PRECAUTIONARY CONSTRUCTION MANAGEMENT FOR SUSTAINABILITY

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“Bismillahirrahmanirrahim”

“Dengan nama Allah Yang Maha Pemurah Lagi Maha Penyayang”

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ABSTRAK

Pelaksanaan untuk kelestarian dalam sektor pembinaan bergantung kepada pelbagai peringkat di peringkat global, nasional, serantau, tempatan, korporat dan individu. Pencegahan dalam pembangunan kelestarian di semua sektor pembinaan akan membawa banyak manfaat dan fungsi kepada orang-orang pada masa kini dan juga untuk generasi akan datang yang digunakan. Bagi mencapai pembinaan mampan, sangat penting untuk menyeimbangkan asas-asas asas persekitaran iaitu kemapanan, aspek ekonomi dan sosial bersama-sama. Objektif kajian ini adalah mengkaji dan mengenal pasti prinsip-prinsip utama kemampanan dan menggalakkan kesan positif dan meminimumkan kesan negatif ke atas ekonomi, alam sekitar dan sosial, untuk mengenal pasti dan merekabentuk rangka kerja soal selidik yang berkaitan dengan pengurusan pembinaan berjaga untuk kemampanan, dan untuk menganalisis pengurusan pembinaan berjaga-jaga untuk kelestarian. Kajian ini dilakukan melalui soalan tentang kelestarian dalam sektor pembinaan. Sebanyak 75 soal selidik diedarkan dan dijawab oleh responden. Data dianalisis menggunakan Relatif Index Penting. Dari kajian ini, didapati bahawa tujuan pengurusan pembinaan berjaga-jaga adalah untuk memelihara akses kepada perkhidmatan ekosistem yang penting untuk kesihatan dan kesejahteraan. Kesimpulannya, menghormati orang dan alam sekitar setempat mereka, dan berusaha meminimumkan kesan sosial yang buruk dan memaksimumkan kesan sosial yang positif terhadap projek ini adalah penyelesaian untuk pengurusan pembinaan pencegahan untuk kelestarian sektor pembinaan.

ABSTRACT

The implementation for sustainability in the construction sector depends on the varying extents at global, national, regional, local, corporate and individual levels. The precautionary in sustainability development in all construction sector will brings a lot of benefits and functions to people nowadays and also for future generations used. To achieve sustainable construction, it is very important to balance the basic principles of sustainability i.e. environment, economic and social aspect together. The objectives of this study are review and identify the key principles of sustainability and promote positive impacts and minimizing negative impacts on economic, environmental and socials, to identify and design questionnaire framework related to precautionary construction management for sustainability, and to analysis the precautionary construction management for sustainability. The study is carried out through questionnaires. A total of 75 questionnaires were distributed and answered by respondents. The data were analyzed using Relative Importance Index. From the study, it was found that the purpose of the precautionary construction management is to preserve access to ecosystems services essential to health and wellbeing. In conclusion, respect people and their local environmental, and seek to minimize the adverse social impacts and maximize the positive social impacts of the project is the solution for the precautionary construction management for sustainability in construction sector.

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LIST OF ABBREVIATIONS

WCED	World Commission on Environment and Development
SA	Sustainability Assessment
PP	Precautionary Principle
RII	Relative Importance Index

CHAPTER 1

INTRODUCTION

1.1 Overview

In a broad term, sustainability is refers to the need to develop the sustainable models necessary for both the human race and planet earth to survive. Sustainable development (or sustainability) is about enabling all people throughout the world to satisfy their basic needs and enjoy a better quality of live without compromising the quality of live for future generation (Sahota, 2013).

According to the Report of the World Commission on Environment and Development (WCED): Our Common Future state that, *"sustainability is the development that meet the needs of the present without compromising the ability of future generations to meet their needs"*(Brundtland, 1987).

Sustainability in building development is a broad and complex matter, which is nowadays, has been one of the biggest issues in the construction industry. Sustainability deals with action oriented part such as planning for a long duration, assessing the impact on environment, influence on society, protecting nature, embracing innovation, understanding the constraints, creating and fostering awareness about the system and following the best practices.

The currently prevailing the meaning of sustainability underlines cross generational equity, clearly an essential idea however one which postures troubles since it is not generally simple to decide future generation's needs. Anchoring an alternative definition to the connection between a population and the conveying limit of this planet offers unrivalled operational use since it contains various key factors, all possibly quantifiable. For example; population numbers, rate of consumption of resources, impacts on absorption limit of sinks, a measure of prosperity, and the like.

Subsequently, in general, however more significantly in the specific setting of human activity on the planet, the accompanying is advertised:

Sustainability:

"A dynamic equilibrium in the processes of interaction between a population and the carrying capacity of an environment such, that the population develops to express its full potential without adversely and irreversibly affecting the carrying capacity of the environment upon which it depends" (Ben-Eli, 2006)

1.2 Background of Study

Topics of sustainability have been addressed by several studies, but it still a lot of important matters to be considered and focussed about this topic before construct any construction. The conditions for sustainability are difficult to achieve and even more difficult to demonstrate (Boswell et al., 2005). Sustainability is a complex term to define in a sufficiently significant or practical way so as to make it operative and there are wide ranging insights into sustainability and its practices.

Sustainability implies the preservation of the physical and social environment and the application of the concept of sustainability, which is vital important. The sustainability is based on the three main principles that constitute environmental, economic and socials sustainability. Sustainability is usually related to the environmental protection, however, for their effective implementation it is necessary to comply with the other three principles.

The implementation for sustainability in the construction sector depends on the varying extents at global, national, regional, local, corporate and individual levels. The precautionary in sustainability development in all construction sector will brings a lot of benefits and functions to people nowadays and also for future generations used. The sustainability construction can be better developments if the construction does not causing more environments, socials and economics problem during or after the construction finish and does not need a lot of maintenance for the construction.

Precautionary in construction management means that the first things to do before any construction work is to observe and analyse for any of risks or unwanted problem occur before, during or after the construction at the site.

It is important to point out that human beings are the focus of sustainability and have the right to a healthy and productive life in harmony with nature. The sustainability is most easily achieved by the participant of all concerned citizens at all levels and the state should encourage public awareness and provide all necessary information so that sustainability development becomes a strategic guideline.

1.3 Problem Statement

Precautionary construction management for sustainability in construction sector is an important matter that needs consideration regardless the requirement and to fulfil the needs for the future generation. For any sustainable construction before commencing any of projects, the precautionary need to be considered at the site area. The consideration for precautionary construction managements based on the environmental, economic and social interest.

In environmental issues may present themselves as temporary or permanent changes to the atmosphere, water and land due to human activities, which can result in impacts that may be either reversible or irreversible.

In environmental aspects, the precautionary is an important matter that need to be focus on before commence any work progress. At the risky places, for example the site is at the hillside. The developers, engineers, contractor or project manager must follow the "Safety Guideline for Hill-Site Development 2012". This guideline is for safety and environment of hill-site development. It also provides a clear and consistent application procedures and control during construction and maintenance (Sew, 2014).

In society aspect, its highlight the unity and continuity society that accepted and allow people to do the work that can achieve to meet their goals. Social sustainability is about identifying and managing business impacts, both positive and negative, on people. Directly or in directly, companies affect what happens to employees, workers in

the value chain, customers and local communities, and it is important to manage impacts proactively. Social sustainability also covers the human rights of specific groups: labour, women's empowerment and gender equality, children, indigenous peoples, people with disabilities, as well as people-centered approaches to business impacts on poverty. As well as covering groups of rights holders, social sustainability encompasses issues that affecting them, for example, education and health.

On the other hand, for the economic sustainability can be interpreted in term of the nowadays generation performing the economic activities that can still be continued by the future generation without any burdens. The economic sustainability relies on the environmental aspect. Climate change is only one of many environmental sustainability problems, like freshwater supply, pollution of many kinds, soil fertility lost, and deforestation and so on. If put it all together, economic sustainability looks impossible to be achieved.

1.4 Research Objective

The research will be conducted about the precautionary construction management for sustainability in order to identify several objectives. The objectives of this study are as follow:

a) Review and identify the key principles of sustainability and promote positive impacts and minimizing negative impacts on environmental, economic and socials.

b) To identify and design a questionnaire framework related to precautionary construction management for sustainability.

c) To analysis the precautionary construction management for sustainability.

1.5 Scope of Research

The scope of research is to focus on precautionary construction management for sustainability in construction. This study would target toward Malaysian contractors in order to achieve sustainability in construction. This research would highlight the possibilities of the precautionary construction management for sustainability in construction can be applied in their construction progress. The questionnaire would be distributed to those who have significant role in construction management in construction.

1.6 Significant of Study

There are very uncommon research that have been done regarding to the precautionary construction management for sustainability in construction. Firstly, the priority of this study is to focus on the key principles of sustainability. Secondly, the research is to promote positive impacts and minimize negative impacts on environmental, economic and social aspects. This precautionary construction management is analysed to point out the proper solution to be applied or implemented in construction progress. Furthermore, this topic is not seriously discuss and taken up by others. So, the data, information and the research is necessary in order to achieve the sustainability goals in construction and get the right result and action. This research may got attention to others parties and development researchers.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Sustainability is a way toward green building and eco-friendly building in construction. So in order to achieve the sustainability goals, precautionary construction management is crucial at the early stage of planning and surveying. To make sure the sustainability goals to be achieved, the construction has come out three aspects to be considered before the construction start. The first aspect is about the key principles of sustainability construction. It is important to balance the principles in environment, economic and social aspect together. Next is about the decision criteria for sustainability. It about making up some decisions criteria for sustainability based on the condition, requirement and also it implications. Then, the sustainability assessments which are used for supporting the decision makings and it approaches advancement in a broad context. Last but not least, the precautionary principle. The precautionary principle has been applied to a differing scope of fields, including health protection, environment regulation, biodiversity management and emerging technologies.

2.2 Key Principles of Sustainability Construction

Sustainability is a dynamic concept. It requires decision makers to be flexible and willing to modify their approaches. To achieve sustainable construction, it is very important to balance the basic principles of sustainability i.e. environment, economic and social aspect together (Jamilus, Ismail, & Aftab, 2013).

The above meanings of sustainability construction are altogether encircled towards making a healthy built environment through asset proficient and ecologically stable procedures, conserving of ecosystems and maintain of natural balance between improvement and conveying limit of this planet. The key principles whereupon the above definitions have been expressed can be summarised into the main principles of sustainability construction.

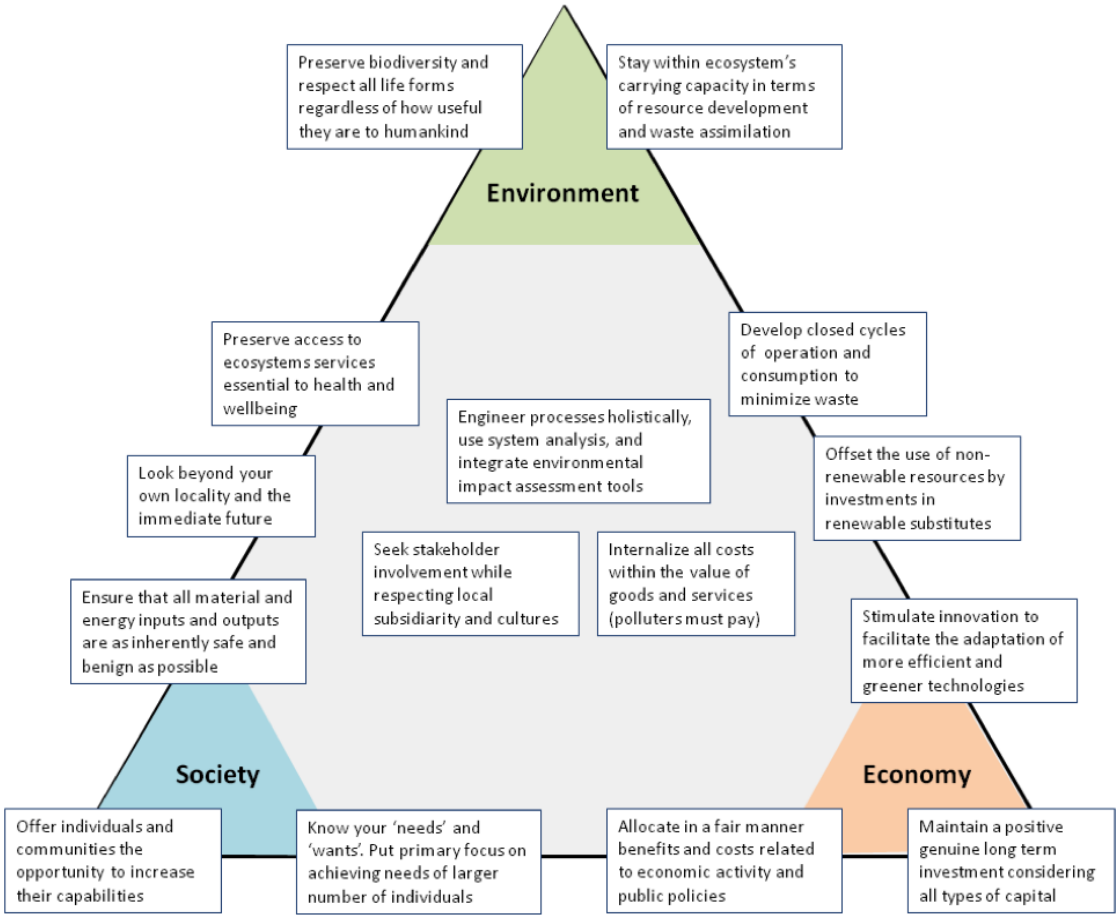

Figure 2.1 Principle of sustainability

Figure 2.2 records the various principles of sustainability in construction versus environmental, economic and socials aspects. Some of these principles clearly gravitate towards one of the edges of the triangle and along these lines address particularly societal, environmental or economic concern. But some others, which are placed along the side of the triangle, have connections to two of the aspects of the diagram and address both societal and economic, or both economic and environmental concerns in some proportion. (Gagnon, Leduc, Gagnon, ϒ, & Savard, n.d.) Those principles placed in the center of the diagram combine all three aspects of sustainability to a certain degree

and hence their implementation would benefit all societal, environmental and economic stakeholders.

These principles can be viewed as guidelines for a specific engineering project out there. Referring these as guideline could address some of new engineering solution that need and brings benefits in sustainability.

A definitive goal of setting up the idea of sustainability as an organizing principle is to cultivate a well-working arrangement between people, society, the economy and the regenerative limit of the planet's life-supporting ecosystems. This arrangement represents to a specific type of balance in the connection between a population and the conveying limit of this planet. It is this specific balance which must be the focus of a significant meaning of sustainability. (Ben-Eli, 2006)

The principles which take after are grounded in this definition and the five domains in relation to which they are expressed represent key dimensions of the underlying interaction.

2.2.1 The Five Core Principles

The principles are articulated in a general fashion but can receive a specific operational meaning in relation to particular sectors of the economy, development issues, business strategies, investment guidelines, or initiatives taken by individuals. They are expressed in relation to five fundamental domains:

- **The Material or Environmental Domain:** Constitutes the basis for regulating the flow of materials and energy that underlie existence.
- **The Economic Domain:** Provides a guiding framework for creating and managing wealth.
- **The Domain of Life:** Provides the basis for appropriate behaviour in the biosphere.
- **The Social Domain:** Provides the basis for social interactions.
- **The Spiritual Domain:** Identifies the necessary attitudinal orientation and provides the basis for a universal code of ethics.

Table 2.1 The Five Core Principles

Domains	Principles	Underlying Premise	Policies and operational implications
Materials and Environmental	Contain entropy and ensure that the flow of resources, through and within the economy, is as nearly non-declining as is permitted by physical laws.	• All the physical procedures which give the premise to human presence are liable to the essential laws of thermodynamics – the First Law, which tends to the principal preservation of energy in universe and the Second Law, which stipulates the course of the energy occasions.	• Strive for highest resources productivity. • Amplifying performance with each cycle of use. • Employ "income" rather than "capital" sources and continuously recycles non-regenerative resources.
Economics	Adopt an appropriate accounting system, fully aligned with the planet's ecological processes and reflecting true, comprehensive biospheric pricing to guide the economy.	• Economies comprise of business sectors where exchanges happen and controlling structures by which exchanges are assessed and decisions about duties are made.	• Align the world's economy with nature's regeneration capacity and incorporate critical "externalities" in all cost and benefit accounts. • Embody a measure of well-being and human development in economic calculations.

Life	Ensure that the essential diversity of all forms of life in the Biosphere is maintained.	• The adaptive achievement of the human species and its speedy engendering wherever on the planet earth come at the consistent cost of numerous different types of life.	• Assume a responsible stewardship for our planet's web of biological diversity. • Harvest species only to regeneration capacity. • Conserve the variety of existing generation pool.
Socials	Maximize degrees of freedom and potential self-realization of all humans without any individual or group, adversely affecting other.	• Every one of these considerations fortify the still delicate thought that open procedures, responsive structures, majority of articulation and the fairness to all people should constitute the cornerstones of social life.	• Foster tolerance as a cornerstone of social interactions. • Promote sustainability literacy through education at all levels. • Embody sustainability enhancing concepts in an effective planetary framework of legislation.
Spiritual	Recognize the seamless, dynamic continuum of mystery, wisdom, love, energy, and matter that links the outer reaches of the cosmos with our solar system, our planet and its biosphere including all humans, with our internal metabolic systems and their externalized technology extensions -- embody this recognition in a universal ethics for guiding human actions.	• The term spiritual carries opposing connotations: sacred, exalted, virtuous, divine, but also, insubstantial and occult. It is meant here to evoke a sense of a deep, underlying essence -- a combination of inspiration, meaning, purpose, and a motivating, all-encompassing value.	• Acknowledge the transcendent mystery that underlies existence • Seek to understand and fulfil humanity's unique function in Universe • Honour the Earth with its intricate ecology of which humans are an integral part

2.3 Decision Criteria for Sustainability

Sustainability is a critical concept. Its considerations are comprehensive, including socio-economic as well as biophysical matters and their interrelations and interdependency over the long term as well as the short term.(Patil, 2018) Most of the attention paid to it because the current situation and trends appear not to be viable for a long time. It also stated that whether it is able to understand sustainability by resting on two intersection pillars (ecological and human) or three (social, ecological and economic) or more.

In any case, this was basically accentuation. The imperative point is that all are incorporated and that human and natural prosperity are adequately related. Under all the layers of artifice and ingenuity, people are ultimately and unavoidably subject to biospheric conditions that are well disposed to human life, and we now play a huge role in controlling those conditions. In this way, the general frameworks that must be attractive and enduring are not just simply ecosystems. They are socio-ecological systems. Feasible advancement must plan to cultivate and preserve socio-ecological systems, from the family to the worldwide levels that are dynamic and versatile, fulfilling, flexible and therefore durable.

There is a need to effectively bring a sustainability perspective into the beginning times of the product development process and support decision-making with tools that incorporate also a long-term and strategic perspective from a meaning of accomplishment. (Bonn & Fisher, 2011)

There are defined eight key elements for successfully implementing a strategic sustainability perspective:

1. Guarantee authoritative help from senior management
2. Effectively present a sustainability perspective early in the product development process
3. Use information and experience of acquisition staff in the earliest phases of the process
4. Incorporate social aspects over the product life cycle and its value chain
5. Appoint duty regarding sustainability implementation in the product development process

6. Have a deliberate path of information sharing and skill working in the sustainability field to illuminate choices taken in future product improvement projects
7. Use tools for managing decisions as a supplement for assessment tools
8. Utilize tools that incorporate a back-casting point of view from a definition of accomplishment.

Sustainability criteria and their content should be linked to the understanding of what is sustainable development and sustainability. Simply put, sustainability criteria are requirements to the sustainable quality of a product and its sustainable production, which have to be fulfilled in order to acquire a sustainability status or certification. (Pavlovskaia, 2014)

Distinguishing the pillars has underscored the significance of the few factors. However characterizing sustainability needs in the common place yet isolate classifications of environment, governmental issues, society, financial matters and culture. Most taking interest people and organizations go to the sustainability table with specific subject matters, command and enthusiasm to apply and defend. Encouraging them to think and act outside these boxes is simpler when sustainability is characterized in ways that pressure the interconnections and go all too the more specifically to the substance of what must be considered and done.

Bottom-up sustainability assessments, driven by the communicated public concerns encompassing specific cases or activities, regularly abandon the pillars classifications and spotlight rather on issues and goals that cross the environmental, social and economic limits. Public-issue identification and priority-setting processes regularly distinguish secure livelihoods, safety and health, energetic and appealing communities, new opportunities and decision, and impacts in choices as key objectives. None of these is an absolutely social, economic and ecological issue.

Sustainability assessment criteria that maintain the strategic distance from the pillars and focus on consideration of the fundamental prerequisites for development as opposed to the set-up categories of tendency (Gibson, 2006). Numerous such approaches have been proposed and utilized. Some are not much more than varied records, and some neglect to incorporate all the vital needs. However, there are still

numerous that attempt to unite the full scope of considerations from the most exceptional reasoning and their decisions think about expansive understanding the fundamentals.

There are some fundamental sustainability requirements that should be viewed as the center commitments of sustainability-oriented decision-makers. Following the approach proposed over, this arrangement of requirements is not pillar-based, however the components draw from the standard classifications. Rather, it focuses consideration on what must be accomplished, and what key activities are included to move reliably toward more prominent sustainability. These requirements are framed here as criteria for sustainability assessments.

In any occasion, a satisfactory listing of core sustainability requirements is only a beginning. For practical applications, there are accumulation, correlation and strife issues to be tended to. Logically, the mix requirement demands that the initial six prerequisites be pursued in commonly good ways that win positive outcomes all rounds, and the precaution and adjustment be incorporated into each case. Maybe this pleasing can be accomplished more regularly than we may expect, yet existing illustrations are uncommon. In practice, there will be strains and clashes between and among the targets.

2.3.1 Indicators for Sustainability Criteria

Sustainability criteria can be developed to define the sustainability design space and thereby make more use of the detailed metrics such as indicators. In contrast to sustainability criteria, several sets of sustainability indicators or metrics have been explored during the latest years. (Hallstedt, 2017)

An indicator should be obviously planned and moderately easy to apply. Indicators for sustainability criteria are tools used to check and assess the satisfaction of sustainability criteria as well as progress towards sustainability. Indicators can give quantitative estimation and qualitative assessment of human activities and their effect on the surrounding world. These criteria should be used to set targets, and guide the development of concepts and new innovations.

Indicators that deal with the satisfaction of sustainability criteria should be connected to sustainability objectives and targets of the framework. They should reflect

the performance of the sustainability criteria. There are different interpretations, methods and approaches for developing and using them.

These indicators present some adaptability by addressing additional and generation particular viewpoint. From the environmental point of view, it is essential that indicators, both core and supplementary, consider worldwide environmental issues, such as global warming, acidification, water shortage and biodiversity. The function of indicators can be enhanced, if they are intended to reflect performance as far as a more total arrangement of system attributes, which incorporates proportions of profitability, asset utilize productivity and power.

The core indicators are not viewed as more important that supplementary indicators. They are seen as an initial step in searching for common measures for sustainable products and their economical generation. A preliminary list of core indicators for sustainable products and their sustainable production can incorporate the accompanying parameters:

1. Energy and material use during the production process: Energy and materials are conserved and the type of energy and materials connected are most suitable for the desired outcome.
2. Natural environment, including human health: Wastes and ecologically incompatible side-effects are persistently diminished, disposed of, or recycled; chemical substances, physical agents, technologies and work practices that present hazards to human health or the environment are likewise constantly reduced.
3. Economic performance: Administration is focused on an open, participatory process of consistent assessment and improvement, concentrated on the long-term economic performance.
4. Products: Product and packaging are intended to be protected and ecologically stable for the duration of their life cycle; services are designed to be sheltered and naturally stable.

There are different approaches, strategies and interpretations for creating and utilizing indicators. End based on indicator values are typically made answering the question of whether numerical qualities are higher or lower than previously, and in a

while in term of whether the differences are probably going to be functionally significant.(Rosen & Kishawy, 2012)

Assessments on how sustainability criteria have been satisfied, made with the assistance of one indicator, yet applying diverse evaluation strategies and techniques, can vary substantially even when connected to similar criteria. A critical inquiry that still remains is the means by which to make all-encompassing assessment of the relative sustainability of various frameworks given the different indicators that represent various sustainability objectives and goals.

The significance of constant surveys and evaluations of sustainability goals, criteria and indicators inside a legitimate system or a sustainability standard should be underlined. Surveys and evaluations made with the assistance of various techniques can prompt diverse outcomes and understandings, even when connected to a similar framework or standard. An assessment in a long-time perspective can add much to the efficient function of indicators. Some analysts push that just through a consistent review and amendment of indicators and the entire framework, inside which they work, a nonstop improvement can be accomplished. Enhancing the relationship between indicators, sustainability criteria and sustainability goals is a priority for the future work.

2.4 Sustainability Assessment

Sustainability assessment (SA) is one of most the complex appraisal method. It not just entails the environmental, economic and social, yet in addition cultural and value-based components. Moreover, sustainability assessment is normally conducted for supporting decision making and approach advancement in a broad context. Without a doubt, assessing sustainability is progressively getting to be regular practice in product, policy and institutional appraisals.(Nushi & Nixha, 2013)

The term ‘sustainability assessment’ can be utilized to refer to process that are ex post evaluative methods and in addition those that are forward-looking ex ante forms that mean to foresee the potential impacts of an activity prior to its implementation. One type of sustainability assessment is a developing field within the impact assessment tradition, where impact assessment is defined as the way toward

distinguishing the future outcomes of a current or proposed activity and the subject of the evaluation is typically a proposed new policy, plan or project.

Sustainability assessment is a recent framing of impact assessment that places emphasis on delivering positive net sustainability gains now and into the future. It can be directed to any type of decision-making, can take many forms and is fundamentally pluralistic (Bond, Morrison-Saunders, & Pope, 2012).

Concepts such as 'Integrated Assessment' and 'Sustainability Assessment' are introduced with offer new points of view to impact assessment outfitted towards planning and decision-making on sustainable development. Examples of current meanings of policy-oriented sustainability assessment are: (Sala, Ciuffo, & Nijkamp, 2015)

- Sustainability assessment is a technique that can help decision-makers and policy-makers decide what actions they should take and should not take trying to make society more sustainable.
- The objective of sustainability assessment is to seek after that plans and exercises make an ideal commitment to sustainable development.

This definition is adequately expansive to include an immense scope of decision-making from selections of individuals in regular day to day existence through to projects, plans, programs or policies more recognizably tended to in the field of impact assessment. This broad perspective of sustainability assessment brings with it some extra challenges for both researchers and experts, not the least of which is the way to understand the scope of utilization, procedures and practices that currently multiply.

However, the pursuit of sustainability is different. In a universe of rapid change, specialized expertise, narrow mandates and immediate pressure, consideration regarding interconnections and future generations is unusual. Regard for sustainability objectives is driven not so much by a desire to preserve tested traditions as by demands for improvement – to address the difficulty of providing decent livelihoods to all without wrecking the planet.

Basically, the present concept of sustainability is a reaction to confirm that present conditions and patterns are not suitable over long run and that the explanations behind this are as much social and economic as they are biophysical and ecological. (Gibson, 2006) Thus, current sustainability efforts are not just integrative and forward looking. They are likewise attempts to push us onto an alternate and more hopeful path and in that capacity they are an attack on entrenched habits and structures of decision-making. This is genuine additionally of sustainability assessment initiatives, comprehensively.

2.4.1 Sustainability Concept Basics

Sustainability as an ongoing thought emerged in response of two major issues and a large group of specific one. The two major stresses – the spreading inlet among rich and poor and the proceeded with debasement of biospheric frameworks – are weaved in a vicious spiral that increasingly threatens the huge accomplishments made in different fields. The numerous particular concerns have centred on the normal and now and then catastrophic failures of decision-making effort that neglected to consider key linked factors into account.

Since 1987, when the World Commission on Environment and Development (WCED) issued its report, *Our Common Future*, the terms ‘sustainability’ and ‘sustainable development’ have been widely, if here and there pessimistically, grasped by open and private sector bodies. There has been much discussion about the significance and implications of serious commitment to sustainability and these thoughts proceed. By the by, following two many years of experimentation and study, there has been obvious advancement towards agreement on the essentials, supported by complementary developments in a few contiguous regions of theory and practice.

The accompanying eight points are presently sheltered statements about the essential bits of knowledge, in any event for the purposes of sustainability assessment:

1. Sustainability considerations are comprehensive, including socioeconomic and biophysical matters, and their interrelations and interdependency over the long term as well as short term.
2. Precautionary measure is required because human and ecological impacts must be tended to as factors in open, dynamic, multi-scalar systems, which are so complex that full description is impossible, prediction of changes uncertain and surprise likely.
3. Minimizing of negative impacts is not enough; assessment requirements must encourage positive steps towards greater community and ecological sustainability, towards a future that is more feasible, lovely and secure.
4. Corrective actions must be woven together to serve numerous goals and to look for positive feedback in complex framework.
5. Sustainability requires acknowledgment both of sacred points of confinement and of unlimited opportunities for creative innovation.
6. Sustainability is not about balancing, which presumes a focus on compromises and trade-offs. Rather the point is numerous strengthening gains. Trade-offs are worthy just if all else fails when the various alternatives have been observed to be more regrettable.
7. The thought and quest for sustainability are both widespread and context-dependent. While a constrained arrangement of basic, extensively pertinent necessities for progress towards sustainability might be distinguished, many key considerations will be location-specific, reliant on the particulars of local ecosystems, institutional capacities and public preferences.
8. In the pursuit for sustainability, the methods and closures are interlaced and the process is open-ended. There is no end state to be accomplished.

The sustainability assessment processes must force decision-makers about possibly critical activities to give genuine essential regard for sustainability requirements. To do this, the processes must apply decision criteria that establish

meeting the core requirements for progress to sustainability as the main test of the proposed purposes, alternatives, plans and practices. The processes must put use of these sustainability based criteria at the centre of decision-making, not as one advisory contribution among many.

Sustainability assessment processes must apply these insights in the full set of process elements:

- Identifying appropriate purposes and options for new or continuing undertakings;
- Assessing purposes, options, impacts, mitigation and enhancement possibilities, and so on;
- Choosing (or advising decision-makers on) what should or should not be approved and done, and under what condition;
- Monitoring, learning from the results and making suitable adjustments through implementation to decommissioning or renewal.

2.4.2 Sustainability Assessment Framework

Raising awareness of project sustainability impacts and developing mind-sets within the project team to establish a culture of care for the environment and people is important. Project team members and project managers, in particular, need to ensure that the project meets not only the projected economic return but also respect the environment and the needs of the communities involved. Understanding what sustainability means at a big picture level as well as what it means at a tangible day-to-day level is part of the challenge.

The sustainability management framework would ensure that environmentally sustainable practices are included in the design, construction and operational phases of the project, and will take into account the social and economic aspects of project performance. The framework ensures that sustainability considerations in the project's learning loop are taken care of.(Chi & Tam, 2010)

The sustainability assessment framework as shown in Figure 2.2 adopts a three pillars approach of economic sustainability, environmental sustainability and social sustainability. Sustainability assessment is program context dependable. This means that sustainability considerations for a project on a wind farm development, for instance, are different from the project of waste treatment in a community.

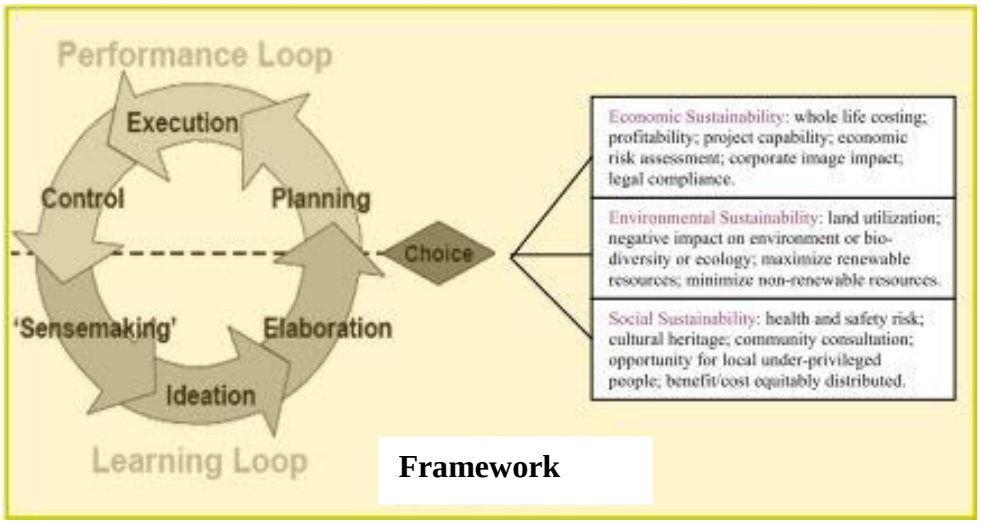

Figure 2.2 Sustainability assessment framework

The framework shows that when the project team is developing a project by means of sense making, ideation and elaboration in the learning loop, sustainability considerations have to be included in the 'choice' process. It is necessary to ensure that the various options or related projects of the program chosen will not only bring economic benefits for the survival of the business, but will also consider environmental sustainability and social sustainability to be critical issues for the long-term success of business.

Assessment of the program options in the elaboration process for choice aims to promote positive sustainability impacts and minimize negative impacts in the three dimensions. The project manager together with team members should be able to develop competence in understanding various sustainability issues, and identifying the impacts of the project options. The project manager should be capable of making a balanced decision, or even a trade-off on chosen solutions with a target to maximize overall positive sustainability effects.

The sustainability assessment should be part of the learning loop rather than being conducted after the project is chosen based on purely economic considerations. When the chosen project is being established, the project managers will be responsible for the project sustainability of their respective projects. The project manager should refer to their previous project experience, including the nature of the project and its context to identify appropriate potential impacts of interest. The list under various sustainability dimensions in the assessment framework above is non exhaustive; nevertheless, it can be taken as a starting point for project managers to identify relevant sustainability requirements for assessment.

2.5 Precautionary Principle

The precautionary principle has been applied to a differing scope of fields, including health protection, environment regulation, biodiversity management and emerging technologies. It may be hard to reach agreement on exactly how to implement the precautionary principle, since the understandings of hazard can change among decision-makers, stakeholders and citizens.

The idea of precautionary measure is of great relevance in environmental regulation in many countries. Despite the somewhat vague nature of the legislation, some consideration has recently been given to the precautionary principle within frameworks and models of economic interpretation and their application.

The principle has still not been obviously or for all intents and purposes figured and keeps on being in adequate as a guideline for the design of regulatory policies. Numerous discussions have emerged about the level of environmental hazard required to trigger the principle, the role of economic and social consequences and the severity of precautionary measures, especially in circumstances where it is thought economic activity might be prejudiced. Political entities are in charge of characterizing the design of this principle, and regulatory frameworks are required to implement it.

The European Commission's Communication on the Precautionary Principle (PP) provides additional information about the procedural steps that decision-makers are expected to take in implementing the precautionary principle. (Policy, 2017)

The Communication states that an approach based on the precautionary principle should:

a) Start with the fullest possible evaluation, identifying at each stage and as far as possible;
b) Entail an evaluation of various risk-management options, including the option of taking no precautionary action; and
c) Involve as early as possible and to the extent reasonably possible, all interested parties.

2.5.1 Precautionary for Sustainability

The precautionary for sustainability aims to anticipate and minimize the potentially serious or irreversible risks under condition of scientific uncertainty. Thus it preserves the potential for future developments.(Som, Hilty, & Ko, 2009)

The uncertainty describes situations where the nature of future possible events is known but probabilities cannot be assigned to their outcomes or where there is ignorance about both what events are possible as well as their probabilities. Uncertainty arises from many sources, including incomplete understanding of natural processes and phenomena and of complex socioeconomic systems. There is uncertainty regarding the preferences of future generations, and of future resource endowments, products and technologies.(Peterson, 2006)

In order to achieve the sustainability in construction, we should be aiming to create appropriate civil engineers works or buildings. The things should do to deliver the sustainability in construction are:

- Construction in the right place.
- Construction with a sound choice of materials from the right resources.

- Construction with high environmental performance (energy and water consumption, water minimization, maintainability).
- An appropriate design life.
- In harmony with its surrounding and neighbours.
- Adopt a whole life approach using life-cycle costing and whole-life environmental assessment.
- Move to sustainability impact assessment instead of just environmental.
- Widen sustainability construction to sustainable development, so as to persuade our clients to adopt new approaches to their development projects.
- Waste avoidance use less energy and water generate dramatic improvement in social condition.
- Procedure dramatic improvement in the natural as built environment.

2.5.2 Consideration in Precautionary Construction Management

Construction industry has been growing rapidly and plays a vital role in the economic growth of a country. It helps in improving the quality of life of its citizens by providing the necessary socio-economic infrastructure such as roads, hospitals, schools and other basic and enhanced facilities. However, it also generates implications to the environment and social aspect of the country. (Patil, 2018)

It is vital to promote and encourage an environmental sustainability culture development: meeting society's demand of industrial and technological products with the indispensable proper disposal of their products at the end of life, that is, discard minimizing environmental impacts on the completion of its life cycle. In the specific case of construction, begins to be aroused interest from external factors. Among them, there is the availability of solutions to minimize negative environmental impacts identified and applicable management tools.

There are some considerations to be focused which might be the solution for the precautionary construction management for sustainability:

1. Re-use and improve the performance of existing built assets, on buildings and civil engineering works, meeting clients' functional requirements may not require new buildings or structures. Refurbishment and/or renovation to improve their sustainability performance may be a better solution than to build new units.
2. Establish any new development in appropriate localities. We need to avoid inappropriate localities and, ideally, ensure that a new building is harmony with its surroundings, both physical and human.
3. Relate land-use planning to transport and infrastructure. We need to consider how occupants and/or uses of the facility we build will gain access to it and the impacts of the development or surrounding transport system and infrastructure.
4. Design for minimum waste and effective use of resources. For the whole life cycle we need to design for waste minimization. Specify materials with care and seek more- efficient use of resources. We also need to consider using recycled materials whenever it is appropriate.
5. Design for life. We need to carefully consider the appropriate life of our buildings taking into account likely changes of use and the need for adaptability, plus the need to dissemble it, rather than simply demolish it, at the end of its useful life.
6. Aim for lean construction. We need to work on continuous improvement in performance, waste elimination, a strong customer focus, delivering value for money alongside high environmental quality, with high-quality management of projects and improved communications with your stakeholders.
7. Energy consumptions. We need to design for minimum whole-life energy consumptions, including combined heat and power, passive systems using natural light, air movement and ventilation. Construction in an energy efficient manner and operating built facilities efficiently.
8. Do not pollute the wider environment. Reduce to a practical minimum the chances of polluting the environment surrounding your project. Use a formal Environmental Management System that meet requirement of ISO 14001.

9. Preserve and enhance natural features and biodiversity. Throughout the project phases, from conception to construction of raw materials and landscaping, we must always look for opportunities to provide, improve and protect wildlife habitats.
10. Conserve water resources. We should design for increased water efficiency in building services and for water consideration in the overall built environment, for example using grey water recycling for uses that do not require potable water.
11. Respect people and their local environmental, and seek to minimize the adverse social impacts, and maximize the positive social impacts of your project. Finally, we need to involve and be responsive to the local community in planning and understanding our projects. We need to provide a safe and respectful working environment for staff and construction workforce, to design to minimize nuisance to neighbour during construction and operational phases.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This part gives a framework of the research methodology as a part of the examination of the precautionary construction management for sustainability. The part of this section is to talk about the strategies utilized in this issue. It is likewise a critical segment keeping in mind the end goal to accomplish the destinations of the choice unmistakably, precisely, and accurately. In this part, we can see the theoretical structure and the steps which for the most part received to distinguish how to gather investigation and translations of information. It covers parts of research configuration, look into process, populace and examining, outline of questionnaire, information accumulation strategy, and information examination.

3.2 Research Design

Research design is a guide or general arrangement on the best way to answer the explore questions. Research configuration is a methodology utilized by specialists to recognize logical issues and solve it according to systematic plan .The methods to gather of data through questionnaires or meeting the individual in order to gain information is always be used. It demonstrates how all the fundamental part in the examination of such measures; tests or gatherings, seminar or projects are utilized together with a specific end goal to deal with look into questions.

The research design can be portrayed as the acknowledgment of rationale in a strategy to measure the legitimacy of the information utilized as a part of the research. Research design has three sorts of techniques for qualitative, quantitative. The qualitative is investigating bits of knowledge and comprehension of an individual, the view of occasions by subjects, propensities and interpretative.

The quantitative is to test the hypothesis in goals or objectives by looking at the connection between factors. It likewise comprises of control and the outcome is affirmed by information of data and statistics. The questionnaire on this research is appropriate to accumulate data. Quantitative technique typically utilize simpler to get feedback from the respondents. The respondents that incorporate such as contractors, employee, project team and administration staff in the construction project.

The fundamental procedure of review research can be arranged in the following:

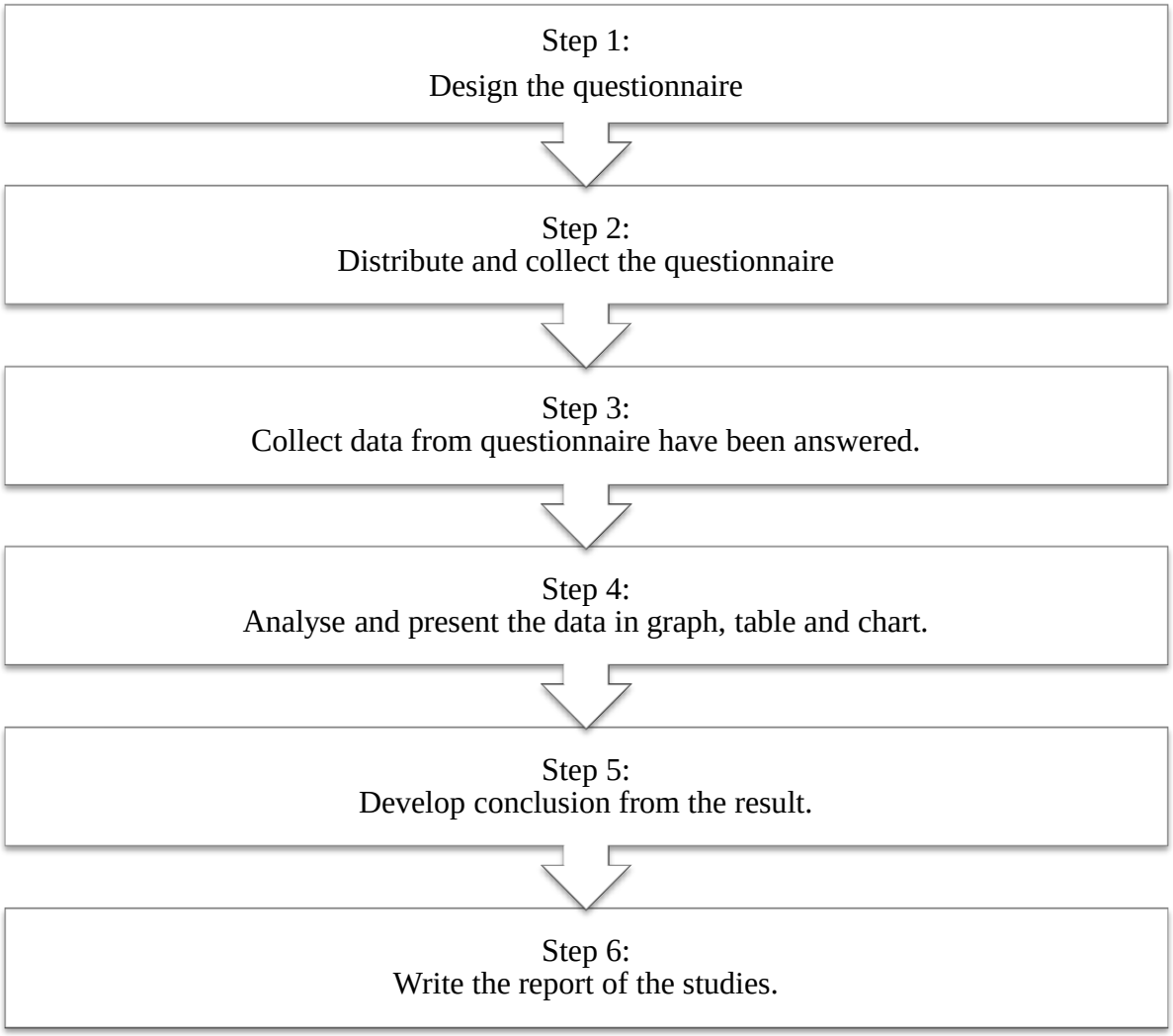

Figure 3.1 The Research Process

As shown in Figure 3.1, the procedure for research process have six stages which is design the questionnaire, distribute and collect the questionnaire, collect data from the questionnaire that have been answered, analysed the data and present it in table, graph and chart, develop conclusion form the result and write the report of the studies.

Step 1 is design the questionnaire. In this stage, the design questionnaire is partitioned into four sections which is Section A, Section B, Section C and Section D. The Section A is incorporated statistic factors identified with profile of company. In Section B is tested with perspective of authorities about precautionary construction

management for sustainability. The Section C is about the purpose of precautionary construction management for sustainability. The Section D is regarding the solution for precautionary construction management for sustainability to be practice in the construction company. Step 2 is to distribute the questionnaire to 75 respondents then collect the questionnaire that have been answered by them. Step 3 is collecting data from the questionnaire. Step 4 is to analyse the data and present it in table, graph and chart by using the Microsoft Excel. Step 5 is to develop the conclusion from the result we gain from the answered questionnaire. The last step, Step 6, we write the report of the studies.

3.3 Population and Sampling

Population is the whole gathering of individuals, articles or occasions that viewed properties. Target populace in this study is that contractors engaged with construction projects in in Malaysia. Testing is a procedure, measures or strategies used to choose the suitable example or part of the populace to decide the characteristics or parameters of the overall population. The methodology utilized used by researchers to assemble individuals, questions or places in the study. It is the way toward choosing a person or object from the chose populace and contains delegate components of the attributes of the whole populace.

3.4 Design of Questionnaire

The questionnaire design for this examination is closed ended which is for the most part including certain conceivable answer given which is respondents need to react to the question given. Closed ended is characterized as question where just need to tick the classification by respondents which conceivable answer are set out in the survey that best shows the respondent answer. The exploration survey plan in this investigation was contained by four sections to achieve the target of this examination which is Section A, Section B, Section C and Section D. Section A is incorporated statistic factors identified with individual company data. Section B is analysed about the perspective of authorities. Section C analysed the purpose of precautionary construction management for sustainability. Section D is analysed the solution for precautionary construction management for sustainability.

3.5 Data Collection Technique

Information is one of the imperative and essentials parts of any research studies. Each exploration depends on the information which is broke down and translated to get data. There are two sources of information have been utilized as a part of this research which is primary data and secondary data.

Primary data is the first information gathered for particular research goals. In these studies, primary data used to gather information. Information was gathered through quantitative techniques of survey questionnaires were delivered to respondents. Questionnaires are dispersed to respondents with email, personnel and web overview (Google forms). The surveys that is conveyed by email can spare time and cash yet it must holding up the response from the respondents. The questionnaires that utilization by personally is easier to get a result because the respondents can reply shortly but it require go to the company.

Secondary data is to get data from existing sources. A variety of information used to acquire information that journal, thesis, online article, case study, article and literature review. Literature review also as a secondary data or an optional information, it is a content of past investigation that identified with this study.

3.6 Data Analysis Method

This exploration measurably broke down information by the Microsoft Excel software. Microsoft Excel software can interpret, summarize and portray the amount of information accumulation. Microsoft Excel software demonstrated the data as indicated by information from the questionnaire. The relative importance index method, (RII) methods empower to figure out the crude information accurately got from the measuring instruments. The information investigation strategy can be interpreted according to objectives.

3.6.1 Analysis Stage

The relative importance index method (RII) method formula is such as below:

$$RII = \frac{\Sigma W}{A * N}$$

Where,
W = weighting given to each factor by the respondents (ranging from 1 to 5),
A = highest weight (i.e. 5 in this case),
N = total number of respondents.

In this case we have 1 to 5 rankings. 1 which is 'Less Effect' while 5 ranking with 'Most Effect'. The rankings was used to compare the relative importance in section B which is the perspective of authorities, section C which is the purpose of precautionary construction management for sustainability and section D that showed solution to precautionary construction management for sustainability. In section A, profile of company just uses percentage to interpret data. The indices (RII) were then used to determine the rank of each item.

The questionnaire survey would be analysed using relative importance index method (RII) method. There are five point scale ranged:

1 = Less Effect ($0.1 \leq RII < 0.2$)
2 = Rarely Effect ($0.2 \leq RII < 0.4$)
3 = Average Effect ($0.4 \leq RII < 0.6$)
4 = More Effect ($0.6 \leq RII < 0.8$)
5 = Most Effect ($0.8 \leq RII < 1.0$)

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

The questionnaire statistic that was collected from 100 respondents was classified by using Microsoft Excel. The data was analysed to know the mean and proportion of each group. This chapter is distributed in some parts since the goals of this research are to identify the key principles of precautionary construction management for sustainability. Besides this research is also want to analysis the precautionary construction management for sustainability.

This questionnaire can be classified by 4 sections:

Section A: Profile of company.

Section B: Perspective of authorities.

Section C: Purpose of precautionary construction management.

Section D: Solution for precautionary construction management for sustainability.

4.2 Profile of Company

For the section A or part of the information demographic analysis was to classify gender, age, company standard, sector of company, working experience and current position.

4.2.1 Gender

According to Table 4.1 and Figure 4.1, the female respondents are less than male. There are 37.3 % of female respondents which are 28 people and the male respondents are 62.7% which are 47 people from the total amount of 75 respondents.

Table 4.1 Gender

Gender	Frequency	Percentages %
Male	47	62.7
Female	28	37.3
Sum	75	100

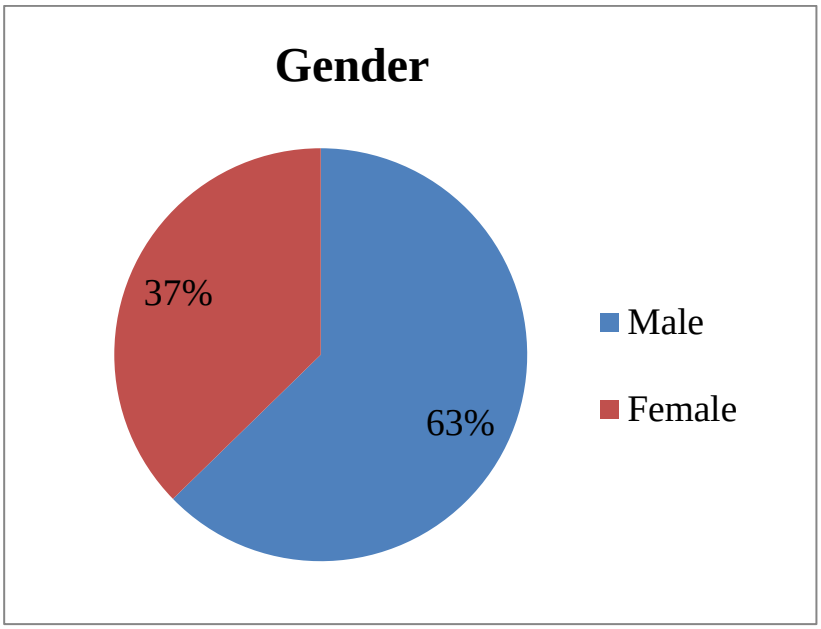

Figure 4.1 Percentages of Gender

4.2.2 Ages

From the Table 4.2, the most age of respondents is between 25 – 30 years old which are 28 people with 37.3% from total of 75 respondents. The age more than 35 years old is the lowest respondents which are only 3 people with 4%.

Table 4.2 Ages

Age	Frequency	Percentages %
Less than 25	21	28
25 - 30	28	37.3
30 - 35	23	30.7
More than 35	3	4
Sum	75	100

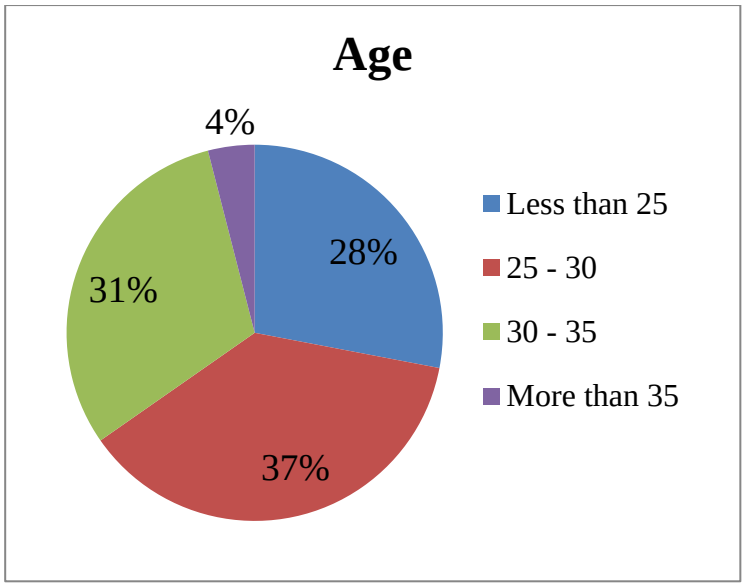

Figure 4.2 Percentages of Ages

4.2.3 Company Standard

From the Table 4.3 and Figure 4.3 shows that the most respondent are from Bumiputera company standard with 43 people which are 57.3% compared to the Non-Bumiputera company standard with 32 people which are 42.7% from total of 75 respondents.

Table 4.3 Company Standard

Company Standard	Frequency	Percentages %
Bumiputera	43	57.3
Non-Bumiputera	32	42.7
Sum	75	100

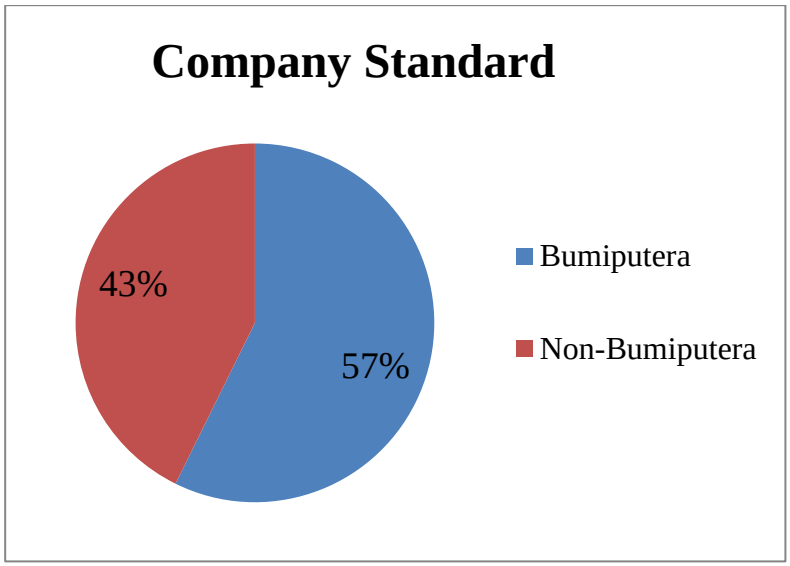

Figure 4.3 Percentages of Company Standard

4.2.4 Sector of Company

In the Table 4.4 and Figure 4.4, the highest respondents are in private sector which is 55 people with 73.3%. The respondents in governance sector are 20 people with 26.7% from total of respondents.

Table 4.4 Sector of Company

Sector of company	Frequency	Percentages %
Governance	20	26.7
Private	55	73.3
Sum	75	100

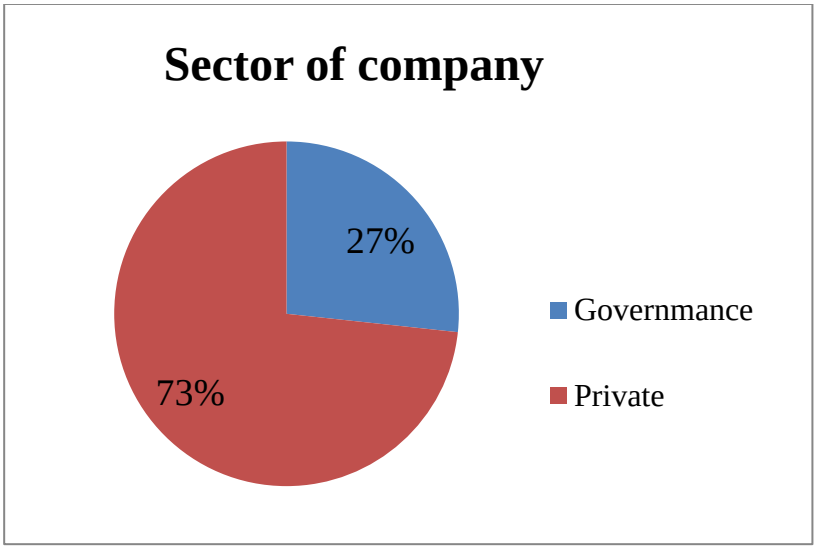

Figure 4.4 Percentages Sector of Company

4.2.5 Working Experience

In the Table 4.5 and Figure 4.5 shows that the highest working experience is between 1 – 5 years which are 51 people with 68%. The lowest working experience is more than 5 years which are 8 people with 10.7% out of 75 respondents.

Table 4.5 Working Experience

Working Experience	Frequency	Percentages %
Less than 1 year	16	21.3
1 - 5 years	51	68
More than 5 years	8	10.7
Sum	75	100

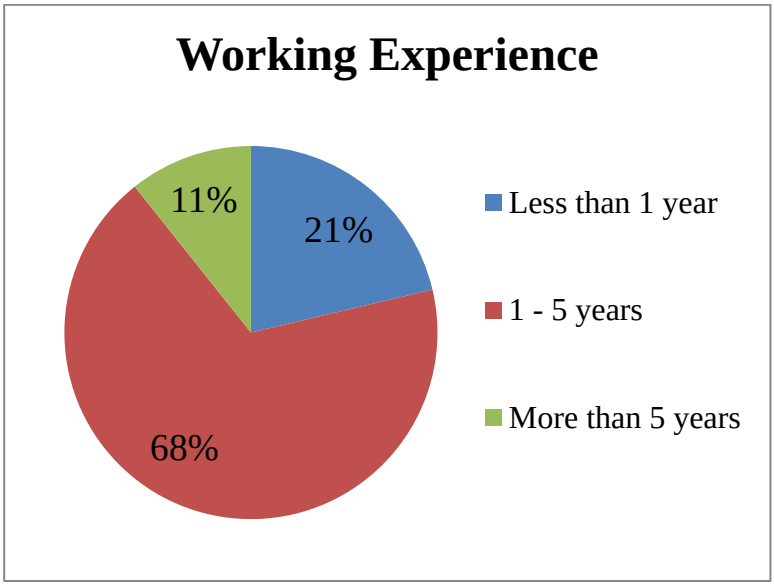

Figure 4.5 Percentages of Working Experience

4.2.6 Current Position

From Table 4.6 and Figure 4.6, the most current position of respondents is engineer and contractor position which both are 26 people with 34.7% and the lowest is the general manager position which is 1 people with only 1.3%.

Table 4.6 Current Position

Position	Frequency	Percentages %
General manager	1	1.3
Project manager	17	22.8
Engineer	26	34.7
Contractor	26	34.7
Others	5	6.5
Sum	75	100

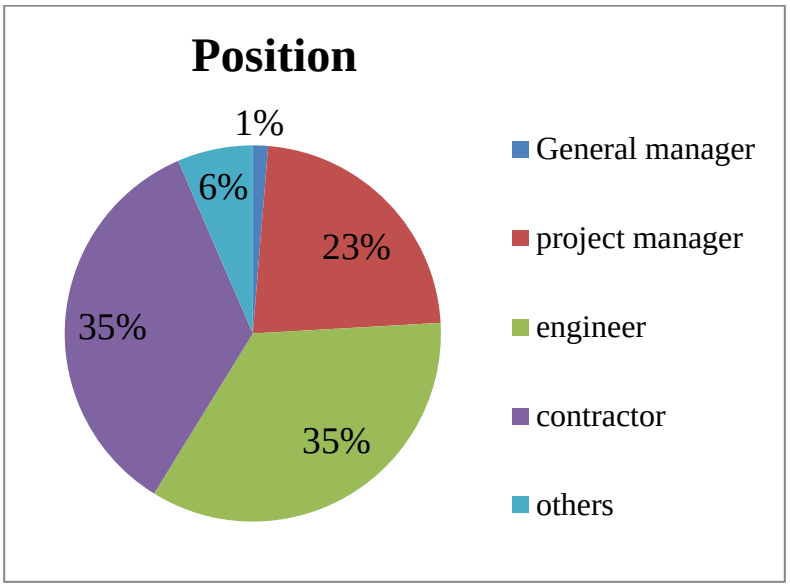

Figure 4.6 Percentages of Current Position

4.3 Perspective of Authorities

For the section B or part of information demographic analysis is about knowledge of precautionary construction management for sustainability. The purpose was to gain perspective views from respondents about the precautionary construction management for sustainability in construction sector.

4.3.1 Knowledge about Precautionary Construction Management

In the Table 4.7 and Figure 4.7 shows that 50 people of respondents know about the precautionary construction management for sustainability with 66.7% and 8 of the respondents with 10.6% do not know about it. The others 17 of respondents with 22.7% are maybe know or not about the precautionary construction management for sustainability.

Table 4.7 Knowledge about Precautionary Construction Management

Did you know about the precautionary construction management for sustainability?	Frequency	Percentages %
Yes	50	66.7
No	8	10.6
Maybe	17	22.7
Sum	75	100

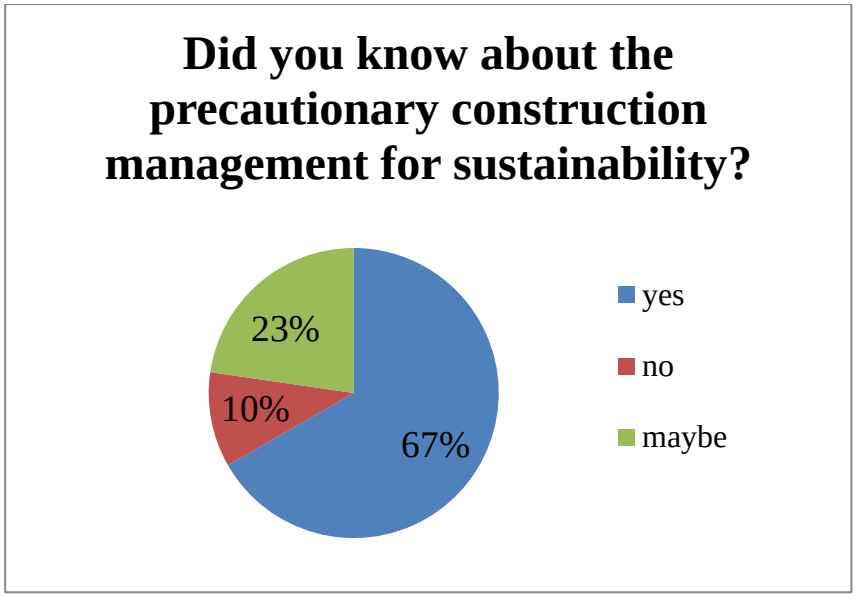

Figure 4.7 Percentages of Knowledge about Precautionary Construction Management

4.3.2 Experience with Precautionary Construction Management

From the Table 4.8 and Figure 4.8, mostly of the respondents had experience with precautionary construction management for sustainability. There are 46 of the respondents with 61.3% had the experience with it and 29 of the respondents with 38.7% do not have experience with it.

Table 4.8 Experienced with Precautionary Construction Management

Have you experienced with the precautionary construction management for sustainability?	Frequency	Percentages %
Yes	46	61.3
No	29	38.7
Sum	75	100

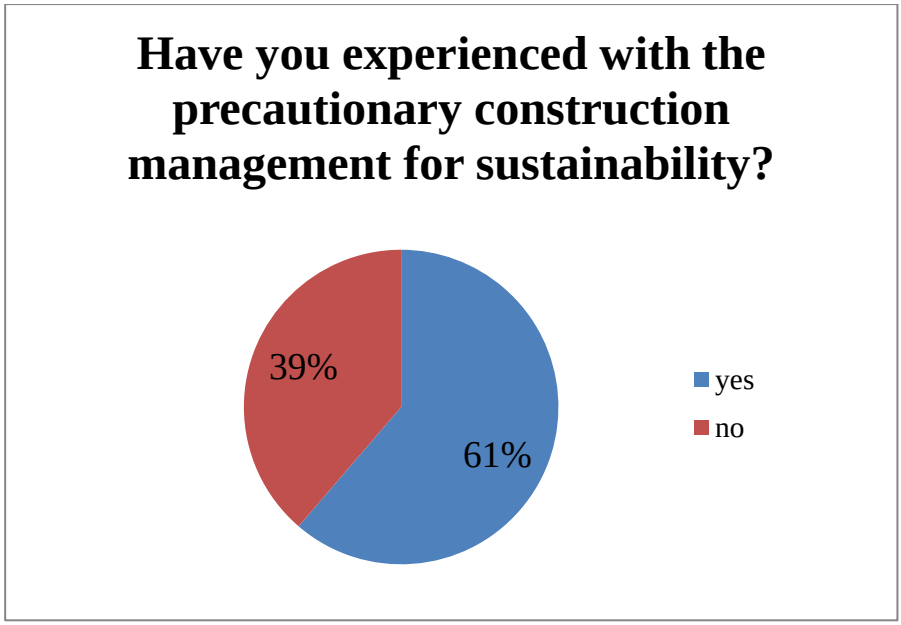

Figure 4.8 Percentages of Experienced with Precautionary Construction Management

Table 4.9 Importance Index and Rank of Perspective Authorities about Precautionary Construction Management

Perspective of Authorities	1	2	3	4	5	**RII**	**Category**
Sustainability is a way toward green building and eco-friendly building in construction. In order to achieve the goal, is the precautionary construction management is crucial at the early stage of construction?	0	2	3	26	44	0.9	Most Effect

1 = Less Effect ($0.1 \leq RII < 0.2$)

2 = Rarely Effect ($0.2 \leq RII < 0.4$)

3 = Average Effect ($0.4 \leq RII < 0.6$)

4 = More Effect ($0.6 \leq RII < 0.8$)

5 = Most Effect ($0.8 \leq RII < 1.0$)

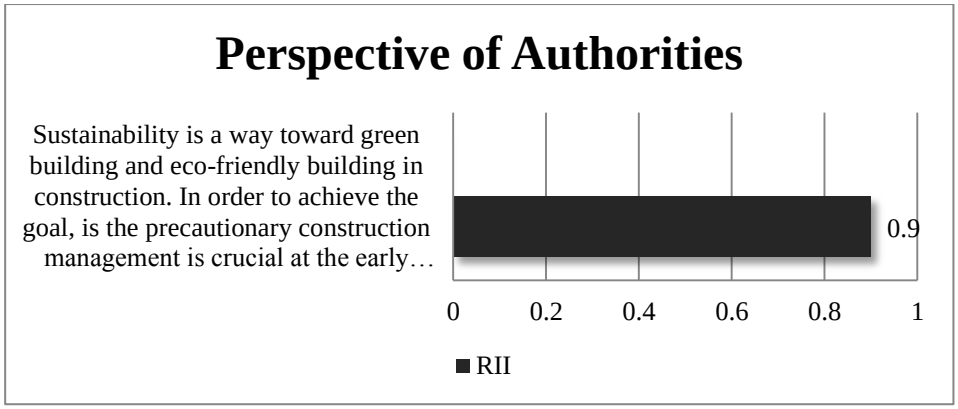

Figure 4.9 RII Value of Perspective Authorities about Precautionary Construction Management

In the Table 4.9 and Figure 4.9 above, from the perspective of the respondents, it shows that the respondents mostly agree with the precautionary construction management is crucial at the earlier stage of construction with the RII value is 0.9.

From Table 4.10 and Figure 4.10 is about the consideration of the environmental, economic and social aspects for sustainability. All 75 of the respondents say yes that the precautionary construction management needs to consider all the aspect above in term for sustainability in construction sector.

Table 4.10 Consideration of Environmental, Economic and Social aspects for Sustainability

Does the precautionary construction management need to consider the environmental, economic and social aspects for sustainability?	Frequency	Percentages %
Yes	75	100
No	0	0
Sum	75	100

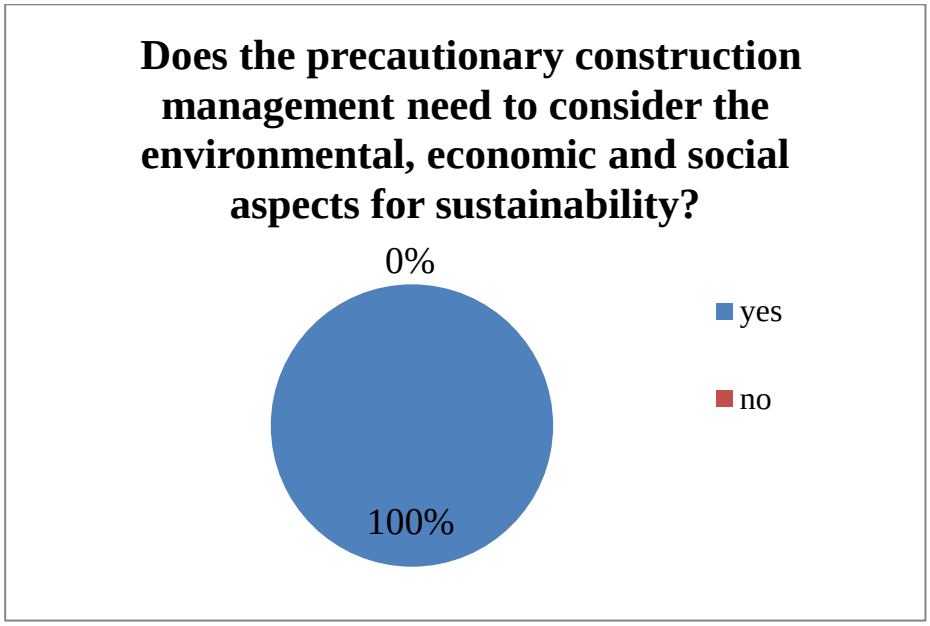

Figure 4.10 Percentages Consideration of Environmental, Economic and Social aspects for Sustainability

4.4 The Purpose of Precautionary Construction Management for Sustainability

In this section C or part of the information demographic analysis was to analyses the purpose of precautionary construction management for sustainability. These purposes have the consideration based on environmental, economic and social aspects in term of sustainability.

Table 4.11 Importance Index and Rank the Purpose of Precautionary Construction Management for Sustainability

The Purpose of Precautionary Construction Management for Sustainability	1	2	3	4	5	**RII**	**Category**
Preserve biodiversity and respect all life forms regardless of how useful they are to humankind.	0	0	5	48	22	0.85	Most Effect
Stay within ecosystem's carrying capacity in terms of resource development and waste assimilation.	0	1	16	36	22	0.81	Most Effect
Develop closed cycles of operation and consumption to minimize waste.	0	1	10	43	21	0.82	Most Effect
Offset the use of non-renewable resources by investments in renewable substitutes.	0	1	12	42	20	0.82	Most Effect
Stimulate innovation to facilitate the adaption of more efficient and greener technologies.	0	2	20	30	23	0.8	Most Effect
Maintain a positive genuine long term investment considering all types of capital.	0	0	19	35	21	0.81	Most Effect
Allocate in a fair manner benefits and costs related to economic activity and public policies.	0	3	12	35	25	0.82	Most Effect

Know the 'needs' and 'wants'. Put primary focus on achieving needs of larger number of individuals.	0	3	18	39	15	0.78	More Effect
Offer individuals and communities the opportunity to increase their capabilities.	0	1	17	38	19	0.8	Most Effect
Ensure that all materials and energy inputs and outputs are as inherently safe.	0	0	3	25	47	0.92	Most Effect
Look beyond the own locality and the immediate future.	0	0	4	27	44	0.91	Most Effect
Preserve access to ecosystems services essential to health and wellbeing.	0	0	3	17	55	0.94	Most Effect

1 = Less Effect ($0.1 \leq RII < 0.2$)

2 = Rarely Effect ($0.2 \leq RII < 0.4$)

3 = Average Effect ($0.4 \leq RII < 0.6$)

4 = More Effect ($0.6 \leq RII < 0.8$)

5 = Most Effect ($0.8 \leq RII < 1.0$)

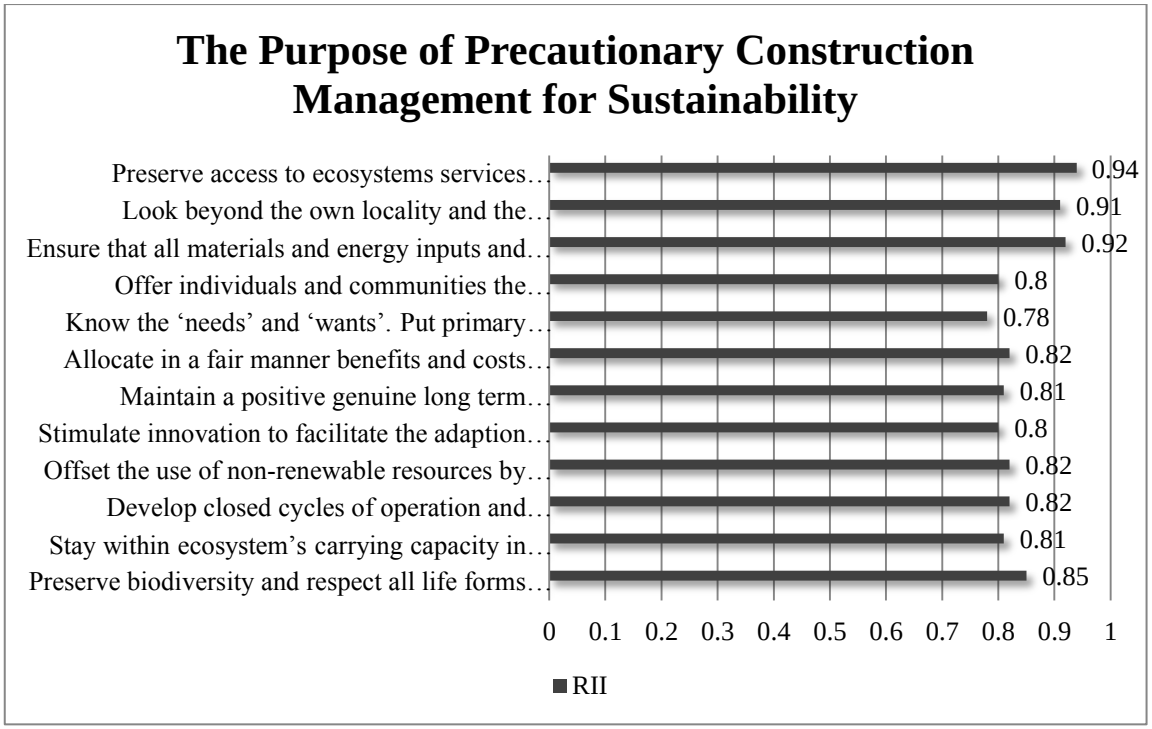

Figure 4.11 RII Value of the Purpose of Precautionary Construction Management for Sustainability

The purpose of the precautionary construction management for sustainability is based on the RII method. Based on Table 4.11 and Figure 4.11, the highest RII value is preserve access to ecosystems services essential to health and wellbeing which is 0.94, while know the 'needs' and 'wants' is has the lowest value of 0.78. Then it followed with ensure that all materials and energy inputs and outputs are as inherently safe with 0.92 and next is look beyond the own locality and the immediate future with 0.91. After that, preserve biodiversity and respect all life forms regardless of how useful they are to humankind with 0.85.

Develop closed cycles of operation and consumption to minimize waste, offset the use of non-renewable resources by investments in renewable substitutes and allocate in a fair manner benefits and costs related to economic activity and public policies are have same value of 0.82. Besides, stay within ecosystem's carrying capacity in terms of

resource development and waste assimilation and maintain a positive genuine long term investment considering all types of capital both have the same value of 0.81.

Lastly, stimulate innovation to facilitate the adaption of more efficient and greener technologies and offer individuals and communities the opportunity to increase their capabilities have same value of 0.80. A strategic development can be provided via balanced and consistent synergy of environmental, economic, and social components of sustainability. As ecological and social sustainability cannot present without economic sustainability, it is accepted that social sustainability is a precondition of economic sustainability. These three components should be taken into consideration as inseparable parts of a whole because of their full integrations with each other. (Mustafa & Bak, 2015)

4.5 The Solution for Precautionary Construction Management for Sustainability

In this section D, it was to classify the solution for precautionary construction management with consideration of key principle of sustainability and also the others aspect toward sustainability.

Table 4.12 Importance Index and Rank of the Solution for Precautionary Construction Management for Sustainability

The Solution for Precautionary Construction Management for Sustainability	1	2	3	4	5	**RII**	**Category**
Re-use and improve the performance of existing built assets on buildings and civil engineering works.	0	3	11	42	19	0.81	Most Effect
Establish any new development in appropriate localities to ensure that the new building is harmony with its surroundings.	0	3	24	23	25	0.79	More Effect
Relate land-use planning to transport and infrastructure by considering how the occupants or uses of the facility have built will gain access to it and also the impacts of the development.	0	2	21	30	22	0.79	More Effect
Design for minimum waste and effective use of resources for the whole life cycles.	1	2	18	28	26	0.8	Most Effect
Appropriate design for life of the buildings need to take into account like changes of use and the need for adaptability, plus the need to dissemble it, rather that demolish it.	0	0	24	33	18	0.78	More Effect

Aim for lean construction in improving the performance, waste elimination, high environmental quality and with high-quality management of projects.	0	1	12	33	29	0.84	Most Effect
Design for minimum whole-life energy consumptions. Construction in an energy efficient manner and operating built facilities efficiently.	0	0	10	42	23	0.83	Most Effect
Reduce to practical minimum the chances of polluting the environment surrounding the project.	0	1	9	39	26	0.84	Most Effect
Preserve and enhance natural features and biodiversity.	0	0	2	24	49	0.93	Most Effect
Respect people and their local environment, and seek to minimize the adverse social impacts, and maximize the positive social impacts of the project.	0	0	1	20	54	0.94	Most Effect

1 = Less Effect ($0.1 \leq RII < 0.2$)

2 = Rarely Effect ($0.2 \leq RII < 0.4$)

3 = Average Effect ($0.4 \leq RII < 0.6$)

4 = More Effect ($0.6 \leq RII < 0.8$)

5 = Most Effect ($0.8 \leq RII < 1.0$)

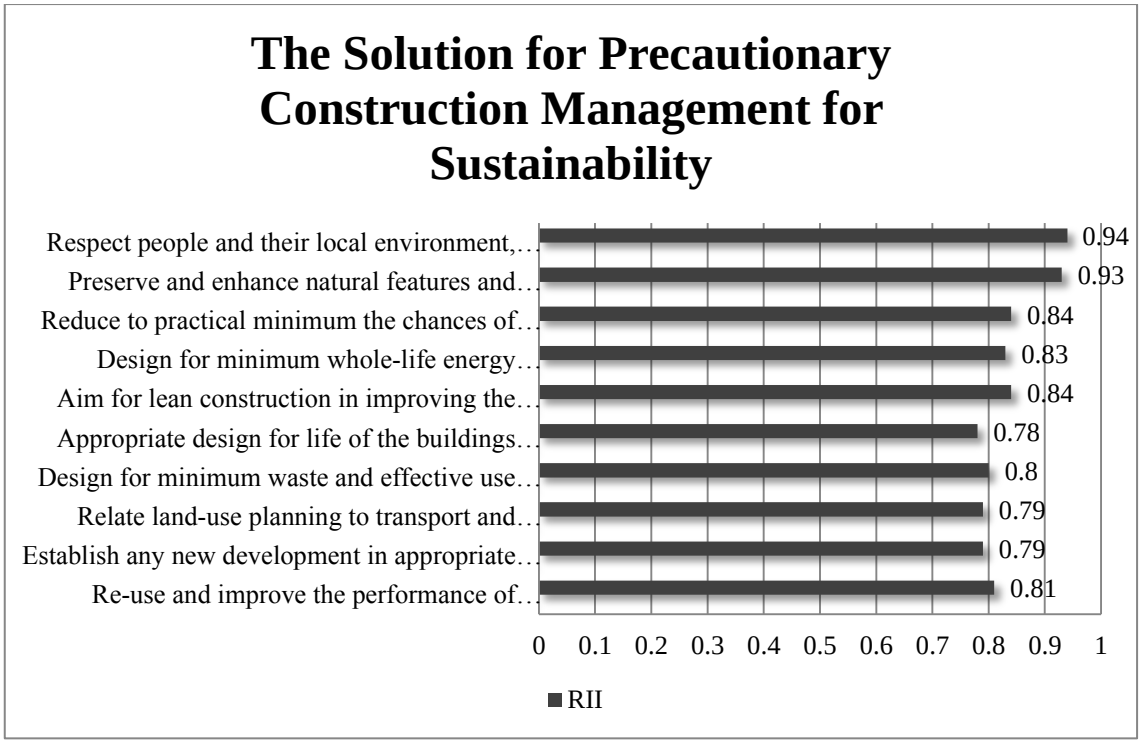

Figure 4.12 RII Value of the Solution for Precautionary Construction Management for Sustainability

Table 4.12 and Figure 4.12 above indicated the solution for precautionary construction management for sustainability by using the RII method analysis. From that, the highest RII value is 0.94 which indicated respect people and their local environment, and seek to minimize the adverse social impacts, and maximize the positive social impacts of the project. For the lowest RII value of 0.78 is appropriate design for life of the buildings need to take into account like changes of use and the need for adaptability, plus the need to dissemble it, rather that demolish it.

The solution by preserve and enhance natural features and biodiversity has the RII value of 0.93 then followed by aim for lean construction in improving the performance, waste elimination, high environmental quality and with high-quality management of projects and reduce to practical minimum the chances of polluting the environment surrounding the project with RII value for both is 0.84. Next is design for minimum whole-life energy consumptions. Construction in an energy efficient manner

and operating built facilities efficiently with the RII value of 0.83. Besides, the re-use and improve the performance of existing built assets on buildings and civil engineering works and design for minimum waste and effective use of resources for the whole life cycles with the RII value of 0.81 and 0.80 respectively.

Lastly, with the same of RII value of 0.79 are establish any new development in appropriate localities to ensure that the new building is harmony with its surroundings and relate land-use planning to transport and infrastructure by considering how the occupants or uses of the facility have built will gain access to it and also the impacts of the development.

CHAPTER 5

CONCLUSION

5.1 Introduction

From the study that had been carried out, there are three objectives were identified. The first is review and identify the key principles of sustainability and promote positive impacts and minimizing the negative impacts on economic, environmental and social aspects. Second is to identify and design questionnaire framework related to precautionary construction management for sustainability. Lastly, the objective is to analysis the precautionary construction management for sustainability in construction sector.

5.2 Conclusion

For the conclusion, precautionary construction management is very importance and crucial in the earlier stages of any construction. In other to achieve the goal for sustainability in construction sector, the precautionary is a must by consideration of the environmental, economic and social aspects. The better constructions contribute a lot of benefits for the future generation without compromising the quality of live for them.

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5.2.1 Objective 1: Review and identify the key principles of sustainability and promote positive impacts and minimize negative impacts on environmental, economic and socials.

The first objective is about to review and identify the key principles of sustainability and promote positive impacts and minimizing the negative impacts on environmental, economic and social aspects. Based on the analysis, there are some of the key principles that can promote positive impacts and minimize the negative impacts. The most focused aspect in sustainability is the environmental aspect. This is because it the importance thing to be aware at the first place in precautionary construction management for sustainability. In construction sector, the environmental aspects contributes a lot of problem for the construction if it only been taken for granted. This aspect also effect to the economic and social aspects. That mean the precautionary construction management need to consider the environmental aspects, economic aspects and social aspects for sustainability.

5.2.2 Objective 2: To identify and design a questionnaire framework related to precautionary construction management for sustainability

The second objective is about to identify and design questionnaire framework related to precautionary construction management for sustainability. In the analysis, there are two type of questionnaire related to precautionary construction management which is about the purpose of the precautionary construction management for sustainability and the solution for precautionary construction management for sustainability in construction sector. In the purpose section through the analysis using the RII method, the most effective purpose is preserve access to ecosystems services essential to health and wellbeing. This purpose is based on the key principles of sustainability and consideration of environmental, economic and social aspects. The selective purpose contains all of the aspects and known to be the main purpose of the precautionary construction management for sustainability.

In the solution section from the questionnaire, also based on the RII method analysis, the highest rated is respect people and their local environment, and seek to minimize the adverse social impacts, and maximize the positive social impacts of the project. This also answered the first objective which is promote positive impacts and minimizing the negative impacts on environmental, economic and social aspects.

5.2.3 Objective 3: To analysis the precautionary construction management for sustainability

For the last objective which is to analysis the precautionary construction management for sustainability in construction sector. From the study, in construction sector, the precautionary construction management is a required before commencing any construction. Knowing the purposes and the solutions in precautionary construction management can contribute to eco-friendly construction and green building. This precautionary construction management also needs to be practiced and applied in all construction sectors because it can prevent and minimize certain problem regarding to environmental aspects, economic aspects and also social aspects.

5.3 Recommendation

Overall, after the study has been conducted, the recommendation is to provide some education and training regarding to the precautionary construction management for sustainability. Create a closer connection between training organizations, government and industry to review current training programs and develop new topic areas to ensure students are aware of current and also future regulations. These groups can work collaboratively by introducing a think tank on how best to introduce energy saving features into standard building practices.

Other than that, training in sustainability and sustainable practices must be imbedded in all trainings and courses related to the building and construction industry – ranging from Certificate I – V in Building and Construction. The education and training should incorporate sustainability concept and made it well known and accepted by all people. Education is seen as an important tool in promoting sustainability and

improving the capacity of the people to address environment and development issue. This will increase the level of awareness both among the actors in the entire construction process, as well as the general public.

Besides, building maintenance organizations should consider environmental consciousness as a factor of competitiveness. Environmental consideration will be integrated into all stages of development, program planning and implementation and all aspects of policy making. Environmental inputs shall be incorporated into economic development planning activities, including regional plan, master plans, structure and local plan.

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APPENDIX A

GANT CHART OF REPORT PROGRESS PSM

SEM 2 2017/2018

TASK	W1	W2	W3	W4	W5	W6
Identify research issues						
Decide and approval research						
Preparation of project research						
Introduction, background of study, problem statement, research objective						
Research question, scope of research, significance of study						
Literature review						
Research methodology						
Design questionnaire						
Submit draft proposal to SV						
Submit FYP 1 report to SV						
Presentation						
Collecting data						

SEM 1 2018/2019

TASK	W1	W2	W3	W4	W5	W6
Analysis respondent						
Interpret data						
Conclusion						
Overview of study						
Discussion						
Recommendation of future study						
Conclusion						
Submit draft proposal						
Presentation						
Submit a report						

APPENDIX B

UNIVERSITI MALAYSIA PAHANG

FACULTY OF CIVIL ENGINEERING AND EARTH RESOURCES

QUESTIONNAIRE

TITLE:

PRECAUTIONARY CONSTRUCTION MANAGEMENT

FOR SUSTAINABILITY

RESEARCHER: MOHAMAD SAIFUL TERMIZI BIN MOHAMAD JANI

STUDENT BACHELOR OF (HONORS) CIVIL ENGINEERING

All information provided is confidential and private. It will not be used for purposes contrary to the purpose of this study. Cooperation from your part very much appreciated and proceeded by thanksgiving.

QUESTIONNAIRE FOR THE RESPONDENT

"Precautionary Construction Management for Sustainability"

SECTION A: PROFILE OF COMPANY

Please tick (/) one answer from the following question**.**

1) Gender: Male ◯ Female ◯

2) Age:
- ◯ Less than 25
- ◯ 25 – 30
- ◯ 31 – 35
- ◯ More than 35

3) Company Standard:
- Bumiputera ◯
- Non-Bumiputera ◯

4) Sector of company you work:
- Public ◯
- Private ◯

5) Working Experience in Construction Sector:
- Less than 1 year ◯
- 2 – 5 years ◯
- More than 5 years ◯

6) Current Position:
- General Manager ◯
- Project Manager ◯
- Engineer ◯
- Contractor ◯
- Others, please specify: ……....

SECTION B: PERPECTIVE OF AUTHORITIES

Please kindly rank these causes by ticking the appropriate option:

5 – Strongly Agree 4 – Highly Agree 3 - Average

2 – Slightly Agree 1 – Disagree

i. Did you know about the precautionary construction management for sustainability?

◯ Yes
◯ No
◯ Maybe

ii. Have you experienced with the precautionary construction management for sustainability?

◯ Yes
◯ No

iii. Sustainability is a way toward green building and eco-friendly building in construction. In order to achieve the goal, is the precautionary construction management is crucial at the early stage of construction?

1	2	3	4	5
◯	◯	◯	◯	◯

iv. Does the precautionary construction management need to consider the environmental, economic and social aspects for sustainability?

◯ Yes
◯ No

SECTION C: THE PURPOSE OF PRECAUTIONARY CONSTRUCTION MANAGEMENT FOR SUSTAINABILITY

Please kindly rank these causes by ticking the appropriate option:

5 – Strongly Agree 4 – Highly Agree 3 - Average

2 – Slightly Agree 1 – Disagree

1. Preserve biodiversity and respect all life forms regardless of how useful they are to humankind.

1	2	3	4	5
◯	◯	◯	◯	◯

2. Stay within ecosystem's carrying capacity in terms of resource development and waste assimilation.

1	2	3	4	5
◯	◯	◯	◯	◯

3. Develop closed cycles of operation and consumption to minimize waste.

1	2	3	4	5
◯	◯	◯	◯	◯

4. Offset the use of non-renewable resources by investments in renewable substitutes.

1	2	3	4	5
◯	◯	◯	◯	◯

5. Stimulate innovation to facilitate the adaption of more efficient and greener technologies.

1	2	3	4	5
◯	◯	◯	◯	◯

6. Maintain a positive genuine long term investment considering all types of capital.

1	2	3	4	5
◯	◯	◯	◯	◯

7. Allocate in a fair manner benefits and costs related to economic activity and public policies.

1	2	3	4	5
◯	◯	◯	◯	◯

8. Know the ‘needs’ and ‘wants’. Put primary focus on achieving needs of larger number of individuals.

1	2	3	4	5
◯	◯	◯	◯	◯

9. Offer individuals and communities the opportunity to increase their capabilities.

1	2	3	4	5
◯	◯	◯	◯	◯

10. Ensure that all materials and energy inputs and outputs are as inherently safe.

1	2	3	4	5
◯	◯	◯	◯	◯

11. Look beyond the own locality and the immediate future.

1	2	3	4	5
◯	◯	◯	◯	◯

12. Preserve access to ecosystems services essential to health and wellbeing.

1	2	3	4	5
◯	◯	◯	◯	◯

SECTION D: THE BEST SOLUTION FOR PRECAUTIONARY CONSTRUCTION MANAGEMENT FOR SUSTAINABILITY

Please kindly rank these causes by ticking the appropriate option:

5 – Strongly Agree 4 – Highly Agree 3 - Average

2 – Slightly Agree 1 – Disagree

1. Re-use and improve the performance of existing built assets on buildings and civil engineering works.

1	2	3	4	5
◯	◯	◯	◯	◯

2. Establish any new development in appropriate localities to ensure that the new building is harmony with its surroundings.

1	2	3	4	5
◯	◯	◯	◯	◯

3. Relate land-use planning to transport and infrastructure by considering how the occupants or uses of the facility have built will gain access to it and also the impacts of the development.

1	2	3	4	5
◯	◯	◯	◯	◯

4. Design for minimum waste and effective use of resources for the whole life cycles.

1	2	3	4	5
◯	◯	◯	◯	◯

5. Appropriate design for life of the buildings need to take into account like changes of use and the need for adaptability, plus the need to dissemble it, rather that demolish it.

1	2	3	4	5
◯	◯	◯	◯	◯

6. Aim for lean construction in improving the performance, waste elimination, high environmental quality and with high-quality management of projects.

1	2	3	4	5
◯	◯	◯	◯	◯

7. Design for minimum whole-life energy consumptions. Construction in an energy efficient manner and operating built facilities efficiently.

1	2	3	4	5
◯	◯	◯	◯	◯

8. Reduce to practical minimum the chances of polluting the environment surrounding the project.

1	2	3	4	5
◯	◯	◯	◯	◯

9. Preserve and enhance natural features and biodiversity.

1	2	3	4	5
◯	◯	◯	◯	◯

10. Respect people and their local environment, and seek to minimize the adverse social impacts, and maximize the positive social impacts of the project.

1	2	3	4	5
◯	◯	◯	◯	◯