

A STRUCTURED CRITICAL SUCCESS FACTORS MODEL FOR
IMPLEMENTING PROJECT QUALITY MANAGEMENT SYSTEM IN
CONSTRUCTION

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CONSTRUCTION

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*Specially dedicated to my father, family, wife and children and the person that I
love most, my late mother. You all are always in my heart*

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ABSTRACT

In the ISO 9000-based project quality management system (PQMS), the parties involved implement the system according to the requirements stated in the individual quality plan. This approach creates a lot of problems such as lack of commitment and teamwork; contradiction of requirements between the parties' quality systems, contract and project management; and generation of unnecessary voluminous and duplicate paperwork. These problems are augmented by the lack of knowledge and skills of the construction players in managing the PQMS. One of the solutions is the implementation of Critical Success Factors (CSF) that prompted this research with the formulation of three related objectives which are: 1) to identify the PQMS's CSF; 2) to evaluate the criticality and ranks of the PQMS's CSF; and 3) to develop the relationship model for the PQMS's CSF. To achieve the objectives, three research methodologies were employed that involved literature review, expert's opinions and questionnaire survey. Six PQMS's CSF were identified as constructs of the study with each CSF comprising three indicators. The six PQMS's CSF were client's commitment, integration of quality plan, education and training, measurement and improvement, teamwork and communication, and the use of the information, communication and technology (ICT). Having confirmed the constructs through the analysis of the questionnaire survey data, experts' opinions were sought to develop the relationship among the PQMS's CSF using Interpretive Structural Modelling (ISM). The ISM-based model was then evaluated using Structural Equation Modelling (SEM). The final model is a four-factor model with eleven indicators. It is a structured CSF model for the PQMS implementation where the client's commitment, and the education and training in quality are the drivers; followed by the integration of quality plan; and finally the measurement and improvement.

ABSTRAK

Di dalam Sistem Pengurusan Kualiti Projek (SPKP) yang berasaskan ISO 9000, pihak-pihak yang terlibat melaksanakan sistem tersebut berdasarkan kehendak-kehendak yang ditetapkan di dalam pelan kualiti persendirian. Pendekatan ini menimbulkan banyak masalah seperti kurangnya komitmen yang bersepadu dan kerja berpasukan; percanggahan kehendak-kehendak di antara sistem kualiti, kontrak dan pengurusan projek; dan penghasilan kertaskerja yang banyak dan bertindih dan tidak diperlukan. Masalah-masalah ini menjadi lebih besar disebabkan oleh kekurangan ilmu dan kemahiran di dalam melaksanakan SPKP. Satu cara penyelesaian ialah dengan melaksanakan faktor kejayaan kritikal (FKK) yang telah mencetuskan kajian ini dengan pembentukan tiga objektif yang berkaitan iaitu: 1) mengenalpasti FKK SPKP; 2) menilai tahap kritikal dan kedudukan FKK SPKP; dan 3) membangunkan model hubungan bagi FKK SPKP. Untuk mencapai objektif tersebut, tiga metodologi kajian telah digunakan yang melibatkan kajian literatur, pendapat pakar dan kajian soalselidik. Enam FKK SPKP telah dikenalpasti sebagai konstruk dengan setiap FKK mempunyai tiga indikator. Enam FKK SPKP tersebut ialah komitmen klien; pelajaran dan latihan; pengukuran dan penambahbaikan; integrasi plan kualiti; penggunaan ICT; dan kerja berpasukan dan komunikasi. Setelah konstruk disahkan, pandangan pakar diambil untuk membentuk perhubungan sesama FKK SPKP dengan menggunakan kaedah "*Interpretive Structural Modelling*" (ISM). Model berasaskan ISM tersebut kemudiannya diuji dengan kaedah "*Structural Equation Modelling*" (SEM). Model yang terhasil adalah sebuah model empat-faktor dengan sebelas indikator. Ianya adalah sebuah model FKK berstruktur untuk pelaksanaan SPKP di mana komitmen klien, dan pelajaran dan latihan adalah pemandu; diikuti oleh integrasi plan kualiti; dan akhirnya pengukuran dan penambahbaikan.

TABLE OF CONTENT

CHAPTER	TITLE	PAGE
	TITLE PAGE	i
	DECLARATION	ii
	DEDICATION	iii
	ACKNOWLEDGEMENT	iv
	ABSTRACT	v
	ABSTRAK	vi
	TABLE OF CONTENT	vii
	LIST OF TABLES	xii
	LIST OF FIGURES	xv
	LIST OF ABBREVIATIONS	xvii
	LIST OF APPENDICES	xix
1	INTRODUCTION	1
	1.1 Background of the Research	1
	1.2 Problem Statement	4
	1.3 Objective of the Research	8
	1.4 Scope of the Research	9
	1.5 Research Methodology	9
	1.5.1 Literature Review	10
	1.5.2 Experts' Opinions	10
	1.5.3 Questionnaire Survey	11
	1.6 Significance of the Research	13

1.7	Organisation of the Thesis	13
2	CRITICAL SUCCESS FACTORS FOR ISO 9000-BASED PROJECT QUALITY MANAGEMENT SYSTEM	15
2.1	Introduction	15
2.2	Definition of Quality, QMS and PQMS	16
2.3	ISO 9001 Quality Management System	17
2.3.1	ISO 9001 Principles	18
2.3.2	Project Quality Plan (PQP)	21
2.4	ISO 9000-based Project Quality Management System (PQMS)	24
2.5	Previous Research Related to PQMS	24
2.6	CSF and Its Identification Methods	33
2.7	The CSF for PQMS	35
2.7.1	Client's Commitment to Quality	61
2.7.2	Integration of Quality Plan with Other Requirements	64
2.7.3	Performance Measurement and Improvement	67
2.7.4	Education and Training in Quality Management	69
2.7.5	Teamwork and Communication	71
2.7.6	Use of Information and Communication Technology (ICT) in Managing Information	73
2.8	Constructs of PQMS's CSF and Its Indicators	74
2.9	Summary	78
3	RESEARCH METHODOLOGY	79
3.1	Introduction	79
3.2	Research Methodology	79
3.3	Literature Review	86

3.4	Experts' Opinions and Formation of ISM-based Model	87
3.4.1	Structural Self-Interaction Matrix (SSIM)	88
3.4.2	Initial Reachability Matrix	91
3.4.3	Final Reachability Matrix	93
3.4.4	Classification of Factors	94
3.4.5	Level Partitions	95
3.4.6	Formation of ISM-based Model	98
3.5	Questionnaire Survey	100
3.5.1	Data Collection Procedure	101
3.5.1.1	Sample Size and Respondent	101
3.5.1.2	Questionnaire Design	102
3.5.1.3	Questionnaire Distribution and Collection	106
3.5.2	Analysis of Data	107
3.5.2.1	Analysis Using SPSS	107
3.5.2.2	The Structural Equation Modelling (SEM) Procedures	108
3.6	Summary	117
4	DATA COLLECTION AND ANALYSIS	119
4.1	Introduction	119
4.2	Response Rate	119
4.3	Respondent's Demographic Profile	120
4.4	Internal Consistency of the PQMS's CSF	122
4.5	Agreement Level of the PQMS's CSF	122
4.6	Usage Level of the PQMS's CSF	124
4.7	Differences Between Group's Opinions on the Agreement of the PQMS's CSF	125
4.8	Ranking of PQMS's CSF According to the	126

	Construction Parties	
4.9	Ranking of PQMS's CSF According to the Working Level	128
4.10	Experts' Opinions and ISM-based Structural Model	129
	4.10.1 Structural Self-Interaction Matrix (SSIM)	131
	4.10.2 Initial Reachability Matrix	135
	4.10.3 Final Reachability Matrix	136
	4.10.4 Classification of Factors	137
	4.10.5 Level Partitions	138
	4.10.6 Formation of ISM-based Model	140
4.11	SEM-based Structural Model	142
	4.11.1 Schematic Diagram and the Proposed SEM PQMS's CSF Model	142
	4.11.2 CFA for Model A	144
	4.11.3 Analysis of Structural Model	155
4.12	Summary	159
5	RESULTS AND DISCUSSION	160
5.1	Introduction	160
5.2	CSF for PQMS Implementation	161
5.3	Criticality and Ranking of the PQMS's CSF	164
5.4	Structural Relationship Model of the PQMS's CSF	167
5.5	Summary	170
6	CONCLUSIONS AND RECOMMENDATIONS	171
6.1	Introduction	171
6.2	Main Conclusions	171
6.3	Implications and Significant Contribution of the Research	174
6.4	Thesis Limitation	176
6.5	Direction for Further Research	178

REFERENCES

179

Appendices A – F

193-270

LIST OF TABLES

TABLE NO.	TITLE	PAGE
2.1	Previous studies related to the CSF for PQMS	35
2.2	CSF for PQMS implementation	59
2.3	CSF and indicators for PQMS implementation	74
3.1	Types of research questions and their appropriate strategy	80
3.2	The blank SSIM for PQMS's CSF	89
3.3	The comparison form for experts' SSIM	90
3.4	Example of the comparison exercise between the experts' SSIM on the PQMS's CSF of measurement and improvement	91
3.5	Example of the consensus SSIM for CSF of TQM implementation in SME industry	91
3.6	Example of initial reachability matrix for CSF of TQM implementation in SME industry	92
3.7	Example of final reachability matrix for CSF of TQM implementation in SME industry	93
3.8	Iteration 1	96
3.9	Iteration 2	97
3.10	Iteration 3	97
3.11	Iteration 4	97
3.12	Iteration 5	97
3.13	Iteration 6	98
3.14	Iteration 7	98

3.15	The PQMS's CSF constructs, indicator variables and question statement	103
3.16	Characteristics of fit indices demonstrating goodness-of-fit	116
4.1	Response rate according to construction parties	120
4.2	Response rate according to working levels	120
4.3	Respondent experience in construction and QMS	121
4.4	Reliability statistics for PQMS's CSF	122
4.5	Frequencies of agreement level of the PQMS's CSF	123
4.6	Frequencies of usage level of the PQMS's CSF	124
4.7	Index of the PQMS's CSF according to the construction parties	126
4.8	Ranking of the PQMS's CSF according to the construction parties	127
4.9	Index of the PQMS's CSF according to parties working level	128
4.10	Ranking of the PQMS CSF according to parties working level	129
4.11	Brief profile the expert in QMS	130
4.12	Complete SSIM from expert A	131
4.13	Complete SSIM from expert B	131
4.14	Complete SSIM from expert C	132
4.15	Complete SSIM from expert D	132
4.16	Complete SSIM from expert E	132
4.17	Comparison of the expert's opinion on the client's commitment	133
4.18	Comparison of the expert's opinion on the integration of quality plan	133
4.19	Comparison of the expert's opinion on the measurement and improvement	133
4.20	Comparison of the expert's opinion on the education and training	134

4.21	Comparison of the expert's opinion on the teamwork and communication	134
4.22	The final SSIM for PQMS's CSF	134
4.23	The initial reachability matrix for PQMS's CSF	136
4.24	The final reachability matrix for PQMS's CSF	136
4.25	Iteration 1	139
4.26	Iteration 2	139
4.27	Iteration 3	140
4.28	Iteration 4	140
4.29	Iteration 5	140
4.30	The CFA results summary of Cronbach's Alpha (CA), Composite Reliability (CR) and Average Variance Extracted (AVE) for PQMS's CSF Model A	150
4.31	The CFA results summary of Discriminant Validity for PQMS's CSF Model A	151
4.32	The CFA results summary of Cronbach's Alpha (CA), Composite Reliability (CR) and Average Variance Extracted (AVE) for PQMS's CSF Model A-1	154
4.33	The CFA results summary of Discriminant Validity for PQMS's CSF Model A-1	155
4.34	The text output for Model B	157
5.1	Comparison between the three sources in ranking the PQMS's CSF	164

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE
1.1	Flowchart of the research methodology	12
2.1	The quality spectrum	17
2.2	ISO 9001 process model	18
2.3	Organisation quality system and plan	22
2.4	The integrated project quality plan (PQP)	23
3.1	The general graphic presentation of IDEF0 modelling tools	82
3.2	A general structural equation model demarcated into measurement and structural components	85
3.3	Example of completed driving power and dependence diagram for CSF of TQM implementation in SME industry	94
3.4	Interpretive Structural Modelling-based Model of CSF for TQM implementation in SME	99
3.5	Six stages process of SEM	115
4.1	Driving power and dependence diagram for the PQMS CSF	137
4.2	ISM-based model for PQMS's CSF	141
4.3	The Schematic diagram for the proposed PQMS's CSF model	143
4.4	The proposed PQMS's CSF model (Model A)	143
4.5	The proposed PQMS's CSF Model A fit indices	144
4.6	CFA – PQMS's CSF Model A (The measurement model combining all constructs simultaneously)	146
4.7	CFA - PQMS CSF Model A (The factor loadings for all	147

	items of the respective constructs)	
4.8	CFA - PQMS CSF Model A (The measurement model after deletion of items below 0.5 factor loading)	148
4.9	CFA – PQMS’s CSF Model A-1 (The measurement model after deletion of items not achieving the acceptable validity and reliability values)	153
4.10	The PQMS’s CSF Model B (Final Model)	156t
6.1	A structured CSF for implementing PQMS in construction	172

LIST OF ABBREVIATIONS

AMOS	-	Analysis of Moment Structure
BPM	-	Business Process Management
BPR	-	Business Process Re-engineering
BSC	-	Balance Score Card
C&D	-	Construction & Demolition
CEO	-	Chief Executive Officer
CFA	-	Confirmatory Factor Analysis
CFEI	-	Critical Factors for Effective Implementation
CFI	-	Comparative Fit Index
CI	-	Continuous Improvement
CIDBM	-	Construction Industry Development Board Malaysia
CIQ	-	Custom, Immigration & Quarantine Complex
CPM	-	Construction Process Management
CPR	-	Construction Process Re-engineering
CQMS	-	Company Quality Management System
CR	-	Critical Ratio
CSF	-	Critical Success Factors
CSP	-	Critical Success Processes
D&B	-	Design & Build
DIY	-	Do-It-Yourself
ERP	-	Enterprise Resources Planning
GFI	-	Goodness of Fit Indices
HACCP	-	Hazard Assessment and Critical Control Points

IC	-	Intellectual Capital
ICT	-	Information and Communication Technology
IPQMS	-	Integrated Project Quality Management System
ISM	-	Interpretive Structural Modeling
ISO	-	International Organization For Standards
KM	-	Knowledge Management
KPI	-	Key Performance Indicator
MHBP	-	Mass Housing Building Projects
MICMAC	-	Matrice d'Impacts Croisés Multiplication Appliquée à un Classement
PCA	-	Principal Component Analysis
PQP	-	Project Quality Plan
PSI	-	Project Success Index
PQMS	-	Project Quality Management System
QA	-	Quality Assurance
QC	-	Quality Control
QCC	-	Quality Control Circle
QLASSIC	-	Quality Assessment System In Construction
QMS	-	Quality Management System
R&D	-	Research & Development
RMSEA	-	Root Mean Square Error of Approximation
SEM	-	Structural Equation Modelling
SME	-	Small and Medium Enterprise
SPSS	-	Statistical Package for Social Science
SQM	-	Strategic Quality Management
SSIM	-	Structural Self-Interaction Matrix
TLI	-	Tucker-Lewis Index
TQM	-	Total Quality Management

LIST OF APPENDICES

APPENDIX	TITLE	PAGE
A	Expert Opinions on the Relationship between the Critical Success Factors (CCSF) For the ISO 9000-Based Project Quality Management System (PQMS) Implementation	193
B	Questionnaire for Critical Success Factors for ISO 9000-Based Project Quality Management System (PQMS) Implementation	197
C1	Raw Data of Online Survey - Agreement on PQMS's CSF	206
C2	Raw Data of Online Survey - Usage of PQMS's CSF	215
D1	Calculation of Index for Construction Parties	224
D2	Calculation of Index for Working Level	228
E	Interpretive Structural Modelling Procedure	232
F	Structural Equation Modelling Procedure	238

CHAPTER 1

INTRODUCTION

1.1 Background of the Research

Construction projects often undergo project delays, cost overruns and non-conformance to quality, leading to poor performance and dissatisfied parties and high operation and maintenance costs resulting from low performance of building systems (Butler, 2002; Senaratne & Sexton, 2009). By citing the findings from other researchers, Sullivan (2010) presented a concrete case that quality level of the construction industry is still poor. In response to these problems, several quality programs have emerged. One of these quality programs is Quality Management System (QMS) such as ISO 9001:2008 and Total Quality Management (TQM). QMS is defined as “all activities of the overall management function that determine the quality policy, objectives and responsibilities, and implement them by means such as quality planning, quality control, quality assurance and quality improvement within the quality system” (SIRIM, 1994).

ISO 9000 is one of the QMS subscribes by many companies and it has become a phenomena in various industries including construction. According to ISO statistic, at the end of year 2005, 776,608 companies from 161 countries are certified with ISO 9000 (Lin & Jang, 2008). Evidence has shown that by adopting ISO 9000 QMS in the construction industry, communication had been improved, mistakes rework and wastage had been minimized and better control of sub-contractors and suppliers became eminent, thus causing an increase in productivity, profit and

market share and meeting the client requirements (Bubshait & Al Atiq, 1999; Djebarni & Eltigani, 1996; Douglas, Coleman, & Oddy, 2003; Motwani, Kumar, & Cheng, 1996; Pheng & Hwa, 1994; Wennerstrom, 2004).

The Circular Bil. 2/2006 issued by Construction Industry Development Board of Malaysia (CIDBM) apparently put a mandatory requirement for the Grade 7 Contractors to obtain the ISO 9001 certification before 1st January, 2009. Failure to observe the regulation will cause relegation of contractors or termination of their registration. CIDBM also had taken a positive step by introducing the Do-It-Yourself (DIY) scheme since 2000 to all contractors in order to facilitate them to be certified with the ISO 9001. The scheme helps the contractors to obtain ISO 9001 certification at an affordable cost and time because unlike the normal consultation, only one quality consultant is required to facilitate a pool of 5 to 10 contractors. Since then the number of certified contractors under the ISO 9001 has grown tremendously. In 2006, when CIDBM imposed the possession of ISO 9001 certification requirement to G7 contractors, 375 contractors were certified with ISO 9001 (CIDB, 2007). Between 2008 and 2009, another 180 contractors were certified (CIDB, 2009). The same situation was observed during the implementation of QMS by ISO 9001 certified consulting firm. The professional bodies such as Institute of Engineers Malaysia, Institutes of Surveyors Malaysia and Persatuan Akitek Malaysia are promoting the consultant firms to be certified with ISO 9001. The situation was further stimulated when Jabatan Kerja Raya, the public works department of Malaysia, the biggest client's representative office, had obtained the ISO 9001 certification. The ripple effect was definitely natural and obvious since the consultants and the contractors too had to follow suit, otherwise their chance to become the JKR's consultants and contractors were then jeopardised. This situation has been a trend in other countries that pioneered the ISO 9001 implementation such as in Hong Kong (Tang & Kam, 1999) and the UK (Giles, 1997; McAdam & Canning, 2001).

According to Barrett (2000) there should be two QMS implementation levels in the construction industry i.e. company-based quality management system (CQMS) and project-based quality management system (PQMS). Notwithstanding the claims that the individual construction company, who enjoyed the benefits and

advantages of being an ISO 9000 certified as highlighted previously, the main objective of QMS implementation, namely the achievement of customer satisfaction in the construction projects however is still at large. The previous researches showed that the construction team faced difficulties to transfer them to the project level. An interesting study on the effect of quality system certification and its impact at project level had been done by Barrett and Grover (1998) in which they concluded that for those companies that have achieved certification, the actual impact on the quality of the service from the client's viewpoint has been only slightly positive. Ng (2005) also reported the dissatisfaction of client on their expected quality level contributed by the engineering consultants in ISO 9000-based construction project. Research by Abdullah (2005) confirmed the similar situation faced by the local construction team in implementing quality system in a large scale construction project. As pointed by Tam, Deng, Zeng, and Ho (2000b) "with all the quality programmes, quality appears far better on paper than it does on site".

There are many problems related to the PQMS implementation cited in the literature. The main problems are the disintegration of individual parties' quality plan (Barrett, 2000; Sjøholt, 1995); lack of commitment (Bubshait, 1994; Carl & Yadira, 1990; Chan & Tam, 2000; Haupt & Whiteman, 2004; Pheng & Hwa, 1994); lack of teamwork and communication (Barrett, 2000; Pheng & Hwa, 1994; Zheng, Li, Mo, & Yun, 2004); incapability due to inexperience and/or lack of quality skills (Abdullah, 2005; Au & Yu, 1999; Haupt & Whiteman, 2004; Pheng & Hwa, 1994); lack of training (Mohammed & Abdullah, 2006; Pheng & Hwa, 1994); contradict requirements between the individual quality plan, project management and contractual requirement (Barrett, 2000; Netto, Low, & Lo, 1997; Orwig & Brennan, 2000); lack of quality culture (Chan & Tam, 2000; Pheng & Hwa, 1994); generation of voluminous paperwork (Bubshait & Al Atiq, 1999; Haupt & Whiteman, 2004; Pheng & Hwa, 1994); lack of incentives for quality attainment (Au & Yu, 1999); and misunderstanding of quality concept and terms (Abdullah, 2005; Pheng & Hwa, 1994).

One of the alternative solutions is to identify and implement the Critical Success Factors (CSF). In fact, while studies are abound on the barriers and

solutions, benefits and costs, and perceptions of the construction team on the quality system (Abdul-Aziz, 2002; Au & Yu, 1999; Bubshait & Al Atiq, 1999; Chini & Valdez, 2003; Haupt & Whiteman, 2004; Hoonakker, Carayon, & Loushine, 2010; Huang, 2010; Lam & Tang, 2002; Lindahl & Ryd, 2007; McAdam & Canning, 2001; Nycyk, 2008; Pheng & Hwa, 1994; Pheng & Teo, 2004; Serpell & Ferrada, 2007; Shamma-Toma, Seymour, & Clark, 1998; Tang & Kam, 1999), a few research has been observed related to CSF in implementing PQMS especially on the ISO 9000-based PQMS.

1.2 Problem Statement

According to Rockart (1979) CSFs are the limited number of areas in which results, if they are satisfactory, will ensure successful competitive performance for the organization. Rockart dedicated his work for the successful performance of an organization with the main aim was to manage the information system. His seminal work has become the inspiration for CSF research in other fields and the CSF acronym has been accepted and widely used in all types of industry. The main issue that the PQMS implementation has brought little improvement only to the construction project led to the consideration of the PQMS's CSF. The identification of CSF in construction project is important in order to limit the areas for the client and construction team to focus on the success factors.

Most of the researchers studied the success factors of TQM implementation in construction and little research was done on the ISO 9000-based PQMS. For instance, Arditi and Gunaydin (1997) recognized that the importance factors affected quality in construction corresponded to the TQM elements; Haupt and Whiteman (2004) studied success factors in transferring the TQM to the construction site; Pheng and Teo (2004) attempted to prove that the TQM could be successfully implemented in the construction industry; and Bryde and Robinson (2007) studied the application of TQM to the construction project management. Others specify the quality system in general as quality management system such as Jha and Iyer (2006) who determined the critical factors affecting the quality performance in construction

project and Ries, Needy, Bansal, and Turan (2010) who analyzed the best practice in leadership and third party certification for QMS in construction.

Researches in ISO 9000-based PQMS success factors are scarce and centred to the single party of the construction team. For instance, Chin and Choi (2003) who determined the success factors for ISO 9000 implementation by the contractor in Hong Kong construction industry. Other research in ISO 9000-based PQMS are not truly related to the success factors such as the study on the performance of the engineering consultants in ISO 9000-based PQMS (Ng, 2005; Tang & Kam, 1999) and the effect of ISO 9000-based PQMS to the performance of the construction project (Din, Abd-Hamid, & Bryde, 2010). However, some points considered as success factors for ISO 9000-based PQMS implementation can be extracted from the articles. In fact there are many researches in implementing ISO 9000-based PQMS that have touched modestly on the several success factors. The problem of these disjointed 'success factors' for ISO 9000-based PQMS has resulted in confusion among construction owners in electing the most-appropriate ISO 9000-based PQMS's CSF for their project. On one hand, it is strongly suspected that the CSF used in the project has a direct effect on the outcome of the ISO 9000-based PQMS implementation, on minimizing the problems and on achieving the benefits mentioned in the previous section. On the other hand, there has been no comprehensive study to encompass the most-appropriate ISO 9000-based PQMS's CSF.

The previous researches also have a tendency to focus on the CSF either for single party or for single stakeholder. For instance, Chin and Choi (2003) studied the success factors for ISO 9000 implementation by the contractor and Ng (2005), and Tang and Kam (1999) studied the performance of the consultant in implementing the ISO 9000. On the other hand, other authors gathering the data related to CSF at the management level only and not the strategic and operational levels. For instance, Love, Edwards, and Sohal (2004) studied the CSF for TQM implementation in Australian contracting organizations by interviewing the managerial level namely the general managers and senior managers. Likewise Vakola and Wilson (2004) surveyed and interviewed the senior managers regarding the CSF in dealing with constant change in virtual construction organization. As highlighted by Finney and

Corbett (2007):

Since the CSF are the limited areas organization must “get right” in order to achieve success, thus it should be necessary to ask all those affected just exactly what “right” is?

(Finney & Corbett, 2007, p. 330)

PQMS implementation involves many parties and working levels. The success of the PQMS implementation does not only rely on the specific party or working level but the right recipe is the active involvement through informal relationship between all parties and working levels (Barrett, 2000). Without the consent from all stakeholders on the PQMS’s CSF, the problems such as lack of commitment, teamwork and communication, and contradict requirements between the parties’ quality plan cannot be resolved.

In reality the construction project generates voluminous reports, records and other paperwork depending on the size of the projects. In fact they are produced mainly to monitor the progress of the works and the quality in terms of compliance to the specification through the inspection and testing activities. All these are grouped under one success factor of the implementation of the PQMS only i.e. the measurement and improvement and it has been the only focus of the construction team. Whereas, other equally important CSF for any implementation of system e.g. management commitment has not been properly addressed. There must be other several factors in which, if properly implemented will ensure the successful implementation of the PQMS and address the root causes of the problems in PQMS implementation. For example, one of the problems in implementing PQMS is incapability of the construction team in handling the PQMS activities that prompting the education and training activity. However, it is seldom for the information on the indicators for education and training at the project level are collected and analysed in order to measure the training effectiveness and to introduce any improvement.

In regard to the PQMS implementation, the construction team seemed do not know what and how to begin the PQMS implementation, likewise the strategy to implement it. For example, Abdullah (2005), Jaafari (1996), and Pheng and Hwa

(1994) clearly showed that due to the failure of conducting regular training in PQMS particularly at the initial stage of the construction project created misunderstanding and misconception of quality program and the resistance to change among the construction team. Consequently they were incapable to manage the PQMS (Tang & Kam, 1999) that can be manifested from the difficulty in securing the commitment, developing the quality plan and conducting auditing for performance measurement. It is obvious that a structured and systematic PQMS's CSF implementation should be done in order to address the sequence of priority or criticality to ensure natural acceptance, smooth and successful implementation.

The above problems suggest that rather than investing, collecting, monitoring and improving one or two less critical and even unnecessary areas, the identification of the comprehensive PQMS's CSF should be conducted especially for ISO 9000-based PQMS. Another important aspect in considering the CSF is the ranking and criticality among the CSF. This is paramount in order to provide the construction team with a structured way or commonly described in CSF literature as a "structural relationship" (Deshmukh, 2010; Singh, 2011) in implementing the CSF for PQMS. The "structural" is defined as "relating to the arrangement of and relations between the parts or elements of a complex whole (Pearsall & Hanks, 1998)". Structural relationship or "what factor lead to what factor" as simplified by Deshmukh (2010) and Singh (2011) can help the PQMS leader in implementing the PQMS's CSF in sequence. As a result, the investment, focus, collecting and analysing information, monitoring and improvement can be done systematically. All these will save a lot of time and cost and provide higher quality of service, where in fact the resources could be channelled to the core business of the construction.

The above directions of the study on the PQMS's CSF that are to prevent the problems and to ensure successful implementation of the PQMS are also supported by the previous studies on the CSF. Most of the research on CSF for the quality system irrespective of the type of the industry also focused on the identifying the CSF, ranking the level of criticality, finding the indicators for each CSF and discovering the relationship between the CSF and the performance of project or company or the parties' involved (Ab Wahid & Corner, 2009; Achanga, Shehab, Roy, & Nelder, 2006; Ahmad, Francis, & Zairi, 2007; Baidoun, 2004; Chin & Choi,

2003; Fotopoulos & Psomas, 2010; Khanna, Sharma, & Laroia, 2011; Kim, Kumar, & Kumar, 2011; Love, *et al.*, 2004; Psomas, Fotopoulos, & Kafetzopoulos, 2010; Salaheldin, 2009a, 2009b; Singh, 2011; Singh, Garg, Deshmukh, & Kumar, 2007). Therefore, this research focuses on answering the following research questions:

What are the CSF for implementing ISO 9000-based PQMS?

Are there any differences in PQMS's CSF in the viewpoints of the parties and working levels involved in the construction project?

What are the indicators of each CSF ISO 9000-based PQMS?

What is the most significant CSF for ISO 9000-based PQMS?

How are the structural relationships among the CSF for ISO 9000-based PQMS?

Again to simplify the wordings, "critical success factors for ISO 9000-based PQMS" will be shortened to "PQMS's CSF" throughout the dissertation.

1.3 Objectives of the Research

Based on the problem statement and research questions, the aim of the research is to provide a structured and systematic approach in implementing the PQMS's CSF. Hence, the following objectives are formulated:

- (a) To identify the CSF and indicators of each CSF for ISO 9000-based PQMS;
- (b) To evaluate the criticality and rank of the CSF for ISO 9000-based PQMS;
and
- (c) To develop the structural relationship model of the CSF for ISO 9000-based PQMS.

1.4 Scope of the Research

The construction industry is well-recognised through its various forms of contract, uniqueness in term of design, temporary team set-up and size. The quality system also contains many kinds of forms such as ISO 9001, TQM, Six-sigma and Business Process Re-engineering (BPR). The former is not so critical in the study as the PQMS's CSF would be the same for any kind of contracts. However, the latter could affect the PQMS's CSF as each of the QMS has its own principles and elements which will dictate the implementation. Since the local construction industry is over-whelmed with the ISO 9001-2008 (See Chapter 1 under Section 1.1 and 1.2) the scope of the study is narrowed to the ISO 9001 requirements as the basis for the identification of the PQMS's CSF.

1.5 Research Methodology

To achieve the stated objectives, this research was carried out using the following methodologies:

- (a) Literature review;
- (b) Expert opinions; and
- (c) Questionnaire survey.

The literature review has been actually an ongoing activity along the course of completing the dissertation. The constructs of CSF derived from the literature review were confirmed using the descriptive analysis on the data gathered from the questionnaire survey. The relationship between the CSF was manually correlated by the selected experts on a structural self-interaction matrix (SSIM). The SSIM was transformed into a model using the interpretive structural modelling (ISM) approach. This model was then validated using the structural equation modelling (SEM) technique by employing the data collected through the questionnaire survey. The interaction of these three methods is as shown in Figure 1.1 and they are briefly explained in the subsequent paragraphs.

1.5.1 Literature Review

The objective of reviewing related literature was to identify gaps in CSF researches implementing quality system in the construction industry. Abstracts of vast amounts of articles related to success factors regardless of the types of industry and level of implementation are skimmed accordingly. Successive rounds of abstract reviews have resulted in only fifty three articles which were considered related to CSF for quality system and construction. The subsequent analysis of all the articles identified the significant gap and the methods used by the researchers in identifying the CSF. The gap was the absence of the CSF study for the ISO 9000-based PQMS. Since articles directly related to CSF for ISO 9000-based PQMS were considered non-existence, another round of literature search for articles that contain the element of “success factors” for implementing quality system in construction was conducted. The aim then was to identify the CSF and indicators of each CSF for ISO 9000-based PQMS. Another set of articles was compiled. The final list of CSF at this phase was the constructs of the CSF for ISO 9000-based PQMS that was used in the field studies. Strategies in collecting and analysing the data appropriate to the CSF study were also gained through the analysis of the articles.

1.5.2 Experts’ Opinions

The experts’ opinions were sought for two circumstances. Firstly they were used for validating the constructs of the CSF for ISO 9000-based PQMS. Secondly their opinions were sought to establish the contextual structural relationships between the CSF by determining which factor “leads to” which factor and which do not have any relationship at all. All these opinions are shown in the SSIM and converted into a structural relationships model using ISM technique. Through the structural relationships the level of criticality of each CSF is determined and using the driving power and dependence diagram, the CSF is distinguished either as driver, autonomous, linkage or dependent. The structural model developed using ISM is then validated with the structural model developed using SEM.

1.5.3 Questionnaire Survey

The construct of CSF and its indicators were converted into questions form. To fine-tuning the survey questions the experts' opinions were sought. The final questionnaires (see Appendix 'A') were sent to the main construction parties i.e. the client representative, consultants and contractors. A likert scale was used to measure the level of the respondent's agreement and usage of each PQMS CSF. Several analysis techniques were used such as frequency, ranking, spearman's rank correlation and analysis of variances of Kruskal-Wallis. The aim was to get the industry to verify the PQMS CSF and to confirm the relationships model developed earlier using interpretive structural modelling (ISM). The confirmation was done by analysing the PQMS's CSF structural relationships using the structural equation modelling (SEM).

The methodology for this research is shown in a flowchart diagram in Figure 1.1.

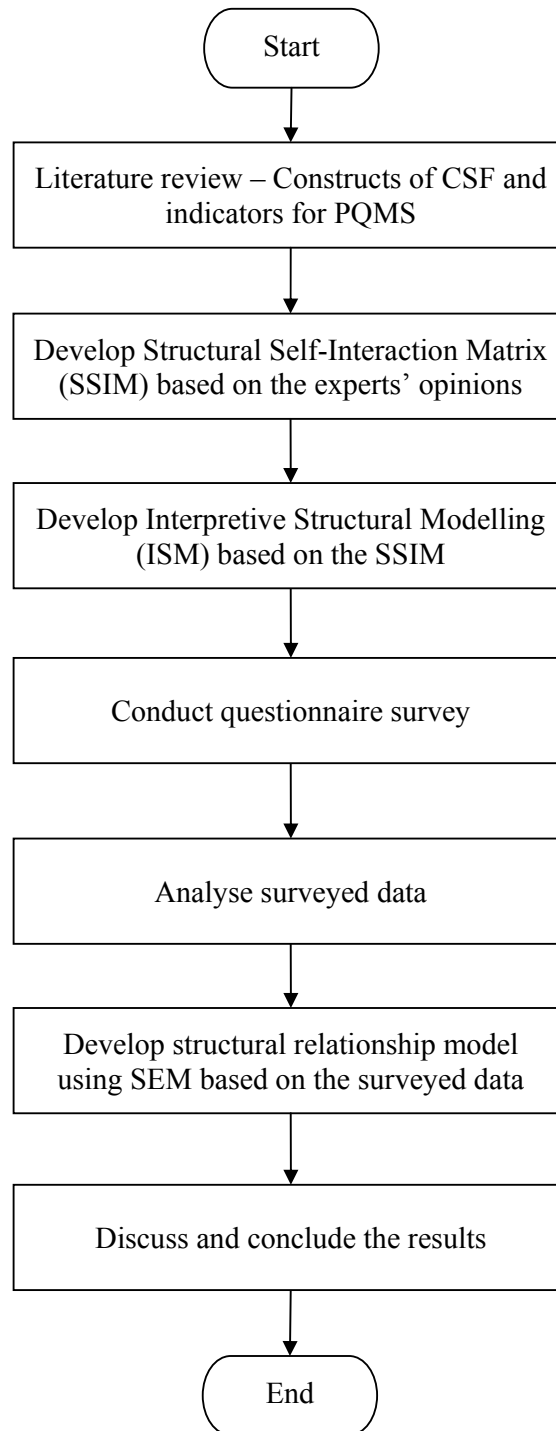


Figure 1.1: Flowchart of the research methodology

1.6 Significance of the Research

The significance of the research should discuss the importance of the research and its relevance to the theory, practice and future research. Thus the significances of this research can be seen in four aspects:

- (a) The result contributes to the academic world in term of the compilation of CSF for ISO 9000-based PQMS. New area of research in understanding the relationships among the factors as well as between the factors is introduced;
- (b) The results of the investigative study on the CSF for ISO 9000-based PQMS will prove useful to the project team especially for the project that implement PQMS in ISO 9000 environment;
- (c) Results from this study can be used as guidelines to the local project team in performing the CSF on other future large-scale projects. Project managers can also use this study to evaluate their current project and compare the perceived and real success factors for knowledge management exercises; and
- (d) The structural relationship model of the CSF for ISO 9000-based PQMS presents a comprehensive structural cause and effect relationship among various success factors to the top management of the project team in deciding the priority, direction and implementation strategy for the PQMS.

1.7 Organisation of the Thesis

This thesis is divided into six chapters i.e.:

Chapter 1 introduces the overall picture of the research such as the research background, problem statement, research objectives, scope of the research, research methodology, significance of the research and the organisation of the thesis.

Chapter 2 identifies the constructs of the CSF for ISO 9000-based PQMS. It also describes the indicators for each CSF. The forty articles reviewed are presented in a tabular form in order to identify the CSF and the frequency of each CSF cited in the articles. Subsequently, the concepts and descriptions of each CSF are scrutinised

to extract its definition and indicators.

Chapter 3 describes the research methods employed for the study and provides weight for the potential of the research to be conducted successfully. A number of data collections and analysis are discussed and finally appropriate research methods in conjunction with the conditions and environments surrounding the research are selected. The modelling techniques used to develop the structural relationship model i.e. ISM and SEM are also discussed in this chapter.

Chapter 4 reports the outcome of the statistical analysis of the data collected from the questionnaires and the experts' opinions exercise. The analysis is carried out on the respondent demographic study; respondents' agreement and usage of CSF; and the difference of perception among the project team i.e. client representative, consultant and contractor. The development of the structural relationship model using the ISM is presented systematically. The SEM techniques in confirming the ISM structural relationship model is also shown in detail.

Chapter 5 highlights the discussion on the findings from the analysis of the questionnaires and expert opinions in answering the objectives of the research i.e. to identify the CSF and indicators of each CSF for ISO 9000-based PQMS; to evaluate the relationships between the CSF for ISO 9000-based PQMS; and to develop the relationship model of the CSF for ISO 9000-based PQMS.

Chapter 6 highlights the main conclusions and several limitations of the research. Several points for further investigation are also highlighted.

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