). A resource-based view of the firm. *Strategic Management Journal, 5*(2), 171-180.

Whipp. (1991). Managing technological changes: opportunities and pitfalls. *Int. J. Veh. Des, 12*(5/6), 469–477.

William, M. (2014). *Generations of R&D and innovation management*: John Wiley & Sons.

Winter. (2003). Understanding dynamic capabilities. *Strategic Management Journal, 24*(10), 991–995.

Wolfe. (1994). Organizational innovation: review, critique and suggested research directions. *Journal of management studies, 31*(3), 405-431.

Won, L., & Sangbum, P. (2011). *The Major Determinants for the Adoption of the Strategic Technology Roadmap (STRM) as an Infrastructure for Technological Innovation.* Paper presented at the 2011 Proceedings of PICMET '11: Technology Management in the Energy Smart World (PICMET) Portland, OR, USA

Wong, & Aspinwall. (2004). Characterizing knowledge management in the small business environment. *Journal of Knowledge Management, 8*(3), 44-61.

Wu, & Lee. (2007). Developing global managers' competencies using the fuzzy DEMATEL method. *Expert System, 32*(2), 499-507.

Wu, Liu, & Chin. (2018). The effect of technology management capability on new product development in China's service-oriented manufacturing firms: a social capital perspective. *Asia Pacific Business Review, 24*(2), 212–232.

Xiaofen Ji, C. P. G. B. (2007). *The Influence of Innovativeness Compatibility on Consumers' Online Purchase Intention on the Creative Product: A Case Study of Fashion* Paper presented at the 2007 International Conference on Wireless Communications, Networking and Mobile Computing.

Yam, LO, Tang, & Lau. (2011a). Analysis of sources of innovation, technological innovation capabilities, and performance. An empirical study of Hong Kong manufacturing industries. *Research Policy*, 391-402.

Yam, Lo, Tang, & Lau. (2011b). Analysis of sources of innovation, technological innovation capabilities, and performance: An empirical study of Hong Kong manufacturing industries. *Research Policy*, *40*, 391-402.

Yamin, M., and U. Andersson. (2011). Subsidiary Importance in the MNC: What Role Does Internal Embeddedness Play. *International Business Review, 20*(2), 151–162.

Yang. (2010). The knowledge management strategy and its effect on firm performance: a contingency analysis. *International Journal of Production Economics*, *125*(2), 215-223.

Yang, Jing-jun, & Chang-xiong. (2007). The Fusion Model of Knowledge Management and Communication Management in Research Organization. *IEEE*, 5394- 5398.

Yang, Shieh, Leu, & Tzeng. (2008). A novel hybrid model combined with DEMATEL and ANP with applications. *International Journal of Operations Research, 5*, 160-168.

Yang, Shieh, & Tzeng. (2011). A VIKOR technique based on DEMATEL and ANP for information security risk control assessment. *Information Sciences*.

Yang, M.-H., Su, C.-H., & Wang, W.-C. (2017). The Use of a DANP with VIKOR Approach for Establishing the Model of E-Learning Service Quality. *EURASIA Journal of Mathematics Science and Technology Education*, *13*(8), 5927-5237.

Yasemin. (2006). Direct and interaction effects of top management team and board compositions on r&d investment strategy. *Strategic Management Journal, 27*, 1081–1099.

Yasunaga, & Yoon. (2004). Technology Road mapping with Structuring Knowledge and Its Advantages in R&D Management. *IEEE*, 581-585.

Yi. (2009). A measure of knowledge sharing behavior: Scale development and validation. *Knowledge Management Research & Practice, 7*, 65–81.

Yildirim, O. U., Oner, A., & Basoglu, N. (2001). *Technology Processes Management Capability Profiles of Machine Manufacturers in Turkey*. Paper presented at the PICMET'01. Portland International Conference

Ying, Y.-J. C. a. T.-M. (2012). A Novel Method for Technology Forecasting and Developing R&D Strategy of Building Integrated Photovoltaic Technology Industry. *Mathematical Problems in Engineering, 2012*.

Yli-Renko, H., Autio, E. and Sapienza, H.J. (2001). Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms. *Strategic Management Journal,, 22*(6-7), 587-613.

Yoon, a. L. (2012). Applicability of patent information in technological forecasting: A sector-specific approach. *Journal of Intellectual Property Rights, 17*(1), 37-45.

Young. (2006). Implementing a knowledge retention strategy: a step-by-step process to combat organizational knowledge loss. *Knowledge Management Review, 9*(5), 28-33.

Zaaimuddin, Gan, & Eze. (2009). Knowledge Management Process and New Product Development Performance in a Malaysian Research and Development Organization. 997-1001.

Zabala-Iturriagagoitia. (2012). Technology Outlook as a tool for the management of innovation. *Cuadernos de Gestión, 12*, 125–144.

Zabala, J. M., & Iturriagagoitia. (2014). Innovation management tools: implementing technology watch as a routine for adaptation. *Technology Analysis & Strategic Management, 26*(9), 1073-1089.

Zabot, & Silva. (2002). *Gestão do Conhecimento*. São Paulo: Atlas.

Zahra. (2010). Harvesting Family Firms' Organizational Social Capital: A Relational Perspective. *Journal of management studies, 47*(2), 345–366.

Zahra, S. A., George. (2002). Absorptive capacity: a review, reconceptualization, and extension. *Acad. Manage. Review of Economic Studies, 27*(2), 185 – 203.

Zammit, & Woodman. (2012). *A case for repositories in knowledge management systems*. Paper presented at the 13th European Conference on Knowledge Management, ECKM 2012, Spain.

Zanello, G., Fu, X., Mohnen, P., & Ventresca, M. (2015). The creation and diffusion of innovation in developing countries: A systematic literature review. *Journal of Economic Surveys, 0*(1), 1–29.

Zarządzenie, Ł. (2009). Technology management. Evaluation and improvement. *Zeszów: Oficyna Wydawnicza Politechniki Rzeszowskiej*.

Zawislak, P. A., Alves, A. C., Tello-Gamarra, J., Barbieux, D., & Reichert, F. M. (2012). Innovation Capability: From Technology Development to Transaction Capability. *Journal of Technology Management & Innovation, 7*(2), 14-27.

Zedtwitz. (1999). *Managing interfaces in international R&D Unpublished PhD thesis.* University of St. Gallen, Bamberg- Switzerland.

Žemaitis, E. (2014). Knowledge management in open innovation paradigm context: high tech sector perspective *Procedia - Social and Behavioral Sciences, 110* 164 – 173.

Zhen. (2012). An Analytical Study on Service-Oriented Manufacturing Strategies. *International Journal of Production Economics, 139*(1), 220–228.

Zhu, & Xu. (2014). *Evaluation of Independent Innovation Capability of Enterprises Based on Factor Analysis.* Paper presented at the 2014 International Conference on Education Reform and Modern Management (ERMM-14). Atlantis Press.

Zollo, & Winter. (2002). Deliberate learning and the evolution of dynamic capabilities *Organization Science, 13*(3), 339-351.

APPENDIX A
FOCUS GROUP DISCUSSION

Dated (3- Mar 2018)

To: Respondent
Subject: Invitation for research participation

I am a researcher from Universiti Malaysia Pahang (UMP, Malaysia) and I am currently undertaking a full-time PhD at the Faculty of Industrial Management, Universiti Malaysia Pahang, and Malaysia. I am currently conducting a study on R&D in public organization. The purpose of my research is to find capabilities related to knowledge, innovation and technology management practicing among R&D in public organization of Pakistan by using Focus Group Technique[1] to obtain consensus on those Capabilities.
Your contribution to this research is very important to the success of this study. Therefore, I am inviting you to participate in this study. If you agree to participate in this study, you will be required to respond on two sessions. The first phase belongs to Focus Group questionnaires. While, the second session belong to DANP (DEMATEL based ANP) Questionnaire all data instruments are well structured. Each section will take about less than 45 minutes to complete. In the first session of the Focus Group Discussion, you will be asked to rate and list the capabilities influencing R&D. Your response in this session will be organized and returned to you as supporting information. In case of second session DEMATEL based ANP matrix close ended questions will provided. Your response in the second session will be analyzed.
All information provided will be treated with confidentiality and solely used for the purpose of the research only. Participants ‘names and details will not be disclosed to anybody or organization, only summarized information will be reported. Please, don‘t hesitate to contact me if you have any questions.

Sincerely yours

Zeeshan Asim
PhD. Candidate, Universiti Malaysia Pahang, Malaysia
E-mail: zeeshanasimump@gmail.com
zasim@ssuet.edu.pk

Capabilities that influencing R&D Management: First Session

The main purpose of this study is to refine the capabilities belongs to related to knowledge, innovation and Technology management that influence R&D Management. This Research questionnaire main to explore the significance of these capabilities by adopting the expert's opinion as reference point instead of using of applying large scale statistics

Instractions for questionnaire The quesionnaire is basically divided into three section . The first section are related to personal and organizational information', your will required to fill in the form at approapiate space. The information will be in a condition of ambiguity. It will be utilized only for follow-up, not for publishing

The next sections related to 'Focus group disussuion(FGD)'are split into '**knowledge management capability', 'Innovation management capability', 'technology management capability**' with 'criteria based on these capabilities that influence of **R&D,** this section also utilize to refine the relvent sub-criteria related to KM process capability, KM infrastructure capability, KM strategic capability, IM process capability, IM infastrure capability, IM strategic capability, TM process capability, TM infastrure capability, TM strategic capbility. You will be ask to rate the importance of each capabilities by putting a tick (✓) in the scale on the right hand side. The measuring scale design (0-4 scale) is how below

scale	Explanation
0	Not important at all
1	Little important
2	Moderately important
3	Important
4	Very important

Remarks *K.M – Knowledge Management, I.M- Innovation Management, T.M, Technology Management*

Example:

At the end of each section, you have an opportunity to suggest the other specified capabilities which you practicing and in their contributions to capabilities related to knowledge management, Innovation management, and technology management influence R&D in public organization

Q1: Do you agree on following dimensions involve in R&D Management?		
1. Knowledge Management Capability	Yes✓	NO☐
2. Innovation Management Capability	Yes☐	NO☐
3. Technology management Capability	Yes☐	NO☐

Q2: Rate Dimensions involve in R&D Management?			
Dimension		**Rating For Group consensus**	**Result**
Knowledge Management Capability	Yes✓ NO☐	0☐ 1☐ 2☐ 3✓ 4☐	
Innovation Management Capability	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology management Capability	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Questionnaire for refining the sub-criteria related to management supporting discipline

Please answer the following questions by putting a tick (✓) or providing information at appropriate places

Section 1
Session 1
Personal detail

Q1. Please provide your personal information? *(for follow-up contact)*
Mr./Mrs./Miss____
Name Surname
Email address: ____
Telephone: _____________________________________ ____________
Address: ____
____
____

Q1.2 Please describe your current job position?

Present job position: ____
Current Employer (*Institute*): ____________________________________
Department: ____
Years in this position: __________years __________months

Q1.3 Please indicate your Education background? [tick *(✓)*]s

Education Background: [ ] Bachelor degree [ ] Master degree [ ] Doctoral degree and above

Field of study: ____

Q1.4 Please describe your main Job responsibility related to R&D during this period?

Current job position: ____
Institute: ____
Department: ____
Years in this position: __________years __________months

Previous job Position ____

Q1.4 Please describe your main Job responsibility related to R&D during this period?

Current job position: ____
Institute: ____
Department: ____
Years in this position: __________years __________months

Gender (*Check ✓only one*) Male [ ], Female [ ]
Previous job Position ____

Q1.5 Please describes your main job Responsibility during this period *(Check ✓only one)*

[ ] R&D Management [ ] non-R&D Management

[ ] R&D (internal R&D) [ ] External R&D

[ ] R&D Marketing [ ] Supportive areas e.g. Training, Management development etc

[ ] Other *(please specify)* ……………………………………………..………..

Please explain if you held any previous job position *(both in current and previous organisations)*

(Provide only jobs had been worked more than 5 years in chronological sequence, listing the most recent employment first)

Employer Name	Job responsibility	Years of Experience

Organizational Background *(Operational Domain)*

Q2. Please indicate the main research type of your section. *(Check ✓only one)*
[ ] Basic Research [ ] Applied Research [ ] Pure Research

[ ] Non-research activity *(please specify)* ………………………………………..

Q2.1 Please indicate organization main research area of your section. *(Check ✓only one)*
[ ] Computer/IT [ ] Medicine [ ] Manufacturing

[ ] Biotechnology [ ] Material [ ] Electrical/ Electronics [ ] Textile

[ ] Other *(please specify)* ……………………………………………………..

Q2.2 Please approximates the proportion of funding *(in your section)* **supported by government.** *(Check ✓only one)*
[ ] less than 50% [ ] 50 - 69% [ ] 60-69%
[ ] 70-79% [ ] 80-89% [ ] 90-99%
[ ] 100% *(purely funding from government)*

Q2.3 Please indicate the major Spending in your department.
[ ] Internal R&D [ ] External R&D (outsourcing)
[ ] R&D collaborative projects
[ ] Other *(please specify)* ……………………………………………………..

Q2.4 Please specify the total number of employees in your department.
[ ] 1 to 25 [ ] 26 to 50
[ ] 56 to 100 [ ] more than 100

Q2.5 Please indicate if there are corporate social responsibility programs (*i.e. projects responding to non-commercial customers, societies and the nation***) in your department.**
[ ] Yes (*please estimate years of launch*) …… years [ ] No

Section 2: Capabilities related to Knowledge Management, Innovation Management, and Technology Management influence on R&D

As a public organisation, please indicate the importance of the following benefits

0= not important at all, 1= of little importance, 2= moderately important, 3= important, 4= very important

Q1: Do you agree on the following dimensions involve in R&D?		
1. Knowledge Management Capability	Yes☐	NO☐
2. Innovation Management Capability	Yes☐	NO☐
3. Technology management Capability	Yes☐	NO☐
4. Other *(please specify)* …………………...................	Yes☐	NO☐

Q2: Do you agree on following Criteria belong to Knowledge Management capabilities?		
1. Knowledge Management Process Capability	Yes☐	NO☐
2. Knowledge Management Infrastructure Capability	Yes☐	NO☐
3. Knowledge management Strategic Capability	Yes☐	NO☐
4. Other *(please specify)* …………………...................	Yes☐	NO☐

Q3: Rate criteria are being a part of knowledge Management Capabilities?

Criteria			**Rating For Group consensus**	**Result**
Knowledge Management Process Capability	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge Management Infrastructure Capability	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge management Strategic Capability	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify)* ………………….....	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q4: Do you agree upon following sub- criteria's belongs to knowledge Management Process Capabilities?		
Knowledge sharing	Yes☐	NO☐
Join Sense Making	Yes☐	NO☐
Knowledge Implementation	Yes☐	NO☐
Knowledge Transfer	Yes☐	NO☐
Affective Commitment	Yes☐	NO☐
Knowledge creation	Yes☐	NO☐
Knowledge generation	Yes☐	NO☐
Knowledge Protection	Yes☐	NO☐
Knowledge Acquisition	Yes☐	NO☐
Knowledge Utilization	Yes☐	NO☐
Intellectual knowledge portfolio	Yes☐	NO☐
Other *(please specify)*…………………....……….	Yes☐	NO☐

Q5: Rate sub- criteria are being a part of knowledge Management Process Capabilities?				
Sub-criteria			**Rating For Group consensus**	**Result**
Knowledge sharing	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Join Sense Making	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge Implementation	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge Transfer	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Affective Commitment	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge creation	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge generation	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge Protection	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge Acquisition	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge Utilization	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Intellectual knowledge portfolio	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify)*	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q6: Do you agree upon following sub- criteria's belongs to knowledge Management Infrastructure Capabilities?		
Organizational learning	Yes☐	NO☐
Culture	Yes☐	NO☐
Community of Practice	Yes☐	NO☐
IT	Yes☐	NO☐
Technology	Yes☐	NO☐
Structure	Yes☐	NO☐
Contribution of skills & expertise	Yes☐	NO☐
Novelty & uniqueness of innovation	Yes☐	NO☐
Role of leadership innovation & supports	Yes☐	NO☐
Other *(please specify)* ………………….....	Yes☐	NO☐

Q7: Rate sub- criteria are being a part of knowledge Management Infrastructure Capabilities??				
Sub-criteria			**Rating For Group consensus**	**Result**
Organizational learning	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Culture	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Community of Practice	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
IT	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Structure	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Contribution of skills & expertise	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Novelty & uniqueness of innovation	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Role of leadership in innovation	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify)*………............	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q8: Do you agree upon following sub- criteria's belongs to Knowledge Management Strategic Capabilities?		
External Knowledge Source	Yes☐	NO☐
Internal Knowledge Source	Yes☐	NO☐
Joint Internal Collaboration	Yes☐	NO☐
Joint External Collaboration	Yes☐	NO☐
HRM	Yes☐	NO☐
Innovative Performance	Yes☐	NO☐
Explicit knowledge	Yes☐	NO☐
Tacit Knowledge	Yes☐	NO☐
Codification	Yes☐	NO☐
Personalization	Yes☐	NO☐
R&D expenditure	Yes☐	NO☐
Success rate of R&D products	Yes☐	NO☐
R&D intensity	Yes☐	NO☐
Other *(please specify …………………...…………….………)*	Yes☐	NO☐

Q9: Rate sub- criteria are being a part of knowledge Management Strategic Capabilities?				
Sub-criteria			**Rating For Group consensus**	**Res**
External Knowledge source	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Internal Knowledge source	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Joint learning :internal collaboration	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Joint learning :External collaboration	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Tacit knowledge	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Explicit knowledge	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
HRM Practices	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Performance	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Codification	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Personalization	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
R&D expenditure	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Success rate of R&D products	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
R&D intensity	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify …………..)*	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q10: Do you agree on following Criteria belong to Innovation Management capabilities?		
1. Innovation Management Process Capability	Yes☐	NO☐
2. Innovation Management Infrastructure Capability	Yes☐	NO☐
3. Innovation Management Strategic Capability	Yes☐	NO☐
4. Other *(please specify ……………………………….)*	Yes☐	NO☐

Q11: Rate criteria are being a part of Innovation Management Capabilities?								
Criteria			**Rating For Group consensus**					**Res**
Innovation Management Process Capability	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Innovation Management Infrastructure Capability	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Innovation management Strategic Capability	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Other *(please specify* ……………………………)	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	

Q12: Do you agree upon following sub- criteria's belongs to Innovation Management Process Capability?		
R&D cooperation	Yes☐	NO☐
Acquisition Internal R&D	Yes☐	NO☐
Acquisition External R&D	Yes☐	NO☐
Technology Transfer	Yes☐	NO☐
Decision Making process	Yes☐	NO☐
Knowledge Sharing	Yes☐	NO☐
Inbound Open Innovation	Yes☐	NO☐
Project management (control & monitoring)	Yes☐	NO☐
Innovativeness compatibility	Yes☐	NO☐
Rate of introduction of new product/ service per year	Yes☐	NO☐
Internal & external Knowledge sharing ability	Yes☐	NO☐
Knowledge creation process	Yes☐	NO☐
Open Innovation	Yes☐	NO☐
Other *(please specify* ……………………………)	Yes☐	NO☐

Q13: Rate sub- criteria are being a part of Innovation Management Process Capability?								
Sub-criteria			**Rating For Group consensus**					**Res**
R&D cooperation	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Acquisition Internal R&D	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Acquisition External R&D	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Technology Transfer	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Decision Making process	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Knowledge Sharing	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Inbound Open Innovation	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Project management	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Innovativeness compatibility	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Rate of introduction of new product	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
(Inter & Exter)Knowledge sharing ability	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Knowledge creation process	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Open Innovation	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	
Other *(please specify* ………………)	Yes☐	NO☐	0☐	1☐	2☐	3☐	4☐	

Q14: Do you agree upon following sub- criteria's belongs to Innovation Management Infrastructure Capability?		
R&D investment	Yes☐	NO☐
External Networking	Yes☐	NO☐
R&D Employee	Yes☐	NO☐
New Knowledge	Yes☐	NO☐
Radical Innovation	Yes☐	NO☐
External knowledge	Yes☐	NO☐
Formulation	Yes☐	NO☐
Absorptive capacity	Yes☐	NO☐
Knowledge incentives	Yes☐	NO☐
Other *(please specify ………………)*	Yes☐	NO☐

Q15: Rate sub- criteria are being a part of Innovation Management Strategic Capability?			
Sub-criteria		**Rating For Group consensus**	**Res**
R&D investment	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
External Networking	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
R&D Employee	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
New Knowledge	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Radical Innovation	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
External knowledge	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Formulation	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Absorptive capacity	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Knowledge incentives	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify ……*)	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q16: Do you agree upon following sub- criteria's belongs to Innovation Management Strategic Capability?		
IP performance	Yes☐	NO☐
Technological Performance	Yes☐	NO☐
Innovative Performance	Yes☐	NO☐
Technology trends	Yes☐	NO☐
Organization strategy	Yes☐	NO☐
Innovation strategies and initiatives	Yes☐	NO☐
Other *(please specify ……*)	Yes☐	NO☐

Q17: Rate sub- criteria are being a part of Innovation Management strategic Capability?				
Sub-criteria			**Rating For Group consensus**	**Res**
IP performance	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technological Performance	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Innovative Performance	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology trends	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Organization strategy	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Innovation strategies and initiatives	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify ……*)	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q18: Do you agree on following Criteria belong to Technology Management capabilities?		
1. Technology Management Process Capability	Yes☐	NO☐
2. Technology Management Infrastructure Capability	Yes☐	NO☐
3. Technology Management Strategic Capability	Yes☐	NO☐
4. Other *(please specify ……*)	Yes☐	NO☐

Q19: Rate criteria are being a part of Technology Management Capabilities?				
Criteria			**Rating For Group consensus**	**Res**
Technology Management Process Capability	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Management Infrastructure Capability	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology management Strategic Capability	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify ……*)	Yes☐	NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q20: Do you agree upon following sub- criteria's belongs to Technology Management Process Capability?		
Technology Acquisition	Yes☐	NO☐
Technology Exploitation	Yes☐	NO☐
Technology Identification	Yes☐	NO☐
Technology learning	Yes☐	NO☐
Technology Protection	Yes☐	NO☐
Technology Selection	Yes☐	NO☐
Technology Planning	Yes☐	NO☐
Technology Development	Yes☐	NO☐
Technology deployment	Yes☐	NO☐
Technology development	Yes☐	NO☐
Technology Assessment	Yes☐	NO☐
Technology Forecasting	Yes☐	NO☐
Technology Watch	Yes☐	NO☐
Technology Transfer	Yes☐	NO☐
Other *(please specify ……*)	Yes☐	NO☐

Q21: Rate sub- criteria are being a part of Technology Management Process Capability?			
Sub-criteria		**Rating For Group consensus**	**Res**
Technology Acquisition	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Exploitation	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Identification	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology learning	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Protection	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Selection	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Planning	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Development	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology deployment	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Assessment	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Forecasting	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Watch	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology Transfer	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify ……*)	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q22: Do you agree upon following sub- criteria's belongs to Technology Management Infrastructure Capability?		
Management Capability	Yes☐	NO☐
Facility	Yes☐	NO☐
Organization capability	Yes☐	NO☐
Personal skill	Yes☐	NO☐
Other *(please specify ……*)	Yes☐	NO☐

Q23: Rate sub- criteria are being a part of Technology Management Infrastructure Capability?			
Sub-criteria		**Rating For Group consensus**	**Res**
Management Capability	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Facility	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Organization capability	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Personal skill	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify ……*)	Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

Q24: Do you agree upon following sub- criteria's belongs to Technology Management Strategic Capability?		
Strategic Technology Road Mapping	Yes☐	NO☐
Technology absorptive capability	Yes☐	NO☐
Technology innovation capability	Yes☐	NO☐
Absorptive capacity	Yes☐	NO☐
Descriptive capacity capability	Yes☐	NO☐
TM (Corporate Technology Strategy)	Yes☐	NO☐
TM(Corporate Business Strategy)	Yes☐	NO☐
TM(Technology Alliance Strategy)	Yes☐	NO☐
Other *(please specify ……*)	Yes☐	NO☐

Q25: Rate sub- criteria are being a part of Technology Management Strategic Capability?		
Sub-criteria	**Rating For Group consensus**	**Res**
Strategic Technology Road Mapping Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology absorptive capability Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Technology innovation capability Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Absorptive capacity Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Descriptive capacity capability Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
TM (Corporate Technology Strategy) Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
TM(Corporate Business Strategy) Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
TM(Technology Alliance Strategy) Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	
Other *(please specify ……*) Yes☐ NO☐	0☐ 1☐ 2☐ 3☐ 4☐	

APPENDIX B

DANP (DEMATEL BASED ANP) QUESTIONNAIRE

Session 2

Section 2

Evaluation of influence among criteria's, and sub-criteria's orientations for future R&D Management

Focus Group number: ___________________________________

This questionnaire aims to evaluate the interrelationship among criteria and sub-criteria orientations for future in your organisation. The factors related to alternative orientations were identified from previous questionnaire **'capabilities that influence R&D'**.

Instruction for the questionnaire

The questionnaire based on single big Matrix: **'Pairwise comparison of main capabilities'**, **'Pairwise comparison of criteria'**, and **'Pairwise comparison of sub-criteria orientations'**.

You will be asked to compare relative significance of several pairs of capabilities and orientations. Each capabilities of a pair are provided on the opposite sides of a row. Please circle the appropriate number

Scale	Explanation
0	Not important at all
1	Little important
2	Moderately important
3	Important
4	Very important

Example: If you think **'Knowledge creation'** is extreme important to **'knowledge Transfer'**

your response will be:

Directions:

Scale	Explanation
0	Not important at all
1	Little important
2	Moderately important
3	Important
4	Very important

i	j	Knowledge Creation	knowledge Acquisition	Intellectual Knowledge Portfolio	Knowledge Sharing	Knowledge Implementation	Knowledge Transfer
		$j_{0...4}$					
Knowledge Creation	$I_{0...4}$						4
Knowledge Acquisition							
Intellectual Knowledge Portfolio							
Knowledge Sharing							
Knowledge Implementation							
Knowledge Transfer							

Total Average of Criteria Matrix (T_Sub-cri]	knowledge Management Capability	Innovation Management Capability	Technology Management Capability	K.M Process Capability	Knowledge Creation	knowledge Acqusition	Intellectual Knowledge Portfolio	Knowledge Sharing	Knowledge Implementation	Knowledge Transfer	K.M Infrastructure Capability	Culture	Structure	Technology	People	Role of Leadership & Support	Organizational Learning	K.M Strategic Capability	Success rate of R&D products	R&D Expenditure	Combination	Internalization	Externalization	Socialization	I.M Process Capability	Technology Transfer	Decision Making Process	Open Innovation	Project Management	Innovativeness Compatibility	Rate of Introduction New Product	Internal& External Knowledge Sharing	R&D cooperation	I.M infrastructure Capability	External Networking	knowledge incentives	Radical Innovation	Absorptive capacity	R&D Employee	I.M Strategic Capability	Technology trends	Innovative Performance	Innovation strategies and initiatives	Organization Strategy	T.M Process Capability	Technology Acqusition	Technology Exploitation	Technology Protection	Technology Learning	Technology Selection	Techology identification	Technology development	T.M Infrastructure Capability	Management Capability	Facility and Equipment	Organization Capability	Personal Skill	T.M Strategic Capability	Strategic Technology Road Mapping	Corporate Technology Strategy	Corporate Business Strategy	Technology Alliance Strategy	Desorptive Capacity
knowledge Management Capability																																																															
Innovation Management Capability																																																															
Technology Management Capability																																																															
KM Process Capability																																																															
Knowledge Creation																																																															
Knowledge Acqusition																																																															
Intellectual Knowledge Portfolio																																																															
Knowledge Sharing																																																															
Knowledge Implementation																																																															
Knowledge Transfer																																																															
K.M Infrastructure Capability																																																															
Culture																																																															
Structure																																																															
Technology																																																															
People																																																															
Role of Leadership & Support																																																															
Organizational Learning																																																															
K.M Strategic Capability																																																															
Success rate of R&D products																																																															
R&D Expenditure																																																															
Combination																																																															
Internalization																																																															
Externalization																																																															
Socialization																																																															
I.M Process Capability																																																															
Technology Transfer																																																															
Decision Making Process																																																															
Open Innovation																																																															
Project Management																																																															
Innovativness Compability																																																															
Rate of Introduction New Product																																																															
Internal & External Knowledge Sharing																																																															
R&D cooperation																																																															
I.M Infrastructure Capability																																																															
External Networking																																																															
knowledge incentives																																																															
Radical Innovation																																																															
Absorptive capacity																																																															
R&D Employee																																																															
I.M Strategic Capability																																																															
Technology Trends																																																															
Innovative Performance																																																															
Innovation strategies and initiatives																																																															
Organization strategy																																																															
T.M Process Capability																																																															
Technology Acqusition																																																															
Technology Exploitation																																																															
Technology Protection																																																															
Technology Learning																																																															
Technology Selection																																																															
Techology identification																																																															
Technology development																																																															
TM Infrastructure Capability																																																															
Management Capability																																																															
Facility and Equipment																																																															
Organization Capability																																																															
Personal Skill																																																															
T.M Strategic Capability																																																															
Strategic Technology Road Mapping																																																															
Corporate Technology Strategy																																																															
Corporate Business Strategy																																																															
Technology Alliance Strategy																																																															
Desorptive Capacity																																																															

APPENDIX C

GAP ERROR RATIO FOR SUB CRITERIA

Total Average Sub-criteria Matrix (T_Sub) (39 Focus Group)	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(Int & Ext Kno)	(R&D.Corp)	(Ext Net)	(Know .Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Poten)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)
(K.cre)	0	2.12	1.85	2.9	3.36	1.13	3.19	2.1	2.2	2.4	2	1.4	1.9	2.87	0	2.12	1.8	2.99	3.4	1.35	3.17	2.1	2.2	2.4	2	1.4	1.9	2.88	0	2.1	1.86	2.9	3.35	1.1	3.2	2.11	2.2	2.4	2	1.4	1.9	2.87	2.11	1.79	2.9	3.31	1.19	3.2	2.1	2.1	2.4
(K.Acq)	1.86	0	2.61	2.6	1.81	1.35	1.36	2.4	1.4	1.1	1.5	1.4	1.3	1.9	1.9	0	2.6	2.61	1.8	1.35	1.38	2.8	1.4	1.1	1.6	1.4	1.1	1.98	1.9	0	2.61	2.63	1.87	1.4	1.3	2.53	1.4	1.1	1.5	1.4	1.1	1.98	1.89	0	2.7	2.61	1.86	1.4	1.4	2.7	1.4
(Int Kno Port)	2	2.7	0	3.4	1.86	1.36	1.49	2.8	1.5	1.1	1.5	1.5	1.1	1.62	2	2.7	0	3.35	1.9	1.36	1.49	2.8	1.5	1.1	1.5	1.5	1.1	1.62	2	2.7	0	3.36	1.85	1.4	1.5	2.88	1.5	1.1	1.5	1.6	1.2	1.63	2.1	2.69	0	3.37	1.86	1.4	1.5	2.9	1.5
(K.shar)	3.12	3.59	3.13	0	1.88	1.31	1.69	3.1	2	1.5	1.6	1.4	1.1	2.59	3.1	3.61	3.1	0	1.9	1.36	1.71	3.1	2	1.5	1.6	1.4	1.2	2.62	3.1	3.6	3.12	0	1.85	1.4	1.8	3.19	2	1.5	1.6	1.4	1.2	2.62	3.11	3.62	3.1	0	1.85	1.4	1.8	3.1	2
(K.Imp)	2.12	1.86	1.62	1.9	0	2.75	2.17	1.5	1.1	1.4	1.2	1.1	1.5	2.7	2.1	1.78	1.6	1.86	0	2.69	2.19	1.5	1.1	1.5	1.2	1.2	1.5	2.65	2.1	1.9	1.63	1.86	0	2.5	2.2	1.49	1.1	1.5	1.2	1.2	1.5	2.71	2.12	1.86	1.6	1.81	0	2.8	2.2	1.5	1.1
(K.tran)	1.18	1.67	2.12	2.1	2.86	0	2	1.7	1.7	1.7	2	1.7	1.9	2.12	1.2	1.72	2.1	2.12	2.9	0	2	1.7	1.7	1.8	2	1.7	1.9	2.12	1.3	1.8	2.13	2.13	2.88	0	2	1.75	1.8	1.8	2	1.8	1.9	2.13	3.12	1.22	1.2	2	2.49	1.4	0	1.5	1.4
(cult)	3.12	1.21	1.24	2	2.49	1.37	0	1.5	1.4	2.5	1.2	1.2	1.5	2.62	3.1	1.17	1.2	2	2.5	1.37	0	1.5	1.4	2.4	1.2	1.2	1.5	2.61	3.1	1.2	1.22	2	2.42	1.4	0	1.49	1.4	2.5	1.2	1.2	1.5	2.62	3.12	1.22	1.2	2	2.49	1.4	0	1.5	1.4
(stru)	2	3	2.75	3	2	1.63	1.75	0	2.1	1.6	1.8	1.1	1.4	1.63	2	3	2.7	3	1.9	1.65	1.76	0	2.1	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	2	1.6	1.7	0	2.1	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	1.9	1.6	1.7	0	2.1
(Tech)	1.69	1.21	1.49	1.6	1.69	1.62	1.99	1.6	0	2.7	1.9	1.7	2.2	1.62	1.7	1.19	1.5	1.62	1.7	1.62	2	1.6	0	2.7	1.9	1.7	2.2	1.62	1.7	1.2	1.49	1.62	1.77	1.6	2	1.62	0	2.7	1.9	1.7	2.2	1.62	1.71	1.21	1.5	1.62	1.71	1.6	2	1.6	0
(Peop)	2	1.13	1.2	1.6	1.49	2.19	3	1.2	2.9	0	1.4	1.9	2.1	1.62	2	1.13	1.3	1.63	1.5	2.25	3	1.3	2.9	0	1.4	1.9	2.1	1.63	2	1.1	1.19	1.62	1.49	2.3	3	1.25	2.9	0	1.4	1.9	2.1	1.63	2	1.12	1.2	1.62	1.51	2.2	3	1.2	2.9
(Lead& Supp)	1.71	1.37	1.12	1.6	1.2	1.62	1.49	1.5	1.6	1.6	0	1.4	1.1	1.37	1.7	1.37	1.1	1.62	1.2	1.62	1.49	1.5	1.6	1.6	0	1.4	1.1	1.37	1.7	1.4	1.12	1.62	1.19	1.6	1.5	1.49	1.6	1.6	0	1.4	1.1	1.37	1.7	1.37	1.1	1.62	1.22	1.6	1.5	1.5	1.6
(org. Lear)	1.25	1.12	1.37	1.5	1.62	1.62	1.2	1.2	3.1	2.2	1.2	0	3.5	2.12	1.3	1.12	1.4	1.49	1.6	1.62	1.2	1.2	3.1	2.2	1.2	0	3.5	2.12	1.2	1.1	1.37	1.49	1.62	1.6	1.2	1.25	3.1	2.2	1.2	0	3.5	2.12	1.25	1.12	1.4	1.49	1.62	1.6	1.2	1.2	3.1
(Succ. Rate)	1.49	1.19	1.19	1.5	2.19	2.37	1.68	1.4	3.1	2.7	1	2.9	0	1.87	1.5	1.24	1.1	1.49	2.2	2.37	1.7	1.4	3.1	2.7	1	2.9	0	1.87	1.5	1.2	1.12	1.49	2.24	2.4	1.7	1.37	3.1	2.7	1	2.9	0	1.87	1.49	1.19	1.1	1.48	2.23	2.4	1.7	1.4	3.1
(R&D Exper)	3	2	2	3.1	3	2	2.49	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.13	2.9	2.48	2.49	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.13	3	2.5	2.5	1.5	1.4	1.6	0.9	1.5	1.8	0	3	2	2	3.12	3	2.5	2.5	1.5	1.4
(Code)	1.86	2.12	1.85	2.9	3.37	1.15	3.22	2.2	2.2	2.4	1.9	1.4	1.9	2.87	0	2.12	1.8	2.3	3.3	1.34	3.16	2.1	2.2	2.3	2	1.4	1.8	2.88	0	2.1	1.86	2.79	3.35	1.1	3.1	2.15	2.2	2.4	2	1.4	1.9	2.87	2.09	1.75	2.1	3.29	1.15	3.1	2.1	2.1	2.4
(Pers)	2	0	2.61	2.6	1.82	1.35	1.39	2.6	1.4	1.2	1.5	1.3	1.2	1.89	0	0	2.6	2.61	1.8	1.33	1.37	2.8	1.3	1.1	1.6	1.4	1.1	1.91	1.9	0	2.61	2.62	1.87	1.4	1.3	2.52	1.4	1.1	1.5	1.4	1.1	1.95	1.87	0	2.6	2.59	1.84	1.4	1.4	2.7	1.4
(Ext)	3.12	2.68	0	3.3	1.87	1.37	1.47	2.7	1.5	1.1	1.5	1.5	1.1	1.62	1.9	2.63	0	3.35	1.9	1.35	1.48	2.8	1.5	1.1	1.5	1.5	1.1	1.62	2	2.7	0	3.37	1.86	1.4	1.5	2.87	1.5	1.1	1.5	1.6	1.2	1.63	2.11	2.66	0	3.32	1.85	1.4	1.5	2.8	1.5
(Inter)	2.12	3.57	3.11	0	1.88	1.31	1.7	3.1	2	1.5	1.7	1.4	1.1	2.59	2	3.63	3.1	0	1.8	1.34	1.72	3.1	2	1.5	1.6	1.4	1.2	2.62	3.1	3.6	3.11	0	1.85	1.4	1.8	3.17	2	1.5	1.6	1.4	2	2.62	3.14	3.59	3.1	0	1.85	1.4	1.7	3.1	2
(Tech .Tran)	1.19	1.87	1.62	1.9	0	2.73	2.18	1.5	1.1	1.4	1.2	1.1	1.5	2.68	3.1	1.75	1.6	1.86	0	2.68	2.18	1.5	1.1	1.5	1.2	1.3	1.5	2.63	2.1	1.9	1.62	1.86	0	2.5	2.2	1.47	1.1	1.5	1.2	1.2	1.5	2.73	2.1	1.86	1.6	1.79	0	2.7	2.2	1.5	1.1
(Dec.Mak)	3.12	1.65	2.12	2.2	2.87	0	2	1.7	1.7	1.7	2	1.7	1.9	2.12	2.1	1.74	2.1	2.13	2.8	0	2	1.7	1.7	1.7	2	1.7	1.9	2.12	1.2	1.7	2.14	2.12	2.87	0	2	1.72	1.7	1.7	2	1.7	1.9	2.12	3.13	1.23	1.2	2	2.47	1.4	0	1.5	1.4
(In. Op Inn)	2	1.21	1.24	2	2.51	1.37	0	1.5	1.4	2.5	1.2	1.2	1.5	2.62	1.2	1.17	1.2	2	2.5	1.37	0	1.5	1.4	2.4	1.2	1.2	1.5	2.61	3.1	1.2	1.22	2	2.42	1.4	0	1.49	1.4	2.5	1.2	1.2	1.5	2.61	3.12	1.22	1.2	2	2.47	1.4	0	1.5	1.4
(Proj. mang)	1.67	3	2.69	3	2	1.62	1.71	0	2.1	1.6	1.7	1.1	1.4	1.62	3.1	3	2.7	3	1.9	1.64	1.76	0	2.1	1.6	1.7	1.1	1.4	1.61	2	2.9	2.71	2.9	2	1.6	1.7	0	2.1	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	1.89	1.6	1.7	0	2.1
(Inn. com)	2	1.21	1.5	1.6	1.69	1.62	1.99	1.6	0	2.7	1.9	1.7	2.2	1.62	2	1.18	1.4	1.62	1.7	1.62	2	1.6	0	2.7	1.9	1.7	2.2	1.62	1.7	1.2	1.47	1.62	1.77	1.6	2	1.62	0	2.7	1.9	1.7	2.2	1.62	1.69	1.22	1.5	1.62	1.72	1.6	2	1.6	0
(Rate Int)	1.69	1.13	1.2	1.7	1.49	2.21	3	1.2	2.9	0	1.4	1.9	2.1	1.62	1.7	1.11	1.2	1.62	1.5	2.22	3	1.2	2.9	0	1.4	1.9	2.1	1.62	2	1.2	1.17	1.62	1.47	2.2	2.9	1.22	2.9	0	1.4	1.9	2.1	1.62	2	1.12	1.2	1.59	1.49	2.2	3	1.2	2.8
(Int & Ext Kno)	1.25	1.37	1.12	1.6	1.23	1.62	1.49	1.5	1.6	1.6	0	1.4	1.1	1.37	2	1.36	1.1	1.62	1.2	1.62	1.48	1.5	1.6	1.6	0	1.4	1.1	1.37	1.7	1.4	1.13	1.61	1.19	1.6	1.5	1.47	1.6	1.6	0	1.4	1.1	1.35	1.69	1.37	1.1	1.62	1.22	1.6	1.5	1.5	1.6
(R&D.Corp)	1.48	1.12	1.37	1.5	1.62	1.62	1.2	1.2	3.1	2.2	1.2	0	3.5	2.12	1.7	1.14	1.4	1.49	1.6	1.62	1.2	1.2	3.1	2.2	1.2	0	3.5	2.11	1.2	1.1	1.37	1.47	1.62	1.6	1.2	1.25	3.1	2.2	1.2	0	3.5	2.12	1.21	1.12	1.4	1.47	1.59	1.6	1.2	1.2	3.1
(Ext Net)	3	1.18	1.19	1.5	2.21	2.37	1.68	1.4	3.2	2.7	1	2.9	0	1.87	1.2	1.24	1.1	1.49	2.3	2.37	1.7	1.4	3.1	2.7	1	2.9	0	1.86	1.5	1.2	1.13	1.47	2.21	2.3	1.7	1.36	3.1	2.7	1	2.9	0	1.87	1.47	1.17	1.1	1.47	2.21	2.4	1.7	1.4	3.1
(Know .Inc)	1.87	2	2	3.1	3	2	2.49	1.5	1.4	1.6	0.9	1.5	1.7	0	1.4	2	2	3.13	2.9	2.46	2.48	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.11	3	2.4	2.3	1.49	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.12	3	2.5	2.5	1.5	1.4
(Rad Inn)	2	2.1	1.84	2.8	3.3	2	3.2	1.5	2.2	2.4	1.9	1.4	1.9	2.85	3	2.14	1.8	2.51	3.2	1.33	2.48	2.2	2.2	2.3	2	1.4	1.9	2.7	0	2.1	1.8	2.69	3.35	1.1	3.2	2.12	2.2	2.3	2	1.4	1.9	2.86	2.07	1.6	2.1	3.3	1.17	3.2	2.1	2.1	2.1
(Abso. Cap)	3.12	0	2.65	2.6	1.82	1.19	1.37	2.2	1.4	1.2	1.5	1.3	1.2	1.86	0	0	2.6	2.65	1.8	1.32	3.17	2.7	1.3	1.1	1.6	1.4	1.1	1.95	1.9	0	2.62	2.62	1.87	1.4	1.3	2.52	1.4	1.2	1.5	1.4	1.1	1.98	1.79	0	2.6	2.57	1.83	1.4	1.4	2.7	1.4
(R&D Empo)	2.12	2.68	0	3.3	1.86	1.35	1.48	2.6	1.5	1.1	1.5	1.5	1.1	1.62	1.9	2.65	0	3.34	1.8	1.32	1.36	2.8	1.5	1.1	1.5	1.5	1.1	1.62	2	2.7	0	3.36	1.86	1.4	1.5	2.87	1.5	1.1	1.5	1.6	1.2	1.63	2.11	2.67	0	3.31	1.86	1.4	1.5	2.7	1.5
(Tech Tren)	1.21	3.57	3.12	0	1.89	1.37	1.69	2.7	2	1.5	1.6	1.4	1.1	2.61	2	3.63	3.1	0	1.9	1.35	1.46	3.1	2	1.5	1.6	1.4	1.2	2.62	3.1	3.6	3.13	0	1.85	1.4	1.7	3.17	2	1.5	1.6	1.4	1.2	2.61	3.17	3.63	3.1	0	1.86	1.4	1.7	3.1	2
(Inno. per)	3.12	1.87	1.62	1.9	0	1.32	2.19	3.1	1.1	1.4	1.2	1.1	1.5	2.66	3.1	1.72	1.6	1.86	0	2.63	1.73	1.5	1.1	1.5	1.2	1.2	1.5	2.63	2.1	1.9	1.62	1.86	0	2.5	2.2	1.47	1.1	1.5	1.2	1.2	1.5	2.73	2.12	1.86	1.6	1.77	0	2.7	2.2	1.5	1.1
(Inov Str& ini)	2	1.65	2.12	2.2	2.87	2.71	2	1.5	1.7	1.7	2	1.7	1.9	2.17	2.1	1.72	2.2	2.12	2.8	0	2.19	1.7	1.7	1.7	2	1.7	1.9	2.12	1.2	1.7	2.11	2.12	2.87	0	2	1.73	1.7	1.7	2	1.7	1.9	2.11	3.13	1.19	1.2	2	2.46	1.4	0	1.5	1.4
(Org.Str)	1.67	1.22	1.24	2	2.49	0	0	1.7	1.4	2.5	1.2	1.2	1.5	2.62	1.2	1.17	1.1	2	2.5	1.36	2	1.5	1.4	2.4	1.2	1.2	1.5	2.61	3.1	1.1	1.22	2	2.42	1.4	0	1.49	1.4	2.5	1.2	1.2	1.5	2.61	3.12	1.22	1.2	2	2.44	1.4	0	1.5	1.4
(Tech. Acq)	2	3	2.72	3	2	1.39	1.7	1.5	2.2	1.6	1.7	1.1	1.4	1.62	3.1	3	2.7	3	1.9	1.63	0	0	2.1	1.7	1.7	1.1	1.4	1.64	2	3	2.69	3	2	1.6	1.7	0	2.2	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	1.87	1.6	1.7	0	2.1
(Tech. Expo)	1.71	1.21	1.51	1.6	1.7	1.62	1.99	0	0	2.7	1.9	1.7	2.2	1.62	2	1.16	1.4	1.62	1.7	1.59	1.76	1.6	0	2.7	1.9	1.7	2.2	1.62	1.7	1.2	1.49	1.62	1.77	1.6	2	1.62	0	2.7	1.9	1.7	2.2	1.62	1.67	1.21	1.5	1.62	1.69	1.6	2	1.6	0
(Tech. Pro)	1.25	1.13	1.21	1.7	1.49	1.62	3	1.6	2.9	0	1.4	1.9	2.1	1.62	1.7	1.12	1.2	1.62	1.5	2.23	2	1.2	2.9	0	1.4	1.9	2.1	1.62	2	1.1	1.16	1.62	1.47	2.2	3	1.23	2.9	0	1.4	1.9	2.1	1.62	2	1.11	1.2	1.59	1.47	2.2	3	1.2	2.8
(Tech. lear)	1.51	1.37	1.12	1.7	1.21	2.2	1.49	1.2	1.6	1.6	0	1.4	1.2	1.37	2	1.37	1.1	1.62	1.2	1.62	3	1.5	1.6	1.6	0	1.4	1.2	1.37	1.7	1.4	1.12	1.62	1.17	1.6	1.5	1.47	1.6	1.6	0	1.4	1.1	1.33	1.67	1.37	1.1	1.62	1.22	1.6	1.5	1.5	1.6
(Tech. Sele)	3	1.15	1.37	1.5	1.62	1.62	1.23	1.5	3.1	2.2	1.2	0	3.4	2.12	1.7	1.17	1.4	1.48	1.6	1.62	1.47	1.2	3.1	2.2	1.2	0	3.5	2.14	1.2	1.1	1.37	1.47	1.62	1.6	1.2	1.25	3.1	2.2	1.2	0	3.5	2.12	1.21	1.12	1.4	1.49	1.63	1.6	1.2	1.2	3.1
(Tech. Iden)	1.87	1.19	1.22	1.5	2.21	1.62	1.65	1.2	3.2	2.7	1	2.9	0	1.86	1.2	1.24	1.1	1.48	2.3	2.36	1.2	1.4	3.1	2.7	1	2.9	0	1.85	1.5	1.2	1.12	1.47	2.21	2.4	1.7	1.37	3.1	2.7	1	2.9	0	1.87	1.45	1.19	1.1	1.46	2.19	2.4	1.7	1.4	3.1
(Tech Deve)	2	2	2	3.1	3	2.39	2.47	1.4	1.4	1.6	0.9	1.5	1.7	0	1.5	2	2	3.14	2.8	2.46	1.7	1.5	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.12	3	2.5	2.5	1.49	1.4	1.6	0.9	1.5	1.7	0	3	2	2	3.1	3	2.5	2.5	1.5	1.4
(Mang comp)	3.12	1.87	1.84	3	2	2	0	1.5	2.2	2.4	1.2	1.1	1.4	2.83	3	1.73	1.1	0	1.9	2.35	2.47	0	1.7	2.3	2	1.4	1.8	2.87	0	2.1	1.86	2.77	3.33	1.1	3.1	2.17	2.1	2.3	2	1.4	1.9	2.86	0	1.77	2.9	3.29	1.17	3.2	2.1	2.1	2.4
(Fac)	2.12	1.65	2.68	1.6	1.69	1.41	1.69	3.1	1.4	1.6	2	1.7	2.2	1.84	0	1.17	2.7	1.86	1.7	2.44	2	1.6	1.4	1.1	1.6	1.3	1.1	1.92	1.9	0	2.59	2.62	1.86	1.4	1.3	2.52	1.3	1.1	1.5	1.4	1.1	1.89	1.87	0	2.6	2.59	1.86	1.4	1.4	2.7	1.4
(Org. Poten)	1.22	1.22	0	1.6	1.49	1.62	1.95	1.5	1.5	2.6	1.2	1.9	2.1	1.62	1.7	3	1.4	2.15	1.5	1.34	0	1.2	2.1	1.1	1.5	1.4	1.1	1.62	2	2.7	0	3.36	1.85	1.4	1.5	2.79	1.5	1.2	1.5	1.5	1.2	1.63	2.1	2.69	0	3.29	1.85	1.4	1.5	2.8	1.5
(Pers. Skil)	3.12	3	3.13	1.6	1.23	1.62	3	1.7	2	0	1.7	1.4	1.2	2.62	2	1.14	1.2	2	1.2	1.35	1.76	1.5	0	1.5	1.6	1.4	1.2	2.62	3.1	3.6	3.12	0	1.84	1.4	1.8	3.14	2	1.5	1.6	1.4	2	2.61	3.1	3.59	3.1	0	1.85	1.4	1.8	3.1	2
(Str Tech)	2	1.21	1.62	1.5	1.62	2.3	1.46	1.5	1.1	1.6	1.9	0	3.4	2.62	1.7	1.11	1.2	3	1.6	1.33	2	1.2	2.9	1.5	1.2	1.2	1.4	2.61	2.1	1.9	1.62	1.86	0	2.5	2.1	1.45	1.1	1.5	1.2	1.2	1.5	2.69	2.12	1.86	1.6	1.81	0	2.7	2.1	1.5	1.1
(Corp Tech Stra)	1.67	1.13	2.11	1.5	2.23	1.62	1.21	0	1.7	2.2	1.4	2.9	0	2.17	1.2	1.37	1.3	1.59	2.3	1.31	3	1.4	1.6	1.7	2	1.7	1.9	2.15	1.2	1.7	2.11	2.12	2.87	0	2	1.69	1.7	1.7	2	1.7	1.9	2.12	3.15	1.19	1.2	2	2.47	0	0	1.5	1.4
(Corport Bus Strat)	3	1.37	1.22	3.1	3	1.64	1.67	1.6	1.3	2.7	0	1.5	1.7	2.62	1.4	1.15	1.2	1.64	2.8	2.64	1.47	1.5	3.1	2.4	1.3	1.2	1.5	2.62	3.1	1.2	1.22	2	2.41	1.4	0	1.47	1.4	2.5	1.1	1.2	1.5	2.59	3.12	1.22	1.2	2	2.49	1.4	0	1.5	1.4
(Tech Alli)	1.87	1.15	2.7	1.6	2.23	2.41	2.48	1.6	2.1	1.6	1.2	2.8	3.4	1.62	3	1.25	1.4	1.63	1.5	1.36	1.2	1.4	2.9	1.6	1.7	1.1	1.4	1.62	2	2.9	2.73	2.9	2	1.6	1.7	0	2.1	1.6	1.7	1.1	1.4	1.62	2	3	2.7	3	1.1	1.6	1.7	0	2.1
(Desor. Cap)	1.84	2	2	3.1	3	2	2.47	1.5	1.4	1.6	1.1	1.5	1.7	0	3	2.11	1.8	2.49	3.4	1.36	2.49	2.2	2.2	2.4	2	1.4	1.9	2.88	0	2.1	1.86	2.77	3.35	1.1	3.2	2.17	2.2	2.4	2	1.4	1.9	2.86	1.71	1.22	1.5	1.62	1.72	1.6	2	1.7	0

Total Average Sub-criteria Matrix (T_Sub) (38 Focus Group)	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(Int & Ext Kno)
(K.cre)	0	2.05	1.79	2.8	3.25	1.09	3.08	2.1	2.1	2.3	1.9	1.3	1.8	2.77	0	2.05	1.8	2.89	3.2	1.3	3.06	2	2.1	2.3	1.9
(K.Acq)	1.8	0	2.52	2.5	1.75	1.3	1.31	2.3	1.3	1.1	1.4	1.3	1.2	1.83	1.8	0	2.5	2.52	1.8	1.31	1.33	2.7	1.3	1.1	1.6
(Int Kno Port)	1.93	2.61	0	3.2	1.8	1.31	1.44	2.7	1.5	1.1	1.5	1.5	1.1	1.56	1.9	2.61	0	3.24	1.8	1.31	1.44	2.7	1.5	1.1	1.5
(K.shar)	3.01	3.47	3.02	0	1.82	1.27	1.63	3	1.9	1.4	1.6	1.3	1.1	2.5	3	3.49	3	0	1.8	1.31	1.65	3	1.9	1.5	1.6
(K.Imp)	2.05	1.8	1.56	1.8	0	2.66	2.1	1.4	1.1	1.4	1.1	1.1	1.4	2.61	2	1.72	1.6	1.8	0	2.6	2.11	1.4	1.1	1.4	1.1
(K.tran)	1.14	1.61	2.05	2	2.76	0	1.93	1.6	1.6	1.6	1.9	1.6	1.8	2.05	1.2	1.66	2	2.05	2.8	0	1.93	1.7	1.7	1.7	1.9
(cult)	3.01	1.17	1.2	1.9	2.4	1.32	0	1.4	1.3	2.4	1.1	1.2	1.4	2.53	3	1.13	1.1	1.93	2.4	1.32	0	1.4	1.3	2.3	1.2
(stru)	1.93	2.9	2.66	2.9	1.93	1.57	1.69	0	2.1	1.6	1.7	1.1	1.3	1.57	1.9	2.9	2.6	2.9	1.8	1.59	1.7	0	2	1.6	1.7
(Tech)	1.63	1.17	1.44	1.6	1.63	1.56	1.92	1.6	0	2.6	1.8	1.6	2.1	1.56	1.6	1.15	1.4	1.56	1.6	1.56	1.93	1.6	0	2.6	1.8
(Peop)	1.93	1.09	1.16	1.6	1.44	2.11	2.9	1.1	2.8	0	1.3	1.8	2	1.56	1.9	1.09	1.2	1.57	1.4	2.17	2.9	1.2	2.8	0	1.3
(Lead& Supp)	1.65	1.32	1.08	1.6	1.16	1.57	1.44	1.4	1.6	1.6	0	1.3	1.1	1.32	1.6	1.32	1.1	1.57	1.2	1.57	1.44	1.4	1.6	1.6	0
(org. Lear)	1.21	1.08	1.32	1.4	1.56	1.56	1.16	1.2	3	2.1	1.2	0	3.4	2.05	1.2	1.08	1.3	1.44	1.6	1.56	1.16	1.2	3	2.1	1.2
(Succ. Rate)	1.44	1.15	1.15	1.4	2.11	2.29	1.62	1.3	3	2.6	1	2.8	0	1.8	1.4	1.2	1.1	1.44	2.1	2.29	1.64	1.3	3	2.6	1
(R&D Exper)	2.9	1.93	1.93	3	2.9	1.93	2.4	1.4	1.3	1.6	0.8	1.4	1.6	0	2.9	1.93	1.9	3.02	2.8	2.39	2.4	1.4	1.3	1.6	0.8
(Code)	1.8	2.05	1.79	2.8	3.25	1.11	3.11	2.1	2.1	2.3	1.8	1.3	1.8	2.77	0	2.05	1.8	2.22	3.2	1.29	3.05	2	2.1	2.3	1.9
(Pers)	1.93	0	2.52	2.5	1.75	1.3	1.34	2.5	1.3	1.1	1.4	1.3	1.2	1.83	0	0	2.5	2.52	1.8	1.28	1.32	2.7	1.3	1.1	1.6
(Ext)	3.01	2.59	0	3.2	1.8	1.32	1.42	2.6	1.4	1.1	1.5	1.4	1.1	1.57	1.8	2.54	0	3.24	1.8	1.3	1.43	2.7	1.4	1.1	1.5
(Inter)	2.04	3.45	3	0	1.82	1.27	1.64	3	1.9	1.4	1.6	1.3	1.1	2.5	1.9	3.51	3	0	1.8	1.29	1.66	3	1.9	1.5	1.6
(Tech .Tran)	1.15	1.8	1.56	1.8	0	2.64	2.11	1.4	1.1	1.4	1.1	1.1	1.4	2.59	3	1.69	1.6	1.8	0	2.59	2.11	1.4	1.1	1.4	1.1
(Dec.Mak)	3.01	1.59	2.05	2.1	2.77	0	1.93	1.6	1.6	1.6	1.9	1.6	1.8	2.05	2	1.68	2.1	2.05	2.7	0	1.93	1.7	1.7	1.7	1.9
(In. Op Inn)	1.93	1.17	1.2	1.9	2.42	1.32	0	1.4	1.3	2.4	1.1	1.2	1.4	2.53	1.2	1.13	1.1	1.93	2.4	1.32	0	1.4	1.3	2.3	1.2
(Proj. mang)	1.61	2.9	2.6	2.9	1.93	1.57	1.65	0	2	1.6	1.6	1.1	1.3	1.57	3	2.9	2.6	2.9	1.8	1.59	1.7	0	2	1.6	1.7
(Inn. com)	1.93	1.17	1.44	1.6	1.63	1.57	1.92	1.6	0	2.6	1.8	1.6	2.1	1.56	1.9	1.14	1.4	1.57	1.7	1.56	1.93	1.6	0	2.6	1.8
(Rate Int)	1.63	1.09	1.16	1.6	1.44	2.13	2.9	1.1	2.8	0	1.3	1.8	2	1.56	1.6	1.07	1.2	1.57	1.4	2.14	2.9	1.2	2.8	0	1.3
(Int & Ext Kno)	1.2	1.32	1.08	1.6	1.19	1.57	1.44	1.4	1.6	1.6	0	1.3	1.1	1.32	1.9	1.32	1.1	1.57	1.2	1.57	1.43	1.4	1.6	1.6	0
(R&D.Corp)	1.43	1.08	1.32	1.4	1.57	1.56	1.16	1.2	3	2.1	1.2	0	3.4	2.04	1.6	1.1	1.3	1.44	1.6	1.56	1.16	1.2	3	2.1	1.2
(Ext Net)	2.9	1.14	1.15	1.4	2.13	2.29	1.62	1.3	3	2.6	1	2.8	0	1.8	1.2	1.2	1.1	1.44	2.2	2.28	1.64	1.3	3	2.6	1
(Know .Inc)	1.8	1.93	1.93	3	2.9	1.93	2.4	1.4	1.3	1.6	0.8	1.4	1.6	0	1.4	1.93	1.9	3.02	2.8	2.38	2.39	1.4	1.3	1.6	0.8
(Rad Inn)	1.93	2.03	1.78	2.7	3.19	1.93	3.09	1.4	2.1	2.3	1.9	1.3	1.8	2.75	2.9	2.07	1.8	2.42	3.1	1.28	2.39	2.1	2.1	2.3	1.9
(Abso. Cap)	3.01	0	2.56	2.5	1.75	1.15	1.32	2.1	1.3	1.1	1.4	1.3	1.2	1.8	0	0	2.5	2.56	1.8	1.27	3.06	2.6	1.3	1.1	1.6
(R&D Empo)	2.05	2.59	0	3.2	1.8	1.3	1.43	2.5	1.4	1.1	1.5	1.4	1.1	1.57	1.8	2.56	0	3.23	1.7	1.27	1.31	2.7	1.4	1.1	1.5
(Tech Tren)	1.17	3.45	3.01	0	1.82	1.32	1.63	2.6	1.9	1.4	1.6	1.3	1.1	2.52	1.9	3.51	3	0	1.8	1.3	1.41	3	1.9	1.5	1.6
(Inno. per)	3.01	1.8	1.56	1.8	0	1.27	2.11	3	1.1	1.4	1.1	1.1	1.4	2.57	3	1.66	1.6	1.8	0	2.54	1.67	1.4	1.1	1.4	1.1
(Inov Str& ini)	1.93	1.59	2.05	2.1	2.77	2.62	1.93	1.4	1.6	1.6	1.9	1.6	1.8	2.1	2	1.66	2.1	2.05	2.7	0	2.11	1.7	1.7	1.7	1.9
(Org.Str)	1.61	1.17	1.2	1.9	2.4	0	0	1.6	1.3	2.4	1.1	1.2	1.4	2.53	1.2	1.13	1.1	1.93	2.4	1.32	1.93	1.4	1.3	2.3	1.2
(Tech. Acq)	1.93	2.9	2.63	2.9	1.93	1.34	1.64	1.4	2.1	1.6	1.6	1.1	1.3	1.57	3	2.9	2.6	2.9	1.8	1.58	0	0	2	1.6	1.7
(Tech. Expo)	1.65	1.17	1.46	1.6	1.64	1.57	1.92	0	0	2.6	1.8	1.6	2.1	1.56	1.9	1.12	1.4	1.57	1.7	1.54	1.7	1.6	0	2.6	1.8
(Tech. Pro)	1.21	1.09	1.17	1.6	1.44	1.57	2.9	1.6	2.8	0	1.3	1.8	2	1.56	1.6	1.08	1.2	1.57	1.4	2.15	1.93	1.2	2.8	0	1.3
(Tech. lear)	1.46	1.32	1.08	1.6	1.17	2.12	1.44	1.1	1.6	1.6	0	1.3	1.2	1.32	1.9	1.32	1.1	1.56	1.2	1.57	2.9	1.4	1.6	1.6	0
(Tech. Sele)	2.9	1.11	1.32	1.4	1.57	1.57	1.19	1.4	3	2.1	1.1	0	3.3	2.04	1.6	1.13	1.3	1.43	1.6	1.56	1.42	1.2	3	2.1	1.2
(Tech. Iden)	1.8	1.15	1.18	1.4	2.13	1.56	1.59	1.2	3.1	2.6	1	2.8	0	1.8	1.2	1.2	1.1	1.43	2.2	2.28	1.16	1.3	3	2.6	1
(Tech Deve)	1.93	1.93	1.93	3	2.9	2.31	2.39	1.3	1.3	1.6	0.8	1.4	1.6	0	1.4	1.93	1.9	3.03	2.7	2.37	1.64	1.4	1.3	1.6	0.8
(Mang comp)	3.01	1.8	1.78	2.9	1.93	1.93	0	1.4	2.1	2.3	1.1	1.1	1.3	2.73	2.9	1.67	1.1	0	1.8	2.27	2.39	0	1.7	2.3	1.9
(Fac)	2.05	1.59	2.59	1.6	1.63	1.36	1.63	3	1.3	1.6	1.9	1.6	2.1	1.78	0	1.13	2.6	1.8	1.7	2.36	1.93	1.6	1.3	1.1	1.6
(Org. Poten)	1.18	1.17	0	1.6	1.44	1.57	1.88	1.4	1.4	2.5	1.1	1.8	2	1.57	1.6	2.9	1.4	2.08	1.4	1.29	0	1.1	2	1.1	1.5
(Pers. Skil)	3.01	2.9	3.02	1.6	1.19	1.56	2.9	1.6	1.9	0	1.6	1.3	1.2	2.53	1.9	1.1	1.2	1.93	1.2	1.3	1.7	1.4	0	1.5	1.6
(Str Tech)	1.93	1.17	1.57	1.4	1.57	2.22	1.41	1.4	1.1	1.6	1.8	0	3.3	2.53	1.6	1.07	1.1	2.9	1.6	1.28	1.93	1.2	2.8	1.4	1.1
(Corp Tech Stra)	1.61	1.09	2.04	1.4	2.15	1.56	1.17	0	1.6	2.1	1.3	2.8	0	2.1	1.2	1.32	1.3	1.54	2.2	1.27	2.9	1.3	1.6	1.7	1.9
(Corport Bus Strat)	2.9	1.32	1.18	3	2.9	1.58	1.61	1.6	1.3	2.6	0	1.4	1.6	2.53	1.4	1.11	1.1	1.58	2.7	2.55	1.42	1.4	3	2.4	1.2
(Tech Alli)	1.8	1.11	2.61	1.6	2.15	2.33	2.39	1.5	2	1.6	1.1	2.7	3.3	1.57	2.9	1.2	1.3	1.57	1.4	1.32	1.16	1.4	2.8	1.6	1.7
(Desor. Cap)	1.78	1.93	1.93	3	2.9	1.93	2.39	1.4	1.3	1.6	1.1	1.4	1.6	0	2.9	2.04	1.8	2.4	3.3	1.31	2.4	2.1	2.1	2.3	1.9

Total Average Sub-criteria Matrix (T_Sub) (38 Focus Group)	(R&D.Corp)	(Ext Net)	(Know. Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Poten)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)
(K.cre)	1.3	1.8	2.78	0	2	1.8	2.8	3.24	1.1	3.1	2.04	2.1	2.3	1.9	1.3	1.8	2.77	2.04	1.73	2.8	3.2	1.15	3.1	2	2	2.3
(K.Acq)	1.3	1.1	1.91	1.8	0	2.52	2.53	1.8	1.3	1.3	2.44	1.3	1.1	1.5	1.3	1.1	1.91	1.83	0	2.6	2.52	1.8	1.3	1.3	2.6	1.3
(Int Kno Port)	1.5	1.1	1.56	1.9	2.6	0	3.25	1.79	1.3	1.5	2.78	1.4	1.1	1.4	1.5	1.2	1.58	2.03	2.6	0	3.25	1.79	1.3	1.4	2.8	1.4
(K.shar)	1.3	1.2	2.53	3	3.5	3.01	0	1.79	1.3	1.7	3.08	1.9	1.4	1.6	1.3	1.2	2.53	3.01	3.49	3	0	1.79	1.3	1.7	3	1.9
(K.Imp)	1.2	1.5	2.56	2	1.8	1.57	1.8	0	2.4	2.1	1.44	1.1	1.4	1.2	1.2	1.4	2.62	2.05	1.8	1.6	1.75	0	2.7	2.1	1.4	1.1
(K.tran)	1.7	1.8	2.05	1.2	1.7	2.05	2.05	2.78	0	1.9	1.69	1.7	1.7	1.9	1.7	1.8	2.05	3.02	1.18	1.2	1.93	2.4	1.3	0	1.4	1.3
(cult)	1.2	1.4	2.52	3	1.2	1.18	1.93	2.34	1.3	0	1.44	1.3	2.4	1.2	1.2	1.4	2.53	3.01	1.18	1.2	1.93	2.41	1.3	0	1.4	1.3
(stru)	1.1	1.3	1.56	1.9	2.9	2.61	2.9	1.93	1.6	1.7	0	2	1.6	1.6	1.1	1.3	1.56	1.93	2.9	2.6	2.9	1.83	1.6	1.6	0	2
(Tech)	1.6	2.1	1.56	1.6	1.2	1.44	1.56	1.71	1.6	1.9	1.56	0	2.6	1.8	1.7	2.1	1.56	1.65	1.17	1.4	1.56	1.65	1.6	1.9	1.6	0
(Peop)	1.8	2.1	1.57	1.9	1.1	1.15	1.57	1.44	2.2	2.9	1.21	2.8	0	1.3	1.8	2.1	1.57	1.93	1.08	1.2	1.57	1.46	2.1	2.9	1.2	2.8
(Lead& Supp)	1.3	1.1	1.32	1.7	1.3	1.08	1.57	1.15	1.6	1.4	1.44	1.6	1.6	0	1.3	1.1	1.32	1.64	1.32	1.1	1.57	1.18	1.6	1.4	1.4	1.6
(org. Lear)	0	3.4	2.05	1.2	1.1	1.32	1.44	1.56	1.6	1.2	1.21	3	2.2	1.2	0	3.4	2.05	1.2	1.08	1.3	1.44	1.56	1.6	1.2	1.2	3
(Succ. Rate)	2.8	0	1.8	1.4	1.2	1.08	1.44	2.16	2.3	1.7	1.32	3	2.6	1	2.8	0	1.8	1.44	1.15	1.1	1.43	2.15	2.3	1.6	1.3	3
(R&D Exper)	1.4	1.6	0	2.9	1.9	1.93	3.02	2.9	2.4	2.4	1.45	1.3	1.6	0.8	1.4	1.7	0	2.9	1.93	1.9	3.01	2.9	2.4	2.4	1.4	1.3
(Code)	1.3	1.8	2.78	0	2	1.8	2.69	3.24	1.1	3	2.08	2.1	2.3	2	1.3	1.8	2.77	2.02	1.69	2	3.18	1.11	3	2	2	2.3
(Pers)	1.3	1.1	1.84	1.8	0	2.52	2.53	1.8	1.3	1.3	2.43	1.3	1.1	1.5	1.3	1.1	1.88	1.81	0	2.5	2.5	1.78	1.3	1.3	2.6	1.3
(Ext)	1.4	1.1	1.56	1.9	2.6	0	3.25	1.79	1.3	1.5	2.77	1.4	1.1	1.4	1.5	1.2	1.58	2.04	2.57	0	3.21	1.79	1.3	1.4	2.7	1.4
(Inter)	1.3	1.2	2.53	3	3.5	3	0	1.79	1.3	1.7	3.06	1.9	1.4	1.6	1.3	1.9	2.53	3.03	3.47	3	0	1.79	1.3	1.7	3	1.9
(Tech .Tran)	1.2	1.4	2.54	2	1.8	1.57	1.8	0	2.4	2.1	1.42	1.1	1.4	1.2	1.2	1.4	2.64	2.03	1.8	1.6	1.73	0	2.6	2.1	1.4	1.1
(Dec.Mak)	1.7	1.8	2.05	1.2	1.7	2.07	2.05	2.77	0	1.9	1.66	1.7	1.7	1.9	1.7	1.8	2.05	3.02	1.19	1.2	1.93	2.39	1.3	0	1.4	1.3
(In. Op Inn)	1.1	1.4	2.52	3	1.2	1.18	1.93	2.33	1.3	0	1.44	1.3	2.4	1.2	1.2	1.4	2.52	3.01	1.18	1.1	1.93	2.39	1.3	0	1.4	1.3
(Proj. mang)	1.1	1.3	1.55	1.9	2.8	2.62	2.8	1.93	1.6	1.7	0	2	1.6	1.6	1.1	1.3	1.56	1.93	2.9	2.6	2.9	1.83	1.6	1.6	0	2
(Inn. com)	1.6	2.1	1.56	1.6	1.1	1.42	1.56	1.71	1.6	1.9	1.56	0	2.6	1.8	1.6	2.1	1.56	1.63	1.18	1.4	1.56	1.66	1.6	1.9	1.6	0
(Rate Int)	1.8	2.1	1.57	1.9	1.1	1.13	1.56	1.42	2.1	2.8	1.18	2.8	0	1.3	1.8	2.1	1.56	1.93	1.08	1.2	1.54	1.44	2.1	2.9	1.2	2.7
(Int & Ext Kno)	1.3	1.1	1.32	1.7	1.3	1.09	1.56	1.15	1.6	1.4	1.42	1.6	1.6	0	1.3	1.1	1.3	1.63	1.32	1.1	1.57	1.18	1.6	1.4	1.4	1.6
(R&D.Corp)	0	3.4	2.04	1.2	1.1	1.32	1.42	1.56	1.6	1.2	1.2	3	2.2	1.2	0	3.4	2.05	1.17	1.08	1.3	1.42	1.54	1.6	1.2	1.1	3
(Ext Net)	2.8	0	1.8	1.4	1.2	1.09	1.42	2.13	2.2	1.7	1.31	3	2.6	1	2.8	0	1.8	1.42	1.13	1.1	1.42	2.13	2.3	1.6	1.3	3
(Know .Inc)	1.4	1.6	0	2.9	1.9	1.93	3	2.9	2.3	2.2	1.44	1.3	1.6	0.8	1.4	1.7	0	2.9	1.93	1.9	3.01	2.9	2.4	2.4	1.4	1.3
(Rad Inn)	1.3	1.8	2.61	0	2	1.74	2.6	3.23	1.1	3.1	2.05	2.1	2.3	2	1.3	1.8	2.76	2	1.55	2	3.19	1.13	3.1	2	2	2
(Abso. Cap)	1.3	1.1	1.88	1.8	0	2.53	2.53	1.8	1.3	1.3	2.43	1.3	1.2	1.5	1.3	1.1	1.91	1.73	0	2.5	2.48	1.77	1.3	1.3	2.6	1.3
(R&D Empo)	1.5	1.1	1.56	1.9	2.6	0	3.24	1.79	1.3	1.5	2.77	1.4	1.1	1.4	1.5	1.2	1.57	2.04	2.58	0	3.2	1.79	1.3	1.4	2.6	1.4
(Tech Tren)	1.3	1.2	2.53	3	3.5	3.02	0	1.79	1.3	1.7	3.06	1.9	1.4	1.6	1.3	1.2	2.52	3.06	3.51	3	0	1.8	1.3	1.7	3	1.9
(Inno. per)	1.2	1.5	2.54	2	1.8	1.57	1.8	0	2.4	2.1	1.42	1.1	1.4	1.2	1.2	1.4	2.64	2.05	1.8	1.6	1.71	0	2.6	2.1	1.4	1.1
(Inov Str& ini)	1.7	1.8	2.05	1.2	1.7	2.04	2.05	2.77	0	1.9	1.67	1.7	1.7	1.9	1.7	1.8	2.04	3.02	1.15	1.2	1.93	2.38	1.3	0	1.4	1.3
(Org.Str)	1.1	1.4	2.52	3	1.1	1.18	1.93	2.33	1.3	0	1.44	1.3	2.4	1.2	1.2	1.4	2.52	3.01	1.18	1.1	1.93	2.36	1.3	0	1.4	1.3
(Tech. Acq)	1.1	1.3	1.58	1.9	2.9	2.6	2.9	1.93	1.6	1.7	0	2.1	1.6	1.6	1.1	1.3	1.57	1.93	2.9	2.6	2.9	1.81	1.6	1.7	0	2
(Tech. Expo)	1.6	2.1	1.56	1.6	1.1	1.44	1.56	1.71	1.6	1.9	1.56	0	2.6	1.8	1.6	2.2	1.56	1.61	1.17	1.4	1.56	1.63	1.6	1.9	1.6	0
(Tech. Pro)	1.8	2.1	1.57	1.9	1.1	1.12	1.57	1.42	2.1	2.9	1.19	2.8	0	1.3	1.8	2	1.57	1.93	1.07	1.1	1.53	1.42	2.1	2.9	1.2	2.7
(Tech. lear)	1.3	1.1	1.32	1.7	1.3	1.08	1.57	1.13	1.6	1.4	1.42	1.6	1.6	0	1.3	1.1	1.28	1.61	1.32	1.1	1.56	1.18	1.6	1.4	1.4	1.6
(Tech. Sele)	0	3.4	2.07	1.2	1.1	1.32	1.42	1.56	1.6	1.2	1.2	3	2.2	1.2	0	3.4	2.05	1.17	1.08	1.3	1.44	1.57	1.6	1.2	1.1	3
(Tech. Iden)	2.8	0	1.79	1.4	1.2	1.08	1.42	2.13	2.3	1.7	1.32	3	2.6	1	2.8	0	1.8	1.4	1.15	1.1	1.41	2.11	2.3	1.6	1.3	3
(Tech Deve)	1.4	1.6	0	2.9	1.9	1.93	3.01	2.9	2.4	2.4	1.44	1.3	1.6	0.8	1.4	1.7	0	2.9	1.93	1.9	2.99	2.9	2.4	2.4	1.4	1.3
(Mang comp)	1.3	1.8	2.77	0	2	1.8	2.67	3.22	1.1	3	2.1	2.1	2.2	2	1.3	1.8	2.76	0	1.71	2.8	3.18	1.13	3.1	2	2	2.3
(Fac)	1.3	1.1	1.85	1.8	0	2.5	2.53	1.8	1.3	1.3	2.43	1.3	1.1	1.5	1.3	1.1	1.83	1.81	0	2.5	2.5	1.79	1.3	1.3	2.6	1.3
(Org. Poten)	1.4	1.1	1.56	1.9	2.6	0	3.24	1.79	1.3	1.4	2.69	1.4	1.1	1.4	1.5	1.2	1.58	2.03	2.6	0	3.18	1.79	1.3	1.4	2.7	1.4
(Pers. Skil)	1.3	1.2	2.53	3	3.5	3.01	0	1.78	1.3	1.7	3.03	1.9	1.4	1.6	1.3	1.9	2.52	2.99	3.47	3	0	1.79	1.3	1.7	3	1.9
(Str Tech)	1.2	1.4	2.52	2	1.8	1.56	1.8	0	2.4	2.1	1.4	1.1	1.4	1.2	1.2	1.4	2.6	2.04	1.8	1.6	1.75	0	2.6	2.1	1.4	1.1
(Corp Tech Stra)	1.7	1.8	2.08	1.1	1.6	2.04	2.05	2.77	0	1.9	1.63	1.6	1.6	1.9	1.6	1.8	2.05	3.04	1.15	1.2	1.93	2.39	0	0	1.4	1.3
(Corport Bus Strat)	1.1	1.4	2.53	3	1.2	1.18	1.93	2.33	1.3	0	1.42	1.3	2.4	1.1	1.1	1.4	2.5	3.01	1.18	1.1	1.93	2.4	1.3	0	1.4	1.3
(Tech Alli)	1.1	1.3	1.56	1.9	2.8	2.64	2.8	1.93	1.6	1.6	0	2.1	1.6	1.6	1.1	1.3	1.56	1.93	2.9	2.6	2.9	1.06	1.6	1.6	0	2
(Desor. Cap)	1.3	1.8	2.78	0	2	1.8	2.67	3.23	1.1	3.1	2.1	2.1	2.3	1.9	1.3	1.8	2.76	1.65	1.17	1.4	1.56	1.66	1.6	1.9	1.6	0

$\left|\frac{G_c^p - G_c^{p-1}}{G_c^p}\right|$	(K. cre)	(K. Acq)	(Int Kno Port)	(K.Shar)	(K.Imp)	(K.tran)	(Cult)	(Stru)	(Tech)	(Peop)	(Lead& Supp)	(Org.Lear)	(Succ. Rate)	(R&D Exper)	(Code)	(Pers)	(Ext)	(Inter)	(Tech .Tran)	(Dec.Mak)	(In. Op Inn)	(Proj. mang)	(Inn. com)	(Rate Int)	(Int & Ext Kno)	(R&D.Corp)	(Ext Net)	(Know .Inc)	(Rad Inn)	(Abso. Cap)	(R&D Empo)	(Tech Tren)	(Inno. per)	(Inov Str& ini)	(Org.Str)	(Tech. Acq)	(Tech. Expo)	(Tech. Pro)	(Tech. lear)	(Tech. Sele)	(Tech. Iden)	(Tech Deve)	(Mang Comp)	(Fac)	(Org. Poten)	(Pers. Skil)	(Str Tech)	(Corp Tech Stra)	(Corp Bus Strat)	(Tech Alli)	(Desor. Cap)	
(K.cre)	0	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(K.Acq)	0.03	0	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0	0	0.03	0.03	0	0	0	0	1.613
(Int Kno Port)	0.03	0.03	0	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(K.shar)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	1.613
(K.Imp)	0.03	0.03	0.03	0	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0	0	0	0	0	1.613
(K.tran)	0.03	0.03	0.03	0	0.03	0	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(cult)	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(stru)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Tech)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Peop)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Lead& Supp)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(org. Lear)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Succ. Rate)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(R&D Exper)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Code)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.681
(Pers)	0.03	0	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0	0	0.03	0.03	0	0	0	0	1.578
(Ext)	0.03	0.03	0	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Inter)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	1.613
(Tech .Tran)	0.03	0.03	0.03	0	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0	0	0	0	0	1.613
(Dec.Mak)	0.03	0.03	0.03	0	0.03	0	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(In. Op Inn)	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Proj. mang)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Inn. com)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Rate Int)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Int & Ext Kno)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(R&D.Corp)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Ext Net)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Know .Inc)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Rad Inn)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.716
(Abso. Cap)	0.03	0	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0	0	0.03	0.03	0	0	0	0	1.578
(R&D Empo)	0.03	0.03	0	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Tech Tren)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	1.613
(Inno. per)	0.03	0.03	0.03	0	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0	0	0	0	0	1.613
(Inov Str& ini)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Org.Str)	0.03	0.03	0.03	0	0.03	0	0	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Tech. Acq)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Tech. Expo)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.578
(Tech. Pro)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Tech. lear)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Tech. Sele)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Tech. Iden)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Tech Deve)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Mang comp)	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	0	0	0	0.03	0	0.03	0	0	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	1.578
(Fac)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0	0	0.03	0.03	0	0	0	0	1.647
(Org. Poten)	0.03	0.03	0	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0	0	0	0	0	0	0	0.03	0	0	0	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.613
(Pers. Skil)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	1.613
(Str Tech)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0	0	0	0	0	1.647
(Corp Tech Stra)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.578
(Corport Bus Strat)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647
(Tech Alli)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.681
(Desor. Cap)	0.03	0.03	0.03	0	0.03	0.03	0.03	0	0	0	0	0	0	0	0	0.03	0	0.03	0	0.03	0.03	0	0	0	0	0	0	0.03	0	0	0.03	0.03	0.03	0	0	0.03	0	0	0	0	0	0.03	0.03	0.03	0	0.03	0.03	0	0	0	0	1.647

APPENDIX D

GAP ERROR RATIO MATRIX CRITERIA'S

	KM Process Cap	KM Infra Cap	KM Strate Cap	IM Process Cap	IM infra Cap	IM Strate Cap	TM Process Cap	TM Infra Cap	TM Strat Cap	
KM process Cap	0	2.179	2.231	2.1026	2	2	2.3	2.3	2.2	17.3
KM Infra Cap	2.13	0	2.359	2.1282	2.128	2	2.2	2.4	2.4	17.7
KM Strate Cap	2.23	2.769	0	2.0256	2.282	2	2.2	2.3	2.5	18.3
IM Process Cap	2.31	2.231	2.103	0	2.128	2	2.4	2.5	2.3	17.9
IM infra Cap	2.26	2.128	2.051	2.1026	0	2	2.2	2.3	2.2	17.4
IM Strate Cap	2.46	2.103	2.205	2	2.051	0	2.1	2.5	2.1	17.6
TM Process Cap	2.15	2.154	2.821	2.9231	2.897	3	0	2.5	2.2	20.5
TM Infra Cap	2.1	2.385	2.205	2.1538	2.41	3	2.5	0	2.2	18.5
TM Start Cap	2.62	2.359	2.231	2.9231	2.436	3	2.4	2.2	0	19.7
	18.3	18.31	18.21	18.359	18.33	18	18	19	18	

Total Average of Criteria Matrix (T_cri) 38 Focus group	K.M Process Capability	K.M Infrastructure Capability	K.M Strategic Capability	I.M Process Capability	I.M infrastructure Capability	I.M Strategic Capability	T.M Process Capability	T.M Infrastructure Capability	T.M Strategic Capability
KM Process Capability	0	2.035	2.134	2.035	1.727	1.92	2.05	2.143	1.89
K.M Infrastructure Capability	2.048	0	1.173	2.052	1.467	1.64	1.96	2.317	2.22
K.M Strategic Capability	1.939	2.724	0	1.795	1.735	1.77	2.22	2.511	2.28
I.M Process Capability	1.95	2.181	1.081	0	1.639	1.85	2	2.53	1.54
I.M Infrastructure Capability	1.852	1.446	1.087	1.367	0	2.05	1.54	1.852	2.14
I.M Strategic Capability	1.155	1.745	1.08	0.982	1.658	0	2.07	1.91	1.54
T.M Process Capability	1.658	1.697	2.821	2.821	2.821	2.82	0	2.821	2.07
TM Infrastructure Capability	1.134	1.466	1.445	1.27	2.076	2.42	2.43	0	1.31
T.M Strategic Capability	1.175	0.985	1.464	2.821	1.872	2.46	1.27	1.678	0

APPENDIX D

GAP ERROR RATIO

$\left\|\frac{G_c^p - G_c^{p-1}}{G_c^p}\right\|$	K.M Process Capability	K.M Infrastructure Capability	K.M Strategic Capability	I.M Process Capability	I.M infrastructure Capability	I.M Strategic Capability	T.M Process Capability	T.M Infrastructure Capability	T.M Strategic Capability
KM Process Capability	0	0.06	0.1	0.06	0.05	0.06	0.1	0.1	0.1
K.M Infrastructure Capability	0.06	0	0	0.06	0.05	0.05	0.1	0.1	0.1
K.M Strategic Capability	0.06	0.09	0	0.06	0.05	0.06	0.1	0.1	0.1
I.M Process Capability	0.06	0.07	0	0	0.05	0.06	0.1	0.1	0
I.M Infrastructure Capability	0.06	0.05	0	0.04	0	0.06	0	0.1	0.1
I.M Strategic Capability	0.04	0.05	0	0.03	0.05	0	0.1	0.1	0
T.M Process Capability	0.05	0.05	0.1	0.09	0.09	0.09	0	0.1	0.1
TM Infrastructure Capability	0.04	0.05	0	0.04	0.07	0.08	0.1	0	0
T.M Strategic Capability	0.04	0.03	0	0.09	0.06	0.08	0	0.1	0

APPENDIX E

LIST OF R&D IN PUBLIC SECTOR ORGANIZATION

R&D in Pakistan Public Organization

Agriculture Research Institute
Coal Research Center, NFC IET
Asian Management Institute* Central Cotton Research Institute
Centre Of Excellence In Analytical Chemistry
National Institute for Biotechnology and Genetic Engineering
Hydrocarbon Development Institute of Pakistan
Inspectorate of Mines, Government of Punjab Lahore
Institute of Marine Engineers Pakistan
National Centre for Physics
Marine Fisheries Department, Ministry port and Shipping Pakistan
National Fertilizer Development Centre
National Institute of Electronics
National Transport Research Centre
PARC-IIBC Station, International Institute Of Biological Control
Perac Research & Development Foundation
Petroleum Institute of Pakistan
Soil Research and Survey Center
South Asia Institute for Human Sexuality
Veterinary Research Institute
Water Management Training Institute
Research and Development Foundation
National Textile Research Center, National Textile University
Taxila Institute of Transportation Engineering
Pakistan Forest Research Institute, Peshawar
National Institute of Oceanography
Pakistan Scientific & Technological Information Centre
Pakistan Institute of Engineering and Applied Sciences
Pakistan Institute of National Development
Pakistan Council of Scientific &industrial Research
Textiles Industry Research & Development Centre
Station for Ostrich Research and Development
Department of Poultry Science PMAS Arid Agriculture University, Rawalpindi Pakistan
Advance Educational Institute & Research Center
Agriculture Research Institute, Quetta
Al-Khwarizmi Institute of Computer Science, UET, Lahore
Environmental Protection Agency, Punjab
Institute of Research Promotion (IRP)
Karachi Industrial Research Group (KIRG)
NDFC- Pakistan Development Banking Institute
PIA, Training Centre, Karachi Airport
Sustainable Development Policy Institute
Pakistan Automotive Manufacturers Association

Pakistan Pharmaceutical & Drug Association
Pakistan Space and Upper Atmosphere Research Commission (SUPARCO)
Geological Survey of Pakistan
National Transmission and Dispatch Company
Pakistan Atomic Energy Commission
Pakistan Botanical Society, Karachi University
Zoological society of Pakistan. Karachi University
Pakistan Petroleum Limited
Radiology Research Section
Pakistan Civil Aviation Authority
Karachi Port Trust , Pakistan
Pakistan National Shipping Corporation
Pakistan Leather garments Manufacturer & Association
Pakistan Gems and Jewellery Development Company
Department of Polymer Engineering, NUST
Engineering Development Board Pakistan
Pakistan Sports Goods and Manufacturers & Exporters Association
The Surgical Instruments Manufacturers Association of Pakistan
Pakistan Footwear Manufacturers Association
National Telecommunication Corporation
Pakistan Broadcasting Corporation

APPENDIX F
ABBREVIATION

Knowledge Creation	**(K.cre)**
Knowledge Acquisition	**(K.Acq)**
Intellectual Knowledge Portfolio	**(Int Kno Port)**
Knowledge Sharing	**(K.shar)**
Knowledge Implementation	**(K.Imp)**
Knowledge Transfer	**(K.tran)**
Culture	**(cult)**
Structure	**(stru)**
Technology	**(Tech)**
People	**(Peop)**
Role of Leadership & Support	**(Lead& Supp)**
Organizational Learning	**(org. Lear)**
Success rate of R&D products	**(Succ. Rate)**
R&D Expenditure	**(R&D Exper)**
Codification	**(Code)**
Personalization	**(Pers)**
External Knowledge Source	**(Exter.Kn)**
Internal Knowledge Source	**(Int.Kn)**
Technology Transfer	**(Tech .Tran)**
Decision Making Process	**(Dec.Mak)**
Open Innovation	**(In. Op Inn)**
Project Management	**(Proj. mang)**
Innovativeness Compability	**(Inn. com)**
Rate of Introduction New Product	**(Rate Int)**
Internal & External Knowledge Sharing	**(Int & Ext Kno)**
R&D cooperation	**(R&D.Corp)**
External Networking	**(Ext Net)**
knowledge incentives	**(Know .Inc)**
Radical Innovation	**(Rad Inn)**
Absorptive capacity	**(Abso. Cap)**
R&D Employee	**(R&D Empo)**
Technology Trends	**(Tech Tren)**
Innovative Performance	**(Inno. per)**
Innovation strategies and initiatives	**(Inov Str& ini)**
Organization strategy	**(Org.Str)**
Technology Acquisition	**(Tech. Acq)**
Technology Exploitation	**(Tech. Expo)**
Technology Protection	**(Tech. Pro)**
Technology Learning	**(Tech. lear)**
Technology Selection	**(Tech. Sele)**
Technology identification	**(Tech. Iden)**
Technology development	**(Tech Deve)**

ABBREVIATION

Management Competency	**(Mang Comp)**
Facility and Equipment	**(Fac)**
Organization Potential	**(Org. Poten)**
Personal Skill	**(Pers. Skil)**
Strategic Technology Road Mapping	**(Str Tech)**
Corporate Technology Strategy	**(Corp Tech Stra)**
Corporate Business Strategy	**(Corport Bus Strat)**
Technology Alliance Strategy	**(Tech Alli)**
Desorptive Capacity	**(Desor. Cap)**

APPENDIX G

PRISMA

Searching Scheme For Knowledge Management Capabilities

On 12 Dec 2017, an extensive searching string applied on Scopus data was performed based to reclaim all the significant studies related to Knowledge management capabilities impact on R&D. The following typology configuration was applied into Scopus search engine: Searched for article: "Knowledge management and R&D" OR "Knowledge organization capabilities" OR "R&D and Knowledge capabilities" OR "Knowledge capacity" OR "Knowledge Management in R&D" OR "Knowledge Management & R&D" OR "Knowledge Management Strategic Capability" OR "Knowledge Management & R&D " OR "Knowledge Capabilities and R&D " OR "Knowledge and R&D" OR "Knowledge Management on R&D" OR "K.M capabilities" OR "K.M with R&D capabilities" OR "K.M" OR "K.M "All the probable keywords relevant to Knowledge management Capabilities (K.M capabilities) were take into account during systematic searching query.

Type of Studies included

The search reclaimed 664 document which had emerges in 41 journals from 1990 to 2016. Those article were published frequently by 25 institutions spread across 52 countries and by 156 authors these documents comprise on 412 (62%), conference article 208 (31.3%), Review 28 (4.2%), Book chapter 7 (1.05%), conference review 5 (0.75%), Article in Press 3 (0.45%), Short survey 1 (0.15%)

VOS viewer outcome along with Some of Highest Occurrence of Key words (Knowledge)

Cluster	Total Key words in Cluster	Some of Highest Occurrence
	111	Data mining, Artificial intelligence, Business Intelligence, Business process management, cloud computing, Data mining, Database, Decision making, Decision support system, Information retrieved, Information management
	77	Assessment, Communication, Disasters management, E-learning, Evaluation, Higher Education, HRM, Knowledge Management, Leadership, Organization learning
	38	Case study, Competitive Advantages, Information, Knowledge Management, New Product Development, SMEs, Social Networks
	37	Capability, Collaboration, Community of Practice, Creativity, Education, knowledge, Learning Training, Nurse
	36	Competitiveness, banking, Critical success factor, Information technology, Technology Transfer, Total Quality, Six sigma
	35	Knowledge acquisition, Knowledge application,

		Knowledge conversion, knowledge creation, knowledge generation, knowledge integration,
	35	Innovation Management, Intellectual capital, knowledge economy, Open innovation, Organization innovation, strategic management, R&D management, Process innovation , organizational culture, Organizational learning; Culture, IT, Community of Practice, Technology, Structure; People, Contribution of skills & expertise
	32	External Knowledge , Internal knowledge, implicit, Explicit, Technology strateg, strategic alliance, combination, internalization, and socialization
	30	Knowledge network, leadership, Learning organization, value chain, value creation, social software, social network system, system review
	22	Organizational performance, Organizational capability Organizational design, organizational learning, Dynamic capability, knowledge based view
	19	Business performance, business strategy, Strategic alliance, project portfolio

		management, Quality , SMEs
	15	Architecture, development, environment, framework, infrastructure, integration, practices
	13	Innovativeness, Hotel industry, Agility, corporate social response, ICT, Alliance

Searching Scheme For Innovation Management Capabilities

On 12 Dec 2017, an extensive searching string applied on Scopus data was performed based to reclaim all the significant studies related to Innovation management capabilities impact on R&D. The following typology configuration was applied into Scopus search engine: Searched for article: The following typological setting was applied into Scopus search engine: "Innovation Management and R&D" OR "Innovation organization" OR "R&D and Innovation management" OR "Innovation and Research & Development" OR "Innovation capabilities" OR "Innovation Management in R&D" OR "I.M in R&D" OR "Innovation management and (R&D)" OR "Innovation Capability" OR "Innovation & R&D" OR "Innovation management capability & research and developement" OR "Innovation capabilities" OR "Innovation & Capabilities" OR "Innovation R&D in Public organization". All the probable keyword relevant to Innovation management capabilities (I.M capabilities) was taking into account during systemic searching query.

Type of Studies included

The search reclaimed 972 documents which had emerged in 54 journals from 1990 to 2018. Those article were published frequently by 26 institute spread across 59 countries and by total of 172 Author's, these documents comprise on 745 (68.18%), Conference article 154(21.9696%), Review 35(4.419%), Book chapter 19(2.398%), conference review 5 (0.6313%), Shorter survey 5 (0.6313%), Book 4(0.505%), Article in press 3 (0.3787%) and Note 2 (0.2525%)

VOS viewer outcome along with Some of Highest Occurrence of Key words (Innovation)

Cluster	Total Key words in Cluster	Some of Highest Occurrence
	67	Business process management, capabilities, corporate culture, corporate entrepreneurship, dynamic capability, knowledge economy, knowledge integration, open innovation, organizational capability, organizational change, performance
	64	Innovation capability, innovation management, competitiveness, intellectual property, knowledge transfer, knowledge management, management capabilities , technology capabilities, technology management, technology strategy, technology development
	58	Diffusion innovation, exploitation, innovativeness, information technology, knowledge management, process management, product development, resource management, product innovation, total quality management, diffusion innovation

	45	Innovation process, policy, radial innovation, economic development, environmental management, globalisation, green innovation
	43	Corporate governance, corporate social responsibility, networking, organizational learning, r&d management, technological innovation capabilities , collaborative innovation, green innovation
	42	Technological performance, technology trends initiative, technology roadmapping , strategic management , strategic planning
	41	Business environment, Business development, commercialization, portfolio management , total innovation management, uncertainty and venture
	38	Knowledge acquisition, knowledge innovation, organizational capabilities, regional innovation mechanism, resource and capabilities, supply chain, supply chain integration, strategic orientation
	26	Cloud computing, cybernetics, big data, information system, IT innovation, IT capability
	26	Manufacturing strategy, manufacturing, strategic flexibility, flexibility,

		organizational development, communication, competencies
	14	Decision making process, acquisition external R&D, acquisition internal R&D, knowledge sharing, knowledge creation , R&D cooperation, technology transfer, in bound open innovation ability
	14	Absorptive capability, r&d investment, organizational culture, new knowledge, external knowledge source, formulization ability

Searching Scheme For Technology Management Capabilities

On 12 Dec 2017, an extensive searching string applied on Scopus data was performed based to reclaim all the significant studies related to Technology management capabilities impact on R&D. The following typology configuration was applied into Scopus search engine: Searched for article: “Technology management and R&D” OR “Technology Management capabilities” OR “R&D and Technology capabilities” OR “Technology capacity” OR “Technology Management in R&D” OR “Technology Management with R&D” OR “TM Capability in Public R&D” OR “Technology Management & (R&D) ” OR “Technology Strategic Capabilities R&D ” OR “Technology capabilities and R&D” OR “Technology Management in research and developement” OR “Technology capabilities” OR “T.M capabilities & (R&D)” OR “TM & R&D capabilities ”

Type of Studies included

All the probable keywords relevant to Technology management Capabilities (T.M capabilities) were take into account during systematic searching query. The search reclaimed 662 document which had emerges in 51 journals from 1990 to 2018. Those article were published frequently by 176 institutions spread across 52 countries and by 176 authors these documents comprise on 514 (57.4%) journal article , conference article 82 (35.5%), Review 42 (4.5%), Book chapter 7 (0.76%), conference review 3 (0.3265%), Article in Press 3 (0.2175%), Short survey 11 (1.195%)

Cluster	Total Key words in Cluster	Some of Highest Occurrence
	93	Business strategy, capabilities, Business performance, competitive advantages, customer relationship, diversification, dynamic capabilities, IT capabilities
	88	Cloud computing, Analytics, computer networks, mobility management, routing and security
	65	Adaption, Ambidexterity, concurrent engineering, critical success factor, exploitation, globalization, knowledge Acquisition, knowledge transfer
	53	Construction management, information management, data analysis, data mining, decision making, distributed system, anthologies
	46	Algorithms, Artificial intelligence, crisis management, data collection, data fusion, disaster management, disaster response, Risk Assessment, Risk management
	45	Electronic health record, Electronic medical records, Enterprise architecture, Evolution, genomics, Telemedicine, Transformation,

	38	Bio mass, organizational structure, distribution, health management, management systems, measurement Organizational structure, system engineering, maintenance
	36	Capability, capability maturity mode, computing, development, IT governance, IT services, Knowledge management system, process improvement, reliability, risk analysis, software development
	18	Business intelligence, business value, data analysis, technology integration, information sharing, social media, collaboration, communication management, enterprise management
	18	Forecasting, Fuzzy logic, information security, strategic planning, real options, classification, database, intelligent agent

APPENDIX H
DEMOGRAPHICS ANALYSIS

Demographic Characteristics of the Experts

A complete range of experts that were involve in composition of thirty nine focus group were represented in Appendix-x comprise of Chief scientific officers, R&D manager, Consultants, Professional engineer, Technical research officers, Government chief research officer and academician have been placed. The same panel experts were involved in both Focus group discussion and DANP (DEMATEL based ANP) techniques. Initially almost forty one focus groups were invited to participate in order to cover the maximum reliability of instrument. But only 39 focus groups were turning it up only. These thirty nine multidisciplinary focus group were fully participated in both session. All focus groups returned the questionnaire of first session reflecting 100% response rate. Table: 1 represents the complete outline of expert's profile that confirms that the panellist were experienced who can present their consensus on the issue under study, as result both the session of Focus group discussion were proceeds.

Table 1: Demographic Characteristics of the Experts

Orientation	Categorize	N	%
Group	Chief Research officers	32	16.4
	Professional Engineers	30	15.3
	R&D Manager	32	16.4
	Consultants	33	16.9
	Technical Research Officers	35	17.9
	Academician	33	16.9
	Total	*195(39)*	*100*
Gender	Male	130	66.6
	Female	65	33.3
	Total	*195(39)*	*100%*
Age	31-41	27	13.8
	41-51	89	45.6
	51-above 60	78	40
	Total	100	100
Current Designation	Director/ Deputy Director	43	22.0
	Chief Scientific Officer	112	57.4

	Principle	11		5.64
	Senior Lecture	13		6.6
	Associate Professor	6		3.07
	Professor	10		5.12
	Total	*195(39)*		*100*
Education	Bachelor	48		24.6
	Masters	79		40.5
	PhD degree	68		34.8
	Total	*195*		
	Average (Research Publication)	*7.1Journal/experts*		
Industrial and Academic Experience	Chief Scientific Officer	264 years		18.9
	Professional Engineer	250 years		17.9
	R&D Manager	196 years		14.0
	Consultants	366 years		26.2
	Technical Research Officers	336 years		24.1
	Total (Industrial Experience)	*1392 years*		*100*
	Academician	310 years		
	Total (Academician Experience)	310 years		
	Average Industrial Experience	43.39 years		
	Average Academician Experience	9.39 years		
	Average Industrial and Academician Experience	52.78 *years*		
International Association/Professional Certification	IAMOT, the Int'l Association for the Management of Technology	0-4 years	20	16.3
		5-10 years	71	58.1
		11-20 years	31	25.4
		20-Above	nil	
		Total	*122*	*100*
	R&D management society based in the UK	0-4 years	57	49.5
		5-10 years	31	26.9
		11-20 years	21	18.2
		20-Above	6	5.2
		Total	*115*	*100*
	ATD, Certified Knowledge Management, UK	0-4 years	13	52%
		5-10 years	12	48%
		11-20 years	nil	
		20-Above	nil	
		Total	25	100%
Committee Association/ Scientific Society Membership	Pakistan Engineering Council	0-4 years	70	50.3
		5-10 years	41	29.4
		11-20 years	21	15.1
		20-Above	7	5.01

	Total	*13 9*	*100*
National Science Foundation	0-4 years	78	40%
	5-10 years	69	35.3 8
	11-20 years	21	10.7 6
	20-Above	27	13.8
	Total	*19 5*	*100*
Pakistan science and technology council	0-4 years	41	21.0
	5-10 years	78	40
	11-20 years	42	21.5
	20-Above	34	17.4
	Total	*19 5*	*100*
National Productivity Organization , Pakistan	0-4 years	48	28.7
	5-10 years	52	31.1
	11-20 years	67	40.1
	20-Above	Nil	
	Total	*16 7*	*100*
Professional Engineering Certificate	0-4 years	60	43.1
	5-10 years	41	29.4
	11-20 years	21	15.1 0
	20-Above	17	12.2
	Total	*13 9*	*100*

Experts from Public sector R&D were composing to form thirty nine Focus groups. Of those experts 32 or 16.4% were scientist, 30 or 15.3 were Professional Engineers, 32 or 16.4 were R&D Managers, 33 or 16.9%, 35 or 17.9% were Consultants, 35 or 17.9% were Technical Research Officers, 33 or 16.9 % were Academician. The composition of multi-disciplinary experts from various R&D discipline mention (Appendix –E) make this research novel and unique. The multi-disciplinary composition should assuage any unfairness's that might occur during focus group discussion The majority of experts were commonly were male (*N=130 or 66.6%*), which specify that the majority of R&D in Public sector firms most experts were male. Within the thirty nine focus groups, 13.8% (N=27) participants were in between 31-41 years, while 45.6% (N=89) were in between 41-51 years, 40% (N=78%) in between 51-above 60. This output specify that majority of experts have a immense professional experience in the R&D Public firms

The most recent designation held by the experts from chief research officers panel as manager or director (N=43 or 22%), while professional engineers held designation as chief scientific officer (N=112 or 57.4%). Consultant panel consider as principle investigator (N=11or 5.64%). The Academician held a positions as Senior Lecture (N=13 or 6.6%), along with Associate Professor (N= 6 or 3.07%) and Professor (N=10 or 5.12%). With respect to the educational background 24.6% (N=48) of experts hold bachelor degree, 40.5% (N=79) holds masters degrees, while 34.8% (N=68) of experts hold doctorate degree. These outcome were reflect little similarity with previous findings of Hsiao (1997); (Rintamaa & Aho-Mantila, 2011) who emphasize that the experts level of education profile is one of the significant attributes when selecting expert for focus group or any other techniques

The experts exceptionally contributes to the body of knowledge in the R&D sector through publication at average of 7.1 journals and conference proceeding papers, 31.2% (N=121) were published in peer view journals, 8.1% (N= 51) were books chapters and 61.7% were other symposium presentation (N=144) . The cumulative year of industrial experiences among experts was around 1392 years at average of 43.9 years in focus group. Similarly, the cumulative years of academics experience was 310 with average of 9.39 years per experts in focus group. The combine cumulative professional experience of experts for both industrial and academics were around 1702 years at an average of 8.7 years per experts in focus group. From previous studies Klentien and Kamnungwut (2017) illustrate the significance of experts by indicating that experts should have adequate experience. Certainly, in the studies with in focus group conducted by O.Nyumba et al. (2018), and suggested that experts average experience as around 5.5years to 8.1 years per experts with in focus group, respectively, which is lesser than the current study

16.3 % (N=20) of experts were internationally registered with less than 5 years tenure to practice with international professional bodies of instance “IAMOT, the Int'l

Association for the Management of Technology" similarly 58.1 % (N=71) of experts were registered more than 5 years tenure with same professional body, while 25.4% (N=31) of them associated under tenure 10 years. 49.5% (N=57) of experts were associated "R&D management society based in the UK" with less than 5 years membership while 26.9% (N=31) associated with more the 5 years membership and around 18.2% (N=21) were associated with more than 10 years of membership 5.2 % (N=6) having lifetime membership. 52% (N=13) of experts were "ATD, Certified Knowledge Management, UK" having less than 5 years membership while around 48 % (N=12) were carries 5 years membership

50.3 % (N=70) experts were carries less than 5 years membership with "Pakistan Engineering Council" 29.4 % (N= 41) experts were having more than 5 years membership. While 15.1 % (N=21) were carries more than 10 years membership 5.01% (N=7) experts were life membership. In similar fashion, 40% (N=78) experts carries less than 5 years association with "Pakistan Science Foundation" and 35.38% (N=69) experts were having more than 5 years association. 10.76% (N=21) panellist were having more than 10 years membership while 13.8% (N=27) experts carries lifetime association. 21.0% (N=41) experts were carries less than 5 years registration with "Pakistan Science and Technology Council" while 40% (N=78) experts carries more than 5 year membership while 21.5% (N=42) experts were having more than 10 years membership similar way 14.4% (N=34) experts were having lifetime membership

28.8% (N=48) having experts were carries less than 5 years registration with "National Productivity Organization, Pakistan" while 31.1% (N=52) experts carries more than 5 year membership while 40.1% (N=67) experts were having more than 10 years membership. 43.1% (N=60) having experts were carries less than 5 years registration with "Professional Engineering Certificate" while 29.4% (N=41) experts carries more than 5 year membership while 15.10% (N=21) experts were having more than 10 years membership 12.2% (N=21) panellist were having more than 10 years membership while 13.8% (N=17) experts carries lifetime association

The most crucial aspect of the findings from these demographics orientation of the experts is the current accumulated professional experience panel in R&D in Public organizations because the outcome of Focus group discussion completely based upon the consensus among these experts. In holistic view these findings had supplements to author's assertion that the data collected from the Focus group discussion were reliable, which would permit to get a valid and comprehensive conclusion. In summarizing above findings, the criteria for experts qualification with respect to current study to concludes as

1. A range of multi-disciplines related to R&D industry are covered
2. Forty eight individuals carries Bachelor's Degree. 79 possess Masters Degrees while around 68 individuals carry Doctorate Degree. The entire range of panelist somehow connect their expertise to field study related to of R&D management
3. The experts exceptionally contributes to the body of knowledge in the R&D sector through publication at average of 7.1 journals and conference proceeding papers, 31.2% (N=121) were published in peer view journals, 8.1% (N= 51) were books chapters and 61.7% were other symposium presentation (N=144)
4. The panel has over 1392 *years* of industrial experience in R&D Public organization
5. The panel has over 310 *years* of Academic experience in R&D Public organization

APPENDIX I
LIST OF PUBLICATION

Asim, Z., and Sorooshian S. (2017a). Overview on Pakistan R&D sector in context adopting technological capabilities *Information (Japan)*, *20*(10), 7217-7226.

Asim, Z., and Sorooshian S. (2017b). Disabilities in Pakistan's R&D sector: Knowledge management capability *Information (Japan)*, *20*(10), 7209-7216.

Asim, Z., & Sorooshian, S. (2016). Analytic network process decision making algorithm. *Far East Journal of Mathematical Sciences*, *100*(10), 1565-1578.

Asim, Z., and Sorooshian S. (2018a). Capabilities of R & D: Literature analysis. *International Journal of Mechanical Engineering and Technology*, *9*(10), 316-324.

Asim, Z., and Sorooshian S. (2018b). A technique to address four-layed DANP method *International Journal of Civil Engineering and Technology*, *9*(10), 281-288.

Asim, Z., and Sorooshian S. (2019) Innovation Management Capabilities for R&D in Case of Pakistan: Innovation Management for R&D. In: Khosrow-Pour M (ed) Encyclopedia of Information Science and Technology. Hershey, Pennsylvania: IGI Global Publisher.

Asim, Z., Sorooshian, & Ahmad. (2019). Publication Trends on Overlapping Boundaries among Capabilities related to Knowledge, Innovation and Technology Management in R&D Context. *International Journal of Recent Technology and Engineering*, *7*(352-363).

Asim, Z., & Sorooshian. (2019). Exploring the Role of Knowledge, Innovation and Technology Management (KNIT) Capabilities that Influence Research and Development. *Journal of Open Innovation: Technology, Market, and Complexity*, *5*(21), 2-51.