A HYBRID MODEL FOR ASSESSING THE QUALITY PERFORMANCE OF DEMOLITION CONTRACTORS

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Dedicated to:

My Parent and my Wife, for their innumerable prayers and encouragement

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ABSTRACT

The demolition project is reasonably labour-intensive and the shortage of qualified demolition contractors resulted in poor workmanship in many demolition projects. The current performance assessment of demolition contractors in Malaysia is highly based on subjective evaluation while a few of authorities and clients incorporated contractor past performance within the quality assessment process. This is due to the lack of an assessment framework that can supports the evaluation process of demolition contractors. However, different contractor's quality assessment methods have been successfully developed, but, there has been limited effort to view complexity parameters in the process of evaluation. Hence, it made it necessary to identify an appropriate assessment criteria in order to evaluate the quality of demolition contractor's performance in a structured way along with considering the complexity of demolition project. This research first applied the Delphi method as a scientific means to collect the required information for developing of the assessment framework, which constitutes thirty performance indicators for demolition contractors. Then, an assessment method has been developed in the form of a hybrid Quality Function Deployment (QFD) and Cybernetic Analytic Network Process (CANP) model for demolition contractors. This involves the use of QFD to translate the customer's expectations into assessment indicators and the CANP to weight the expectations and assessment criteria. Three different case studies were used to demonstrate the implementation of the model and the results indicated that despite the extensive consideration on cost and time in the assessment of demolition contractors, the safety indicators were rated as the most significant Malaysian clients' expectations for quality assessment of demolition contractor. The results also show that, the project complexity indicators, comparatively received high priority in the quality assessment of demolition contractors among all other indicators. In conclusion, this research has demonstrated that the developed hybrid model is an effective tool for assessing the quality of demolition contractor's performance and it is hoped that the research work may provide a first step into a better customer-driven demolition project, and eventually increase the quality of demolition projects over time.

ABSTRAK

Projek perobohan adalah berintensifkan buruh dan kekurangan kontraktor perobohan yang berkelayakan menyebabkan mutu tenaga kerja menjadi rendah dalam kebanyakan projek perobohan. Penilaian prestasi terkini untuk kontraktor perobohan di Malaysia adalah berdasarkan penilaian subjektif manakala beberapa pihak berkuasa dan klien menggabungkan prestasi kontraktor pada masa lalu dalam melaksanakan proses penilaian kualiti. Amalan ini dilaksanakan kerana kekurangan rangka kerja penilaian yang boleh digunakan untuk menyokong proses penilaian kontraktor perobohan. Walau bagaimanapun, kaedah penilaian kualiti kontraktor yang berbeza telah berjaya dibangunkan, tetapi, terdapat usaha yang terhad untuk melihat kerumitan parameter dalam proses penilaian. Oleh itu, adalah perlu untuk mengenalpasti kriteria penilaian yang sesuai untuk menilai kualiti prestasi kontraktor perobohan dengan cara yang sistematik dengan mengambil kira kerumitan projek perobohan. Kajian ini menggunakan kaedah Delphi sebagai cara saintifik untuk mengumpul maklumat yang diperlukan untuk membangunkan rangka kerja penilaian, di mana ia terdiri daripada tiga puluh petunjuk prestasi bagi kontraktor perobohan. Kemudian, kaedah penilaian telah dibangunkan dalam bentuk hibrid Fungsi Kualiti Penempatan Hibrid (QFD) dan model Proses Jaringan Sibernatik Analitis (CANP) untuk kontraktor perobohan. Ini melibatkan penggunaan QFD untuk menterjemahkan jangkaan pelanggan ke dalam penilaian petunjuk dan CANP untuk mengukur jangkaan dan kriteria penilaian. Tiga kajian kes yang berbeza telah dilaksanakan untuk demonstrasi implementasi model dan keputusan menunjukkan bahawa, walaupun banyak pertimbangan ke atas kos dan masa dibuat dalam penilaian kontraktor perobohan, petunjuk keselamatan telah dinilai sebagai jangkaan pelanggan Malaysia yang paling penting bagi penilaian kualiti kontraktor perobohan. Hasil kajian juga menunjukkan bahawa, petunjuk kerumitan projek menerima keutamaan yang tinggi dalam penilaian kualiti kontraktor perobohan berbanding petunjuk yang lain. Kesimpulannya, kajian ini telah menunjukkan bahawa model hibrid yang dibangunkan merupakan alat yang berkesan untuk menilai kualiti prestasi kontraktor perobohan. Adalah diharapkan hasil kajian ini dapat menyediakan satu langkah permulaan dalam projek perobohan berasaskan kehendak pelangaan yang lebih baik dan akhirnya meningkatkan kualiti projek perobohan dari semasa ke semasa.

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LIST OF ABBREVIATIONS

AHP	-	Analytic Hierarchy Process
ANP	-	Analytic Network Process
ASEAN	-	The Association of Southeast Asian Nations
BS	-	British Standard
CANP	-	Cybernetic Analytic Network Process
CDN	-	Contractor disputes numbers
CFR	-	Cost of field rework
CIDB	-	Construction Industry Development Board
CIS	-	Construction Industry Standard
CQP	-	Contractor Quality Performance
CR	-	Customer's Requirements
CSC	-	Client satisfaction on cost
CSQ	-	Client satisfaction on quality
CST	-	Client satisfaction on time
EIA	-	Environmental Impact Assessment
EOT	-	Extension of Time
HOQ	-	House of Quality
HSE	-	Health and Safety Executive

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CHAPTER 1

INTRODUCTION

1.1   Overview

Demolition industry can be considered as one of the most hazardous operations with highly intricate tasks that can contributes in number of incidents and fatalities around the world including Malaysia. For example the collapsed of Jaya Supermarket during demolition works, which killed 7 workers on May 2009 (Yeng Ai Chun et al., 2009).

After this horrific incident Construction Industry Development Board (CIDB) was tasked to improve the quality of demolition works and try to mitigate its negative impact on the safety of workers, environment and community. Consequently particular attention has been focused on assessing and monitoring the demolition contractors' performance to achieve the desired level of quality (Fauzey and Ismail, 2010).

At the first step, The CIDB with collaboration of the Department of Standards Malaysia have developed the MS2318:2012 Malaysian Standards, Demolition of Buildings- Code of Practice to foster the demolition industry efficiency and development, improving of the health and safety of the public, protecting the

consumers, and facilitating job for all parties by giving detailed practical guidance on how to comply with demolition requirements and obligations under work health and safety laws. Then CIDB enforced all demolition contractors to register with the CIDB Act 1994, Category B26 (specialist demolition contractors), before undertaking or completing any demolition project. Any contractor who undertakes and complete any demolition work without registering as a registered contractor with the CIDB, commits an offence under the Act and if convicted may be fined up to fifty thousand ringgit.

This thesis constitutes an attempt at providing a method that can assess the quality of demolition contractor performance and assist the demolition contractors in meeting the client's requirements. The research first discusses on the concept of quality, client satisfaction, performance and their interrelationships in the context of the demolition industry. Second, the proposed methodology are explained in details and the steps that have been followed to build up the proposed model. Finally, the proposed hybrid model has been validated through the different case studies and the results were discussed along with recommendations for future studies. This thesis is yield from a PhD research which aimed at developing a hybrid model for assessing the effectiveness of demolition contractors' performance.

This introductory chapter began with the background of the research and then presents the research problem, defines the aim and objectives of the research, and provides the research's significance. The chapter accomplishes by outlining of the research organization which presents the individual chapters function to provide a general achievements of the thesis.

1.2   Background of Research

Demolition is risky and dynamic operation includes uncertainties and always changing. As well as, demolition contractors' failure is always possible, even for capable and well-established contractors, and happens when the contractor fails to fulfill the contractual obligations (Clarke, 2010).

In addition, there is a worldwide trend towards considering client's expectations with regard to the quality of proposed demolition work. Several studies have been conducted on the area of quality in the construction industry which includes monitoring the contractors' performance, however, there is still lacking of research on quality assessment of demolition work. Quality on project success can be defined as how well contractor can meet the client and end-user expectations (Kärnä, 2014) and this goal can only be achieved if an assessment tool is adopted to address quality of contractors with emphasis on performance improvement (Callistus et al., 2014).

For the last thirty years, manufacturing and other sectors applied Quality Function Deployment (QFD) to evaluate the product or services they were offering to their customer in addition, many researchers addressed its use in construction industry and particular used for contractor's performance assessment (Dikmen et al., 2005; Yasamis-Speroni et al., 2012; Yee, 2012). QFD is a structured planning method, which can assist the project team to clearly identify the customers' needs and systematically evaluates the contractor's capability in terms of its ability to fulfillment of defined customers' needs. On the other hand, QFD attempts to produce competitive quality service in projects, by prioritizing the customers' needs. QFD is a systematic methods that translate the customers' needs into measurable parameters, using a series of matrices (Jafari, 2013).

In contractors' performance assessment, the decision makers always need to perform the evaluation based on imprecise information (Nieto-Morote and Ruz-Vila, 2012). To overcome this problem, researchers have integrated Multi Criteria Decision Making (MCDM) with one custom methods in which it enables to qualify performance assessment based on vague data which is often expressed with

an unquantifiable dimension, imperfect, non-obtainable information and partially ignorant facts (Nieto-Morote and Ruz-Vila, 2012). The hybrid model, first used by Nguyen (1985) to develop a contractor evaluation model. His proposed model considers three different aspects of contractors include cost, contractor past experience and project owner's view (Nguyen, 1985; Nieto-Morote and Ruz-Vila, 2012).

A proposed hybrid MCDM-QFD model suggested by Juan and *et al.* (2009) in order to select the qualified contractor which includes the following process: (i) customer's needs identification (WHATs), (ii) contractors assessment qualifications (HOWs), (iii) calculate WHATs' and HOWs' weight and importance, (iv) structuring a relation matrix between WHATs and HOWs obtained, (v) evaluating and ranking of the contractors: (vi) Assess tender characteristics obtained from each contractor's service or specifications; (vii) Rank potential contractors according to their performance (Juan et al., 2009). They discussed that some extensions and improvements need to be accomplished from his proposed approach. The approach can be extended to explore various MCDM issues such as selection among alternatives or project assessment, if the variables or criteria can be modified with flexibility to conform to the practical needs. Another challenge that Juan and *et al.* (2009) concerned about was the large number of questionnaire samples for determining WHATs, HOWs and their computing results. How to ensure the completeness of judgment information, such as explicit service or tangible specifications offered by customer, to rationalize the approach were another issue that they discussed need to be studied more.

Afterward, many researchers extended hybrid MCDM-QFD into their studies particularly for the quality assessment in construction industry (Chua and Li, 2000; Luu et al., 2008; Jaskowski et al., 2010). There has been however extensive researches on evaluating of contractor's level of quality but the quality assessment of contractors on site, still is a challenge, mainly due to the difference in evaluation techniques and difficulty in finding proper measurement technique (Corona-Suárez et al., 2014). Particularly in demolition projects which there has been no research published about the quality of demolition contractors' assessment. This research presents a basis for evaluating demolition contractor's quality assessment which mainly focuses on the performance of demolition contractors.

The entire research works are divided into four key parts, namely, the development of quality framework, the further use of QFD in quality assessment, the incorporation of Cybernetic Analytic Network Process (CANP)-based priorities in QFD, and decision making analysis.

1.3   Problem Statement

Demolition industry is a reasonably labour-intensive industry and the shortage of skilled demolition contractors resulted in poor workmanship in many demolition projects (Wong et al., 2010). Evaluating the quality of demolition contractor is an important matter faced by local authorities or clients who wish to achieve successful demolition project results. In order to improve the quality of demolition work, the CIDB in Malaysia is required to develop a quality development strategy towards current demolition standard for the demolition industry (Rakhshanifar, 2013). As respects, the CIDB recently issued the demolition standard, particular attention has been focused on assessing and monitoring the demolition contractors' performance to achieve the desired level of quality. The current performance assessment of demolition contractors in Malaysia is highly based on subjective criteria while a few of authorities and clients incorporated contractor past performance within the quality assessment process. This mainly because of the lack of data that can supports the evaluation process, therefore, the technical assessment given to the demolition contractor is only based on the experience (Rizman, 2010). It is necessary for local authorities or clients to adopt a rational assessment system which refer how to handle uncertainties in the data, and how to aggregate the data to obtain reliable outcomes for demolition contractor quality assessment.

The level of quality expected by the client is represented by quality measures such as percent within difficulties and limitations. Most researches on project quality assessment, have not addressed the complexity of project in the process of evaluation. There has been a limited effort to view complexity parameter in its broader dimensions. Previous contractor's assessment model established inadequate

and subjective methods that a significant problem was a lack of understanding regarding complexity, risk and uncertainty associated with construction project. A number of recommendations for further research were made as a result of the work, to further evolve the system that capable to apply complexity factors that affect the contractors' evaluation.

Different quality measurement methods were developed to improve the quality of contractors' work, however they have been subjected to a number of criticisms. Most of the MCDM methods such as Fuzzy-AHP techniques, relying on the absolute measurement and they require an agreed upon measure with which to compare elements. Additionally, they are based on paired comparisons among the set of criteria with respect to a common attribute or element which leads to an intensive work, time and effort that can be inconvenient for practical purposes (Saaty, 1986; Raharjo et al., 2008). Other non MCDM methods mostly focuses on the process of service or product (project) delivery, neither the outcomes of the product (project) and nor on customer needs (Nieto-Morote and Ruz-Vila, 2012).

Therefore, based on the mentioned problems, this research introduced a hybrid model which evaluates the quality of demolition contractors based on their performance. Figure 1.1 illustrates the existing gaps in current quality assessment researches and the needs to conduct this research in current demolition projects.
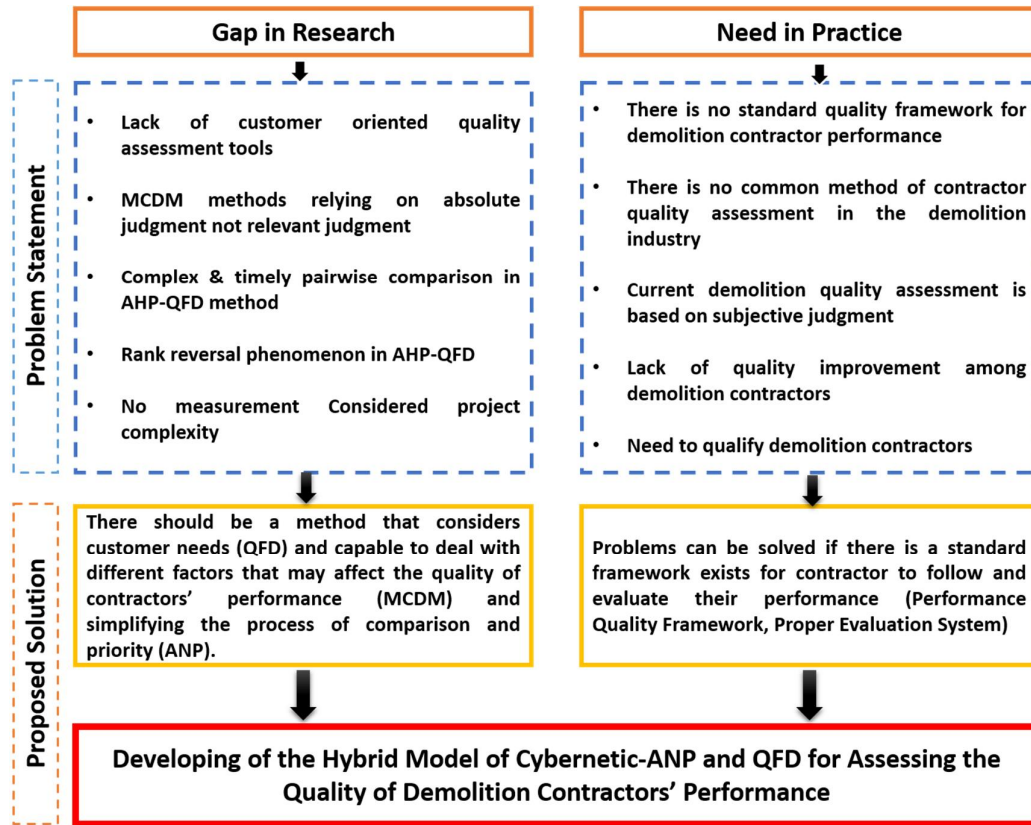
Figure 1.1: Problem statement

1.4 Research Questions

Reflecting upon the problem statement described in Section 1.3, the following main research question was formulated:

Main research question: *How to assess the quality of demolition project based upon the performance of demolition contractor?*

The main research question was extended into five more specific sub-questions which includes:

Sub-question 1: *What are the main client's requirements in a demolition project?*

Sub-question 2: *Is there any quality framework for demolition projects, based upon the contractor's performance in demolition industry?*

Sub-question 3: *How the QFD approach can assists in achieving the desired level of quality in demolition projects by considering to the customer needs and requirements.*

Sub-question 4: *In what ways does Cybernetic-ANP, contribute to an improved QFD analysis?*

Sub-question 5*: How the hybrid Cybernetic-ANP and QFD model works in real demolition project?*

Table 1.1 shows the proposed methodology to answer each research question.

Table 1.1: Research questions and methodologies

Research Questions	Research Methodology	Chapter Number
✓ *Is there any quality framework for demolition projects, based upon the contractor's performance in demolition industry?*	• Literature Review • Delphi Methods • ISM	2,3
✓ *How the QFD approach can assists in achieving the desired level of quality in demolition projects by considering to the customer need.*	• Delphi Methods • QFD Method	2,3
✓ *In what ways does Cybernetic-ANP, contribute to an improved QFD analysis?*	• Cybernetic ANP-QFD	4
✓ *How the hybrid Cybernetic-ANP and QFD model works in actual demolition project?*	• Case Studies	5

1.5   Aim and Objectives

The research aims to develop a method that improve the demolition contractors' quality and the levels of customer satisfaction derived from it by focusing on the quality performance of the demolition contractor. The research attempted to fill the gaps in the current quality assessment techniques through achieving the following objectives:

i.   To develop the customer requirements framework that capable to measure the demolition contractors' performance quality;

ii.   To adopt the QFD method, for translating client's needs into performance-based criteria and for evaluating the quality of contractor's performance;

iii. To develop a hybrid Cybernetic ANP and QFD model for assessing the quality of demolition contractor's performance; and

iv.   To evaluate the hybrid model by real demolition projects in Malaysia.

1.6   Research Scope

The objective of this study is to develop a model that can help all operatives in demolition business, including developers, contractors, demolition consultant and local authorities, to evaluate the quality performance of demolition contractors. The model considered factors related to the demolition stage of a structure life-cycle and effective factors on the assessment from the construction stage are disregarded.

Since the criteria of the proposed model are generated from the progressive demolition type, therefore, the proposed model is not applicable to other types of demolition such as explosion and deliberate collapse mechanisms. The database

generated and used in this research is based on data collected from existing demolition projects in Malaysia and criteria are developed based on the Malaysian customer expectations.

For the purpose of this research, the scope of study shall cover five main areas, which are shown in Figure 1.3.
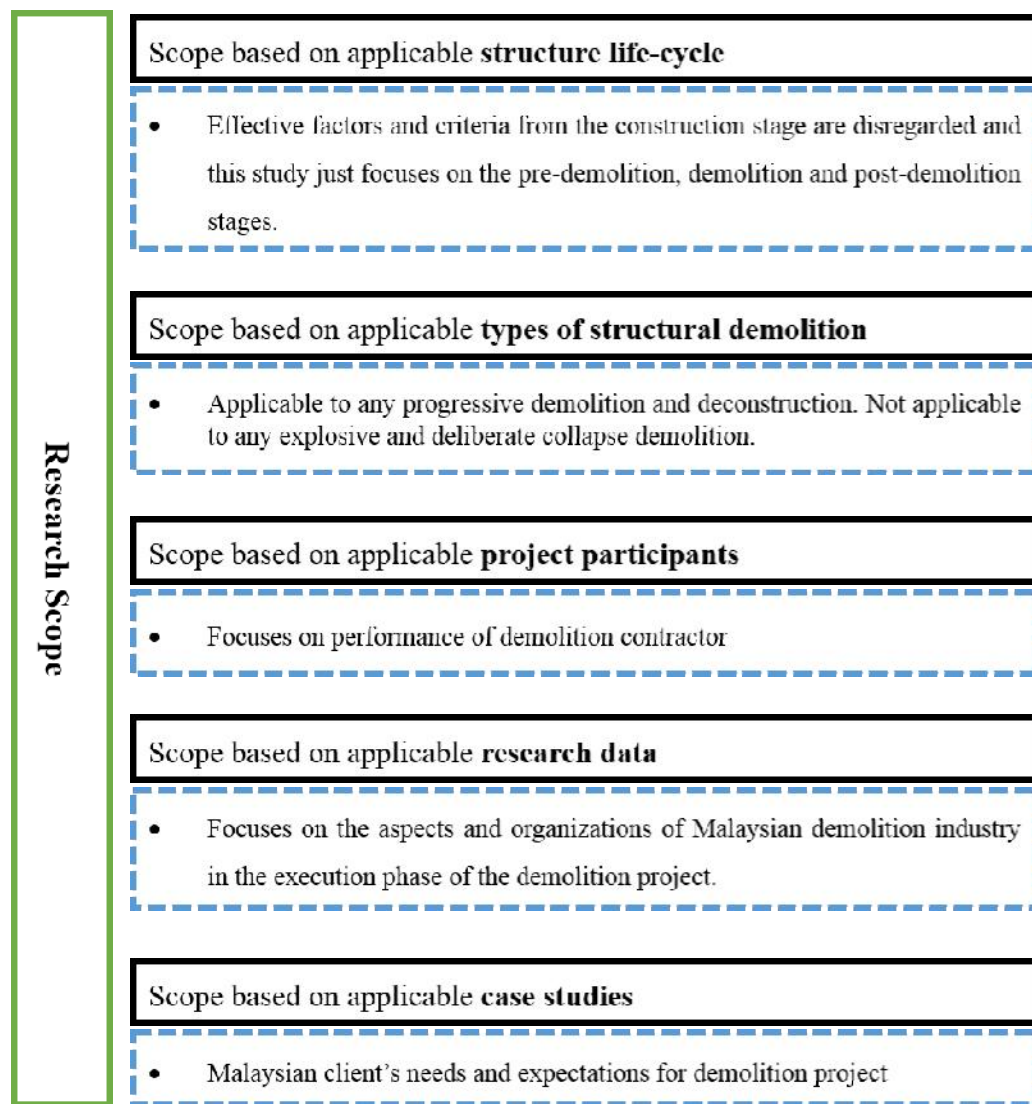
Figure 1.2: Research scope

1.7   Research Significance

The proposed research will bring a variety of benefits to the demolition industry, due to the current lack of knowledge and methodologies for implementing quality assessment of demolition work. This research has significant contribution in the following aspects in both academic and industry:

Currently there is lacking of a framework in demolition industry to evaluate the quality of demolition work in accordance to demolition contractors' performance. This research developed a framework which constitutes the critical criteria for the quality assessment of demolition contractors. The proposed framework assists decision-makers responsible for assessing the quality of work in particular demolition project and select the most qualified demolition contractor for future project.

Furthermore, the hybrid QFD model applied to this research can enhance the contractors' attention to the client needs and contributes to increase in customer satisfaction and shorten project planning time. Due to the vagueness and uncertainty of importance attributed to judgment of customer requirements, the crisp comparison in the conventional QFD seems to be insufficient and imprecise to capture the degree of importance of customer requirements. Therefore the conventional QFD had been integrated with ANP to acquire the optimal decision-making and improve the imprecise ranking of customer requirements. Since in the most demolition projects, there is a set of criteria based on the project difficulties and contractor's performance which may affect the project quality, therefore the problem of complexity in decision making also had been solved by applying the multi-criteria decision making method (ANP) to the process of contractor quality assessment.

The proposed approach in this research reduces the complexity of the fuzzy analytical methods such as AHP in terms of pairwise comparisons by applying the Cybernetic ANP analysis which the comparison process stands on pair-wiser comparison instead of pairwise comparison. Moreover, the Cybernetic ANP approach has the flexibility to combine quantitative and qualitative factors, in order

to cover wide range of opinions expressed by experts for the quality assessment of demolition project.

In summary, this research is seeking to propose a network model, by employing a systematic and effective approach for eliciting the team's judgments, which provides more accurate information of the inner-relationship or interrelationship among the factors that may be crucial to the QFD team's success. This research would help decision-makers to weaken the complexity of quality assessment and strengthen capacity to enhance quality of demolition work.

1.8   Thesis Outline

This thesis is divided into 6 chapters and a brief summary of each chapter's contents is described below:

Chapter 1, sets out the introduction, the research objectives, problem background, research questions, significance of research and research outline.

Chapter 2, gives the overall review of demolition industry including definition, demolition planning, demolition process, and problems that are involved in demolition industry. It also discusses on the issue of quality in demolition industry. Furthermore, this chapter explained the concept of QFD methodology and the MCDM integration with QFD method.

Chapter 3, describes the methodology used to develop the proposed hybrid model and approaches to research problems. Consequently, each step of the proposed methodology is explained.

Chapter 4, describes the development of the hybrid model and presents the functional structure of the model. It then discusses on the process of hybrid model and demonstrates the operation of the model in details.

Chapter 5, presents the case studies which had been selected to observe the practical application of the methodology. The development of these cases consist of a series of interviews and questionnaires with relevant demolition experts. The results are presented in section 5.4 of this thesis, providing a data analysis and report.

Chapter 6, summarizes the thesis work by providing the conclusions regarding the findings and problems of this research and accordingly the recommendations for further research in this area.

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