An Expert-Approved R&D Model

Zeeshan Asim, Tan Seng Teck, Shahryar Sorooshian

Abstract: The initial intention of this descriptive analysis is to confine closer encounter regarding the potential impact of supporting management discipline on R&D in public organization among developing countries. In this, context prior theories on R&D in Public organizations draw some conceptual models with 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. Based on their relationship this study developed a conceptual framework to draw significance of supporting management discipline on R&D that has been long been striving to convene capability prospective among developing countries. The author analysis based on R&D fit to the context of public organization and portrays case of Pakistan under Focus Group Discussion. The experts from 81 R&D of public organizations were involved; where 195 participants are, compose into 41 Focus Groups. The outcome of Focus Group Discussion shows that process, infrastructure and strategic are consider as potential criteria's that draw relationship among capabilities related knowledge, innovation and technology management disciplines.

Index Terms: R&D, Knowledge Management, Technology Management, Innovation Management.

I. INTRODUCTION

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 [1]. Supporting management disciplines have involved as part of the significant contributor in research and development process for over 50 years [2]. However, during such period the supporting management discipline evolves to drive functional orientation since the primary focus was R&D [2]. 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 Fig. 1 [3, 4].

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Figure 1. Supporting Management Discipline to R&D

On the research stream of supporting management disciplines, not many exclusive models have been ultimately acknowledged. In 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 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 [5] 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 organizations 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 to develop a 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.

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

II. METHODOLOGY

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 [6]. In this approach, wider research questions along with all positive and negative pre-classified concepts were recognized in a structured pattern from data" [6]. 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 [7]. 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 [8]. According to Krueger and Casey [7], 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" [9]. The Focus groups primarily utilized for creating information through collective discussion. While, the translation of information are fundamentally depends 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 [10].

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 [11]. 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 [11] 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: [11] 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-attendees [12]. 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 [12] 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 proposed two universal principles[11]:

• 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 [13]. 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 [13] 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 mention a description of active moderators has a personality with analytical and listening skill [11, 14, 15].

But these are not simply the only proficiencies that moderator must be competent. Focused interview gurus Merton et al. [16] 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 which have an same opinion: "Interviewing session appears to be deceptively simple, but it involves psychological sentiments, during the interview preparation and group interaction [7, 17]. 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 [7]. 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 [18]. 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 questionnaires were sends to covers remaining 47 R&D's in Public organization nearly 30 questionnaires received 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. During the Focus group discussion these 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 fulfill 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 needs 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.

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 [7]. These research venues may be a recreational center, a community center, university union center, private home or college campus [7]. 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 [7].

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.

III. RESULTS AND DISCUSSION

In this research, 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.

An Expert-Approved R&D Model

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. 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 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 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 an up-to-date R&D framework introduced by Asim and Sorooshian [19]. 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 1. According to Arber; Hall [20, 21]. The response rate of return of 50-60% is justifiable, whereas Kelley et al., Sitzia and Wood, and Sumsion [22-24] recommended a response rate of 70% for each session of focus discussion group (FGD).

Table 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 %

Table 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 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 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

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 is shown in Table 2 to 5.

Table 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

A. Knowledge Management

Because the 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). 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 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.

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 acknowledging by multi-disciplinary experts during the discussion. Additionally, all criteria were highly acknowledged 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, and 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.

In case of selecting sub-criteria, details are shown in table 6.

Table 6 Importance and consensus on sub-criteria

Knowledge Management Process Capability (sub-Criteria)	Level of consensus	Knowledge Management strategic Capability (Criteria)	Level of consensus	Knowledge Management Infrastructure Capability (sub- Sub-Criteria)	Level of consensus
Knowledge Sharing	3.256	Joint learning :internal collaboration	1.18	Organization Learning	3.179
Join Scense	1.179	Joint learning :External collaboration	1.1	Culture	3.282
Affective Commitment	1.31	Tacit knowledge	1.26	IT	1.03
Knowledge Transfer	3.23	Explicit knowledge	1.18	Community of Practice	1.33
Knowledge creation	3.205	HRM Practices	1.282	Technology	3.31
Knowledge generation	1.256	Performance	1.05	People	3.256
Knowledge utilization	1.44	Codification	3.231	Contribution of Skill and Expertise	1.44
Knowledge protection	1.103	Personalization	3.256	Novelty & uniqueness of innovation	1.103
Knowledge Acquisition	3.41	External Knowledge source	3.308	Role of leadership innovation & supports	3.41
Knowledge implementation	3.359	Internal Knowledge source	3.28	Structure	3.307
Intellectual knowledge portfolio	3.256	R&D expenditure	3.3		
		Success rate of R&D products	3.256		
		R&D intensity	1.154		

B. Innovation Management

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. 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.

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.

An Expert-Approved R&D Model

In case of selecting sub-criteria, details are shown in table 7.

Table 7. Importance and consensus on sub-criteria

Innovation Management Process Capability (sub-Criteria)	Level of consensus	Innovation Management strategic Capability (Criteria)	Level of consensus	Innovation Management Infrastructure Capability (sub-Sub-Criteria)	Level of consensus
R&D cooperation	3.308	IP performance	1.282	R&D investment	1.385
Acquisition Internal R&D	1.36	Technological Performance	1.2	External Networking	3.2
Acquisition External R&D	1.101	Innovative Performance	3	R&D Employee	3.28
Technology Transfer	3.32	Technology trends	3.23	New Knowledge	1.15
Decision Making process	3.23	Organization strategy	3.21	Radical Innovation	3.28
Knowledge Sharing	1.28	Innovation strategies and initiatives	3.26	Knowledge incentives	3.26
Inbound Open Innovation	3.359			Formulation	1.077
Project management (control & monitoring)	3.256			Absorptive capacity	3.282
Innovativeness compatibility	3.211			External knowledge	1.4
Rate of introduction of new product/ service per year	3.2615				
Internal & external Knowledge sharing ability	3.2308				
Knowledge creation process	1.26				

C. Technology Management

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. 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.

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).

In case of selecting sub-criteria, details are shown in table 8.

Table 8. Importance and consensus on sub-criteria

Technology Management Process Capability (sub-Criteria)	Level of consensus	Technology Management strategic Capability (Criteria)	Level of consensus	Technology Management Infrastructure Capability (sub-Sub-Criteria)	Level of consensus
Technology Acquisition	3.231	Strategic Technology Road Mapping	3.21	Management competency	3.35
Technology Exploitation	3.28	Technology absorptive capability	1.11	Facility	3.3
Technology Identification	3.38	Technology innovation capability	1.16	Organization potential	3.38
Technology learning	3.21	Absorptive capacity	1.24	Personal skill	3.281
Technology Protection	3.181	Descriptive capacity	3.29		
Technology Selection	3.308	Corporate Technology Strategy	3.395		
		Corporate Business Strategy	3.368		
		Technology Alliance Strategy	3.184		

D. Final Model For Pakistan

During refining process, majority of experts from focus groups agreed on involvement of other elements that can consider as sub-criteria. 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 Fig.2.
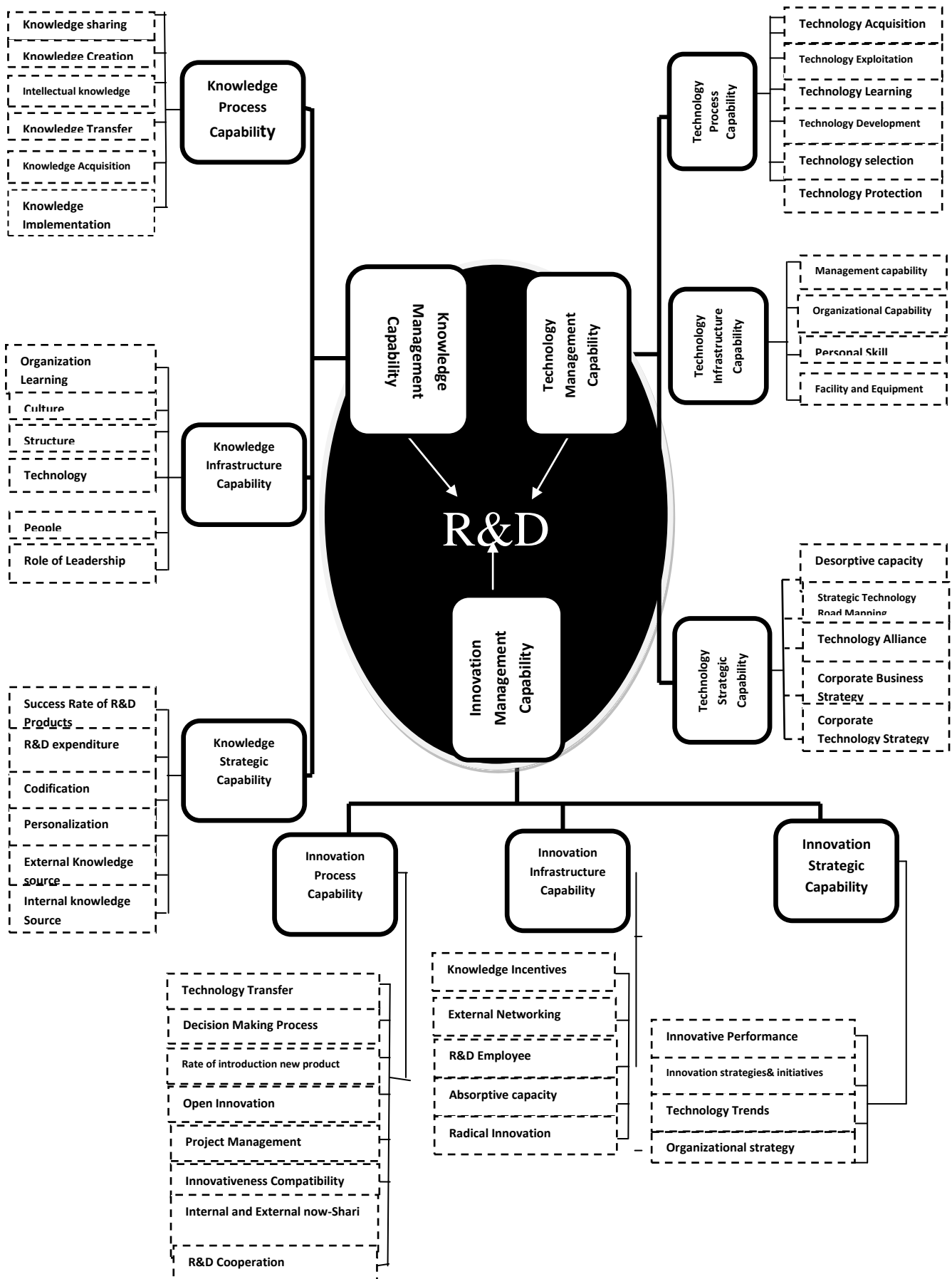
Figure 2. Expert-approved model for devising R&D orientation

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IV. CONCLUSION

This research contributes to national level 0f Pakistan, as a 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.

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