A Conceptual Framework of Safety and Health in Construction Management

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Abstract. Models to analyse and calculate the costs of prevention in the construction industry are not easy to apply in this area. Firstly, because they are based on studies carried out in the manufacturing sector; and secondly because the traditional models for analyzing these costs are limited to identifying and classifying them. This calculation models need to be improved. Hence this study is an attempt to fill the gap by develops a safety and health cost framework from pre-construction stage until to construction stage in order to assist client to allow the compliance of safety aspects in a tender document can be assured. A mixed method research will be used in this study. Semi structured interview and content analysis will be used as a main tool for the data collection. Then, the questionnaire will be distributed to the expertise in construction industry.

1 Introduction

Construction is a complex activity where various stake-holders are present working under constant challenges from the demands of the job. Each job will have several safety and risk factors, requiring quality and safety management systems to be established as indicated by Mehta & Agnew [35]. This view is supported by Nadeem [4] who writes the process of planning, executing and maintaining all project activities is complex and time-consuming. The situation is made complex by many external factors such as organizational structure, communication, clear instructions, safety culture, codes and standards, training, leadership and responsibility have been suggested to have influence on the general safety at the workplace.

Workplace accident rates are very high compared to other sectors [34]. Regarding the situation in Malaysia in this respect, the Department of Occupational Safety and Health (DOSH), reported that among the total of 112 numbers of fatal injuries in September 2015, 42 numbers of death occurred in construction sector. This statistics indicate that the construction industry is among the most hazardous industries in Malaysia.

Various losses would be incurred by the injured workers after the occurrence of an accident. These losses may include costs to victims and their families; and to employers and society. Accidents and the corresponding damage they cause to productivity, property, equipment and morale can have detrimental effects on a construction company's profit and loss statement [9]. Other losses would be incurred are leading to delays in project completion, increased cost and loss of constructors' reputation [38]. The costs associated with these accidents are both human (not directly measurable) and financial for companies and for society as a whole (sick leave, medical treatment, etc.). Other costs also arise, such as delays in project implementation, impaired company image or market loss [28].

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2 Problem and Issues

Numerous studies have attempted to explain the various losses would be incurred by the companies. However, Lingard and Rowlinson (2005) showed that many of the losses incurred by an accident are "hidden" and difficult to quantify. These "hidden" costs may be significant, and some may be particularly prominent in construction industry. This view is supported by [28], who points out that the costs being "hidden" are difficult to evaluate, to isolate, identify, and quantify. These hidden costs are often difficult to calculate due to the challenges associated with quantifying the specific magnitude of their economic consequences and the manner in which these costs are typically tracked in conventional accounting practices.While it is easy to obtain reliable data on compensation costs (insurance), little information is available on indirect costs (absence, supervision, productivity loss, etc.) in the work environment. A real problem is to collect all the necessary consequence data needed for cost calculation. Therefore, both direct and indirect costs of accidents need to be examined to reflect the true costs of accidents to an employer.

Many researches were done to study the safety cost model in manufacturing sector and some researchers were study on research relates to accident cost (direct and indirect costs) which is focused more on the construction stage of a project. There is limited study appears to have been conducted to investigate on safety costs involved from pre-construction until to construction stage.

Moreover, models to analyse and calculate the costs of prevention in the construction industry are not easy to apply in this area. Firstly, because they are based on studies carried out in the manufacturing sector; and secondly because the traditional models for analyzing these costs are limited to identifying and classifying them [32]. This calculation models need to be improved. Hence this study is an attempt to fill the gap by develops a safety and health cost model from pre-construction stage until to construction stage in order to assist client to allow the compliance of safety aspects in a tender document can be assured.

3 View on Safety and Health in Construction Industry

Construction industry is among the most hazardous industries, and needs a comprehensive and simple-to-administer tool to continuously assess and promote its health and safety performance [33]. Construction is a high hazard industry that covers work on new or existing commercial, industrial or domestic buildings or structures. This view is supported by [36] who writes the construction industry is unique among other industries as the activities of construction often take place in the outdoor under conditions not conducive for safety and health. Workers in the construction sites have to face constant change in the nature of work, the location of work and the mix of workers. Most of the people tend to relate construction industry with dangerous working environment and high risk as compared to others.

The safety in construction site is one of the most essential issues that cannot be taken lightly. Because even it only minor accident, it may cause serious and huge effect to the organization especially within the industry involved machinery that is very much related with the issues of safety awareness. To improve it, some countries such as Australia, Singapore, and the United Kingdom have enacted legislations regulating safety working practices on site. Owing to the advocacy of self-management approach, some construction firms have actively begun to seek effective safety management systems [47].

A number of studies have done a research on safety performance, safety culture, safety leadership and safety compliance in construction industry. Other researches were done to study the safety cost model in manufacturing sector and some researchers were study on research relates to accident cost (direct and indirect costs) which is focused more on the construction stage of a project. There is limited study appears to have been conducted to investigate on safety costs involved from pre-construction until to construction stage. Table 1 shows the summary of studies related to the safety and health management from previous research.

Table 1. The Previous Research Related to the Safety Management

	Safety Performance	Safety Culture	Safety Leadership	Safety Compliance	Safety Element	Safety Cost (Construction Stage)	Safety Cost (Pre-Construction Stage)	Safety Cost (Manufacturing Sector)
(Feng 2013)	x	x				x		
(López-Alonso et al. 2013)						x		
(Griffin & Hu 2013)			x	x				
(Sun et al. 2006)						x		
(Feng et al. 2014)	x					x		
(Gurcanli et al. 2015)						x		
(Jallon et al. 2011a)						x		
(Feng et al. 2015)			x			x		
(Zin & Ismail 2012)				x				
(Oxenburgh & Marlow 2005)								x
(Amador-Rodezno 2005)								x
Napsiah and Faridah, 2012					x			
(Hare & Cameron 2012)					x			

4 Safety and Health Elements in Construction Management

STAGES	SAFETY ELEMENT		
	(OGC Gateway Model) Billy [40]	**RIBA Plan of Work 2013**	**Napsiah [39]**
Pre-Construction Stage	*Concept Phase* i. Possible need for project • Client's role in **H&S** throughout project; supply information, time allowed and **budget** required for project ii. Define user needs • Align **H&S policies** for project; how supply chain will be informed of H&S requirements, expertise required, criteria for evaluating competence, resources and commitment. • Identify **H&S hazards** (risk register).	*Strategic Definition Stage* • Identify client's **Business Case** and Strategic Brief and other core project requirements. • Review feedback from previous project.	*Inception Stage* • **OSH** in **project brief** & **objective**
	Feasibility Phase i. Options to meet user needs • Include **H&S performance**, materials and components specified by output performance can meet functional and H&S requirements. • Option evaluation chart to include H&S. • Input from end user's operation and maintenance at this stage; include format for **H&S file** and budget for maintenance strategy. • Initial **H&S box information** in during **concept designs**. ii. Prepare business case • H&S objectives, **H&S milestones** included. • Evaluate cost of specific **H&S items.** • Assess risks, decide management arrangements and control procedures, update **risk register.** iii. Project brief • H&S objectives included, decide project H&S Performance Indicators, agree format for **H&S File**. iv. Feasibility study option • Consider **H&S risks** on each site via option evaluation chart. v. Procurement strategy • Agree **H&S criteria** for selection of supply chain. Seek advice on maintenance and access issues during operation and maintenance period to prevent H&S problems.	*Preparation and Brief Stage* • Prepare Handover Strategy and Risk Assessments	*Feasibility Stage* • OSH in project brief & objective

Pre-Construction Stage	*Design & Planning Phase* i. Contract preparation • Develop **H&S milestones** for project program. Review specifications for prescriptive items that may generate H&S risks during construction, operation and maintenance. ii. Expression of interest/vetting • Use **H&S criteria** previously outlined to vet supply chain. iii. Partner/contractor selection • Include current **H&S file**. Co-operation between parties involved in negotiation/ tender process with regard to H&S issues. Ensure **H&S criteria** sufficiently weighted in decision. iv. Award contract • Confirm H&S duties. **H&S hazard workshop** and integrated responsibility chart with H&S included. v. Outline design • Identify **H&S hazards/risks** on **drawings**. Cross reference H&S plan to program. H&S milestones on program. vi. Detailed design • Site issues regarding residual risk have been addressed by the contractor ahead of completing the construction H&S plan. Identify **H&S hazards/risks** on **drawing**.	*Developed & Technical Design* • Review Construction Strategy, including sequencing, and update **Health and Safety Strategy**.	*Design Stage* i. Design • **Safety education** and **training** for designer • **Safey prevention** through design (PtD). ii.Tendering • Client is optimal responsibility in insisting on the safe performance of the contractors in making their selection. • **Selection of contractor** was based on the most cost-effective solution to control the **health, safety** and quality **risks**.
Construction Stage	*Construction Phase* i. Site establishment • Display H&S Executive Officer notice, site inductions-confirm operatives have received and understood method statements, communicate site rules. Confirm contractor's supply chain input to construction **H&S plan** and **H&S file**. • Monitor **H&S performance** and **resources**. • Safety inspections continue to monitor **H&S performance** and resources, **report incidents/accidents.** • Identify potential **H&S risks** at commissioning during use. Ensure contractor's supply chain submit information for **H&S file**. ii. Handover • Final inclusions and completion of H&S file. Include **H&S issues** in testing of M&E equipment. Communicate **H&S residual risks (H&S file).**	*Construction Stage* • Review and update Sustainability Strategy and implement Handover Strategy, including agreement of information required for commissioning, training, handover, asset management, future monitoring and maintenance. • Update construction and **Health and Safety Strategies**	

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According to Ghani [20] concludes that matters related to the safety and health aspects during pre-construction, construction and post-construction must be the priority in the construction industry. Basically, Construction Management is divided into 3 sections: Pre-construction, Construction and Post-construction [45]. Pre-construction stage is the initial stage for a Construction Project Management, which covers Inception & Feasibility, Design, and Tendering [30]. It is commences with "Inception and Feasibility". This stage is more focused on the client's requirement and is being described as pre-project planning (Hendrickson & Au, 2000). It encompasses the project objectives, land matters, feasibility study and setting up of the project organisational structure. "Design" falls after Inception & Feasibility which contains project brief, conceptual & schematic design development, planning approval, detailing on design, cost budget preparation, and value of engineering [27]. The goal during this phase is to acquire a complete and accurate understanding of project requirements. The last stage in Pre-construction is "Tendering". During this stage, the tender document is issued and then being evaluated to choose potential contractor [15].

According to OGC [40] as cited by Billy [26] the UK Office for Government Commerce (OGC) "Gateway" model for construction procurement has flexibility which allows various procurement routes to be adopted; and it is primarily for general construction management purposes. This OGC model had been used to build the Health and Safety elements. According to RIBA Plan of Work 2013, the safety element task involved is stated from the 'Preparation and Brief' stage until the 'Construction' stage only. While in Malaysia, specific assessment of safety elements is limited. Based on Napsiah [39], the safety elements were identified during pre-construction stage only. The summary of safety elements involved in Construction Management is documented as per following table.

5 Safety Cost in Construction Project

5.1 Iceberg Theory

The Accident Cost Iceberg proposed by Bird (1974) showed that the proportion of hidden costs could be much larger than the costs directly related to the accident [7]. While the direct cost can be estimated based on the nature of the accident, the indirect proportion is the biggest obstacle for a reliable predictor of the total cost of accidents. Accident incurred losses to the organization. Most organizations are aware that once an accident occurs at the work place, cost will be affected. No matter how much they have paid their insured costs such as the monthly or yearly insurance premiums for the safety of their workers (for instance: medical insurance, hospitalization insurance, building safety insurance, capital item insurances) the losses or hidden or uninsured costs are much greater than the insured costs.
Most hidden costs lie in the penalties, fines imposed on the organization, the amount of productive time spent by the safety officer and safety and health committees doing investigation and interviewing witness, the time lost on productivity and outputs, loss of sales and potential customers, damages to the machines or equipment, cost of idle time, repair and set up costs, loss of man hours, cost incurred to hire replacement workers, documentation cost, et cetera. Thus preventing accidents is the best management strategy in reducing accidents costs [42]. Figure 1 provides a graphical representation of the Iceberg Model of Accident Costs.

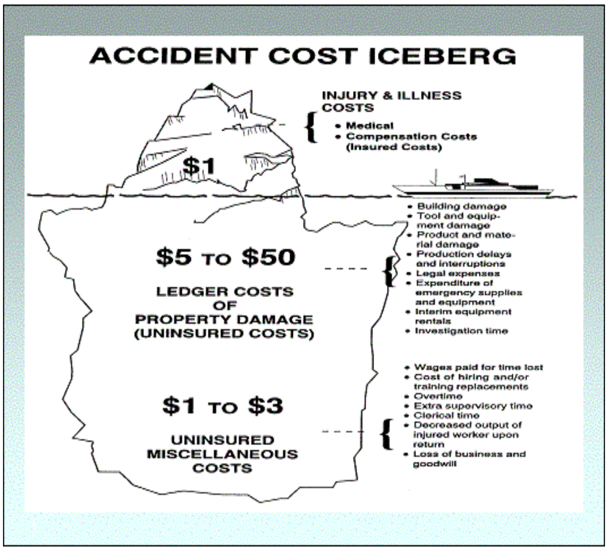

Figure 1. Iceberg Model of Accident Costs

5.2 Types of Safety Cost

[32] found that the cost related to safety and health in the workplace can be classified into three groups as follows:

1) Safety Cost
It is distinguish between prevention costs and those of evaluation and monitoring. Prevention costs are those incurred in order to comply with legal requirements with respect to accident prevention, to implement measures to prevent accidents during construction work and to improve health and safety conditions in all areas of the work performed. In relation to Evaluation and monitoring costs, these are de- rived from the actions taken by the company for appropriate testing and maintenance of the health and safety measures adopted, regarding every facet of the work in question, with the aim of reducing or minimizing the risk of accident or occupational disease.

2) Non Safety Cost
Those are produced by not ensuring health and safety at work, i.e., the costs a company must meet following accidents, as well as those that may arise from breaches of safety regulations. In turn, we distinguish between tangible and intangible costs of accidents. Tangible costs of accidents reflect the costs associated with the occurrence of an accident at work, which can be estimated or calculated using traditional cost accounting methods, while Intangible costs of accidents, according to Gosselin [22], are the costs which are not measurable in

economic terms or for which there are no performance indices to measure their impact on the organisation, such as impaired company image, low worker morale, labour disputes or loss of market.

3) Other Extraordinary Costs

All losses provoked by events that cannot be prevented by the technical or human resources available to construction works, or which are totally unavoidable, such as natural disasters. This cost category includes all the items that are beyond the scope and control of management, and thus are classed as uncontrollable costs, which cannot be incorporated into a structured model designed to control costs regarding safety in the workplace. Both intangible and extraordinary costs are excluded from this study, the first because, in general, they are neither calculated nor estimated in a construction project, and the second because, being uncontrollable as far as works managers are concerned, they cannot be included in a structured calculation model.

5.3 Safety Cost Model

There are numerous studies that analyse the safety cost in construction project. Several models have been produced by the researchers that analyze the cost of lost working days, insurance, and delay in project duration, etc. **Activity-Based Costing (ABC)** has emerged as a new approach that associates costs directly related to business activities with manufactured products. ABC gives more accurate information especially in complex structures and allows one to obtain information on cost items that are ignored in traditional methods. Furthermore, this method is flexible for all kinds of technology-intensive business systems and can be used success-fully in developing countries. ABC provides detailed information about the cost of activities in a particular process and helps decision-makers to develop reasonable decisions with other firms. The other objectives of this system are providing cost reduction and management; determination of profitability of customers, inventory valuation, and new product and service design [25].

Other models developed by researchers as cited by [25], was introduced a cost of safety model to conceptually describe the **cost-benefit analysis** of accident/injury prevention. Alonso et al. (2013) studied the impact of health and safety on the investment of construction companies by applying a questionnaire in southern Spain. While [33] presented an **Occupational Safety and Health Potential Risk Model** for estimation of the statistical costs of occupational safety and health risk.

Return on Investment (ROI) model is introduced to evaluate the effectiveness of safety cost. ROI model is verified to be easy and typical in investment evaluation. Lately, it has also been used to evaluate the effectiveness of Safety Risk Management System in Construction.

$$\text{ROI (\%)} = \frac{\text{Total Benefit-Cost}}{\text{Cost}} = \frac{\text{Net Benefit}}{\text{Cost}}$$

From the ROI model, the cost of safety allocation will be found out in construction project. This will help to identify and classify the investment or allocation safety cost in construction projects. Investment in construction safety risk reduction is not where a company generates net revenue but a place that generates profit by reducing the levels of safety risks and the possibility of losses.

6 Conceptual Framework of Safety and Health Cost in Construction Management

The propositions outlined above are graphically depicted in Figure 2. A conceptual framework of safety and health cost that emerged from the literature review has been developed in this research. The input gathered from the existing of safety cost models such as ABC Model, CBA Model, and ROI Model need to be improved.

To fill the gap existed in the previous models, the safety elements that involved cost in construction management will be included in the new safety and health framework in order to assist client to allow the compliance of safety aspects in a tender document.

A mixed method research will be used in this study. Semi structured interview and content analysis will be used as a main tool for the data collection. Then, the questionnaire will be distributed to the expertise in construction industry. The new safety and health cost framework will be developed and it will be continuously interpreted and tested through construct validity, internal validity, external validity and reliability. From the result, all the objectives of this research will be achieved.

7 Research Design

Generally, this research design is divided into seven (7) phases (refer to Figure 3). The first phase in doing this research is to study the relevant issues with regards to safety and health elements. The identification of related issues, establishment of problem statement, identification of research objectives and research questions and methodology used will be explained in this phase. For the second phase, types of safety elements and its cost involved in construction project will be determined. For this phase, qualitative methods will be used as research methods to achieve the study objectives and answering research questions. Semi-structured interview and content/document analysis will be done to prepare a questionnaire.

During the third phase, pilot test survey will be conducted to the selected respondents in order to evaluate the correctness of the questionnaire and also attempt to predict an appropriate sample size and improve upon the study design. While in fourth phase, the questionnaires will be distributed to the respondents such as safety officer, consultant and contractor. Determination of weightage for each type of safety elements that involved cost will be determined.

In phase five, the suggested safety and health model is developed through the data collected and evidence sources and it will be continuously interpreted and tested through construct validity, internal validity, external validity and reliability. From the analysis, the author will suggest a safety and health cost framework in construction project. Objective 1,2 and 3 will be achieved in this phase. For the six phases, the safety and health cost framework will be validated by the focus group (expertise). Suggestion from these parties will be taken into consideration in improving the cost framework. Objective 3 will be achieved in this phase.

During the last phase, the author concludes all findings of the study conducted in phases earlier. Then, the author will provide recommendations to improve the safety elements aspect; safety cost efficiency and also provides recommendations towards future research. The research design phases involved in this research is documented as per following figure.

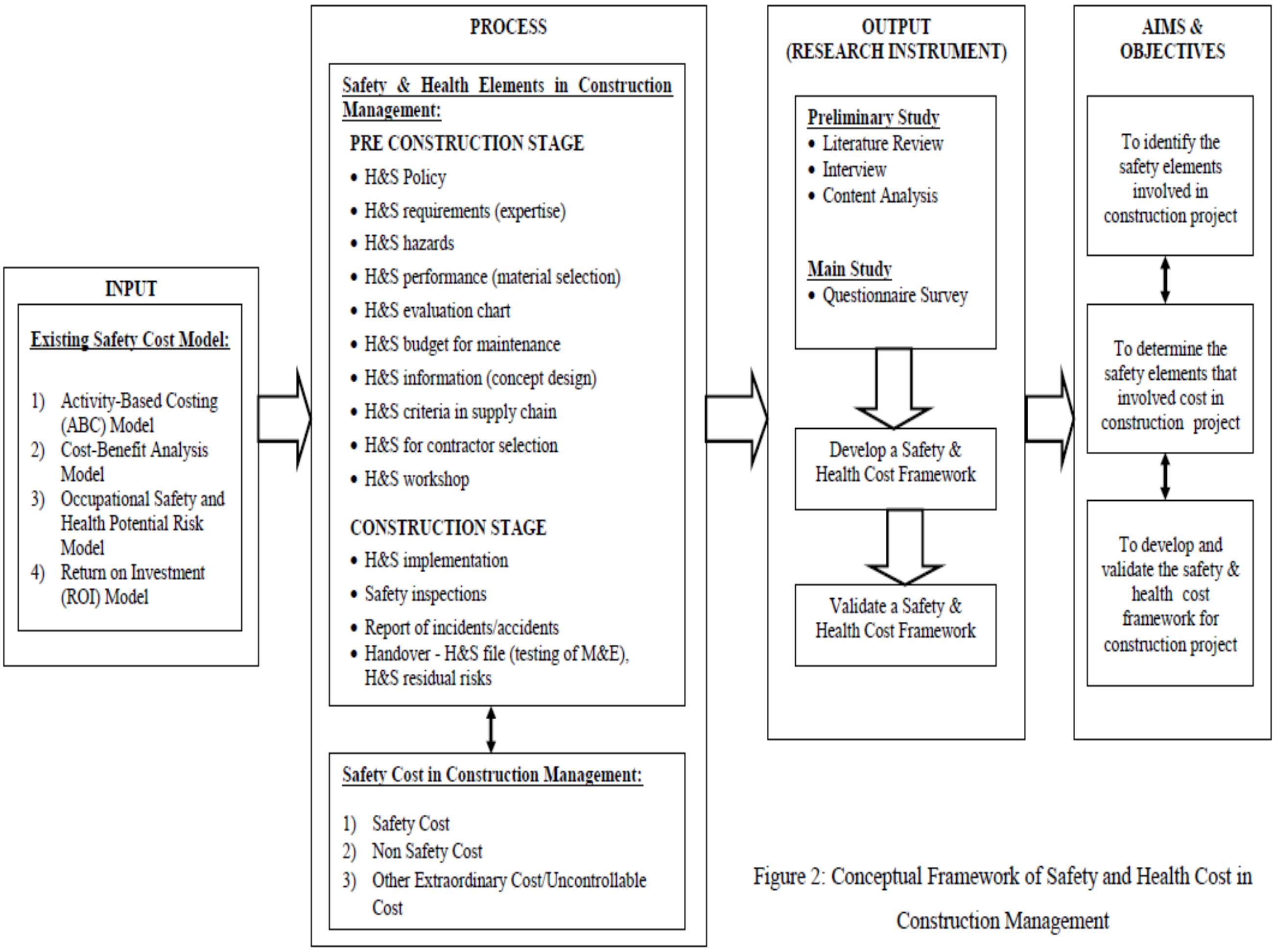

Figure 2: Conceptual Framework of Safety and Health Cost in Construction Management

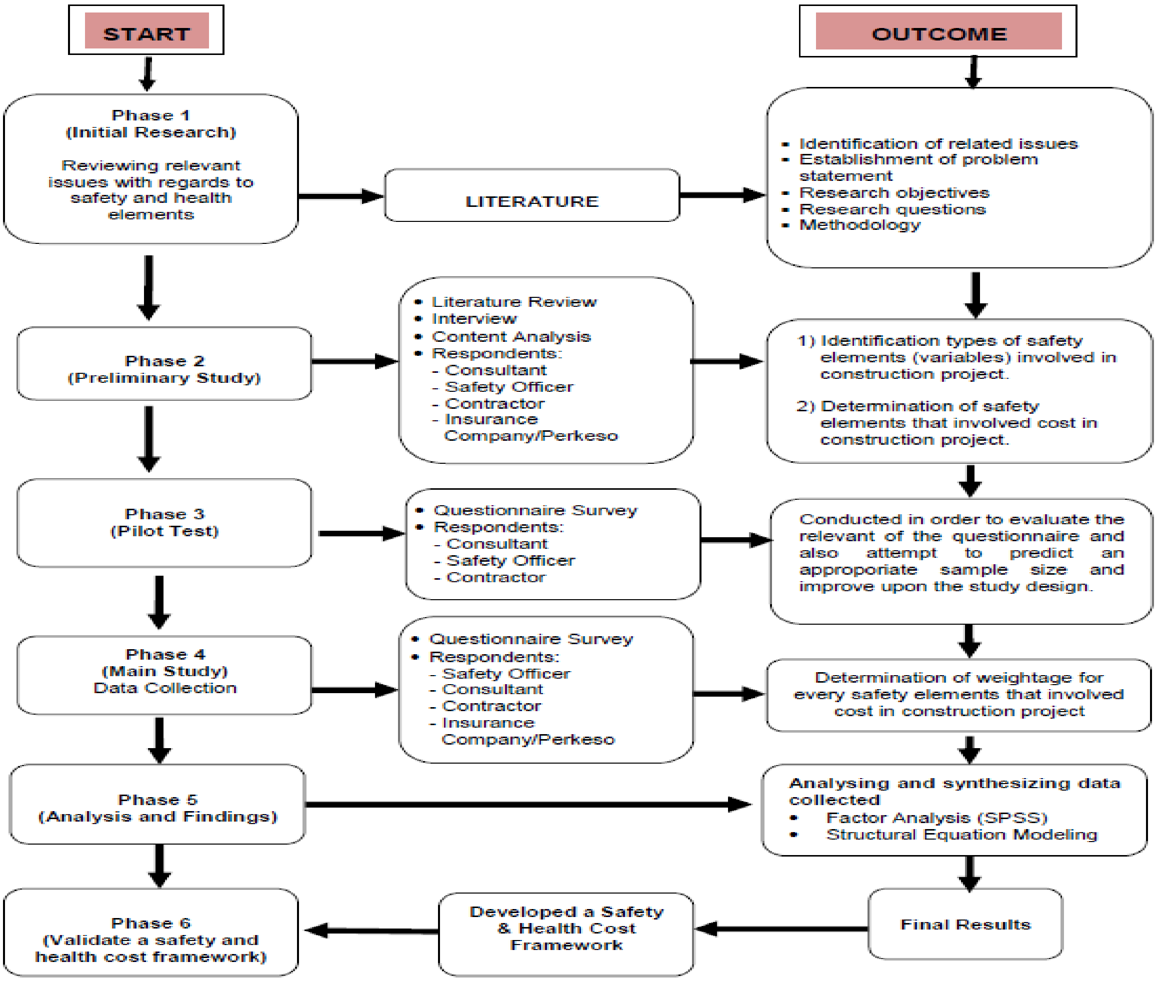

Figure 3. Research Design

8 Implications of Research

By providing opportunities for improvement of project implementation cost, the proposed safety and health cost framework can have a significant role to play in the building industry. It is hoped that this research would be able to contribute significantly in terms of the following:-

a) Helps to achieve OSH Master Plan Program (The National Council of Occupational Safety and Health) in estimating and reflecting the real costs of safety elements;
b) Obtains useful information for National Institute of Occupational Safety and Health (NIOSH) regarding on OSH R&D and training;
c) Helps clients to know the actual cost that the contractor will incur for the full compliance of safety and health in construction project.

9 Conclusion

The research presented in this paper is initially and part of an ongoing PhD research at the Faculty of Architecture, Planning and Surveying, UiTM. This research has elaborated on the safety and health elements which involved cost in construction project and provided a conceptual framework based on a comprehensive review of the existing literature. There is limited study appears to have been conducted to investigate on safety costs involved from pre-construction until to construction stage. The Iceberg Theory was explained the types of safety cost incurred in construction project. In the proposed conceptual framework, this theory will be related with the existence safety cost model in manufacturing and construction sector. Then, the new safety and health cost framework involved from pre-construction stage until to construction stage will be developed in line with the improvement of existing models. Perhaps, it can assist client to allow the compliance of safety aspects in a tender document.

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