The Hong Kong Polytechnic University
The Department of Building and Real Estate

Critical Success Factors for Delivering Healthcare Projects in Hong Kong

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ABSTRACT

Hong Kong's population is ageing. The proportion of the aged (those 65 or over) will increase substantially from 11% in 2001 to 24% in 2031. The outbreak of Severe Acute Respiratory Syndrome (SARS) in March 2003 also highlighted the strains that hospital beds and healthcare facilities could come under. However, healthcare projects, especially hospital projects, take a long time to deliver to the community. They involve a lengthy pre-construction stage and a post-contract period. Past experiences have shown that hospital projects usually end in serious time and cost overruns. Hence, in order to achieve outstanding performance in healthcare projects, defining what constitutes a successful project and how to implement it are crucial issues that have been attracting considerable attention in the construction industry.

The objectives of this research are to identify the major problems involved in running healthcare projects; to develop a framework and a project success index (PSI) to measure the success of healthcare projects; and to formulate a conceptual model to link the critical success factors (CSFs) with the performance of the project.

An analysis of 52 sample opinions from relevant parties via self-administered questionnaires has confirmed that 'highly complicated building services', 'a tight time schedule', 'the need to keep up with up-to-date technology', 'frequent changes demanded by multi-headed client and various end-users' and 'a fixed budget', were considered to be the top five problems faced by industry practitioners. Through a series of face-to-face interviews and a questionnaire survey, eight criteria including time, cost, quality, functionality, safety, environmental friendliness, client's satisfaction, and participants' satisfaction, were selected for assessing the success of healthcare projects. A project success index (PSI) based on the identified criteria was composed using principal components analysis to measure the level of success of healthcare projects.

Using factor analysis and stepwise multiple regression analysis, predictors of the success of healthcare projects were identified. The findings of the research showed that project management action was the best predictor of the success of healthcare projects. The design team leaders' capabilities; client representatives' capabilities; construction team leaders' capabilities; and the nature of the project, were also found to have a strong influence of the success of a project, but to a lesser degree than project management action. They were followed by the client's abilities and the application of innovative project management techniques.

An independent test group consisting of five projects that were not used to develop the regression model was obtained and used to test the reliability and sensitivity of the predictive model. A paired samples T-test, an analysis of the paired data, was then performed to test whether there was a significant difference between the computed values and actual values of the project success indices. From the results, it can be concluded that the critical success factors identified in this study are good predictors for various measures of performance.

The research findings provide valuable information on factors that are important in the success of healthcare projects. The findings enhance the understanding of clients, contractors, and designers on how to run a successful project, and help them to develop a system that can be used to achieve excellent performance in healthcare projects in the future. The findings also assist in the selection of members of the project team, help to identify the needs of the project, and forecast the level of performance of the project. Apart from its practical applications, the research is also useful in the field of academics/education. The results of the research can enrich the content of management education programmes for both students and project managers. Moreover, this study can further be used as a solid basis upon which to conduct an international comparative study of the situation in Asia, Europe, and North America, by extending the investigation in collaboration with fellow researchers in these areas. This will help strengthen our understanding of how healthcare projects are managed in different countries.

PUBLICATIONS ARISING FROM THE THESIS

Conference Papers

1. Chan, A.P.C., Scott, D. & Chan, A.P.L. (2000), *Study of Healthcare Projects in Hong Kong*. Proceedings of the Millennium Conference on Construction Project Management – Recent Developments and the Way Forward, pp.108-115.

2. Chan, A.P.L., Chan A.P.C. & Chan, D.W.M. (2003), *A Study on Managing Healthcare Projects in Hong Kong*. Proceedings of the ARCOM Conference held at the University of Brighton, UK on 3-5 September 2003, pp.513-522.

3. Chan, A.P.L., Chan A.P.C. & Chan, D.W.M. (2003), *An assessment framework for project success in the healthcare project*. Proceedings of the Second International Conference on Construction in the 21st Century – Sustainability and Innovation in Management and Technology, Hong Kong, December 10-12, 2003, pp.318-323.

4. Chan, A.P.L., Chan, A.P.C. and Chan, D.W.M. (2003), *Running healthcare projects in Hong Kong: critical study of potential problems and success factors.* Proceedings of CRICM 2003 International Research Symposium on Advancement of Construction Management and Real Estate, Macau, 3-5 December 2003, pp.364-372.

Journal Papers

1. Chan, A.P.C., Chan, E.H.W. & Chan, A.P.L (2003), *Managing Healthcare Projects in Hong Kong – a case study of the North District Hospital.* International Journal of Construction Management, Vol.3, No.2, pp.1-13.
2. Chan, A.P.L., Chan A.P.C. & Chan, D.W.M. (2003), *The Management of Healthcare Projects: The case of Tseung Kwan O Hospital.* Journal of Building and Construction Management, Vol.8, No.1, pp.34-41.
3. Chan, A.P.C. & Chan, A.P.L. (2004), *Key Performance Indicators (KPIs) for measuring construction success.* Benchmarking – An International Journal, Vol. 11, No. 2, pp.203-221.

4. Chan, A.P.C., Scott, D. & Chan, A.P.L (2004), *Factors Affecting the Success of a Construction Project*, ASCE Journal of Construction Engineering and Management, Vol.130, No. 1, pp.153-155.

5. Chan, A.P.L., Chan, A.P.C. and Chan, D.W.M. (2004), *A critical study of problems in running healthcare projects.* Engineering, Construction and Architectural Management *(under review).*

6. Chan, A.P.L., Chan, A.P.C. and Chan, D.W.M. (2004), *An empirical survey of the success criteria for running healthcare projects.* Architectural Science Review *(in press).*

7. Chan, A.P.L., Chan, A.P.C. and Chan, D.W.M. (2004), *Success factors for a construction project.* Building and Environment *(under review).*

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I would like to dedicate this thesis to my eldest sister and to my father, both of whom passed away during the period of my study. Although they are now in the heaven, I can still feel their support and care. Their encouragement and love will live in my heart forever.

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CHAPTER ONE

INTRODUCTION

1.1 INTRODUCTION

Healthcare projects, especially hospital projects, take a long time to deliver to the community. They consist of a lengthy pre-construction stage and a post-contract period. Past experience has shown that hospital projects usually end in serious time and cost overruns, with the special characteristics of hospital projects playing a major role in this. Good project management is a pre-requisite to achieving outstanding success in healthcare projects. There have been several studies on successful construction projects; however, few have focused on healthcare projects. 'Project success means different things to different people' (Beale and Freeman, 1991; Freeman and Beale, 1992). While some researchers consider project success as merely a matter of meeting the requirements of technical performance, cost, and time; others consider success to be something more complex than simply meeting these basic criteria. The measures of performance for healthcare projects should be even more comprehensive. Besides the basic criteria for success, various attempts have also been made by different researchers to determine the critical factors for a successful construction project. Lists of variables have been drawn up; however, no general agreement can be made on them. Chan (1996) identified the following six major groups of independent variables as affecting the performance of a project: client, project, project environment, project team leaders, project procedures, and project management action. The impact and interaction of these independent variables, in turn, determine the success of the project. Hong Kong has undergone tremendous changes over the past few years in its social, political, and economic environment, stemming from such developments as the re-unification of Hong Kong with China, the Asian financial crisis, and the downturn in the local economy. The findings of previous studies might not fully reflect changing needs in the area of healthcare projects.

This research is structured to improve the conceptual understanding of the issues involved in measuring the success of a project and the specific factors affecting the success of healthcare projects. A more refined model for predicting the success of healthcare projects will be developed. This chapter outlines the research objectives, research hypotheses, research approach, and the significance of the research study.

1.2 OBJECTIVES OF THE RESEARCH

The primary objective of this research is to develop a conceptual model for achieving successful healthcare projects. The specific goals of this research are:

a. to identify the major problems in running healthcare projects;

b. to identify from relevant literature those factors that are critical for running a successful healthcare project (independent variables);

c. to develop a framework and a project success index (PSI) to measure the success of healthcare projects (dependent variables);

d. to identify those factors that have a strong correlation with the success of a project; and

e. to develop a conceptual model explaining the relationship between the critical success factors (CSFs) and the performance of healthcare projects.

1.3 RESEARCH HYPOTHESES

Two hypotheses are formulated for investigation in this research:

(1) A successful healthcare project is one that is completed within budget and on schedule, meets the required quality standards, is environmental friendly and safe, achieves its intended functions, conforms to the expectations of the users, clients, and project participants and satisfies them, and leads to the generation of profits and long-term gains.

(2) The success of a healthcare project is a function of project-related factors, project procedures, project management actions, human-related factors, and the external environment; such factors are both inter-related and intra-related.

1.4 RESEARCH APPROACH

Sekaran (1992), as cited in Walker (1997a), provided a useful general model of a research process for basic and applied research (Figure1.1). This model clearly illustrates the process that a researcher with a rather vague idea of a potential problem worthy of research can follow, by formulating a working hypothesis based upon observations and a review of the works of others, which may contribute to the formulation of a testable hypothesis or set of hypotheses (Walker, 1997a).

The specific methodology of this research followed the concept of Walker's model and is consistent with the approach adopted in previous research (Chan, 1996). It was based on a literature review, questionnaires, and interviews. Details of the research methodology will be discussed in Chapter 6.

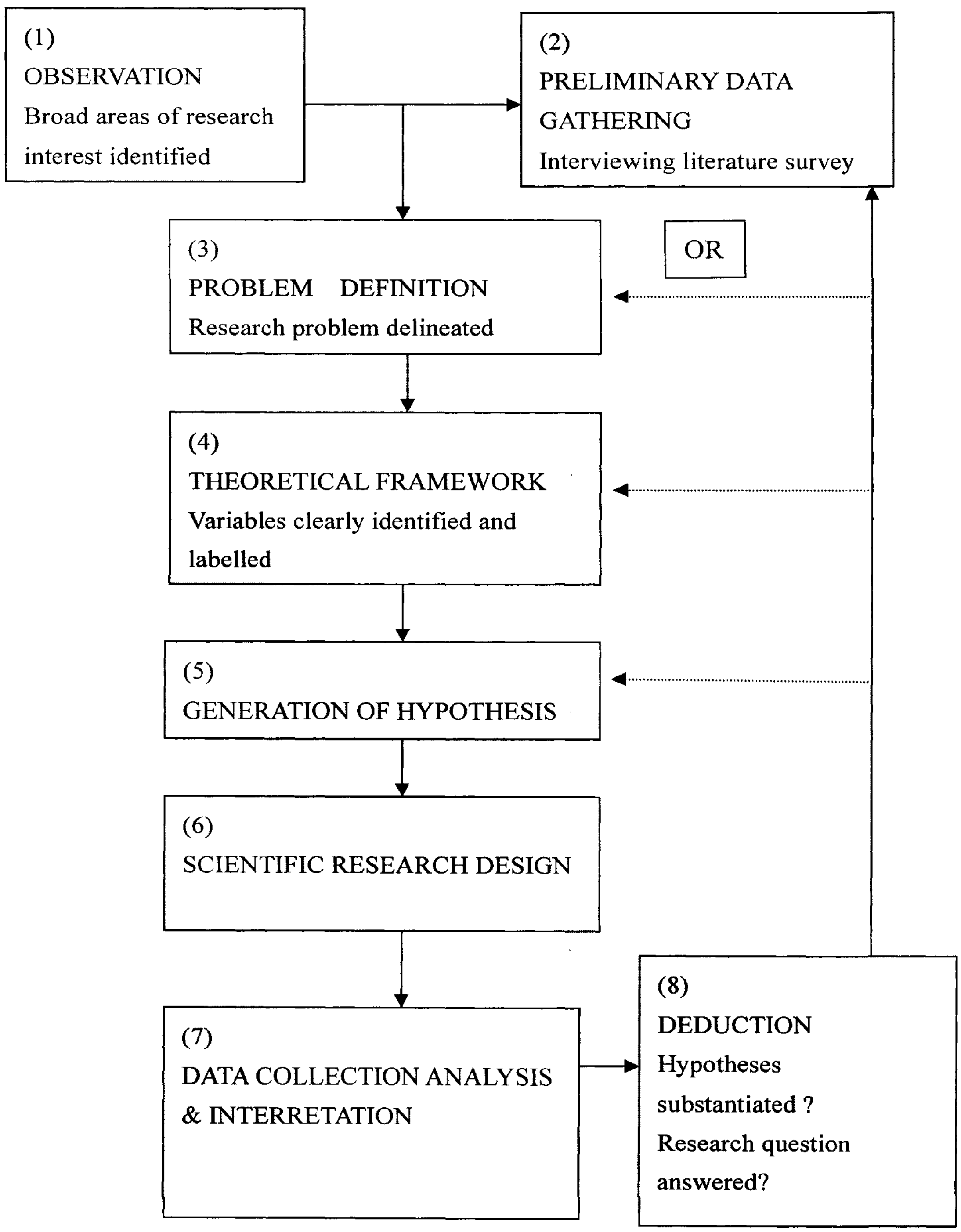


Figure 1.1 Research process for basic applied research [Sekaran (1992), as cited in Walker (1997a)]

1.5 SIGNIFICANCE OF THE RESEARCH

According to the Census & Statistics Department, Hong Kong's population is projected to increase at an average annual rate of 1.3%, from 6.29 million in mid-1996 to 7.38 million in mid-2006, and further to 8.21 million in mid-2016 (Census & Statistics, 2003). The proportion of those aged 65 and over is projected to rise from 10% in 1996 to 11% in 2006 and further to 13% in 2016. Correspondingly, the median age of the population is projected to rise from 34% in 1996 to 39% in 2006 and further to 41% in 2016. Apart from births, both an increase in the number of immigrants and an ageing population are imposing a large demand on healthcare facilities. The situation worsened after the outbreak of Severe Acute Respiratory Syndrome (SARS) in March 2003. Not only did SARS bring about a global alert against infectious diseases, it also highlighted the weakness of the present healthcare system and facilities in Hong Kong. The number of SARS patients came to total 1,755 as at 3 August 2003, and 299 people (including front-line medical staff) died from the illness (Department of Health, 2003). One of the major factors behind the rapid spread of SARS was the lack of effective isolation wards in Hong Kong. In order to prevent another outbreak of infectious disease, the Financial Committee of the Legislative Council agreed to allocate HK$409.6 million to carry out alteration and addition works in nine public acute-care hospitals. The aim was to provide about 1,280 beds in isolation rooms/wards of different sizes for confirmed and suspected SARS patients before the end of 2003 (Information Services Department, 2003). It has been recommended that the government including the building a separate hospital for infectious diseases as part of its long-term plans. In view of this, the number of hospital extension and construction projects is expected to increase in the coming years.

This research will provide a significant amount of information on the factors that are important for a successful healthcare project. It will enhance the understanding of clients, contractors, and designers on the running of a successful project and help them develop an enhanced system for achieving excellent performance on healthcare projects in the future. The findings of this study can also assist in the selection of members of the project team, help to identify the needs of the project, and forecast the performance level of the project. A predictive model will be developed to assess the level of success of the healthcare project even before it commences and as it proceeds. This research will help to set a benchmark for determining the performance of healthcare projects.

Apart from its practical use, this study will also be useful in the field of academics/education. The results of this research will enrich the content of management education programmes for students and project managers.

Hitherto, studies on the managing of healthcare projects have rarely been conducted in Asian countries. Most of the previous studies have been based on the situation in the United Kingdom and North America. Within Asia, each market has very distinct characteristics but all are founded on the common aims of providing accessible, high-quality cost-effective services focused on the needs of the patients. The differences between Asian countries tend to involve those of scale and speed of development, which can be measured by underlying macro-economic conditions, and the political and social environment (Brazier, 1996). Thus, the results of this study can be used as a reference for other Asian countries. It can further be used in an international study involving Asia, Europe, and North America, by extending the study in collaboration with fellow researchers in these areas. This will help strengthen our understanding of how healthcare projects are managed in different countries.

1.6 OUTLINE OF THE STRUCTURE OF THE THESIS

This chapter introduces the background, objectives, hypotheses, research approach, and significance of this study.

Chapter 2 describes the local healthcare system. The definition of healthcare services is provided. The changing structure, distribution, and composition of Hong Kong's population are presented. The roles of the major public organizations responsible for the planning, financing, and provision of healthcare are described.

Chapter 3 describes the characteristics and problems involved in running a healthcare project as identified in the literature review.

Chapter 4 reviews the literature related to the various measures of assessing the success of a project. This chapter aims to provide comprehensive knowledge on how the success of a project is assessed and to develop a research model for measuring the success of a project.

Chapter 5 develops a conceptual framework of the factors affecting the success of a project by providing a comprehensive summary and a systematic critique of the existing literature related to the critical success factors of projects. A new model that includes the factors and their variables is presented.

Chapter 6 describes the methodology adopted in this study. It covers the data collection process, the development and structure of the questionnaire, the sample used, and the statistical techniques used to analyse the data.

Chapter 7 analyses the major problems involved in running healthcare projects by the mean-score method. Different views from clients and contractors are highlighted in this chapter.

Chapter 8 establishes the criteria for the success of healthcare projects in Hong

Kong. The process of developing a Project Success Index (PSI) for healthcare projects is described in this chapter.

Chapter 9 reports the results of the statistical tests. The main statistical tools employed are factor analysis and stepwise multiple regression analysis. The revised research model generated as a result of the factor analysis is presented.

Chapter 10 discusses the significant outcomes reported in Chapter 9 and examines the reasons for the results. This chapter aims to highlight how this study relates to past studies.

Chapter 11 provides an evaluation of the reliability and validity of the derived models for predicting the level of success of the projects.

Chapter 12 presents the conclusion, discusses the implications of the study, and makes recommendations for future studies.

1.7 SUMMARY OF THE CHAPTER

This chapter provides a general outline of this study. The background, objectives, hypotheses, research approach, significance, and structure of the thesis are discussed.

CHAPTER TWO

HEALTHCARE SYSTEM IN HONG KONG

2.1 INTRODUCTION

This chapter introduces the healthcare system in Hong Kong. First, the definition of healthcare services is provided. Then, the changing structure, distribution, and composition of Hong Kong's population are presented. Furthermore, the roles of the major public organizations responsible for the planning of healthcare policies, healthcare financing, and provision are described. Aspects of the financing of the healthcare system will also be examined.

2.2 HEALTHCARE SERVICES

In Hong Kong, healthcare services can be classified into the primary[1], secondary[2], and tertiary[3] levels with acute and extended care[4] components (Hospital

[1] The patient's first point of contact with the healthcare system
[2] More specialized and complex medical care
[3] Highly complex and specialized care
[4] Treatment to a patient in the acute stage of illness to restore health

Authority, 2000). The Hospital Authority provides over 90% of secondary and tertiary care in Hong Kong. The Department of Health and the Hospital Authority provide approximately 15% and 3%, respectively, of primary medical care. The private sector provides 70% of primary medical care and less than 10% of secondary and tertiary care (Hospital Authority, 2000). Extended and long-term care are provided almost exclusively by the Hospital Authority (Hospital Authority, 2000). Being the main provider of secondary care, the Hospital Authority is the leader in providing hospital facilities for Hong Kong residents. Figure 2.1 shows the provision of healthcare services by various parties in terms of percentage.

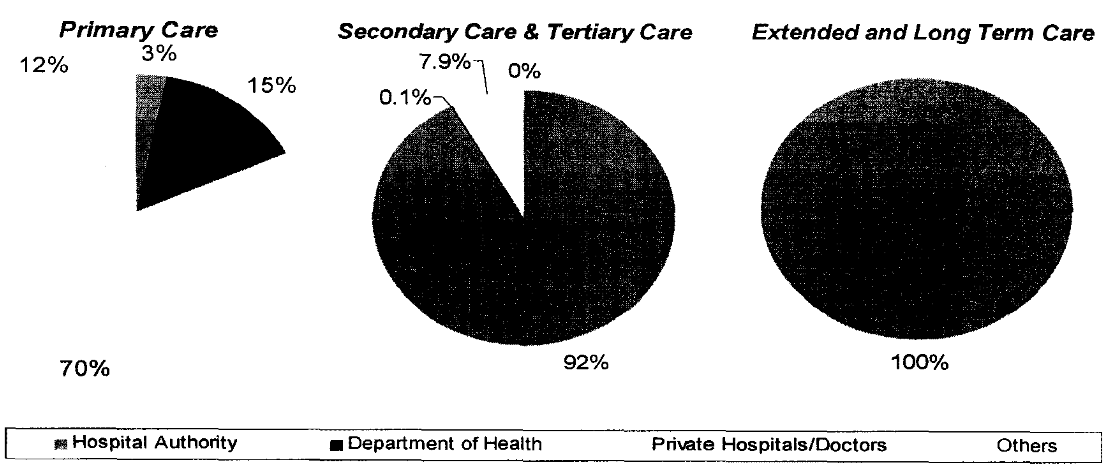


Figure 2.1 The provision of healthcare services by various parties in terms of percentage
Source: Hospital Authority (2000), www.ha.org.hk

2.3 DEMOGRAPHIC STATISTICS

For any given area, population is one of the major factors determining what healthcare services can or should be provided. The characteristics of the population for which the services are provided are likely to influence the nature of the actual services and to influence any assessment of their appropriateness in terms of effectiveness and cost or efficiency (Grant and Yuen, 1998). The healthcare needs of the community can be also assessed with reference to the population growth, the rate at which the population is ageing, health indices, and healthcare expenditures.

2.3.1 Population Growth

Hong Kong's population has grown very slowly in recent years. The annual rate of increase of 5.3% in 1996-1997 fell to about 1% in 1997-1999 and to 0.9% in 2000-2002. The changing structure of the population can be explained by the rate of natural increase[5]. The rate of natural increase dropped from 7.0 in 1992 to 2.1 in 2002. Therefore, the number of births relative to the number of deaths shows a falling trend. Figures 2.2 to Figure 2.4 present the population, the

[5] The number of known live births over known deaths occurring in a year per thousand

number of deaths, and the number of births, respectively in Hong Kong from 1997 to 2002. Despite the natural death and birth rate, immigration is another important determinant of population. Mainland China is the major source of the HKSAR's immigrant population. Under Article 24(2)(3) of the Basic Law, persons of Chinese nationality born outside Hong Kong of Hong Kong permanent residents shall be permanent residents of the HKSAR and enjoy right of abode (ROA). Since July 1, 1997, 130,000 residents of mainland China have entered Hong Kong (HKSARG, 2002). During 2001-2002, about 45,000 mainland residents came to settle and join their families in the HKSAR. Figure 2.5 shows the number of new arrivals from mainland China to Hong Kong. Although the figure shows a declining trend from 2000, the new arrivals still have an effect on the demand for healthcare services.

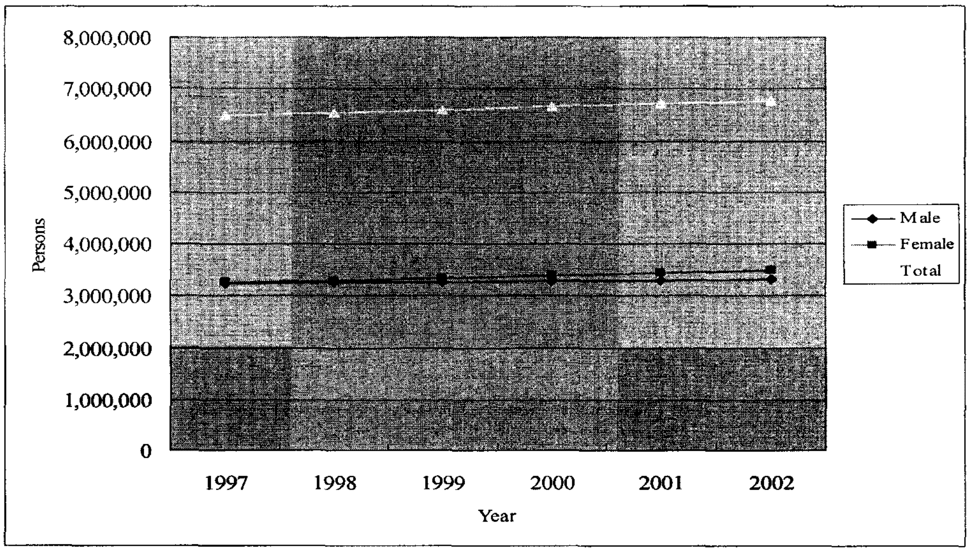


Figure 2.2 Population by age group, 1997- 2002

Source: Census and Statistics Department. Hong Kong Annual Digest of Statistics 2003 Edition. PDHKSARG 2003 p. 5. Table 1.2

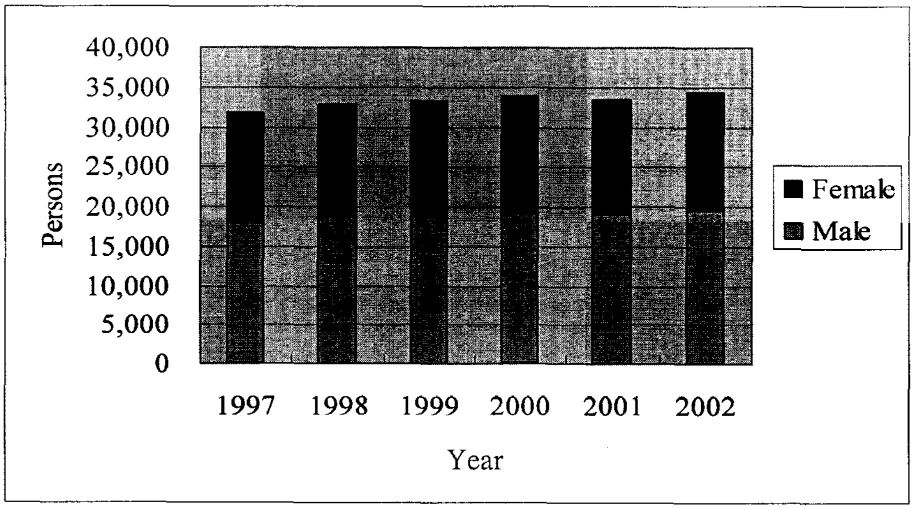


Figure 2.3 Deaths by sex, 1997-2002

Source: Census and Statistics Department. Hong Kong Annual Digest of Statistics 2003 Edition. PDHKSARG 2003 p. 4. Table 1.1

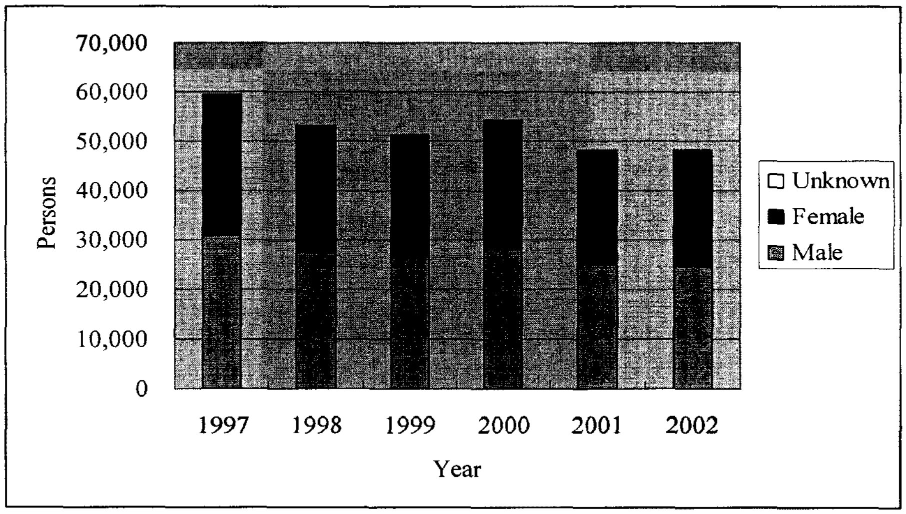


Figure 2.4 Number of births, 1997-2002

Source: Census and Statistics Department. Hong Kong Annual Digest of Statistics 2003 Edition. PDHKSARG 2003 p. 4. Table 1.1

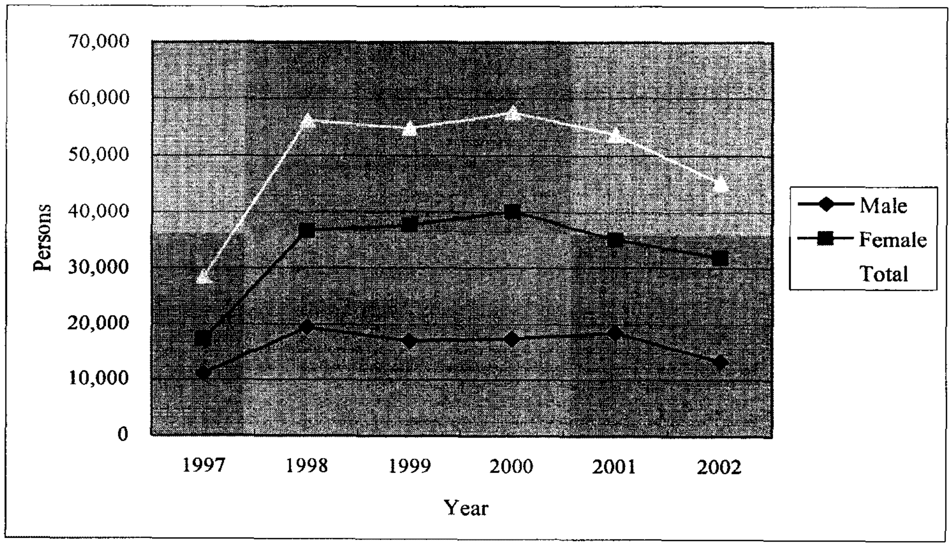


Figure 2.5 New arrivals from mainland China holding a one-way permit (by sex)

Source: Census and Statistics Department. Hong Kong Annual Digest of Statistics 2003 Edition. PDHKSARG 2003 p. 12. Table 1.12

2.3.2 Population Projections

Planning for the delivery of health services is dependent on accurate and timely projections of the future features of the population and its composition (Grant and Yuen, 1998). Three key influences, including fertility, mortality, and migration, need to be considered when making population projections. Table 2.1 presents the projected population by district board districts in 2002, 2006, and 2012.

Table 2.1 Hong Kong resident population by District Council District: 2002, 2006, and 2012 (as at mid-year)

Districts	*2002*#	*2006**	*2012*#
Hong Kong Island	1,296,500	1,408,300	1,322,900
Kowloon	2,026,500	2,103,900	2,372,100
New Territories	3,458,800	3,606,300	3,908,900
Land Total	6,781,800	7,118,500	7,603,900
Marine Residents	5,100	3300	1,700
Whole Territory	6,787,000	7,121,800	7,605,600

Source: Planning Department (2003). Projections of population distribution 2003-2012 by District Council District.

* Source: Planning Department (2002a). Projections of population distribution 2002-2011 by District Council District.

2.3.3 Life Expectancy

Life expectancy is a useful measure to describe and compare the conditions of mortality at specific ages (Census and Statistics Department, 1999). Life expectancy at birth for males rose from 68 to 76, and for females from 75 to 82 during 1971 – 1996. This is a trend common to developed countries (Grant and

Yuen, 1998). Table 2.2 shows the life expectancy in the period 1997 to 2002. The life expectancy at birth for boys and girls rose from 77.2 to 78.4, and from 83.2 to 84.0, respectively. The demand for care is likely to rise sharply as Hong Kong people live longer. Therefore, the need to integrate the component parts of the healthcare system will become more pressing.

Table 2.2 Life expectancy at birth by sex, 1997-2001

Year	***Expectation of Life at Birth (Number of years)***	
	Male	***Female***
1997	77.2	83.2
1998	77.4	83.0
1999	77.7	83.2
2000	78.0	83.9
2001	78.4	84.0

Source: Census and Statistics Department. Hong Kong Annual Digest of Statistics 2003 Edition. PDHKSARG 2003 p. 4. Table 1.1

With reference to the statistics on population and life expectancy, several conclusions can be made. First, Hong Kong's population will grow very slowly because of a low fertility rate and a low birth rate. Children under 15 will drop from 16% of the population in 2001 to 12% in 2031. Life expectancy at birth continues to increase; therefore, the population is ageing and the median age is expected to move from 37 in 2001 to 46 in 2031. Although migration will slow the rate at which the population will age, the number of aged (those aged 65 or over) will still increase substantially, from 11% of the population in 2001 and to 24% in 2031.

Besides the ageing population, the outbreak of Severe Acute Respiratory Syndrome (SARS) in March 2003 also led to a great demand for hospital beds and healthcare facilities, and hinted at the extent to which any future outbreaks of a highly infectious disease could strain the healthcare system. Therefore, the Financial Committee of the Legislative Council agreed to allocate HK$409.6 million to carry out alterations and addition works in the following hospitals in order to provide about 1280 beds before the end of 2003: the Alice Ho Miu Ling Nethersole Hospital, Kwong Wah Hospital, Pamela Youde Nethersole Eastern Hospital, Prince of Wales Hospital, Princess Margaret Hospital, Queen Elizabeth Hospital, Queen Mary Hospital, Tuen Mun Hospital, and the United Christian Hospital (Information Services Department, 2003). An infectious diseases block will be built in the Princess Margaret Hospital, the Tuen Mun Hospital and the Alice Ho Miu Ling Nethersole Hospital within three years (SCMP.COM, 2003). For long-term planning, the Government should build a separate infectious disease hospital. In view of this, the number of hospital extension and construction projects is expected to increase in the coming years.

In Hong Kong, the Planning Department provides guidelines for providing community facilities. Many of the recommended standards for the provision of community facilities are based upon the growth or concentration of the population in a given area (Planning Department, 2002b). The Planning Department recommends that for purposes of long-term planning, the aim is to provide 5.5 beds (including all types of hospital beds both in the public and private sectors) per 1,000 persons. Table 2.3 shows the number of hospital beds in different areas.

Table 2.3 Medical institutions with hospital beds by area and type of institution

Area/Type of institution	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*
Hong Kong Island						
Hospital Authority hospitals						
Institutions	15	15	15	15	15	14
Hospital beds	6,691	6,859	6,905	7,019	6,953	6,925
Hospitals in correctional institutions						
Institutions	6	6	7	7	7	7
Hospital beds	152	132	146	146	146	146
Nursing homes and private hospitals						
Institutions	9	8	8	8	8	8
Hospital beds	1,407	1,389	1,380	1,357	1,310	1,286
Sub-total						
Institutions	30	29	30	30	30	29
Hospital beds	8,250	8,380	8,431	8,522	8,409	8,357
Kowloon						
Hospital Authority hospitals						
Institutions	10	10	10	9	9	9
Hospital beds	8,322	8,332	8,587	8,695	8,882	9,127
Hospitals in correctional institutions						
Institutions	2	2	2	2	2	2
Hospital beds	98	98	98	98	98	98
Nursing homes and private hospitals						
Institutions	8	10	11	12	12	12
Hospital beds	1,405	1,533	1,866	1,878	1,874	1,917
Sub-total						
Institutions	20	22	23	23	23	23
Hospital beds	9,825	9,963	10,551	10,671	10,854	11,142
New Territories						
Hospital Authority hospitals						
Institutions	15	17	17	17	16	16
Hospital beds	11,391	12,692	13,110	13,718	13,408	13,453
Hospitals in correctional institutions						
Institutions	14	14	14	14	14	14
Hospital beds	504	473	473	472	466	485
Government clinics/maternity homes						
Institutions	8	8	7	5	4	4
Hospital beds	72	70	28	26	25	25
Nursing homes and private hospitals						
Institutions	9	12	14	13	12	12
Hospital beds	758	1,258	1,693	1,691	1,690	1,697
Sub-total						
Institutions	46	51	52	49	46	46
Hospital beds	12,725	14,493	15,304	15,907	15,589	15,660
Total						
Institutions	**96**	**102**	**105**	**102**	**99**	**98**
Hospital beds	**30,800**	**32,836**	**34,286**	**35,100**	**34,852**	**35,159**
Beds per thousand of the population	***4.7***	***5.0***	***5.2***	***5.2***	***5.2***	***5.2***

Source: Census and Statistics Department. Hong Kong Annual Digest of Statistics 2003 Edition. PDHKSARG 2003 p. 285-286. Table 13.2

Although the number of hospital beds per 1,000 of the population rose from 4.7 to 5.2 within these years, this is still insufficient to meet the long-term target of providing 5.5 hospital beds per 1,000 persons. If the number of hospital beds remains unchanged, the situation will worsen, with the number of hospital beds per 1,000 persons falling to 4.9 and 4.6 in 2006 and 2012, respectively. Moreover, hospitals need to be planned and developed in a regional context, taking into consideration the likely future concentrations of population (Planning Department, 2002b). Currently, substantial changes are occurring in the location of the population. In the future, there will be a marked redistribution of the population, particularly from Kowloon and Old Kowloon to the New Territories (Grant and Yuen, 1998). This will create a large demand for hospital beds in the New Territories District.

In order to achieve the target of 5.5 hospital beds per 1,000 persons in 2006 and 2012, the number of hospital beds needs to be increased. The number of hospital beds required in 2006 is 39,170, so there will be a shortage of 4,011 beds. Using the North District Hospital, which has 618 hospital beds, as a standard acute-care hospital, this means that about 7 hospitals will need to be constructed in 2006.

After six years, 2,661 additional beds or 4 more hospitals will be needed. The distribution of these extra 11 hospitals will be 4 in Kowloon and 7 in the New Territories. The detailed calculations are presented in Table 2.4.

Table 2.4 Future projections on hospital beds in 2006 and 2012

	2006	***2012***
Required number of hospital beds (=5.5/1000 * estimated population)	= 7,121.8 * 5.5 = 39,170	= 7,605.6 * 5.5 = 41,831
-) Existing number of hospital beds	-) 35,159 (based on 1999)	-) 39,170 (based on estimated number in 2003)
= Shortage of hospital beds	= 4,011	= 2,661
/) Hospital beds in an acute hospital (North District Hospital)	/) 618	/) 618
= Number of hospitals	= 6.49 (7 hospitals)	= 4.31 (4 hospitals)

2.4 PUBLIC AGENCIES: ORANIZATIONS, RESPONSIBILITIES, AND STRUCTURE

In a pluralistic society, responsibility for health services tends not to fall within the jurisdiction of a single government department of monolithic proportions. Therefore, the tendency is for there to be various agencies involved in providing healthcare (Grant and Yuen, 1998). Some organizations are in the public sector, such as government departments or statutory authorities; some are non-government organizations that may be subsidized by the government or by other voluntary organizations; some are in the private sector, and may or may not be controlled by the government. However, the most important ones with the greatest influence on the provision of healthcare is the public sector. Figure 2.6 presents the organizations involved in providing healthcare services in Hong Kong. The following discussion will mainly focus on *the Health and Welfare Bureau of the Government Secretariat, the Hospital Authority, and the Department of Health.*

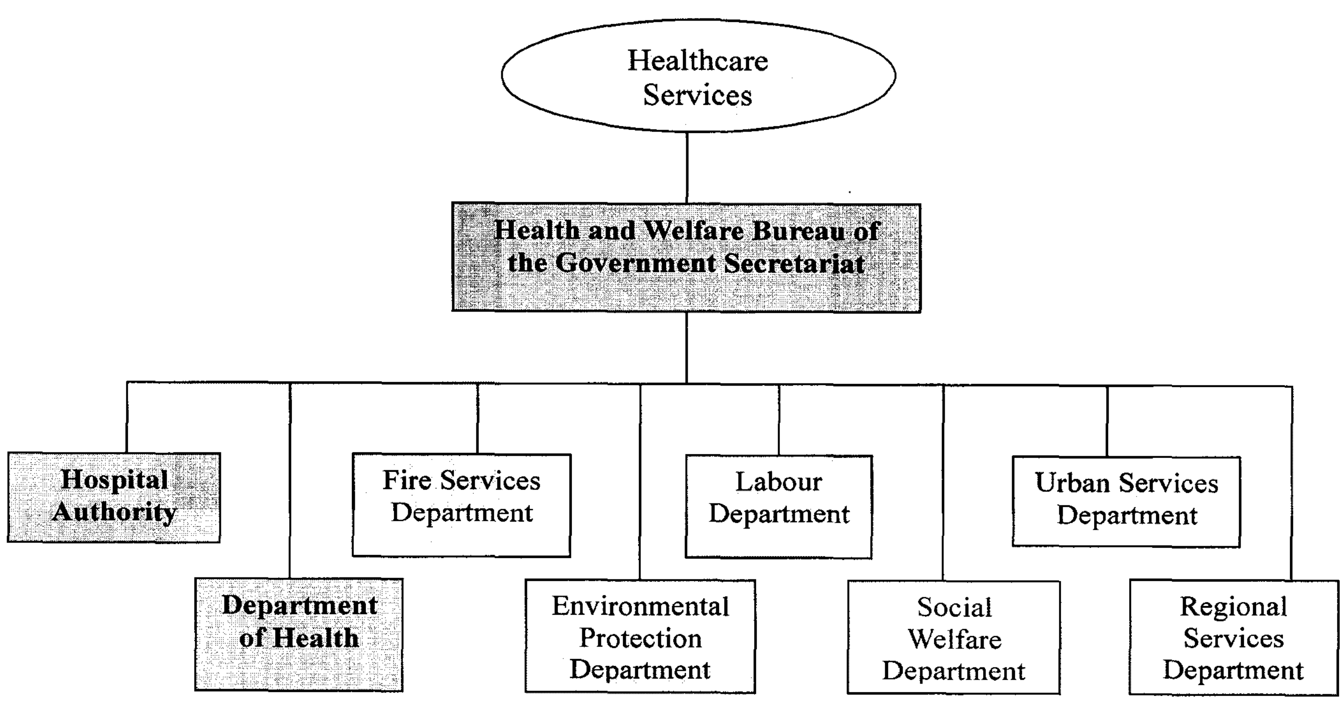


Figure 2.6 Organizations providing healthcare services

2.4.1 Health and Welfare Bureau

The Health, Welfare, and Food Bureau is responsible for formulating policies and allocating resources for health in Hong Kong. It also oversees the implementation of policies to protect and promote public health, to provide comprehensive and lifelong holistic care to each citizen, and to ensure that no one is denied adequate medical treatment due to a lack of means (HKSARG, 2002). The Secretary for Health and Welfare is the head of this Bureau and is responsible for the formulation of health policy, within the overall framework of the policies outlined in the Chief Executive's Budget and the Policy Address.

2.4.2 Department of Health

The Department of Health was established on 1 April 1989. It is the Government's health adviser and agency for executing healthcare policies and statutory functions. It safeguards the community's health through a range of promotional, preventive, curative, and rehabilitative services. It also works with the private sector and teaching institutions to protect the public's health.

2.4.3 Hospital Authority

The Hospital Authority is a statutory body established on 1 December 1990 under the Hospital Authority Ordinance to manage all public hospitals in Hong Kong. It is an independent organization, but is accountable to the government through the Secretary for Health and Welfare, who is responsible for formulating health policies and monitoring the Authority's performance. The Hospital Authority also provides medical treatment and rehabilitation services to patients through hospitals, specialist clinics, and outreach services.

The Hospital Authority formally took over the management of all 38 public hospitals and institutions, and their 37,000 members of staff on 1 December 1991. It currently manages a Head Office, 43 public hospitals/institutions, 47 specialist outpatient centres and 13 general outpatient clinics. As at 31 December 2001, it managed a total of 29,022 hospital beds, representing 4.2 public hospital beds per 1,000 of the population. It employs 49,692 full-time staff and 98 part-time staff. It operated under a recurrent budget of $29,881 million in 2002/03 (Hospital Authority, 2004).

The Authority is mainly responsible for delivering a comprehensive range of secondary and tertiary specialist care and medical rehabilitation through its network of healthcare facilities. It also provides some primary medical services in 13 primary care clinics providing 938,800 general outpatient attendances. In 2001/2002, there were a total of 1,213,600 inpatient discharges and deaths, 8,461,500 specialist outpatient attendances, and 2,594,700 accident and emergency attendances (Hospital Authority, 2004).

Under the Hospital Authority Ordinance, the role of the Hospital Authority includes:

- Advising the Government of the public's needs with regard to hospital services and of the resources required to meet those needs.
- Managing and developing the public hospital system.
- Recommending to the Secretary for Health and Welfare appropriate policies on fees for the use of hospital services by the public.
- Establishing public hospitals.
- Promoting, assisting, and taking part in educating and training HA staff and in research relating to hospital services.

Before the establishment of the Hospital Authority, the responsibility for constructing public hospitals belonged to the Architectural Services Department (ASD). After December 1990, the Hospital Authority took over this role. The Hospital Authority is now the major client for hospital projects. The organizational structure of the Authority is presented in Figure 2.7. The Deputy Director of Hospital Planning & Development is responsible for developing hospital projects. The hospitals in Hong Kong are shown in Figure 2.8.

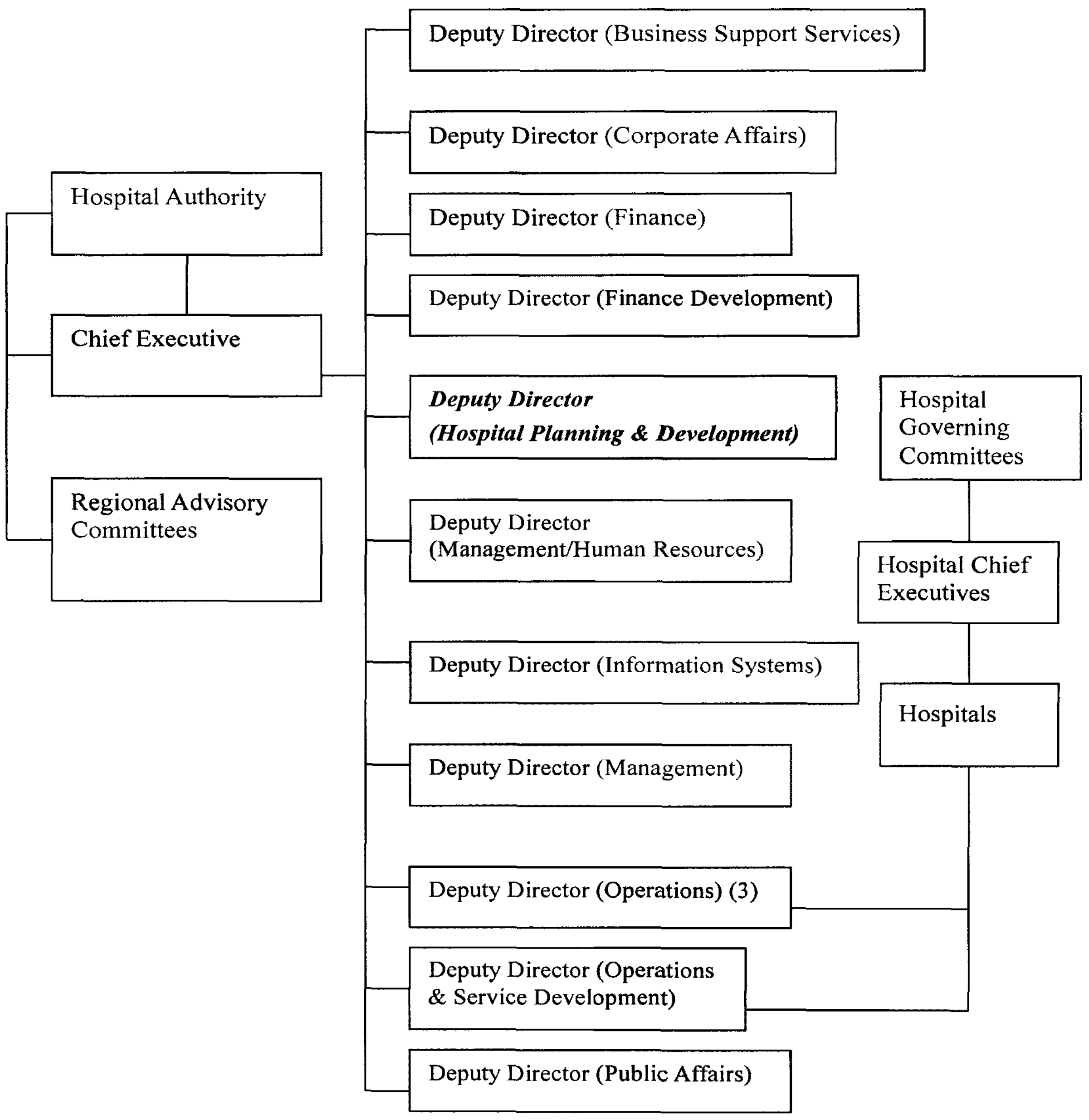
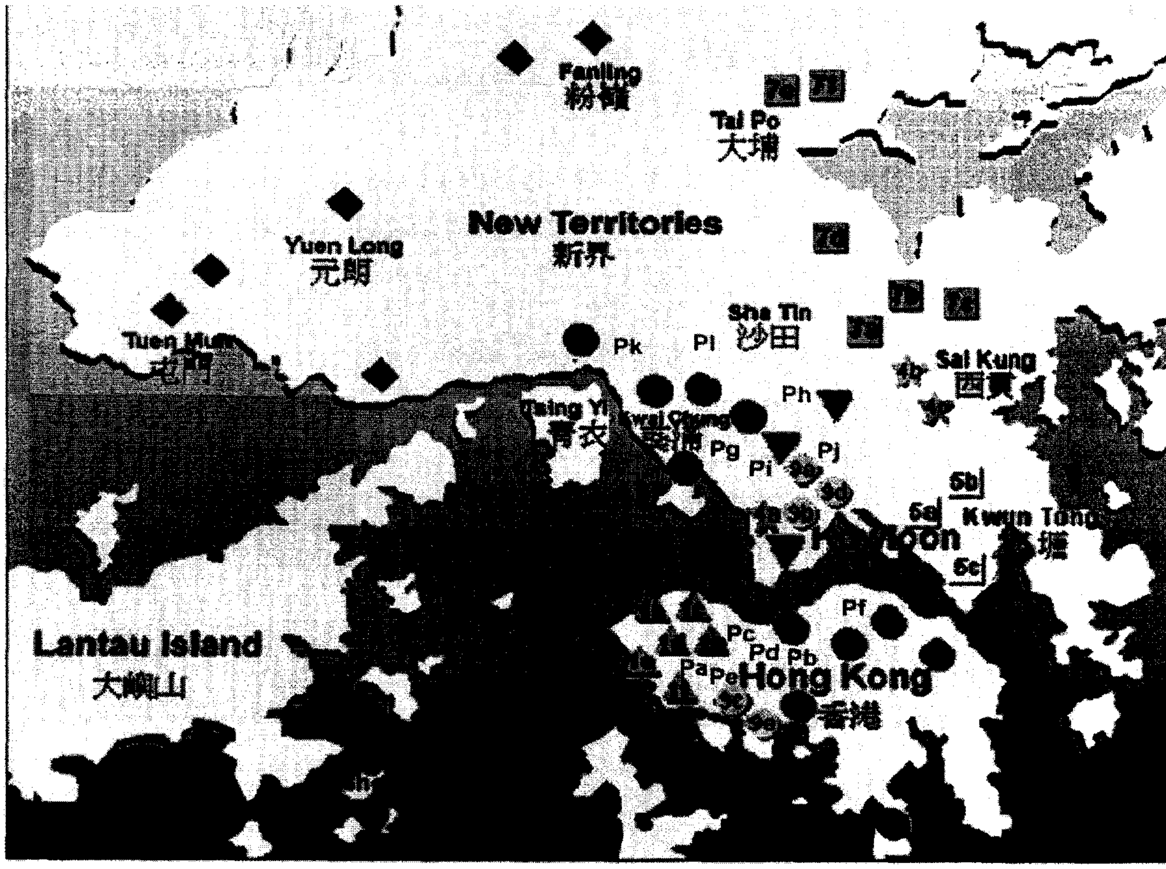


Figure 2.7 Structure of the Hospital Authority



Public Hospital (Hong Kong Island)
1a) Queen Mary Hospital 1b) Tsan Yuk Hospital
1c) Tung Wah Hospital 1d) Fung Yiu King Hospital
1e) Duchess of Kent Children's Hospital
1f) MacLehose Medical Rehabilitation Centre
2a) Pamela Youde Nethersole Eastern Hospital
2b) Tang Shiu Kin Hospital 2c) Ruttonjee Hospital
2d) Tung Wah Eastern Hospital 2e) St. John Hospital
2f) Cheshire Home (Chung Hom Kok)
2g) Wong Chuk Hany Hospital
Private Hospital
Pa) Canossa Hospital (Caritas)
Pb) Hong Kong Adventist Hospital
Pc) Hong Kong Central Hospital
Pd) Hong Kong Sanatorium & Hospital
Pe) Matilda International Hospital
Pf) St. Paul's Hospital
Pg) Hong Kong Baptist Hospital
Ph)Evangel Hospital
Pi)Precious Blood Hospital (Caritas)
Pj) St. Teresa's Hospital
Pk) Tsuen Wan Adventist Hospital
Pl) Union Hospital

Public Hospital (Kowloon)
3a) Queen Elizabeth Hospital 3b) Kowloon Hospital
3c) Hong Kong Buddhist Hospital 4a) Kwong Wah Hospital
4b) Wong Tai Sin Hospital 4c) Our Lady of Maryknoll
5a) United Christian Hospital 5b) Haven of Hope Hospital
5c) Tseung Kwan O Hospital
Public Hospital (New Territories)
6a) Princess Margaret Hospital 6b) Kwai Chung Hospital
6c)Caritas Medical Centre 6d)Lai Chi Kok Hospital
6e) Yan Chi Hospital 7a) Prince of Wales Hospital
7b) Shatin Hospital 7c) Cheshire Home (Shatin)
7d) Bradbury Hospice
7e) Alice Ho Miu Ling Nethersole Hospital
7f) Tai Po Hospital 8a) Tuen Mun Hospital
8b) Pok Oi Hospital 8c) Fanling Hospital
8d) Castle Peak Hospital 8e) Siu Lam Hospital
8f) North District Hospital
Others Public Hospitals and Institutions
9a) Hong Kong Red Cross Blood Transfusion Services
9b) Rehabaid Centre 9c) Grantham Hospital
9d) Hong Kong Eye Hospital 9e) Nam Long Hospital

Figure 2.8 Map showing the distribution of hospitals and institutions in Hong Kong

2.5 HEALTHCARE EXPENDITURE AND FINANCING

Hong Kong has a relatively simple system for financing healthcare. There is no government health insurance system or any hypothecated health tax. But all Hong Kong residents are eligible to receive care, for free or at a heavily subsidized rate from the government. The services provided by the public sector (90% of inpatient care, 15% of outpatient care and most of the preventive and rehabilitative care) are financed almost entirely through general revenues (Grant and Yuen, 1998). For the private sector, direct payment is the dominant mode of financing.

2.5.1 Healthcare Expenditure

Table 2.5 shows the expenditures of the Department of Health and the Hospital Authority in the period 1995 to 1999. Table 2.6 presents the estimated amount of expenditure on capital works by the Hospital Authority. It shows that the budget set for capital works started falling in 2000, due to the serious budget deficits of the HKSAR government. A budget of HK$7770.01 million, including 17 new buildings or improvement projects by the HA (with an estimated value exceeding HK$15 million), was approved in September 2003. Two projects were planned, with the funds for them earmarked in 2002, totalling 518 million. Five projects totalling 1,953.941 million have been completed. Ten projects totalling 7,252.01 million are under construction and under the separate charge of the Architectural Services Department (ASD) and the Hospital Authority (HA). These projects include an expansion of hospital facilities, an expansion or improvement of patient services, hospital improvement, refurbishment, and redevelopment.

Table 2.5 Expenditures of the Department of Health and the Hospital Authority

	1996/97	*1997/98*	*1998/99*	*1999/00*	*2000/01*	*2001/02*
	'000	'000	'000	'000	'000	'000
Department of Health	2,315	2,619	2,945	2,980	3,034	3,198
Hospital Authority	21,595	24,221	26,903	27,908	28,723	30,478
Medical Subventions under the Department of Health	212	243	261	289	262	269
Total	**24,122**	**27,081**	**30,109**	**31,177**	**32,019**	**33,945**

Source: Census and Statistics Department. Hong Kong Annual Digest of Statistics 2003 Edition. PDHKSARG 2003 p. 310. Table 13.22

Table2.6 Estimated amount for capital works by Hospital Authority, 1997 – 2002

Year	Estimate Amount (Million$)
1997-1998	21,306.746
1998-1999	17,836.428
1999-2000	15,687.929
2000-2001	16,152.794
2001- 2002	12,764.758

Source: Hospital Authority (2004), www.ha.org.hk

2.5.2 Healthcare Financing

The construction and provision of healthcare buildings and facilities in Hong Kong are mainly financed by the government through the *Capital Works Reserves Fund* and *Capital Subventions and Major Systems and Equipment,* respectively. The amount and breakdown of these two streams of funding are presented in Table 2.7.

Table 2.7 Healthcare funding, 1989 – 2004

Year	*Capital Works Reserve Fund – approved project estimates ($'000)*		*Capital Subventions and Major Systems and Equipment – approved project estimates ($'000)*
	Clinics	*Hospitals*	
1989-1990	78,695	3,774,056	2,599,283
1990-1991	285,708	4,514,141	2,863,550
1991-1992	206,195	5,140,075	2,863,550
1992-1993	186,200	4,995,350	3,395,867
1993-1994	186200	5843100	3,387,572
1994-1995	215,500	7,506,879	4,220,194
1995-1996	593,990	9,444,044	5,086,048
1996-1997	794,130	9,780,619	5,578,658
1997-1998	844,680	9,476,450	8,664,439
1998-1999	668,480	9,342,050	9,860,390
1999-2000	1,981,480	9,221,690	14,068,506
2000-2001	2,202,437	7,842,740	13,892,602
2001-2002	2,083,437	8,804,740	13,298,360
2002-2003	2,002,157	7,641,090	13,223,907
2003-2004	1,748,757	7,335,650	16,072,856

Source: Finance Bureau. Estimates for the year ending 31st March 1990 … 2004

2.5.3 Trend of Expenditures

The trend in healthcare expenditures in the public sector since 1981 is shown in Table 2.8. It demonstrates that public sector expenditures over the past years have increased significantly in absolute terms as a percentage of total public expenditure, and as a percentage of GDP. In 1981, health expenditures on the public sector consumed only 7.6% of the government budget as compared to

12.4% in 2002/03. In terms of percentage of GDP, it rose from 1.2% in 1981 to 2.1% in 1996/07, and to 2.7% in 2002/03. It is clear that there is a rising trend in expenditures on healthcare in the public sector. The Harvard Team (1999) suggested that public health expenditures will increase from their current level of 2.5% of GDP to between 3.4 and 4.0% of GDP by the year 2016. This means that in the next 18 years, public healthcare expenditures may take up 20 to 23% of the total government budget, a significant increase of 14%.

In conclusion, Hong Kong enjoys a relatively simple system for financing healthcare for the public, which is funded by general revenues and entails minimal changes. Approximately 5% of GDP is spent on healthcare each year. Most inpatient care is provided through the public sector. Such expenditures are expected to rise steadily over the next two decades.

Table 2.8 Public healthcare expenditures, 1981 – 2002

Year	*Recurrent Health Expenditure in the Public Sector (HK$M)* (1)	*Capital Health Expenditure in the Public Sector (HK$M)* (2)	*Total Public Expenditure on Healthcare (HK$M)* (3)=(1)+(2)	*Total Public Expenditure (HK$M)* (4)	*Total Public Expenditure on Healthcare as % of Total Public Expenditure* (5)=(3)/(4)	*Total Public Expenditure on Healthcare as % of GDP* (6)=(3)/GDP
1981-1982	1769.7	344.4	2114.1	27778.2	7.6	1.2
1982-1983	2196.3	195.2	2391.5	34597.8	6.9	1.3
1983-1984	2536.6	188.7	2725.3	33393.1	8.2	1.5
1984-1985	3017.0	295.1	3312.1	39881.7	8.3	1.3
1985-1986	3439.3	327.6	3766.9	43444.0	8.7	1.4
1986-1987	3948.8	517.9	4466.7	47930.9	9.0	1.4
1987-1988	4192.4	729.0	4921.4	53635.8	9.2	1.3
1988-1989	4933.2	739.4	5672.6	64798.6	8.8	1.3
1989-1990	6093.0	1214.0	7307.0	81945.0	8.9	1.5
1990-1991	7724.0	1563.0	9287.0	95198.0	9.8	1.7
1991-1992	9785.0	1379.0	11164.0	108422.0	10.3	1.7
1992-1993	12340.0	1296.0	13636.0	123493.0	11.0	1.8
1993-1994	14520.0	3937.0	18457.0	155207.0	11.9	2.2
1994-1995	17027.0	2295.0	19322.0	165950.0	11.6	1.9
1995-1996	19963.0	4322.0	24285.0	191338.0	12.7	2.2
1996-1997	22702.0	2461.0	25163.0	211248.0	11.9	2.1
1997-1998	26032.0	1950.0	27982.0	234780.0	11.9	2.1
1998-1999	28790.0	2610.0	31400.0	266448.0	11.8	2.5
1999-2000	29909.0	1865.0	31894.0	269484.0	11.8	2.6
2000-2001	30509.0	2244.0	32753.0	267507.0	12.2	2.5
2001-2002	31960.0	2253.0	34213.0	269359.0	12.7	2.7
2002-2003	32462.0	1439.0	33901.0	273055.0*	12.4	2.7

* Estimated value

Source: HKSARG. Hong Kong 1983 ... Hong Kong 2002

2.6 SUMMARY OF THE CHAPTER

In this chapter, the healthcare system in Hong Kong is briefly introduced. Because of a growing and ageing population, rising community expectations for services from the Hospital Authority and advances in medical technology, the existing healthcare system is coming under greater pressure. After its establishment, the Hospital Authority became a major leader in the provision of health services, as well as in the construction of new public hospitals. The importance of the Hospital Authority and its contributions cannot be neglected.

CHAPTER THREE

LITERATURE REVIEW OF PROLEMS IN RUNNING HEALTHCARE PROJECTS

3.1 INTRODUCTION

The purpose of this chapter is to provide a comprehensive literature review on the characteristics and problems on running healthcare projects. The definition of healthcare projects is firstly provided. The characteristics of managing healthcare projects are then presented. Finally, six common problems in managing healthcare projects are formulated.

3.2 DEFINITION OF HEALTHCARE PROJECTS

Healthcare buildings are essential to the society and the general public. A good ordering of the environment is conducive to good health, and a poor design is not (Bush-Brown, 1992). Therefore, a good design can be of fundamental importance, and it can support personal, social, and technical services (Bush-Brown, 1992). Besides a good design, the end users' requirements must be taken into account fully to make an ideal healthcare building.

Hospital is traditionally defined as the institutionalized care for the sick and as a warehouse for the sick (Miller and Swensson, 2002). A hospital has different connotations for different people (Marberry, 1995). To some, a hospital means wellness, sports, and physical therapy. To others, it means laboratories, research, surgery or chronic illness. However, Cox and Groves (1981) defined healthcare buildings as buildings that provide healthcare, fulfilling many different functions and accommodating the whole life span of human being. Healthcare is a more positive term than the treatment of sick people. As the goal of healthcare is to enhance the quality of life, healthcare facilities range from the medical practitioner's office, to general acute-care centres, and long-term-care facilities (Ruga, 1992). Cox and Groves (1981) further suggested that a healthcare building provides the services to people at all social classes and medical needs, through to local clinics and health centres, to small hospitals, general hospitals, teaching hospitals and special services for mental illness and mental handicaps.

3.3 CHARACTERISTICS OF RUNNING HEALTHCARE PROJECTS

A large district hospital is no longer a simple building, but rather functions as a small town because it provides different specialised but necessary facilities and services for people living there (Chan & Chan, 1999). In order to provide an efficient and effective medical cure and operation to the public, hospitals are highly serviced with up-to-date medical equipment, and electrical and mechanical installation. The design of this type of building requires extraordinary considerations of special functions, medical techniques being employed, and the social and economic conditions prevailing at the time (Wong, 1983 cited in Lam et al., 1997a). Healthcare projects exhibit the following distinguishing characteristics (Lam et al., 1997b; Chan et al., 2003a and 2003b):

3.3.1 Complexity of highly serviced buildings

For the purpose of providing effective and accurate cure to the public, hospitals are required to incorporate the most up-to-date medical technology and modern hospital engineering services requirements. Therefore, complex building services, particularly in medial technology, account for a greater percentage of the costs for modern hospitals. On average the cost for building services can be as high as 40-50% of construction cost (Nelson, 1990). For instance, the construction costs are approximately 40% and 45% in Tseung Kwan O Hospital and United Christian Hospital Extension Hospital respectively. In the project of the North District Hospital, there are approximately sixteen building services installation items, including heating, ventilating, electricity, lifts, communication; some of which are unique in hospital projects, such as the medical and non-medical gas, operating theatre fixed services, pneumatic tube, etc. The cost of building services is worth about 45% of the total contract sum.

3.3.2 Up-to-date technology required

Apart from the high complexity and the requirement for complete integration of diverse and intricate building services, the functions of the hospital are equally complex (Lam et al., 1997b). The functions should satisfy the disparate demands of the general public and the highly trained staff who operate the facility. Therefore, the functional performance requirements and the quality of construction are exceptionally high. For a perfect hospital, building services must satisfy the hospital's functional requirements. These, however, should follow developments in clinical practice and changes in medical technology. This means that the target is constantly and quickly moving. Hence, hospital design should be flexible, but it is also difficult and expensive.

3.3.3 Multiple end-users

The hospital is different from other buildings in that it involves many different end-users. The ultimate users of the healthcare building are not homogeneous but comprise of enormous end-users. Different kinds of patients, nurses and doctors can be the end-users in the hospital. Since hospitals are built for serving and protecting the health of the public, different medical facilities and functional rooms with different medical equipment should be provided. This is because only the specialists with experts and medical practitioners are familiar with those specialised facilities and medical equipment. Thus, when designing a hospital, design consultants need to consult with the different specialists in order to understand each function room thoroughly. The contractors also need to discuss the detail drawings with numerous end-users during the construction stage. In the case of Tseung Kwan O Hospital, there were over a hundred of end-users.

3.3.4 Many participants

Lam et al. (1997b) stated that hospital design and construction involves many participants, experts and others, who have to be managed and controlled effectively. A high degree of cooperation between project participants and a good team spirit are essential.

3.3.5 Effective coordination systems

Since there is a large amount of building services works required in healthcare buildings, effective coordination systems are required and crucial to project success (Gibb et al., 1996). Moreover, as there are various departments requiring different building services systems, coordination meetings must be held regularly not only between the architect and building services engineers, but also between contractors and other sub-contractors/specialist and end-users. Considering the case of the North District Hospital, meetings between end-users and contractor had been held for nearly one year and the number of engineers involved in building services installation was over twenty.

3.3.6 Public accountability

Most healthcare projects are publicly funded. Healthcare projects are therefore subject to the close scrutiny of the general public. Once the construction of a hospital is announced, the time and budgets are settled and not easy to change. The designers and contractors have to work against a tight time schedule and defined budgets.

3.4 COMMON PROBLEMS IN MANAGING HEALTHCARE PROJECTS

Wilkins and Smith (1996) advocated that healthcare projects, especially publicly funded hospitals, take a longer time to deliver to the community than other construction projects. These long delivery times consist of lengthy pre-construction and post-contract periods. These unfavourable consequences were mainly due to their complexity, long design and construction periods, ongoing developments in healthcare planning and technology, and the need for high accountability (Shearer and Gray, 1994; Wickings and Shearer, 1994; Baker, 1995; Coile, 1995; Sale, 1995; Strickland, 1996; Wilkins, 1997). Smith and

Wilkins (1995) identified the factors of inadequate coordination of end-user requirements and pressure of accountability to the Government as the main problems in healthcare projects. Wilkins (1997) further identified that the difficulty of coordinating end-user requirements and minimizing subsequent changes, together with the consequent delays and unforeseen extra costs, have been the key features of hospital construction. Review of the literature reveals that common problems in managing healthcare projects can be grouped under the following six headings (Gibb et al., 1996; Lam et al., 1997a & 1997b; Chan and Chan, 1999; Chan et al., 2000a, 2003a, 2003b, 2003c & 2004): -

3.4.1 Uncertainty in design briefs

Building services affect the building structure, and both the interior and exterior spaces (Wong, 1983). Therefore, the analysis of services requirements should be made as precise as possible. In order to achieve smooth and efficient operation of healthcare buildings, the design and installation of building services must be fully integrated and coordinated into the architectural and structural designs. Hence, the architectural and structural design implications arising from building services engineering decisions should also be exhaustively examined as early as possible. A clear and detailed design brief, however, may not be available at the time of preparing schematic designs. The formulation of a design brief even often tends to be uncoordinated and may be either incomplete or differently perceived by the different parties involved in the design (Wilkin and Smith, 1996). Also, the advances in medical and information technology will result in significant and continuing changes in hospital design (Wilkins, 1997). The uncertainties in design brief induce problems for the precise analysis of the services' requirement and it affects the post-contract period by means of variations, cost overruns and project delays (Chan and Yeong, 1995).

3.4.2 Integration and coordination problems

Healthcare buildings, especially hospitals, are highly complicated services buildings. For a sophisticated hospital, the building services design must find a balance between the hospital's functional requirements and the on-going developments in clinical practice and changes in medical technology (Chan et al., 2003a & 2003b), hence flexibility of the design is of crucial importance. However, the problems and conflicts associated with the integration of building services are still more common than any other problems found during the course of a project, though recognised for what they are, coordination problems continue to persist in the design and construction processes (Lam et al., 1998). Nelson (1990), as cited in Lam et al. (1997b), states that despite the importance of the services elements, traditional practices from the drawings board to the construction site still fails to fully recognize the importance of integration and coordination of building services. Therefore, Gibb et al. (1996) concluded that the complicated hospital engineering services requirements have resulted in a great deal of criticisms of the inordinate time to design and construct hospitals, and cost increase in the delivery of new hospitals.

3.4.3 The procurement and installation of medical equipment

Medical equipment is an important component in healthcare projects. Normally, the procurement of the medical equipment is made by the hospital administrators because the equipment is used by the respective hospitals. However, some equipment is required to be installed during the construction stage and it becomes the sole responsibility of the contractor or suppliers. Hence, in most cases, the procurement of the medical equipment is separated from its installation and is handled by two different companies. Parsloe (1994) pointed out that the process of selecting major plant and equipment items, and the design of the building services system are interdependent. Therefore, one of the greatest difficulties, as cited by Penn (1992) is the coordination between the procurement of, and the installation and commissioning of, the medical equipment.

3.4.4 Changes from multi-headed clients and various end-users

Wilkins and Smith (1996) stated that hospital clients, particularly those of publicly funded hospitals, typically involve a large number of end-users and committees, and a protracted approval process. End-users play a dominant role on the hospital design and medical equipment selection due to their specialised medical knowledge. Each of them has a narrow specialist view, but demands equal voice in the design of a hospital. Therefore, a longer briefing process and design period is usually needed, as the design information from a multi-headed client is difficult to obtain during the early stage of the project. This greatly prolongs the pre-construction period. Furthermore, to catch up with the medical advances, request from end-users for changes to the design layout during the construction stage is common, and these will certainly extend the construction time. Fast moving changes in medical technology can make the proposed selection of machinery and techniques obsolete within the stipulated duration of the construction period, and this results in frequent changes of contract specifications. Changes initiated by the end-users are the main source of uncertainty, and the problems of project delay, disruption and additional cost then arise.

3.4.5. Ambiguities in the allocation of design responsibilities

The construction of a building services installation involves a combination of design and installation knowledge which may be drawn from engineers working in different organisations under a variety of contractual arrangements (Parsloe, 1994 and Lam et al., 2003). Therefore, building services design is an evolving process to which professional designers, specialist designers, manufacturers, installation managers and site tradespersons need to contribute. The allocation of design responsibilities for building engineering services must be fully recognised. Parsloe (1994), as cited in Lam et al. (1997b) contended that the successful completion of a project is only possible when there is resolve on both sides to work together to produce the best possible solution, in the coordination of services design and installation. However, a formalised method of clarifying and communicating the division of responsibilities is deficient in common industrial practice. Parsloe (1994), cited in Lam et al. (1997b), concluded that ambiguity over design responsibilities can become the cause of serious conflicts resulting in project delays, increased contractual claims and increased litigation. Gibb (1995) further stated that problems on complex healthcare projects tend to concentrate around the interfaces and therefore interface management is extremely important.

3.4.6 Tight programmes and limited budgets

The provision of healthcare buildings is normally subject to tight time schedules, closely defined budgets, and high quality standards (Gibb et al., 1996). These inter-related but often conflicting objectives create great pressure for the designers and contractors. It has a profound influence upon the selection of the project teams, and thus, the coordination of services at both the design and installation stages (Lam et al., 1997b; Chan et al., 2003a & 2003b). Time spent on project accounting to the Government also affects the project progress and its performance. However, most healthcare projects are still based on a traditional procurement path, which does not fully meet clients' requirements for time performance (Lam et al., 1997a). For example, plans for the construction of a new hospital to meet the increasing demand in the northern part of the New

Territories were initiated by the Hospital Authority in 1992. The launch of the hospital was announced in March 1993, and it had to be completed in June 1997 - a period of just over four years. The time allowed to complete this project was very tight, and it was also under the spotlight of public concern.

3.5 SUMMARY OF THE CHAPTER

In this chapter, the definition of healthcare buildings is firstly introduced. From the literature review, the characteristics on running healthcare projects, including complexity of highly serviced building, a large number of end-users and participants, up-to-date technology, effective coordination system and public accountability, are identified. These features, in turn, create problems that project managers need to face, such as the uncertainty of design brief, integration and coordination problems, changes from the multi-headed clients, and medical equipment procurement, ambiguity in allocation of design responsibilities, tight programme and limited budget.

CHAPTER FOUR

LITERATURE REVIEW OF THE CRITERIA FOR THE SUCCESS OF CONSTRUCTION PROJECTS

4.1 INTRODUCTION

The construction industry is dynamic in nature. The concept of project success has remained ambiguously defined in the construction industry. Many project managers still attend to this topic in an intuitive and ad hoc fashion as they attempt to manage and allocate resources across various project areas (Freeman and Beale, 1992). Project success is almost the ultimate goal for every project. However, it means different thing to different people. While some writers consider time, cost and quality as predominant criteria, others suggest that success is something more complex. The aim of this chapter is to develop a framework for measuring success of healthcare projects. The materials in this chapter provide a useful framework for measuring and comparing project performance for future studies. They also furnish project managers, clients and other project stakeholders useful information to implement a project successfully.

4.2 CRITERIA FOR PROJECT SUCCESS

Munns and Bjeirmi (1996) considered a project as the achievement of a specified objective, which involves a series of activities and tasks that consume resources. From the Oxford Dictionary (1990), a criterion is defined as standard of judgement or principle by which something is measured for value. Lim and Mohamed (1999) advocated a criterion as a principle or standard by which anything is or can be judged. The Oxford Dictionary further defines success as a favourable outcome or the gaining of fame or prosperity. When combining these terms together, criteria of project success can be defined as *the set of principles or standards by which favourable outcomes can be completed within a set specification.*

Project success means different things to different people. Each industry, project team or individual has its own definition of success. Pariff and Sanvido (1993) considered success as an intangible perceptive feeling, which varies with different management expectations, among persons, and with the phases of project. Owners, designers, consultants, contractors, as well as sub-contractors have their own project objectives and criteria for measuring success. For example, architects often consider aesthetics rather than building cost as the main criterion for success. However, clients may value other dimensions more. Moreover, even the same person's perception on success can change from project to project. Definitions on project success are dependent on project type, size and sophistication, project participants and experience of owners, etc (Chan and Chan., 2004).

4.3 ASSESSMENT OF PROJECT SUCCESS BY PREVIOUS RESEARCHERS

Over the last ten years, a number of researchers have shown intense interests in this topic. Chan (1996; 1997) undertook a comprehensive review of measurement of project success in the late 1980s and the early 1990s. More literature has emerged since Chan's review. By extending a critical review of project success in the last decade, the gap could be bridged.

4.3.1 Iron triangle – Time, Cost and Quality

In the early 1990s', project success was considered to be tied to performance measures, which in turns were tied to project objectives. At the project level, success was measured by the project duration, monetary cost and project performance (Navarre and Schaan, 1990). Time, cost and quality are the basic criteria to project success, and they are identified and discussed in almost every article on project success, such as Walker (1995; 1996), Belassi and Tukel (1996) and Hatush and Skitmore (1997). Atkinson (1999) called these three criteria the 'iron triangle'. He further suggested that while other definitions on project management have been developed, the iron triangle is always included in the alternative definitions.

4.3.1.1 Time

'Time' refers to the duration for completing the project. It is scheduled to enable the building to be used by a date determined by the client's future plans (Hatush and Skitmore, 1997). Related to 'time' is the concept of 'effectiveness'. Alarcon and Ashley (1996) defined effectiveness as a measure of how well the project was implemented or the degree to which targets of time and cost were met from the start-up phase to full production. They proposed to include time as a criterion for project success.

4.3.1.2 Cost

Cost is another important measure. Cost is defined as the degree to which the general conditions promote the completion of a project within the estimated budget (Bubashait and Almohawis, 1994). Cost is not only confined to the tender sum only, it is the overall cost that a project incurs from inception to completion, which includes any costs arise from variations, modification during construction period and the cost arising from the legal claims, such as litigation and arbitration.

4.3.1.3 Quality

Quality is another criterion that is repeatedly cited by previous researchers.

However, the assessment of quality is rather subjective. In the construction industry, quality is defined as the totality of features required by a product or services to satisfy a given need; fitness for purpose (Parfitt and Sanvido, 1993). Nowadays, quality is the guarantee of the products that convinces the customers or the end-users to purchase or use. The meeting of specification is proposed by Songer et al. (1996) and Wateridge (1995) as one way to measure quality. They defined specification as workmanship guidelines provided to contractors by clients or clients' representatives at the commencement of project execution. The measure of technical specification is to the extent that technical requirements specified can be achieved. Actually, technical specification is provided to ensure that buildings are built in good standard and in proper procedure. Freeman and Beale (1992) extended the definition of technical performance to scope and quality. Hence meeting technical specification is grouped under the 'quality' category.

4.3.2 Satisfaction Level

Pinto and Pinto (1991) advocated that measures for project success should also include project psychosocial outcomes which refer to the satisfaction of interpersonal relations with project team members. Subjective measures such as participants' satisfaction level are known as the 'soft' measure. The inclusion of satisfaction as a success measure is suggested by Wuellner (1990). Sanvido et al. (1992) suggested nine criteria most concerned by client for measuring project success, one is 'function for intended use', simply is 'functionality'. This term has the meaning of conform and satisfy the users' expectations (Sanvido et al, 1992; Songer and Molenaar, 1997).

4.3.2.1 Functionality (User expectations and Satisfaction)

Kometa et al. (1995) opine that there would be no point in undertaking a project if it does not fulfil its intended function at the end of the day. The importance of functionality is highlighted. This indicator correlates with expectations of project participant and can best be measured by the degree of conformance to all technical performance specifications (Chan et al., 2000b). Quality, technical performance, and functionality are closely related and are considered important to the owner, designer, and contractor. Besides, a number of researchers have included users' expectation as an important criterion. Users are those who actually work or live in the final products. They are the ones who spend most of time in the constructed facilities. It is essential that the completed projects meet the users' expectation and satisfaction. Liu and Walker (1998) consider satisfaction as an attribute of success. Torbica and Stroh (2001) believe that if end-users are satisfied, the project can be considered being successfully completed in the long run. This measure is placed in the second stage (maintenance period), as the users will normally be involved after the project is completed.

4.3.2.2 Client's and participants' level of satisfaction

Participants' satisfaction has been proposed as an important measure in the last decade (Sanvido et al., 1992; Parfitt & Sanvido, 1993 and Cheung et al., 2000). Key participants in a typical construction project include client, design team leader and construction team leader.

4.3.3 Legal Claims, Safety, Environmental Friendliness, and Profit

Pocock et al. (1996) suggested to include the absence of legal claims as an indicator of project success. This then calls for including 'safety' as a success indicator as well, since it is reasonable to expect that if accidents occur, both contractors and clients may be subject to legal claims, as well as financial loss and contract delay in the construction. project. Kometa et al. (1995) used a comprehensive approach to assess project success. Their criteria include: safety, economy (construction cost), running/maintenance cost, time and flexibility to users. Songer and Molenaar (1997) considered a project as successful if it is completed on budget, on schedule, conforms to users' expectations, meets specifications, attains quality workmanship and minimises construction aggravation. Kumaraswamy and Thorpe (1996) included a variety of criteria in their study of project evaluation. These include meeting budget, schedule, and quality of workmanship, client and project manager's satisfaction, transfer of technology, friendliness of environment, health and safety.

4.3.3.1 Value and profits

Alarcon and Ashley (1996) defined the measure of value as evaluating the satisfaction of owner's needs in a global sense. It includes the realization for the owner of quantity produced, operational and maintenance costs, and flexibility. It can be considered as 'business benefit' derived from the completed project. Most projects are profit-oriented. The clients and developers try to maximise profit. Therefore, value and profit is an important success criterion, especially in the handover stage where value and profit materialise.

4.3.3.2 Health and safety

Health and safety are defined as the degree to which the general conditions promote the completion of a project without major accidents of injuries (Bubshait and Almohawis, 1994). The issue of safety has been raised for a long time (Sanvido et al., 1992; Parfitt & Sanvido, 1993 and Kometa et al., 1995) and cannot be overlooked. The measurement of safety is mainly focused on the construction period as most accidents occur during this stage.

4.3.3.3 Environmental friendliness

Construction industry has been regarded as a major contributor to environmental impacts. Construction projects affect the environment in numerous ways across their life cycle (Shen et al., 2000). For example, 14 million tonnages of waste have been put into landfill in Australia each year, of which 44% came from the construction/demolition industry (Songer and Molenaar, 1997). About 62-86% domestic productions of non-metallic minerals, such as glass, cement, clay, and lime and so on in developing regions are consumed by the construction industry

(UNIDO, 1985). The Technical Committee (TC) formed in January 1993 by the International Organization for Standardization (ISO) developed a series of standards known as ISO14000 series to provide guidance on environmental management. ISO14000 provides a benchmark of a proper environmental management practice. Environmental issues are a global concern. The UN and some economics blocs such as the European Community and ASEAN have introduced environmental protection model laws or directives to member countries (Wong and Chan, 2000). Therefore, the level of environmental friendliness is also considered as a performance measure.

4.4 MODELS BY PREVIOUS RESEARCHERS ON ASSESSING THE SUCCESS OF PROJECTS

There are various models on assessment on project success advocated in these ten years period. Each has its own features and content. The followings are some models selected, and from the following models, the history and changes of concept of project success could be identified.

4.4.1 Shenhar et al. (1997)

Shenhar et al. (1997) proposed that project success is divided into four dimensions. As shown in Figure 4.1, these four dimensions are time-dependent. The first dimension is the period during project execution and right after project completion. The second dimension can be assessed shortly afterwards, when the project has been delivered to the customer. The third dimension can be assessed after a significant level of sales has been achieved (1-2 years). Finally the fourth dimension can only be assessed 3-5 years after project completion.

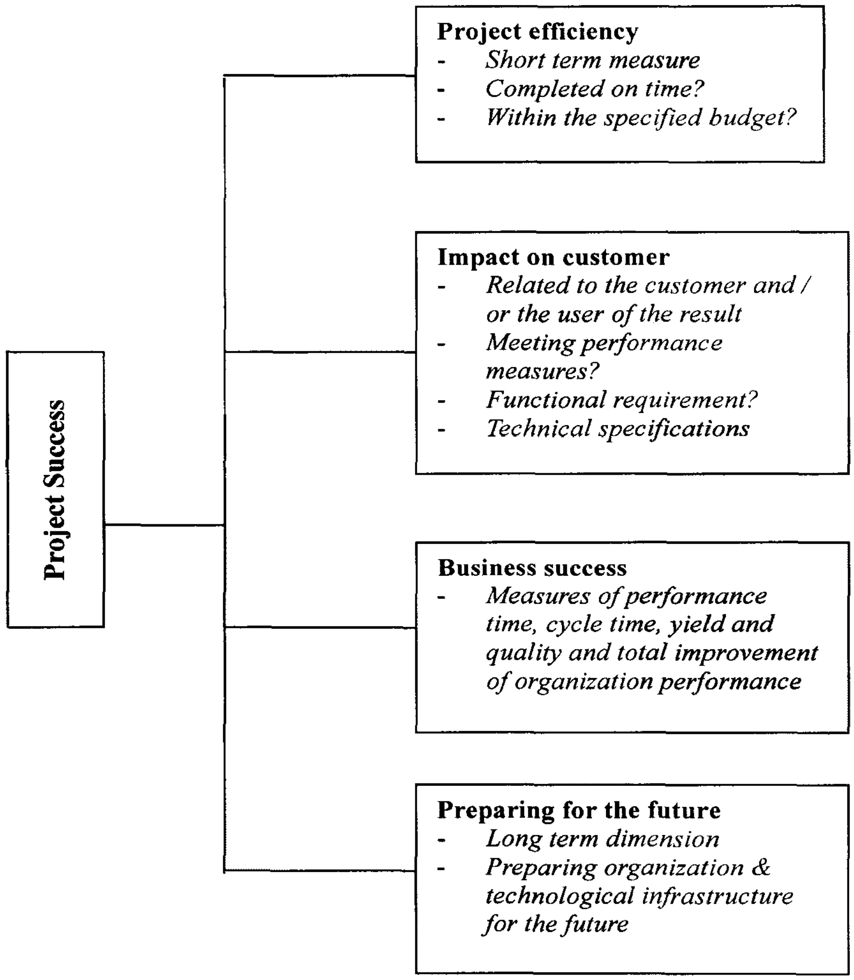


Figure 4.1 The four dimensions of a successful project (Shenhar et al., 1997)

4.4.2 Atkinson (1999)

Atkinson (1999) similarly divided project success into three stages: the first stage is 'the delivery stage: the process: doing it right'; the second is 'post delivery stage: the system: getting it right' and the last stage is 'the post delivery stage: the benefits: getting them right'. Figure 4.2 is used to show Atkinson's model of measuring project success.

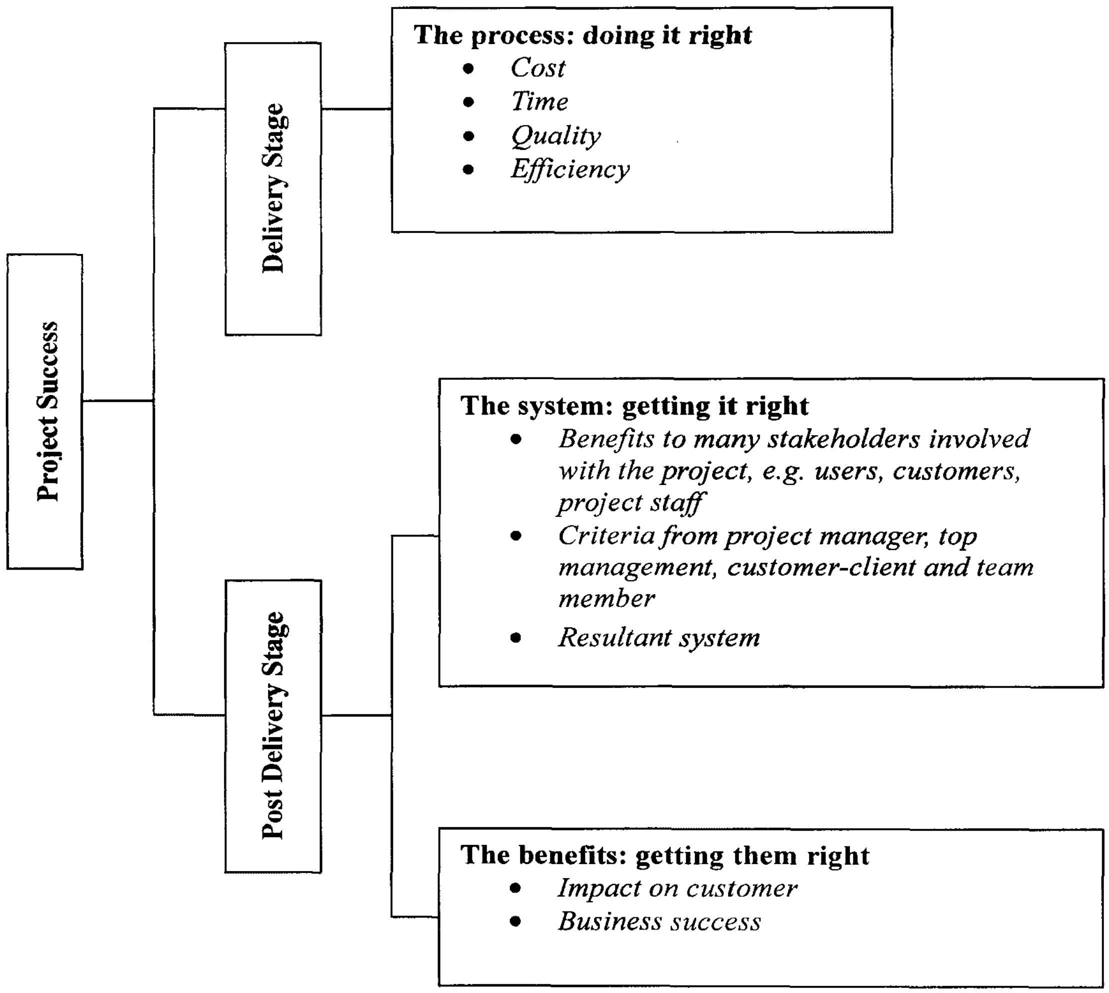


Figure 4.2 Atkinson's model of measuring the success of projects (Atkinson, 1999)

4.4.3 Lim and Mohamed (1999)

Lim and Mohamed (1999) believed that project success should be viewed from different perspectives of the individual owner, developer, contractor, user, and the general public and so on. The authors proposed to evaluate project success from both the macro and micro viewpoints. Figure 4.3 shows two viewpoints of project success.

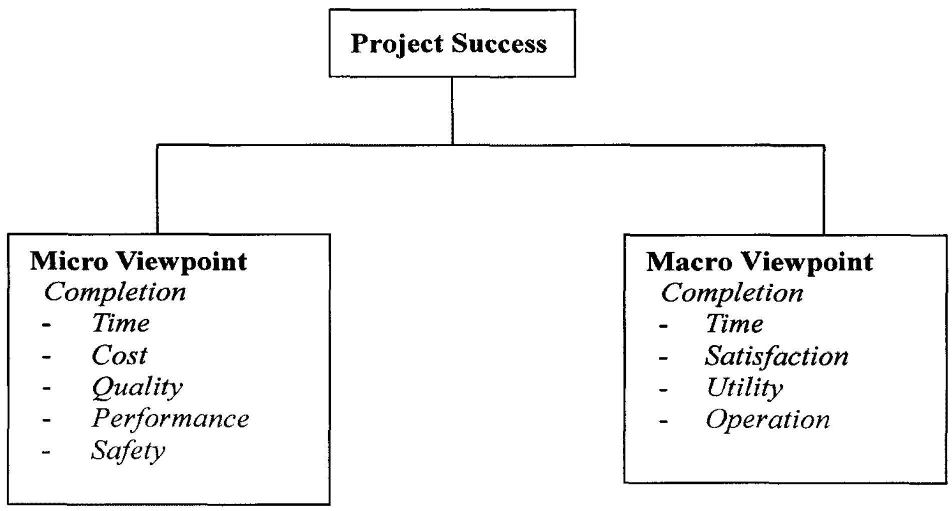


Figure 4.3 Micro and Macro Viewpoints of the Success of projects (Lim and Mohamed, 1999)

4.4.4 Sadeh et al. (2000)

Sadeh et al. (2000) divided project success into four dimensions. The first dimension is meeting design goals, which applies to contract that is signed by the customer. The second dimension is the benefit to the end user, which refers to the benefit to the customers from the end products. The third dimension is benefit to the developing organization, which refers to the benefit gained by the developing organization as a result of executing the project. The last dimension is the benefit to the technological infrastructure of the country and of firms involved in the development process. The combination of all these dimensions gives the overall assessment of project success. Table 4.1 shows the success dimensions and measures.

Table 4.1 Dimensions and Measures of Success (Sadeh et al., 2000)

Success Dimension	Success Measures
Meeting design goals	Functional specifications Technical specifications Schedule goals Budget goals
Benefit to the end user	Meeting acquisition goals Answering the operational need Product entered service Reached the end user on time Product has a substantial time for use Meaningful improvement of user operational level User is satisfied with product
Benefit to the developing organization	Had relatively high profit Opened a new market Created a new product line Developed a new technological capability Increased positive reputation
Benefit to the defence and national infrastructure	Contributed to critical subjects Maintained a flow of updated generations Decreased dependence on outside sources Contributed to other projects
Overall success	A combined measure for project success

4.5 PROPOSED MODELS ON ASSESSING THE SUCCESS OF ROJECTS

From the literature review, it was found that researchers have proposed different criteria for measuring project success over the last decade. Table 4.2 summarises the various measures that were developed by previous research. After incorporating and regrouping the views of various researchers, a consolidated framework for measuring success of construction projects is produced in Figure 4.4. The consolidated framework is used to measure project success in this study.

Table 4.2 Summary table of project evaluation criteria by previous researchers

				Satisfaction													
Authors	Cost	Time	Quality	Clients	Architect	Contractor	User	Project Management / Team members	Reduce modification changes	No legal claim	User expectation	Functionality	Meet technical specification	Commercial profitable	Safety	Effectiveness / Value	Environmental friendliness
Alarcon & Ashley (1996)	√	√														√	
Albanese (1994)	√	√	√												√		
Atkinson (1999)	√	√	√	√	√	√	√	√							√		
Beale & Freeman (1991)	√	√											√				
Belassi & Tukel (1996)	√	√	√														
Belout (1998)	√	√	√	√			√	√						√		√	
Brown & Adams (2000)	√	√	√														
Chang & Ibbs (1998)	√	√	√	√							√					√	
Cheung et al. (2000)	√	√	√	√	√	√		√									

Authors	Cost	Time	Quality	Satisfaction					Reduce modification changes	No legal claim	User expectation	Functionality	Meet technical specification	Commercial profitable	Safety	Effectiveness / Value	Environmental friendliness
				Clients	Architect	Contractor	User	Project Management / Team members									
Chua et al. (1999)	√	√	√														
Dissanayaka & Kumaraswamy (1999a)	√	√		√	√	√		√									
Freeman & Beale (1992)	√	√											√				
Gardiner & Stewart (2000)	√	√	√														
Gray et al. (1990)	√	√	√														
Hatush & Skitmore (1997)	√	√	√														
Hayes (2000)	√	√	√									√		√			
Jang & Lee (1998)	√	√		√													
Jaselskis & Ashley (1991)	√	√															
Kometa et al. (1995)	√	√	√									√		√	√		
Kumaraswamy & Thorpe (1996)	√	√	√	√				√				√			√		√
Lim & Mohamed (1999)	√	√	√	√	√	√	√	√							√		
Liu & Walker (1998)	√	√	√	√	√	√	√	√				√			√		√
Liu (1999)	√	√	√	√		√							√				
Mohsini & Davidson (1992)	√	√	√														
Munns & Bjeirmi (1996)	√	√	√														
Munns (1995)	√	√	√	√													
Naoum (1994)	√	√		√													
Navarre & Schaan (1990)	√	√	√														
Paek (1995)	√	√	√														
Parfitt & Sanvido (1993)	√	√	√	√	√	√		√					√		√		
Pinto & Pinto (1991)	√	√		√	√	√		√									
Pocock et al. (1996)	√	√								√				√			
Pocock et al. (1997a)	√	√							√								
Pocock et al. (1997b)	√	√					√		√	√				√			
Sadeh et al. (2000)	√	√	√	√								√					
Sanvido et al. (1992)	√	√		√	√	√				√		√		√	√		
Shenhar et al. (1997)	√	√	√	√			√						√			√	

Authors	Cost	Time	Quality	Satisfaction: Clients	Satisfaction: Architect	Satisfaction: Contractor	Satisfaction: User	Satisfaction: Project Management / Team members	Reduce modification changes	No legal claim	User expectation	Functionality	Meet technical specification	Commercial profitable	Safety	Effectiveness / Value	Environmental friendliness
Songer *et al.* (1996)	√	√									√		√				
Songer & Molenaar (1997)	√	√	√							√	√		√				
Tan (1996)	√	√	√	√	√	√	√	√									
Walker (1995)	√	√	√														
Walker (1996)	√	√	√														
Wateridge (1995)	√	√	√	√	√	√	√	√			√	√	√	√			
Wuellner (1990)	√	√	√	√										√			

Note: X* refer to the best achievable NPV

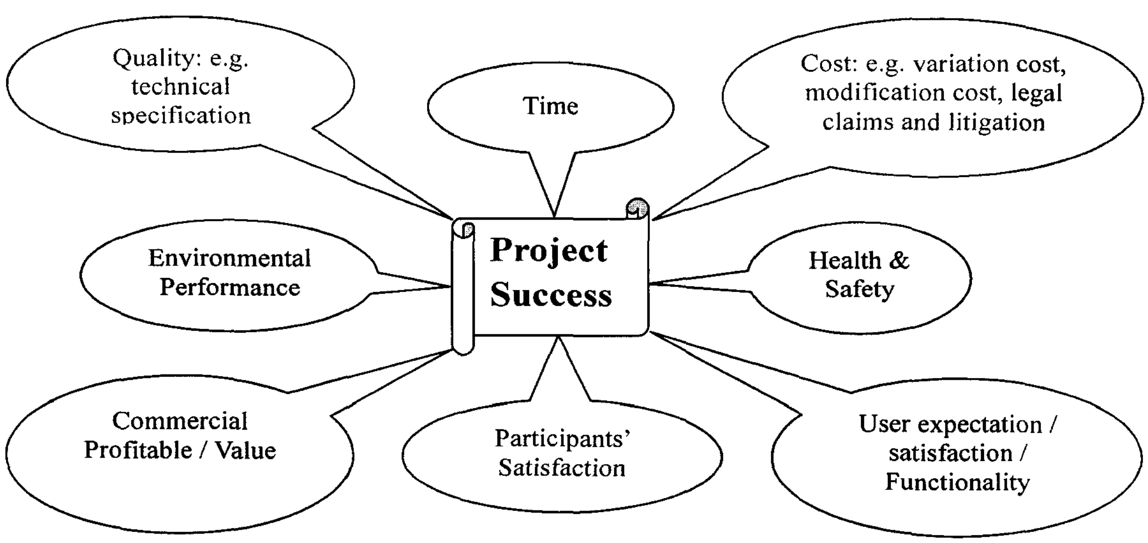


Figure 4.4 Consolidated Framework for Measuring the Success of Projects

4.6 SUMMARY OF THE CHAPTER

Project success has been a recurring topic in the construction management field for many decades. The review of articles on project success reveals that cost, time and quality are the three basic and most important performance indicators in construction projects. Other measures, such as safety, functionality and satisfaction, etc are attracting increasing attention. A consolidated framework is developed to measure project success in this study.

CHAPTER FIVE

LITERATURE REVIEW OF FACTORS IN THE SUCCESS OF CONSTRUCTION PROJECTS

5.1 INTRODUCTION

Different researchers have tried to determine the factors for a successful project for a long time. Lists of variables have been abounded in the literature, however, no general agreement can be made on the variables. The aim of this chapter is to develop a conceptual framework on critical success factors (CSFs). Five major groups of independent variables, namely project-related, project procedures, project management action, human-related factors and external environment are identified as crucial to project success. The definition of critical success factors (CSFs) is firstly provided. Then, a critical review of relevant articles on CSFs is undertaken. A conceptual model on factors affecting project success and the attributes to measure these factors are proposed.

5.2 MEANING OF CRITICAL SUCCESS FACTORS (CSFs)

The term 'CSFs' in the context of project management of projects was first used by Rockart in 1982 and is defined as those factors predicting success on projects (Sanvido et al., 1992). Success can be measured in terms of cost, time, safety, functionality and satisfaction of participants (Pinto and Pinto, 1991; Pariff and Sanvido, 1993; Kometa et al., 1995; Songer & Molenaar, 1997). A critical success factor was assumed to have the same degree of importance throughout the life of the project (Pinto & Prescott, 1988). Sanvido et al. (1992) further suggested that the CSFs are those few things that must go well to ensure success for a manager or organization, and therefore, they represent those managerial or enterprise areas that must be given special and continual attention to bring about high performance. However, CSFs in each project may vary subject to the changing environmental variables, and hence, there is no one best route to success (Liu, 1999).

5.3 MODELS OF FACTORS AFFECTING THE SUCCESS OF PROJECTS

Over the last ten years, a number of researchers have shown intense interests in this topic. Chan (1996) undertook a comprehensive review on factors affecting project success in the late 1980s and the early 1990s. However, a lot of changes have occurred since then. This section attempts to bridge the gap by providing a critical review on factors affecting project success.

5.3.1 Beale and Freeman's Model of the Project Execution Phase

Beale and Freeman (1991) developed a model for project success at the project execution phase. It divides the variables into three main categories: Variables Exogenous to Project, Variables Exogenous to Project Team and Endogenous Variables. Figure 5.1 demonstrates this idea.

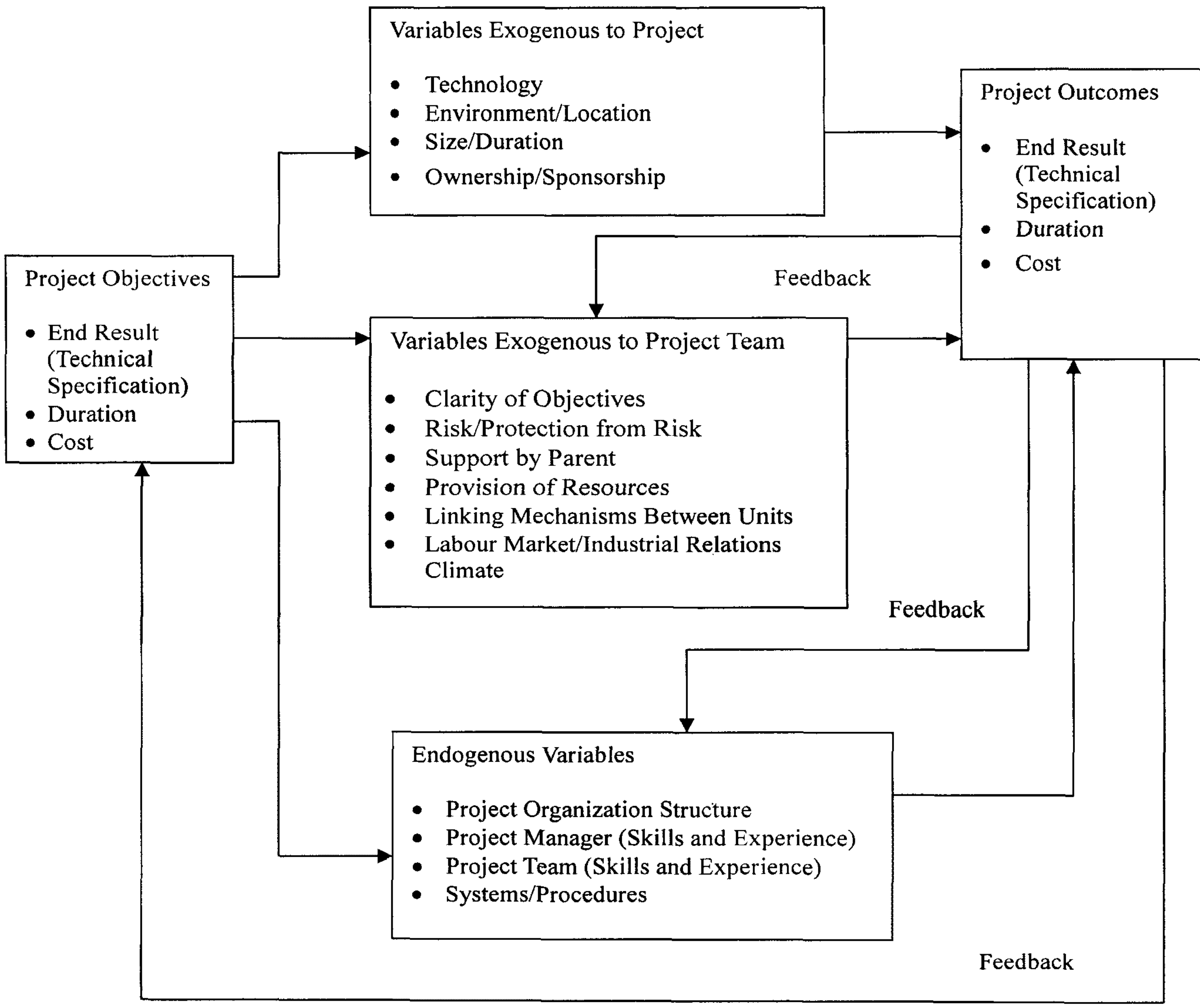


Figure 5.1 Model of the project execution phase (Beale and Freeman, 1991)

5.3.2 Belassi and Tukel's New Conceptual Model

Belassi and Tukel (1996) developed a new framework and it groups the factors into four areas, including factors related to the project; factors related to the project manager and team members; factors related to the organization; and the factors related to the external environment. The proposed groups are interrelated and one group can influence the other groups. Figure 5.2 illustrates this concept.

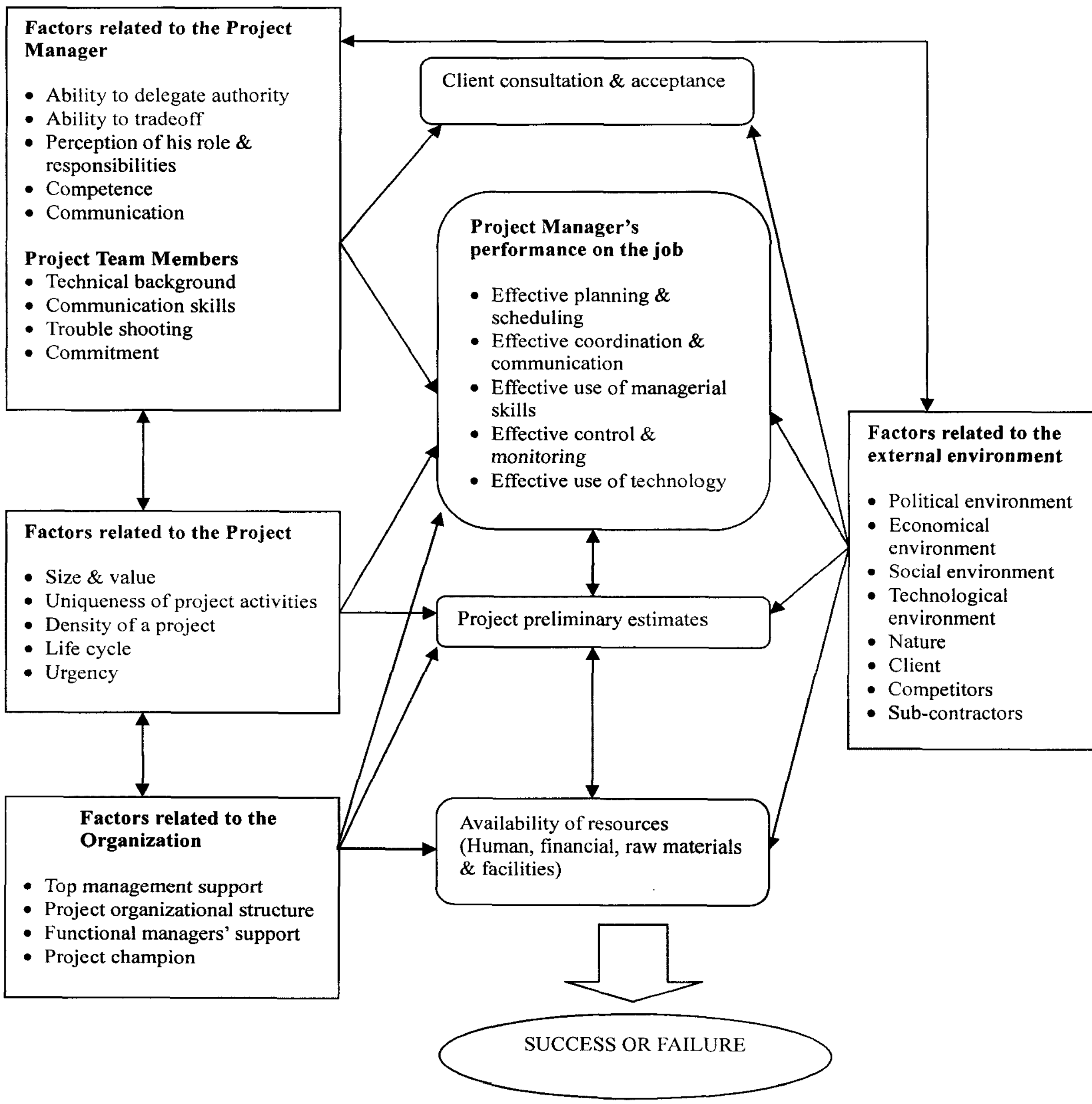


Figure 5.2 A new conceptual model (Belassi and Tukel, 1996)

5.3.3 Chua's Hierarchical Model for the Success of Construction Projects

Based on the typical project environment, Chua et al. (1999) developed a hierarchical model for construction project success. At the top is the goal of construction project success. Then, budget performance, schedule performance and quality performance form the second level in this model. The four main project aspects, project characteristics, contractual arrangement, project participants and interactive process occupy the immediate lower level of the sub-hierarchy. Figure 5.3 is the diagram of this model.

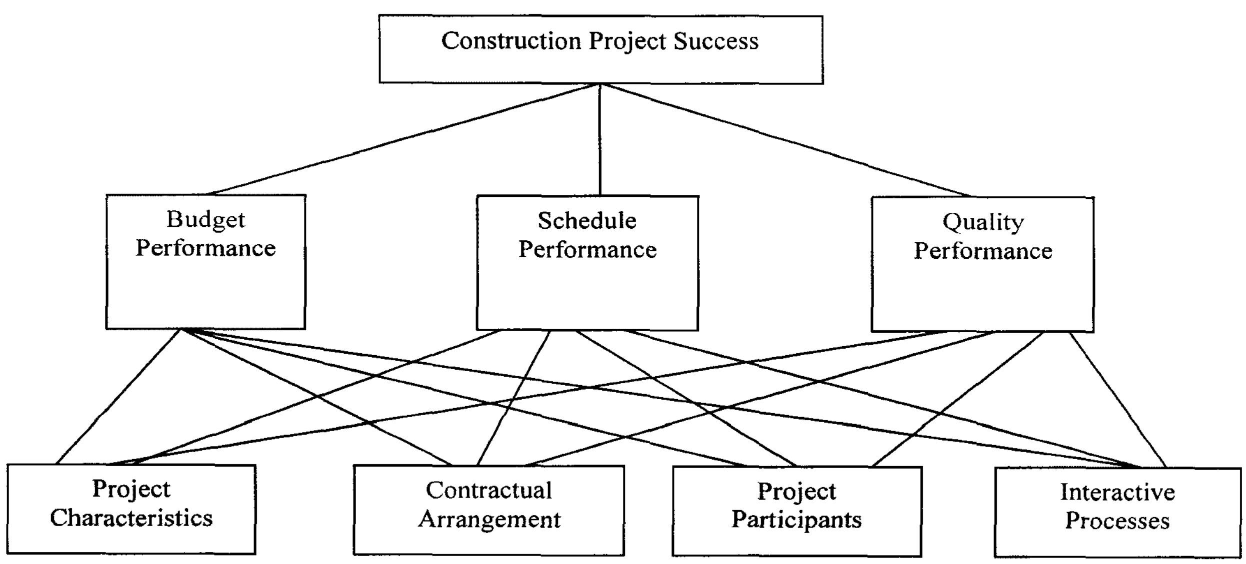


Figure 5.3 Hierarchical model for the success of construction projects (Chua et al., 1999)

5.4 FACTORS AFFECTING THE SUCCESS OF PROJECTS

Review of the relevant literature reveals there are a number of variables influencing the success of project implementation. Previous works in the CSFs vary in content and quality. There are some variables common to others, but there is still no general agreement on this issue. Table 5.1 summarizes the various factors that were suggested by previous researchers. A careful study of previous literature suggests that CSFs can be grouped under five main categories. These include human-related factors, project-related factors, project procedures, project management action and external environment. To simplify the study, a proposed framework similar to Chan (1996) is developed and is illustrated in Figure 5.4.

Table 5.1 A summary table of factors affecting the success of projects by previous researchers

Authors	Human-related		Project-related	Project Procedures	Project Management Action	External Factors
	Clients	Project Team				
Abd & McCaffer (1998)					√	
Akinsola et al. (1997)	√		√			√
Beale & Freeman (1991)	√	√	√		√	√
Belassi & Tukel (1996)		√	√		√	√
Belout (1998)	√	√	√		√	
Bresnen & Haslam (1991)	√					
Chan & Kumaraswamy (1997)	√	√			√	
Chua et al. (1999)	√	√	√	√	√	√
Clarke (1999)	√				√	
Dissanayaka & Kumaraswamy (1999a)	√	√	√	√		√
Genega (1997)		√			√	
Hamburger (1992)					√	
Hassan (1995)	√	√				
Hausechildt et al. (2000)	√	√			√	
Hubbard (1990)					√	
Ibbs (1991)					√	
Jaselskis & Ashley (1991)					√	
Jiang et al. (1996)	√	√			√	
Kaming et al. (1997)					√	√
Kog et al. (1999)		√			√	
Kumaraswamy & Chan (1999)		√	√	√	√	√
Liu (1999)					√	√
Mohsini & Davidson (1992)	√				√	
Munns & Bjeirmi (1996)					√	
Mustapha & Naoum (1998)		√				
Naoum (1994)				√		
Pack (1995)	√	√			√	
Parfitt & Sanvido (1993)	√	√		√	√	
Pinto & Pinto (1991)					√	
Pocock et al. (1996)				√		
Pocock et al. (1997a)				√		
Pocock et al. (1997b)				√		
Sanvido et al. (1992)		√		√	√	
Smith & Wilkins (1996)		√		√		
Songer & Molenaar (1997)	√		√	√		√
Tatum (1990)				√		
Tippett & Peters (1995)					√	
Thomas et al. (1998)					√	
Walker (1995)	√	√	√	√	√	√
Walker (1996)		√				
Walker (1997b)		√		√		
Walker & Vines (2000)		√		√	√	√
Wateridge (1995)	√	√	√		√	

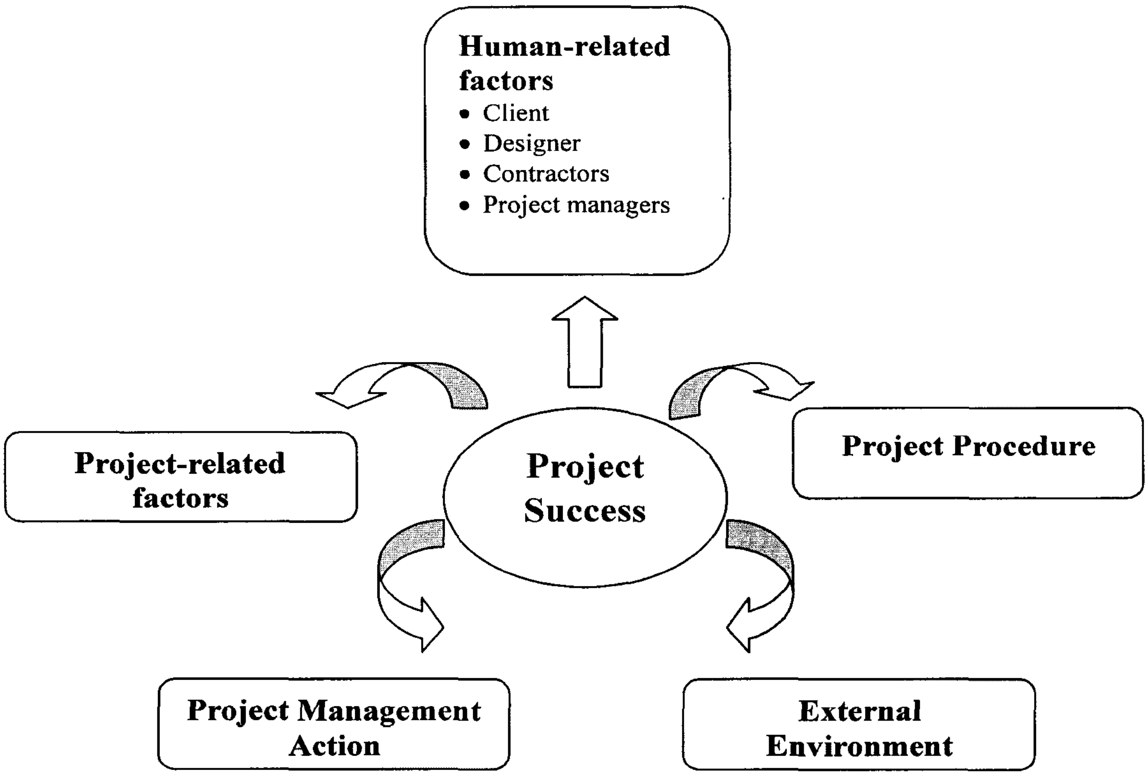


Figure 5.4 Framework on factors affecting the success of project

5.4.1 Project-related Factors

In a study on factors affecting construction time performance (CTP), Walker (1995) postulated project scope as a useful predictor for construction time, he also commented that a number of non-scope factors, such as impact of managerial action, client decision-making, client experience, form of building procurement, project organizational structure, managerial control, designer's experience, internal and external factors, also have an impact on CTP. The importance of project scope factors is echoed by other researchers (Beale & Freeman, 1991; Jaselskis & Ashley, 1991; Wateridge, 1995; Belassi & Tukel, 1996; Jiang et al., 1996; Akinsola et al., 1997; Songer & Molenaar, 1997; Belout, 1998; Kumaraswamy & Chan, 1999; Chua et al., 1999 and Dissanayaka & Kumaraswamy,1999a). The project characteristics factors, such as type, size, complexity and duration of the project are concluded by Akinsola et al. (1997) which have a significant influence on the total value of variations and their frequency. There are different definitions for project scope. The most common one is the size of project (Belassi & Tukel, 1996; Songer & Molenaar, 1997 and Chua, et al., 1999). Others include the value of project, uniqueness of project activities, density of project, life-cycle, urgency, constructability, pioneering status (the technology of the project is new to the project team), project schedule, level of location difficulties, design complexity, construction complexity and complexity due to changes (Beale & Freeman, 1991; Belassi & Tukel, 1996; Dissanayka & Kumaraswamy, 1999a and Chua et al., 1999).

The attributes used to measure project-related factor in this study include type of project, nature of project, number of floors of the project, complexity of project, and size of project.

5.4.2 Procurement-related Factors

Dissanayaka & Kumaraswamy (1999a) indicated the importance of procurement factors and non-procurement factors in their research. A number of researchers also identified the importance of procurement factors (Tatum, 1990; Mohsini & Davidson, 1992; Naoum, 1994; Pocock et al., 1996; Smith & Wilkins, 1996; Pocock et al., 1997a & 1997b; Walker, 1997b; Kumaraswamy & Chan, 1999 and Walker & Vines, 2000). Dissanayaka and Kumaraswamy (1999a) defined the scope of procurement as the framework within which construction is brought about, acquired or obtained. Dissanayaka and Kumaraswamy (1999b) further demonstrated the comprehensive conceptualisation of procurement options in a hierarchy flowing from five sub-systems of: (1) work packaging which based on package size, functionality and location; (2) functional grouping which based on the allocation of design, construction and management responsibilities; (3) payment modality which based on pricing mechanisms and the timing of payments for completed work; (4) selection modality which based on the various processes used to select the contracting parties; and (5) conditions of contracts which based on any standard forms and special conditions used. Therefore, different forms of contracts and tendering systems can be grouped under this factor.

Two attributes are used to measure the project procedure in this study include procurement method (selection of the organization for the design and construction of the project), and tendering method (procedures adopted for the selection of the project team and in particular the main contractor).

5.4.3 Project Management Factors

The factors related to the project management were raised in early 90s. Project Management is a key for project success (Hubbard, 1990). Kog et al. (1999) also stated that the managerial action is critical in achieving project success, particularly with large and complex fast track projects. Munns and Bjeirmi (1996) stated that the role of different project management techniques to implement projects successfully has been widely established in areas, such as the planning and control of time, cost and quality. Jaselskis & Ashley (1991) suggested that by using management tools, the project managers would be able to maximize the project's chances of success. Thomas et al. (1998) stated that effective communications are critical to project success. Ibbs (1991) also suggested that incentive plans used by owners and contractors are valuable contract administration tools useful for enhancing project success. In research focused on the factors causing delay, Abd and MaCaffer (1998) found that the underlying management factors of lack of control, improper planning, poor coordination, inadequate supervision and poor communication will cause delay in construction projects. There are many variables under the project management category. Chua et al. (1999) determined 'interactive processes' as one of factors and refers to communication, planning, monitoring and control, and project organization to facilitate effective coordination throughout the project life. Liu (1999) also suggested the project team motivation or goal orientation towards successful outcome is ensured by the feedback of their task progress; she further commented that increased performance is encouraged by their planning efforts, but is subject to the limits of the project team's capabilities and experiences in relation to the scope or work definition of the project. Therefore, variables in project management include adequate communication, control mechanisms, feedback capabilities, troubleshooting, coordination effectiveness, decision making effectiveness, monitoring, project organization structure, plan and schedule followed, and related previous management experience (Hubbard, 1990; Sanvido et al., 1992; Jiang et al., 1996; Belout, 1998; Chua et al., 1999 and Walker and Vines, 2000).

A number of attributes will affect the project management factor, including communication system, control mechanism, feedback capabilities, planning effort, organization structure, safety and quality assurance program, control of subcontractors' works, and overall managerial action.

5.4.4 Project Participants-related Factors

Chua et al. (1999) defined project participants as the key players, including project manager, client, contractor, consultants, subcontractor, supplier and manufacturers. The client is the project sponsor or initiator, represented sometimes by an individual or commonly an organization (Akinsola et al., 1997). Walker (1995) considered the influence of client and clients' representative as a significant factor on construction time performance. The client-related factors concerned with client characteristics, client type and experience, knowledge of construction project organization, project financing, client confidence in the construction team, owner's construction sophistication, well-defined scope, owner's risk aversion, client project management (Bresnen & Haslam, 1991; Songer & Molenaar, 1997; Chan & Kumaraswamy, 1997 and Dissanayaka & Kumaraswamy, 1999a).

Designers play a vital role as their work involves from inception to completion on a project. Chan & Kumaraswamy (1997) considered that design team-related factors consist of design team experience, project design complexity and mistakes/delays in producing design documents.

The main contractor and subcontractors start their main duties when the project reaches the construction stage. The variables include the contractor's experience, site management, supervision and involvement of subcontracting, contractor's cash flow, effectiveness of cost control system, and speed of information flow (Chan & Kumaraswamy, 1997 and Dissanayaka & Kumaraswamy, 1999a).

The project manager is another key stakeholder in a construction project and his competence is a critical factor affecting project planning, scheduling and communication (Belassi and Tukel, 1996). Effective project managers are essential to project success (Beale & Freeman, 1991; Belassi & Tukel, 1996; Dissanayake & Kumaraswamy, 1999a; Chua et al., 1999 and Hausechildt, et al., 2000). The project manager is the person who is in effect in charge of the project and has sufficient authority, personality, and reputation to ensure that everything that need to be done for the benefit of the project is done (Chua et al., 1999).

Variables under this factor consist of the skills and characteristics of project managers, their commitment, competence, experience and authority (Beale & Freeman, 1991; Belassi & Tukel, 1996 and Chua et al., 1999).

A construction project requires team spirit, therefore team-building is important among different parties. Team effort by all parties to a contract - owner, architect, construction manager, contractor and subcontractors – is a crucial ingredient for the successful completion of a project (Hassan, 1995). Dissanayaka and Kumaraswamy (1999a) suggest team spirit, communication and coordination is crucial in a project. Top management support is also a significant variable as suggested by Belassi and Tukel (1996) and Chua et al. (1999). Besides, partnering, a simple process of establishing good working relations between project parties through establishing commitment among parties, is also highly recommended as a tool for success (Chan et al., 2003d).

The attributes of this factor can be mainly divided into two categories, one is related to client, and another is the project team.

5.4.4.1 The client

The attributes in this factor include client's experience and ability, nature of client, size of client organization, client's emphasis on cost, time and quality, and client's contribution to the project.

5.4.4.2 The project team leaders

Project team leaders refer to the client's representative, design team leader and construction team leader. The attributes include project team leaders' experience and skills, project team leaders' commitment on time, cost and quality, project team leaders' involvement, project team leaders' adaptability, working relationship, and support from the project team leaders' parent companies.

5.4.5 External Environment

Belassi and Tukel (1996) suggested that some factors are external to the organization but they still have an impact on project success or failure. Various researchers support 'environment' as a factor affecting project success (Beale & Freeman, 1991; Walker, 1995; Belassi & Tukel, 1996; Kaming et al., 1997; Songer & Molenaar, 1997; Akinsola et al., 1997; Chua et al., 1999 and Walker & Vines, 2000). Akinsola et al. (1997) further described 'environment' as all external influences on the construction process, including social, political, technical system. The definition of external factors includes economic environment, political risks, impact on public, weather, technology advanced, site limitation and location, social factors, labour market and industrial relation climate (Beale & Freeman, 1991; Belassi & Tukel, 1996; Kaming et al.,1997 and Akinsola et al., 1997).

The attributes used to measure this factor are economic environment, social environment, political environment, physical environment, industrial relation environment; and level of technology advanced.

5.5 CONCEPTUAL FRAMEWORK FOR FACTORS AFFECTING THE SUCCESS OF PROJECTS

The various variables affecting the factors are identified in the previous sections. Variables within each group are interrelated and intrarelated. A variable in one group can influence a variable in the others, and vice versa. For example, the client or project team leaders' experience can be affected by the uniqueness of the project. The client/project team leaders' skill can directly influence the project management action, like the communication system, control mechanism, feedback and planning capabilities. The organization structure is also affected by the project size. The control of subcontractors' works is influenced by the choice of procurement method. Moreover, the economic environment will largely affect the provision of resources from parent companies. The physical environment will affect the complexity of project too.

To study how these factors, project success separately and collectively, it is hypothesised that the 'Project success is a function of project-related factors, project procedures, project management action, human-related factors and external environment and they are interrelated and intrarelated.'

It is further hypothesised that the project is likely to be executed more successfully if the project complexity is low; if the project is of shorter duration; the overall managerial action are effective; if the project is funded by a private and experienced client; if the client is competent on preparing project brief and making decision; if the project team leaders are competent and experienced; and if the project is executed in a stable environment with developed technology and together with an appropriate organization structure. Details of these hypotheses can be found in Table 5.2. Furthermore, a new conceptual framework is developed and shown in Figure 5.5.

5.6 SUMMARY OF THE CHAPTER

A new conceptual framework that includes and regroups the identified variables affecting project success is developed. Hypotheses on implementing a project successfully have been developed. It can be used as a base for further detailed investigation of a hospital project. A more systematic way of determining project success is established.

Table 5.2 Summary of Hypotheses

Variables in Conceptual Framework Hypothesised to:			
Factors	**Variables**	**Induced Success**	**Induced Failure**
Project-related Factors	Project type	Repetitive in nature	One-off project/unique
	Project nature	New works	Refurbishment
	Number of floors	Not more 10 floors	More than 10 floors
	Complexity of project	Easy to access into site and construct; good site conditions; not complicated design buildability and coordination; poor quality management	Difficult to access into the site and construct; poor site conditions; complicated design buildability and coordination; poor quality management
	Size / duration	Not more than 36 months	More than 36 months
Project Procedures	Procurement method	Non-traditional method	Traditional
	Tendering method	Negotiation	Competitive
Project Management Action	Communication system	Effective	Ineffective
	Control mechanism	Effective monitoring and updated plans and holding regular meetings	Ineffective monitoring and outdated plans and holding irregular meetings
	Feedback capabilities	Effective	Ineffective
	Planning effort	Effective	Ineffective
	Organization structure	Developing an appropriate structure	Poor organization structure
	Safety and quality assurance programs	Implementing effective programs	Implementing poor/no programs
	Control of sub-contractor's works	Effective	Ineffective
	Overall managerial action	Effective	Ineffective
Human-related Factors	Experience of client	Sophisticated / specialized	Inexperience / novice
	Nature of client	Single parent / private	Multiple sponsors / public
	Size of client's organization	Shallow	Deep
	Client's ability	Have high capacity on briefing, making decision and defining role	Have low capacity on briefing, making decision and defining role
	Client's contribution	High contribution on design and construction aspects	Low contribution on design and construction aspects
	Client's emphasis	High emphasis on construction cost, quality and time	Low emphasis on construction cost, quality and time
	Project team leaders' experience	Experienced	Inexperienced
	Project team leaders' skill	Competent	Incompetent
	Project team leaders' commitment	High commitment to meet cost, time and quality	Low commitment to meet cost, time and quality
	Project team leaders' involvement in the project	Early and continued	Late involvement
	Project team leaders' adaptability	Adapt changes quickly	Adapt changes slowly
	Project team leaders' relationship	Close	Loose
	Support from project team leaders' parent companies	High support and provision of resources from parent companies	Low support and provision of resources from parent companies
External Factors	Economic, social and political environment	Stable	Turbulent
	Physical environment	Local; weather reasonably predictable	Overseas; remote, offshore; unpredictable weather
	Industrial relations environment	Good	Bad
	Technology	Traditional, well-developed and tested; simple, minimum of different disciplines; no residual technical problems	New, experimental, evolving, or untried; complex, many different disciplines; many residual technical problems

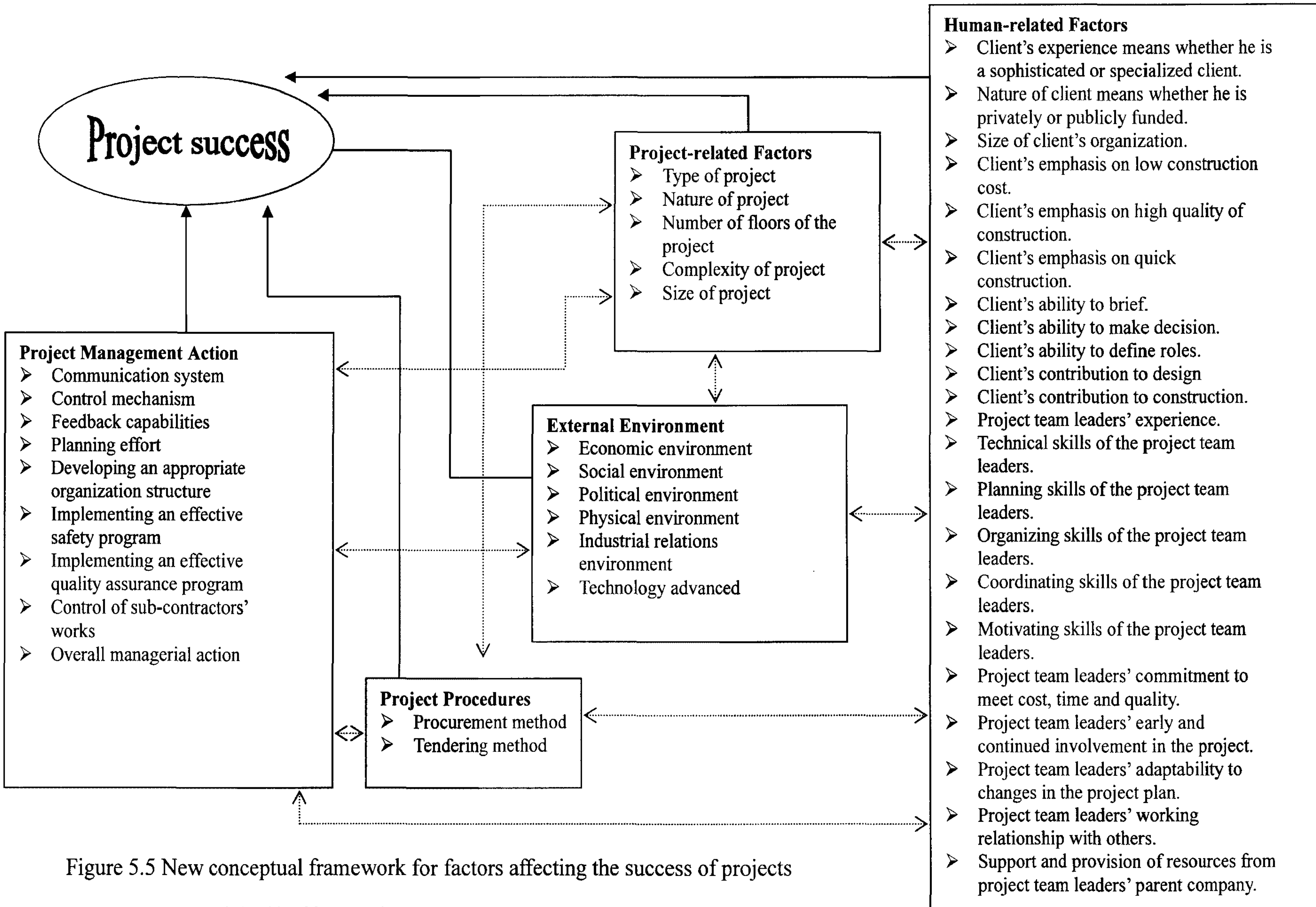


Figure 5.5 New conceptual framework for factors affecting the success of projects

Interrelationship of factors and project success

Intrarelationship among various factors

CHAPTER SIX

RESEARCH METHODOLOGY

6.1 INTRODUCTION

This chapter sets out the research design and methodology adopted in the current study. The primary methods of collecting data were mailed questionnaires and face-to-face interviews. These two methods were related but they were designed to collect different kinds of data and were conducted separately. Prior to sending out questionnaires and conducting interviews, pilot studies were carried out to identify possible areas for improvement. In this chapter, the research framework is first presented, followed by a discussion on the data collection process, development of the questionnaire, and the sample used. It concludes with a presentation of the methods used to analyse the data.

6.2 RESEARCH FRAMEWORK

Figure 1.1 in Chapter 1 provides a useful model proposed by Walker (1997a) to illustrate the process a researcher should follow. By following the concepts in Walker's model (1997a) and Chan's model (1996), the research framework of this study was modified as shown in Figure 6.1. A comprehensive review of the literature was first carried out. Then, a preliminary survey and face-to-face interviews were conducted. The preliminary questionnaire was developed after reviewing the relevant literature and was distributed to the interviewees for comment. Therefore, the interviews not only provided in-depth, professional opinions regarding critical factors leading to the success of the project, but also valuable input in drafting an empirical questionnaire based on the preliminary questionnaires for a second-stage study. Subsequent to the interviews, the empirical questionnaires were finalized and sent out by mail. An analysis of the data in the completed questionnaires was conducted and preliminary conclusions were drawn. To ensure the accuracy of the findings, they were validated by a small-scale questionnaire survey and a statistical analysis. Following confirmation of the validity of the findings, the research findings could finally be reported.

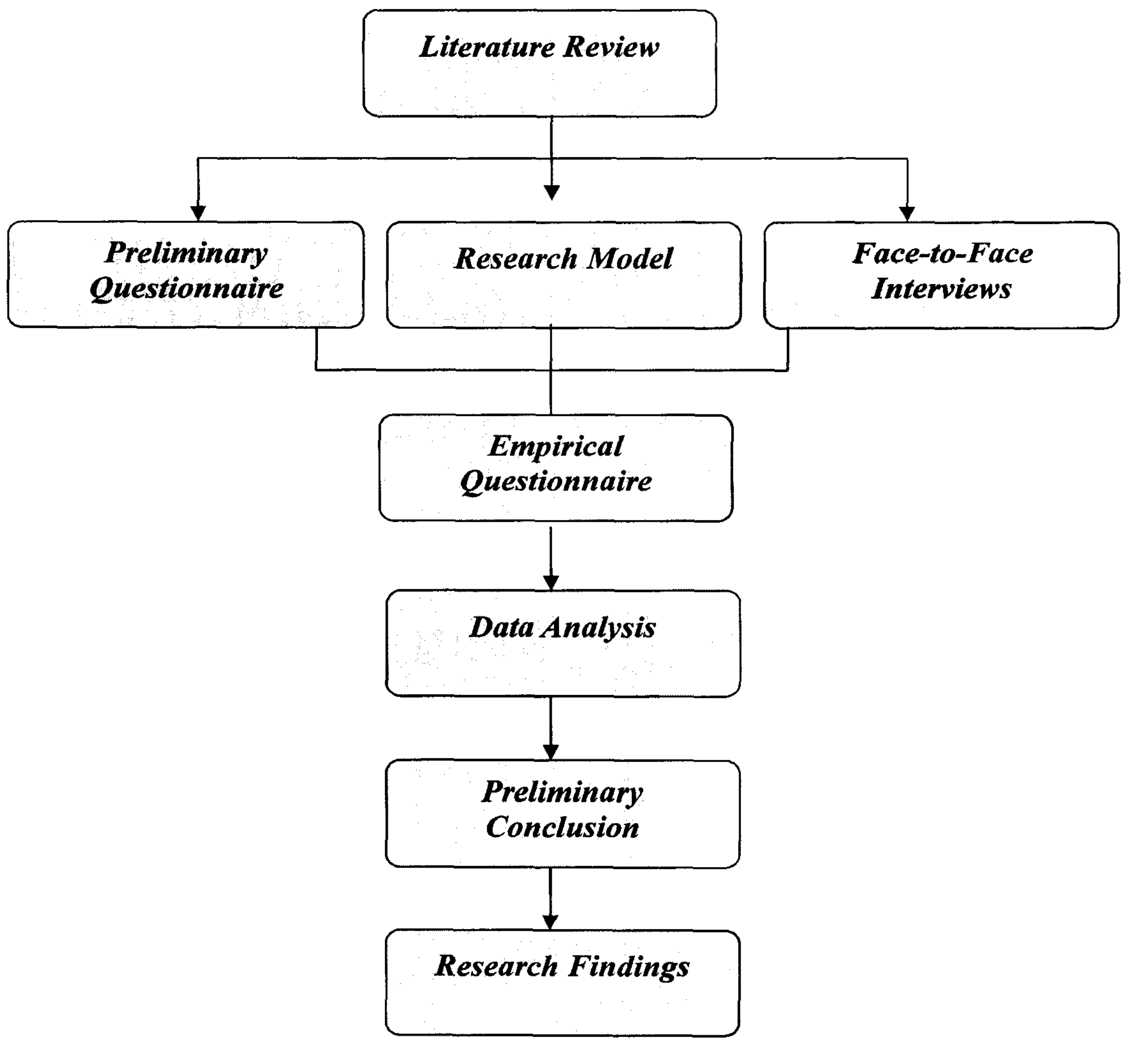


Figure 6.1 Research framework

6.3 DATA COLLECTION

6.3.1 Literature review

A literature review was an essential process in this study. Sekaran (1992), as cited in Walker (1997a), defined a literature review as a preliminary gathering of data. This review provided important information on construction practices and helped to identify relevant sources for developing questionnaires and interviews. The results of the comprehensive reviews on the problems involved in running healthcare projects, the criteria for success and the factors for success in running a construction project have been reported in Chapters 3, 4, and 5.

6.3.2 Development of a research model

With the aid of previous research, as detailed in Chapters 4 and 5, a research model was developed for this study. Sidwell (1985), as cited in Chan (1996), noted that the technique of using models to represent or explain phenomena and relationships in the real world developed from their use in the formal sciences and is now being adopted more and more in the social sciences. It is an attempt to show, in some form or other, the workings of reality (Chan, 1996).

The factors perceived to be of principal relevance were discussed in Chapter 5. Figure 5.5 postulates that the success of a project is a function of project-related factors, project procedures, project management actions, human-related factors, and external environment; and that they are inter-related and intra-related. These factors form the independent variables of this model. Chapter 4 discussed the dependent variable of the model. Figure 4.4 suggests that the success of a project can be measured objectively and subjectively, and that a successful project is one that is completed on budget, on schedule, meets the required quality standards, is environmental friendly and safe, achieves its intended functions, conforms to the expectations and satisfaction of the users, clients, and project participants, and generates profits and long-term gains.

With the combination of Figures 4.4 and 5.5, a research model was developed for this study (Figure 6.2). It sets out the relationships between the independent variable (variables of success factors) and dependent variable (project success). The interaction and combined effect of these independent variables will determine the value of the dependent variable.

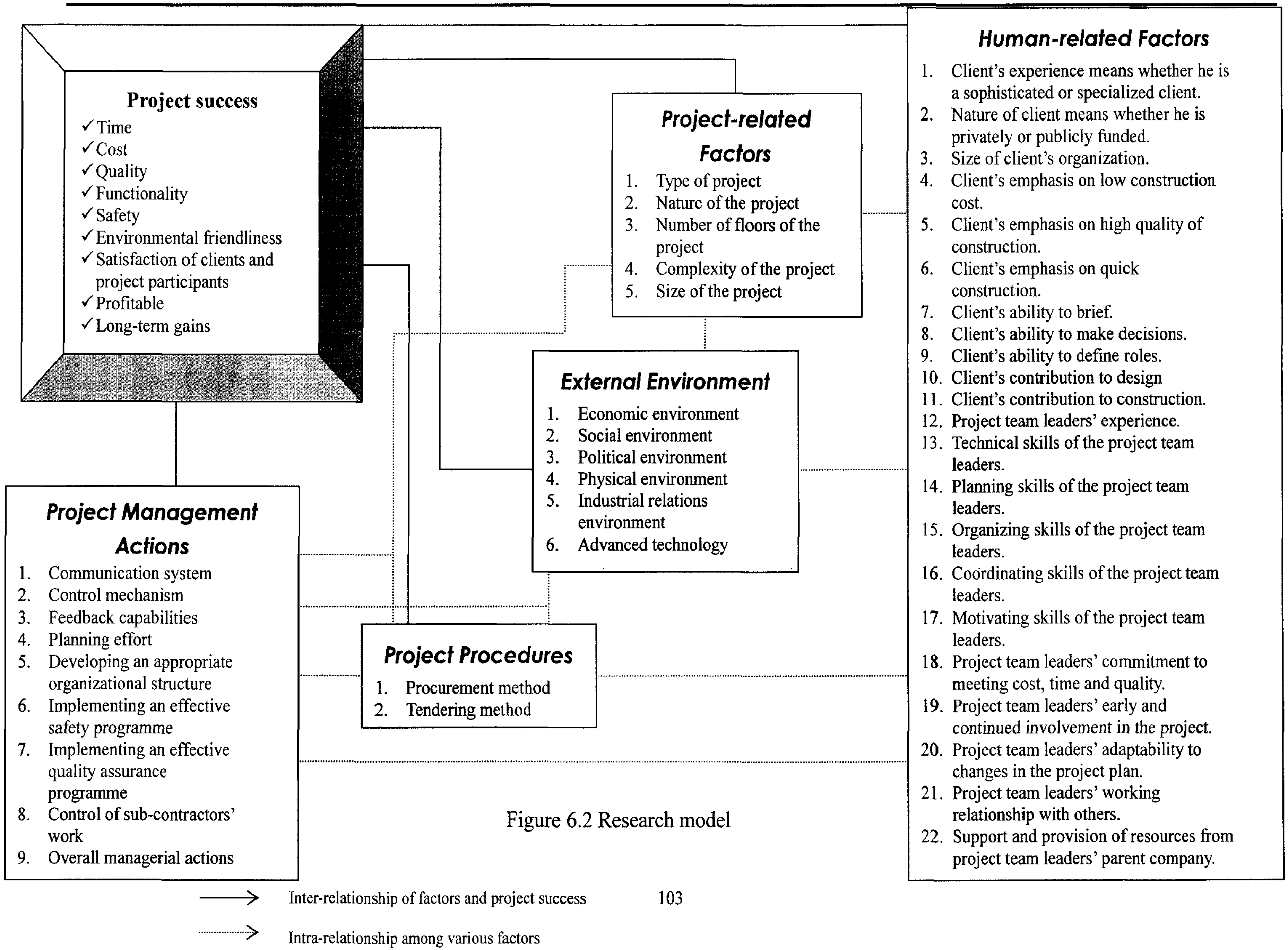


Figure 6.2 Research model

6.3.3 Pilot study

A pilot study was conducted to gain an understanding of the construction practices in healthcare projects in Hong Kong. Walker (1997a) concluded that 'a pilot study has proved to be a useful tool in providing a focus mechanism to establish the research direction more clearly'. It also provides relevant information for the development of the questionnaire. Interviewing only one member of the project team could introduce an element of bias, self-justification, or post-rationalization that would bring the data gathered in the survey into question. Doing so could introduce problems with the validity of the data, which can be avoided by triangulation: collecting information about a single phenomenon from at least three different sources (Walker, 1997a). Therefore, twenty interviews with participants in the industry were conducted, including contractors, consultants, and client representatives. Table 6.1 shows information on the backgrounds of these interviewees. Sekaran (2003) suggested that when a sufficient number of structured interviews have been conducted and adequate information obtained to understand and describe the important factors operating in the situation, the researcher could stop the interview. The main aim of interviews was to ensure that the information sought in the questionnaire is relevant to the current practice and that the respondents find the questions convenient to answer. Sound questionnaire design principles should focus on the wording of the questions; the categorizing, scaling, and coding of the responses received; and general appearance of the questionnaire (Sekaran, 2003). Therefore, apart from the industry participants, the preliminary questionnaire was also sent to some academic staff to ensure that these principles were applied in the questionnaire. The questionnaire was refined a number of times based on feedback from the interviews before it was 'finalized into an empirical questionnaire'.

Table 6.1 Background information of the interviewees

Nature of company	Number of interviewees	Position
Hospital Authority	2	Project managers
Consultants	5	Project managers, engineers
Contractors	6	Project managers, project coordinators, Site agents
Government Departments (mainly from the Architectural Services Department)	7	Architects, engineers, quantity surveyors, technical secretary

6.4 DEVELOPMENT OF THE QUESTIONNAIRE

A questionnaire is a pre-formulated written set of questions to which respondents record their answer, usually within rather closely defined alternatives (Sekaran, 2003). It is an efficient mechanism for collecting data when the researcher knows exactly what is required and how to measure the variables of interest (Sekaran, 2003). Hence, the administration of the instrument of this study was based on Chan (1996), who attempted to investigate the critical success factors (CSFs) of construction projects. Although Chan's work was completed in the early 1990s, most of the factors identified are still applicable to this study. The research tool for this study was developed with reference to Chan's research instrument, and sections 6.4.1 to 6.4.12 provide a detailed discussion of the questionnaire.

The questionnaire covers eight pages and is divided into twelve sections (Appendix A). Table 6.2 provides the structure of the questionnaire.

Table 6.2 Structure of the questionnaire

Section Number	Key information asked about the
1	Respondent
2	Project details
3	Problems in running healthcare projects
4	Project complexity level
5	Project procedures
6	Project environment
7	Client
8	Project team leaders
9	Project management actions
10	Project performance
11	Level of satisfaction
12	Success criteria

The questions have been designed to identify the problems in running healthcare projects, to measure the criteria for success, and the variables addressed in Chapter 3, 4, and 5. Dane (1990) observed that three types of information can be collected by conducting a survey study, including facts (phenomena or characteristics available to anyone who knows how to observe them), opinions (expressions of a respondent's preferences, feelings, or behavioural intentions), and behaviours (actions completed by a respondent). In this study, the facts were collected by asking the respondents questions on professional affiliation, highest academic qualification attained, project details, and so forth. By asking the respondents to rate the importance of each criterion for success, level of satisfaction, etc., the opinions of the respondents were also obtained. However, because of the nature and objectives of this research, behavioural-typed questions were not included.

In this study, most of the pre-coded answers were set to a nominal or ordinal scale. Scaling is the process of assessing numbers or other symbols to an attribute or characteristic for the purpose of measuring that attribute or characteristic (Kendall and Kendall, 2002). Kendall and Kendall (2002) further reminded the researchers that the careless construction of scales can result in the problems of leniency, central tendency, and the halo effect. Therefore, a seven-point scale as proposed by Walker (1994) and Chan (1996) was used to eliminate these problems.

6.4.1 Section 1 – Respondent's background

The first section contained seven questions on the background information of the respondents. Questions included the respondents' job title, professional affiliation, highest academic qualification attained, year of experience in the construction industry (years), the number of healthcare projects they have been involved in, and the principal business and size of the respondents' company.

6.4.2 Section 2 – Project details

The target respondents are those with experience in running healthcare projects. Therefore, the second section focused on the specific healthcare projects in which the respondents were involved. There were a total of seventeen questions, including the name and nature of the project; the respondent's position in the project; classification of project; total number of storeys; original contract sum at the time the tender was awarded; final contract sum at completion; price fluctuations; project commencement date; practical completion date; original construction period at the time the tender was awarded; total project duration; gross floor area (GFA); total agreed E.O.T (extension of time); and approximate number of claims and disputes and accidents.

In this section, the variables in questions 2.3 and 2.4 were coded as follows:

Classification of project	**Code**
Clinic	*1*
Healthcare	*2*
General hospital	*3*
Teaching hospital	*4*
Rehabilitation hospital	*5*
Other	*6*

Nature of project	**Code**
New work	*1*
Refurbishment or Redevelopment	*2*
Extension	*3*
Other	*4*

6.4.3 Section 3 – Problems encountered in running a healthcare project

This section aims to identify the major problems encountered in running healthcare projects by asking the respondents to rate the level of agreement on the proposed twenty-four problems on a seven-point scale[1]. Besides closed-end

[1]

1	2	3	4	5	6	7
strongly disagree	disagree	slightly disagree	neutral	slightly agree	agree	strongly agree

questions, the respondents were encouraged to point out any possible problems that may be encountered in running healthcare projects.

6.4.4 Section 4 – Project complexity level

The fourth section asked the respondents to rate the level of complexity of the project mentioned in section 2 using another set of seven-point scale[2]. Project complexity was assessed in terms of:

a. inherent site conditions;

b. level of design buildability;

c. level of design coordination;

d. level of quality management procedures;

e. access to or within the site; and

f. overall characteristics.

6.4.5 Section 5 – Project procedures

The fifth section was about the method of procurement, tendering method, and

---

2

1	2	3	4	5	6	7
very complex	complex	slightly complex	neutral	slightly simple	simple	very simple

innovative management skills that the project adopted.

6.4.5.1 Procurement system

This variable was examined in question 5.1 of the questionnaire. The coding of the different categories of the procurement method was as follows:

Procurement System	**Code**
Sequential traditional system	*1*
Accelerated traditional system	*2*
Competitive Design and Build	*3*
Enhanced Design and Build	*4*
Novation	*5*
Management contracting	*6*
Guarantee maximum price	*7*
Other	*8*

6.4.5.2 Tendering method

This variable was examined in question 5.2 of the questionnaire. The coding of the different categories of the tendering method was as follows:

Tendering Method	**Code**
Open tendering	*1*
Selective tendering	*2*
Negotiation tendering	*3*
Other	*4*

6.4.5.3 Innovative management skills

This variable was examined in question 5.3 of the questionnaire. The coding of the different categories of innovative management skills was as follows:

Innovative Management Skills	**Code**
Nil	*1*
Partnering Only	*2*
Value Management Only	*2*
Other	*3*
Both partnering and management	*5*

6.4.6 Section 6 – Project environment and technology

The sixth section asked the respondents to rate the degree of complexity of the project environment. The same seven-item scale as in section 4 was used. The project environment was assessed in terms of:

a. physical environment;

b. prevailing economic environment;

c. social-political environment;

d. industrial relations environment;

e. level of advanced technology; and

f. overall environment.

6.4.7 Section 7 – The client

The seventh section of the questionnaire asked the respondents to provide information about the client of the specified projects. This section was further divided into three parts: the client's particulars, the client's objectives, and measures of the client's competence.

6.4.7.1 Client's particulars

This part was related to the background information of the client, including the organization of the client, the type of client, the experience of the respondents with the client, the size and main business of the client organization. Four variables were examined in questions 7.1.2 to 7.1.5, and the coding of these variables were as follows:

Type of Client	**Code**
Public sector	*1*
Private sector	*2*
Other	*3*

Years of experience with client	**Code**
Less than 5 years	*1*
5 to 9 years	*2*
10 to 14 years	*3*
15 to 19 years	*4*
20 years or more	*5*

Size of client's organization	**Code**
Large corporation (500+ employees)	*1*
Medium sized (50+ to 500 employees)	*2*
Small sized (up to 50 employees)	*3*

Main Business of client's organization	**Code**
General construction	*1*
Non-construction	*2*
Multi-disciplinary	*3*

6.4.7.2 Client's objectives

The second part dealt with the client's objectives. The respondents were asked use a seven-point scale[3] to rate the emphasis of the client's project objectives on:

a. low construction cost;

b. quick construction time; and

c. high quality of construction.

6.4.7.3 Measures of the client's competence

The third part asked the respondents to describe the client's ability by rating on another seven-point scale[4] the aspects of:

a. briefing the design team;

b. making authoritative decisions;

c. defining the roles of the participating organizations;

d. contributing ideas to the design process; and

e. contributing ideas to the construction process.

3

1	2	3	4	5	6	7
very low	low	slightly low	average	slightly high	high	very high

4

1	2	3	4	5	6	7
very weak	weak	slightly weak	average	slightly strong	strong	very strong

6.4.8 Section 8 – The project team leaders

The eighth section asked the respondents to rate the effectiveness of the key personnel in the project team, including the client's representative, design team leader, and the construction team leader. The same seven-point scale as in section 6.4.7.3 was used to assess their effectiveness in terms of:

a. technical skills;

b. planning skills,

c. organizational skills,

d. coordinating skills,

e. motivating skills,

f. controlling skills;

g. experience and capabilities;

h. commitment to meeting time, cost, and quality targets;

i. early and continued involvement in the projects;

j. adaptability to changes in the project plan;

k. working relationship with others;

l. support by parent company; and

m. provision of resources from parent company.

6.4.9 Section 9 – The project management action

The ninth section asked the respondents to assess the effectiveness of the project management actions taken by the project team. A different seven-point scale[5] was used for this section to measure the project management variables in terms of:

a. communication system;

b. control mechanism;

c. feedback capabilities;

d. up-front planning efforts;

e. developing an appropriate organizational structure;

f. implementing an effective quality-assurance programme;

g. implementing an effective safety programme;

h. control over the sub-contractors' work;

i. development of a good reporting system;

j. development of standard procedures; and

k. holding of regular meetings.

5

1	2	3	4	5	6	7
very ineffective	ineffective	slightly ineffective	neutral	slightly effective	effective	very effective

6.4.10 Section 10 – The project performance

This section asked the respondents to indicate the performance of the specified healthcare project by choosing the most appropriate choices in a nine-point scale, in terms of:

a. time performance;

b. cost performance;

c. occurrence of disputes;

d. occurrence of claims; and

e. overall performance (from the client's point of view).

All of the five measures of performance, except for overall performance[6], adopted a seven-point scale. The codings of the first four criteria are as follows:

6

1	2	3	4	5
very unsuccessful	unsuccessful	average	successful	very successful

Time Performance	**Code**
Ahead of schedule by more than 10%	*7*
Ahead of schedule by 6% to 10%	*6*
Ahead of schedule by less than 5%	*5*
On schedule	*4*
Behind schedule by less than 5%	*3*
Behind schedule by 6% to 10%	*2*
Behind schedule by more than 10%	*1*

Cost Performance	**Code**
Budget overrun by more than 10%	*1*
Budget overrun by 6% to 10%	*2*
Budget overrun by less than 5%	*3*
On budget	*4*
Budget underrun by less than 5%	*5*
Budget underrun by 6% to 10%	*6*
Budget underrun by more than 10%	*7*

Occurrence of Disputes	**Code**
Above an average project by more than 10%	*1*
Above an average project by 6% to 10%	*2*
Above an average project by less than 5%	*3*
Indifferent to an average project	*4*
Below an average project by less than 5%	*5*
Below an average project by 6% to 10%	*6*
Below an average project by more than 10%	*7*

Occurrence of Claims	**Code**
Above an average project by more than 10%	*1*
Above an average project by 6% to 10%	*2*
Above an average project by less than 5%	*3*
Indifferent to an average project	*4*
Below an average project by less than 5%	*5*
Below an average project by 6% to 10%	*6*
Below an average project by more than 10%	*7*

6.4.11 Section 11 – The level of satisfaction

The eleventh section asked the respondents to indicate their level of satisfaction with the performance of the projects, in terms of:

a. time;

b. cost;

c. quality of design;

d. quality of workmanship;

e. safety record;

f. overall performance;

g. functionality; and

h. environmental friendliness.

A seven-point scale[7] was used to facilitate this assessment. Both section 10 and section 11 will provide information about the project success variables.

6.4.12 Section 12 – Personal views on the criteria for success

The last section asked the respondents to rate the relative importance of criteria to measure the success of a healthcare project. This section helped to determine the weightings of the criteria for success and to develop a project success index (PSI)

7

1	2	3	4	5	6	7
Strongly dissatisfied	dissatisfied	slightly dissatisfied	neutral	slightly satisfied	satisfied	Strongly satisfied

for healthcare projects. Again, a seven-point scale [8] was used and the respondents were asked to rate the relative importance of:

a. timely completion;

b. staying within budget;

c. meeting the quality standard;

d. being fit-for-purpose;

e. a low accident rate;

f. environmental friendliness;

g. client's satisfaction;

h. satisfaction of various project participants;

i. end-users' satisfaction;

j. meeting end-users' expectations;

k. making a profit; and

l. creating further/long-term gains.

[8]

1	2	3	4	5	6	7
strongly disagree	disagree	slightly disagree	neutral	slightly agree	agree	strongly agree

6.5 SAMPLE SIZE

In determining the size of the sample, Sproull (1995) suggested that the following four factors be considered: cost, how much confidence in the results is desired, how much error can be tolerated, and information about the population. Since the distribution of the sample approaches normal with a sample size of thirty, such a sample size was considered to be the absolute minimum to preserve statistical validity.

A total of 185 questionnaires were sent out to personal contacts and to those whose names appeared in a database of people with experience in running healthcare projects, especially those with previous experience in running healthcare projects. However, since only a limited number of healthcare projects have been undertaken in Hong Kong in the last decade, only 57 completed questionnaires were returned, for a response rate of 30.8%. Five returned questionnaires were void because the respondents had no hands-on experience in running healthcare projects. Hence, this study was based on 52 valid replies from respondents who had been involved in a total of 34 projects.

Respondents represented different roles in the construction industry. Thirty-eight per cent (38%) and four per cent (4%) worked for main contractors and sub-contractors, respectively. Forty-five per cent (45%) of the respondents worked for clients, including architects, quantity surveyors, building surveyors, engineering consultants, and project management consultants. Thirteen per cent (13%) of the respondents came from government departments/agencies and were also employed as the consultants for the Hong Kong Hospital Authority (HA) (Figure 6.3).

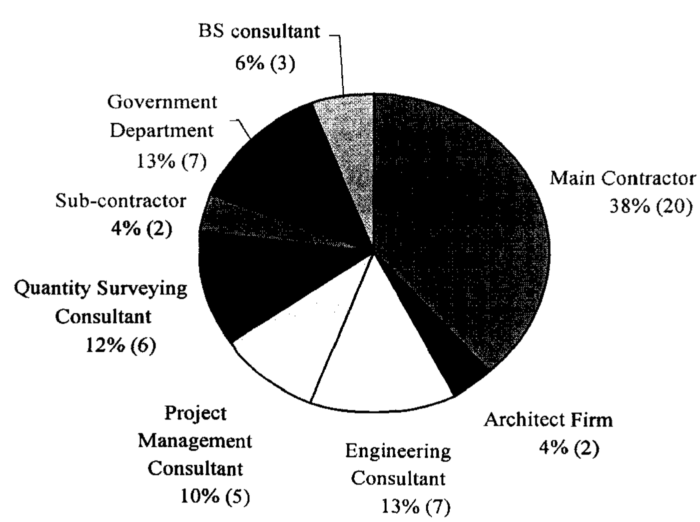


Figure 6.3 The type of organization of the survey respondents

The overall academic qualifications of the survey respondents were high. Nearly 70% had attained bachelor degrees or higher, and 29% had professional diplomas/diplomas (Figure 6.4). Thirty-four per cent of the respondents had between 10 and 19 years of experience working in the construction industry, and 41% had over 20 years of experience (Figure 6.5). Moreover, over 60% of the respondents had worked on two or more healthcare projects (Figure 6.6).

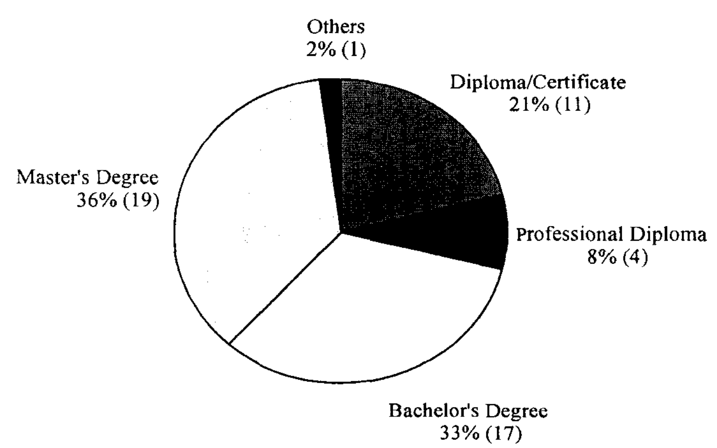


Figure 6.4 Academic qualifications attained by the survey respondents

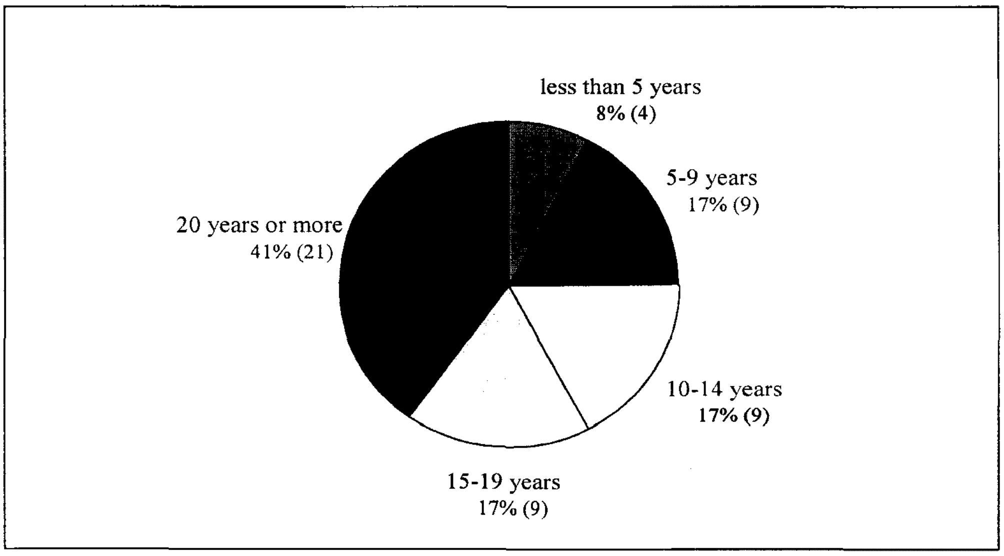


Figure 6.5 The level of experience of the survey respondents in the construction industry

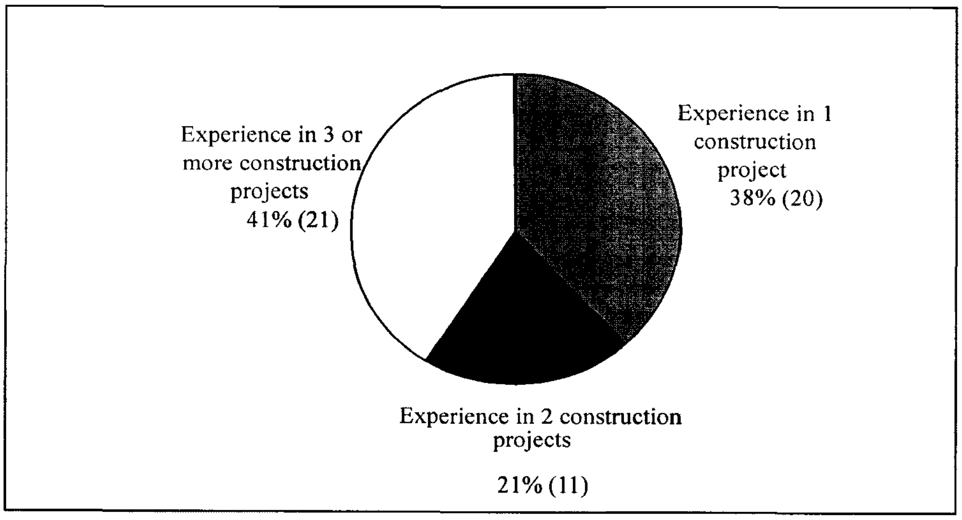


Figure 6.6 The level of experience of the survey respondents in running healthcare projects

6.6 DATA ANALYSIS

Data analysis in this study was carried out using a number of statistical tools, namely, Kendall's coefficient of concordance, Spearman rank correlation coefficient, the Two-tailed t-test, Principal component analysis, Factor analysis, and Multiple regression analysis. The analyses were conducted with the help of the Statistical Package for the Social Sciences (SPSS for Windows, Release 11) and the SAS System for Windows version 8.

6.6.1 Kendall's coefficient of concordance

Kendall's coefficient of concordance (W) is a measure of correlation/association that is employed for three or more sets of ranks. Concordance analysis evaluates the degree of agreement between m sets of ranks for n subjects/objects (Sheskin, 2004). The population parameter estimated by the correlation coefficient is represented by the notation W and the sample statistic computed to estimate the value of W is represented by the notation W. The range of possible values may fall between 0 and +1. If the value of W is zero, this means that there is no pattern of agreement among the sets of m sets of ranks; on the other hand, perfect agreement will result in *W* having a value of one. The value of *W* cannot be negative as it is impossible to have complete disagreement among all sets of ranks (Sheskin, 2004). Siegal and Castellan (1988), as cited in Sheskin (2004), emphasized that a correlation equal to or close to 1 does not itself indicate that the rankings are correct, only that there is agreement among the *m* sets of ranks. The test computations suggested by Sheskin (2004) are as follows:

The coefficient of concordance is a ratio of the variance of the sums of the ranks for subjects divided by the maximum possible value that can be computed for the variance of the sums of the ranks (for the relevant values of *m* and *n*).

$$W = \frac{\text{Variance of } \sum R_J \text{ values}}{\text{Maximum possible variance for } \sum R_J \text{ values for relevant values of } m \text{ and } n} \qquad \text{Equation 6.1}$$

The variance of the R_j values (which is represented by the notation *S*) is computed with Equation 6.2.

$$S = \frac{nU - (T)^2}{n} \qquad \text{Equation 6.2}$$

Finally, *W* is computed with Equation 6.3

$$W = \frac{S}{\left(\frac{m^2 n(n^2 - 1)}{12}\right)}$$ Equation 6.3

6.6.2 Spearman rank correlation coefficient

The Spearman rank correlation coefficient (r_s) is a bivariate measure of correlation/association that is employed with rank-order data to determine the degree to which a monotonic relationship exists between two variables (Sheskin, 2004). A monotonic relationship can either be monotonic increasing or monotonic decreasing. The population parameter estimated by the correlation/association that is employed with rank data is represented by the notation r_s. The range of possible values is between -1 and +1. If the value of r_s is zero, this means that there is no linear correlation relationship between the rankings of the two groups. A value of +1 indicates perfect positive linear correlation, while negative values indicate negative correlation, meaning that a low ranking on the one variable is associated with a high ranking on the other. The strength of the monotonic relationship increases as the absolute value of r_s approaches 1, and decreases as r_s approaches 0. When r_s=0, no monotonic relationship is present (Sheskin, 2004). The equation for computing Spearman's rank correlation coefficient and the test of significance are presented as Equations

6.4 and 6.5, respectively.

$$r_s = 1 - \frac{6\sum d^2}{n(n^2 - 1)}$$ Equation 6.4

$$t = \frac{r^s \sqrt{n-2}}{\sqrt{1 - r_s^2}}$$ Equation 6.5

6.6.3 Two-tailed t-test

The two-tailed t-test tests the null hypothesis that the population mean of a variable is the same for two groups of cases. The confidence interval for the difference between the population means in the two groups is also derived (Norusis, 2002). If the result of the t-test is significant, this indicates that the researcher can conclude that there is a high likelihood that the populations from which the samples were drawn had different means (Sheskin, 2004). The difference would be statistically significant at the 5% level if the corresponding p-value is smaller than or equal to 0.05. Equation 6.6 is a general equation for this test and can be employed for sample sizes that are both equal and unequal.

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\left[\frac{(n_1 - 1)\tilde{s}_1^2 + (n_2 - 1)\tilde{s}_2^2}{n_1 + n_2 - 2}\right]\left[\frac{1}{n_1} + \frac{1}{n_2}\right]}}$$

Equation 6.6

6.6.4 Principal components analysis

Principal components analysis is a technique for forming new variables that are linear composites of the original variables (Sharma, 1996). It is concerned with explaining the variance-covariance structure of a set of variables through a few linear combinations of these variables (Johnson and Wichern, 2002). This method can be preformed either on mean-corrected or standardized data. Mean-corrected is the weight assigned to a variable that is affected by the relative variance of the variable. Standardized data refers to data with standardized variance so that the variance of each variable is the same and not affected by the relative variance. The choice between the analysis obtained from mean-corrected and standardized data depends on whether there is reason to believe that the variances of the variables do indicate the importance of a given variable (Sharma, 1996). The principal components analysis is used to form an index. The principal components analyse the variables from an index. The variables are called 'formative indicators' of the components, as the index is formed by the variables (Sharma, 1996). Johnson and Wichern (2002) suggested that analyses of principal components are more of a means to an end rather than an end in themselves, because they frequently serve as intermediate steps in a much larger investigation. Therefore, in this study, the principal components that were based on standardized data were used to form the project success index (PSI) for healthcare projects and to be inputs to a multiple regression for determining the critical success factors. There is a crucial need to develop a PSI. The data collected from a questionnaire survey on the measures for success are rather diverse. It is difficult to have multiple criteria in assessing success. Therefore, the development of a PSI is an attempt to combine different measures of success to a unified base for easy analysis. A PSI can provide reputable summaries of measured data to improve the reliability of the data.

With reference to Sharma (1996), the analytical approach to a principal components analysis is as follows:

Assuming that there are p variables, the equation of forming the p principal components is presented in Equation 6.7.

$$PRIN1 = w_{11}x_1 + w_{12}x_2 + \ldots\ldots + w_{1p}x_p$$

$$PRIN2 = w_{21}x_1 + w_{22}x_2 + \ldots\ldots + w_{2p}x_p$$

$$\vdots$$

$$PRINp = w_{p1}x_1 + w_{p2}x_2 + \ldots\ldots + w_{pp}x_p \qquad \text{Equation 6.7}$$

where PRIN1, PRIN2...PRINp are the p principal components and w_{ij} is the weight of the ith principal component. The weights, w_{ij}, are estimated so that:

a. The first principal component, PRIN1, accounts for the maximum variance in the data; the second principal component, PRIN2, accounts for the maximum variance that has not been accounted for by the first principal component; and so on.

b. $w_{i1} + w_{i2} + \ldots + w_{ip} = 1 \quad i=1,\ldots,p$ Equation 6.8

c. $w_{i1}\, w_{j1} + w_{i2}\, w_{j1} + \ldots + w_{ip}\, w_{jp} = 0$ for all $i \neq j$ Equation 6.9

From the results of the principal components analysis, the eigenvectors give the weightings of the variables that are used for forming the equation. Once the equation is developed, the scores on each criterion can be inputted and become a compound score that reflects a project's overall level of performance.

6.6.5 Factor analysis

Factor analysis is a statistical technique used to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables (Norusis, 1993a). It is a way of reducing data to a form in which there are no independent and dependent variables; in fact, it is an interdependence technique in which all variables are considered simultaneously (Hair et al., 1995). The extraction and rotation of the factors were carried out to generate a small number of factors and obtain a clearer picture of what these factors represent. With reference to Norusis (1993a), the mathematical model for factor analysis appears somewhat similar to a multiple regression equation. In general, the model for the *i*th standardized variable is written as:

$$X_i = A_{i1}F_1 + A_{i2}F_2 + \ldots\ldots + A_{ik}F_k + U_i \qquad \text{Equation 6.10}$$

where the F's are the common factors (since all variables are expressed as functions of them), the U is the unique factor, and the A's are the coefficients used to combine the *k* factors. The unique factors are assumed to be uncorrelated with each other and with the common factors. This equation differs from the usual multiple regression equation in that F's are not single independent variables. Instead, they are labels for groups of variables that characterize these concepts. These groups of variables constitute the factors and these factors are useful for characterizing a set of variables not known in advance but determined by factor analysis. Factor scores are also estimated for each case in order to represent the values of the factors. A factor can be estimated as a linear combination of the original variables. The general expression for the estimate of the *j*th factor, F_j, is:

$$F_j = \sum_{i=2}^{p} W_{ji} X_i = W_{j1} X_1 + W_{j2} X_2 + \ldots + W_{jp} X_p \qquad \text{Equation 6.11}$$

The W_i's are known as factor score coefficients, and *p* is the number of variables.

6.6.6 Multiple regression analysis

Regression analysis is by far the most widely used and versatile dependence technique, applicable in every facet of business decision-making, ranging from the most general problems to the most specific (Hair et al., 1995). Multiple regression analysis is a statistical technique that can be used to analyse the relationship between a single dependent (criterion) variable and several independent (predictor) variables. One of the objectives of this research is to identify the important predictors of the success of healthcare projects. This technique can best achieve this objective and is therefore chosen to be the principal instrument for this study. The multiple linear regression equation of dependent variable (y) upon the independent variables ($x_1, \ldots x_p$) is expressed in Equation 6.12.

$$y = \beta_0 + \beta_1(x_1) + \beta_2(x_2) + \ldots + \beta_p(x_p) + e \qquad \text{Equation 6.12}$$

where y represents the dependent variable, $x_1 \ldots x_p$ are the independent variables; the parameters $\beta_1, \beta_2, \ldots \beta_p$ are the partial regression coefficients; the intercept β_0 is the regression constant; and e is the error term.

When a regression equation is used to estimate the values of a variable y given the value of independent variables, the estimates y' will usually fall short of complete accuracy. The discrepancies $(y - y')$ on the predicted variable are known as residuals. Therefore, the study of residuals in the regression model is of great importance to give a good account of the model in question. The basic methods of identifying assumption violations for the overall relationship will be discussed in section 6.6.7.

6.6.6.1 Methods for selecting variables – Selection of stepwise variables

Sequential search methods have in common the general approach of estimating the regression equation with a set of variables and then selectively adding or deleting variables until some overall criterion measure is achieved (Hair et al., 1995). There are different sequential search approaches, namely stepwise estimation, forward addition and backward elimination. In each approach, variables are individually assessed for their contribution to the prediction of the dependent variable, and are added to or deleted from the regression model based on their relative contribution (Hair et al., 1995).

Forward selection starts with a model that contains only the constant term and adds the variable that results in the largest increase in multiple R^2. Conversely, the backward selection starts with a regression model that contains all of the independent variables and removes the variable that changes R^2 least.

Stepwise estimation is perhaps the most popular sequential approach to selecting variables (Hair et al., 1995; Norusis, 2000). It is a combination of forward selection and backward elimination. Stepwise estimation was selected in this study, as the variables whose importance diminished as additional predictors are added are removed. The stepwise procedure is illustrated in Figure 6.7.

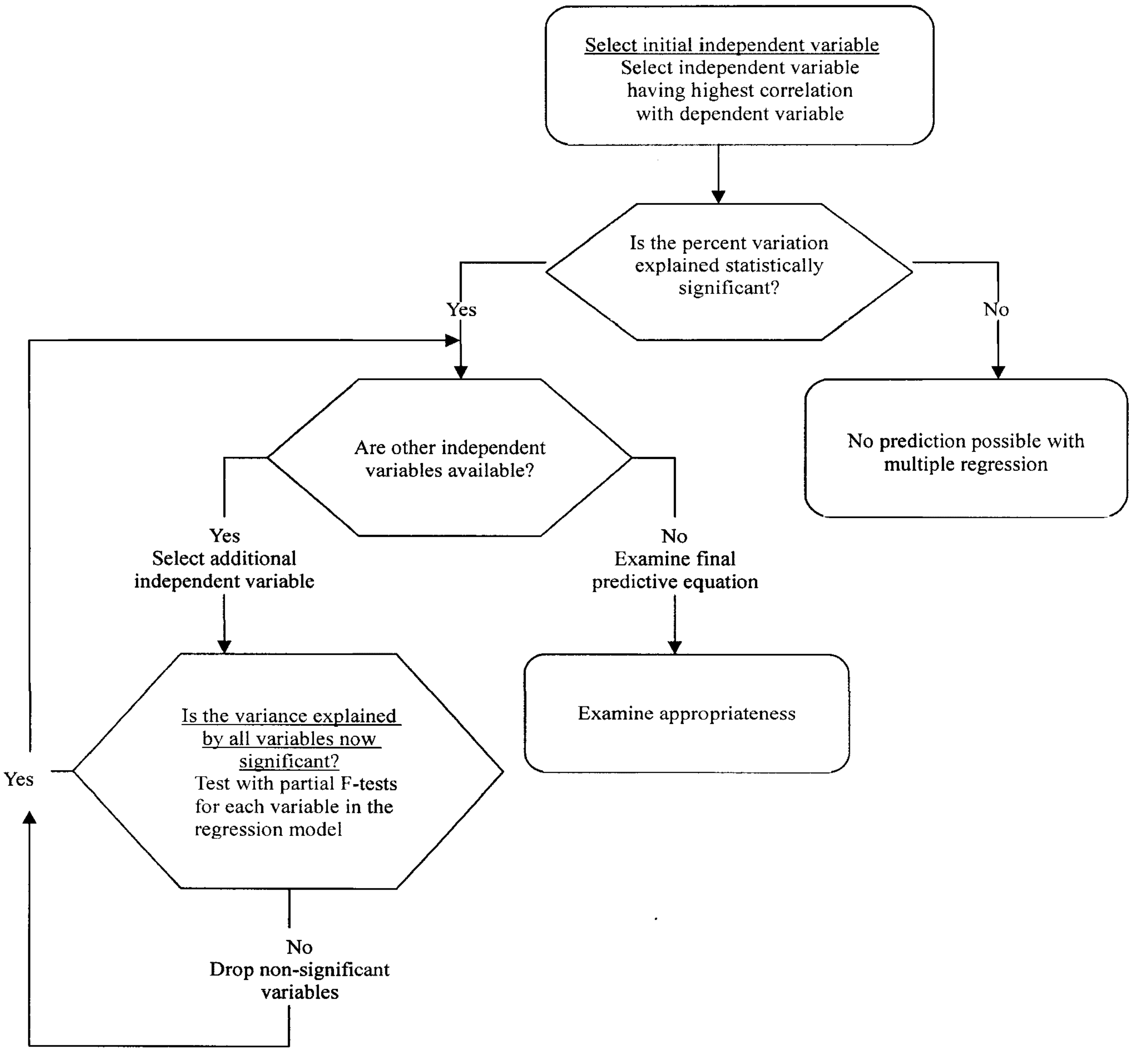


Figure 6.7 Flowchart of the stepwise estimation method (Hair et al., 1995)

6.6.7 Evaluating the variate for the assumptions of regression analysis

In evaluating the estimated regression equations, the statistical significance of these equations must be considered, the validity of the classical assumptions should be assessed, and outliers need to be identified. The four basis assumptions underlying the regressions that need to be assessed include linearity, homoscedasticity, multicollinearity, and normality.

6.6.7.1 Linearity - Partial regression plot

In a multiple regression with more than one independent variable, a partial regression plot can be used to examine the relationship between a single independent variable and the dependent variable (Hair et al., 1995). For the jth independent variable, the partial regression plot is obtained by calculating the residuals for the dependent variable when it is predicted from all of the independent variables excluding the jth and by calculating the residuals for the jth independent variable when it is predicted from all of the other independent variables. This removes the linear effect of the other independent variables from both variables (Chan, 1996). For each case, these two residuals are plotted against each other. In partial regression plots, the curvilinear pattern of residuals indicates a non-linear relationship between a specific independent variable and the dependent variable (Hair et al., 1995).

Figure 6.8 is a partial regression plot for project management action (Factor 1) for the regression equation. The partial regression plot shows the residuals for the project success index on the y-axis and the residual values for project management action (Factor 1) on the x-axis. An examination of the partial regression plot confirms that this specific variable does not violate the assumption of linearity. Partial regression plots for the other variables can be found in Appendices G1 to G10.

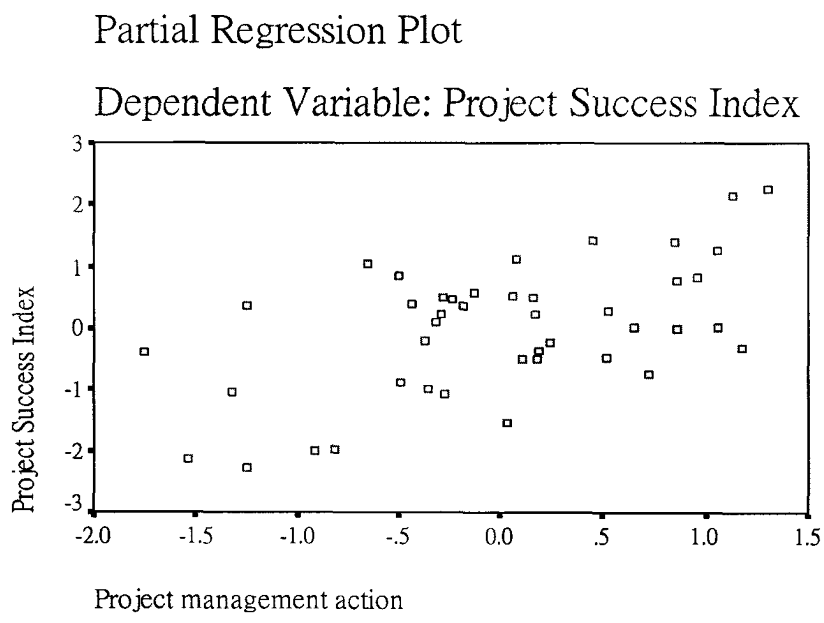


Figure 6.8 Partial regression plot

6.6.7.2 Homoscedasticity - Residual plot

The presence of unequal variances (heteroscedasticity) is one of the most common violations of the assumption of homoscedasticity (Hair et al., 1995). One diagnosis of heteroscedasticity is to plot the residuals (studentized) against the predicted dependent values. If there is no pattern of increasing or decreasing residuals, this indicates homoscedasticity in the multivariate (the set of independent variables) case (Hair et al., 1995).

Figure 6.9 is the scatterplot of the standardized residuals against the standardized predicted values for the performance measures of the project success index (PSI). The plot shows no obvious pattern, thereby confirming that the assumption of homogeneity of variance has been met. Residual plots for other measures of performance can be found in Appendices G1 to G10.

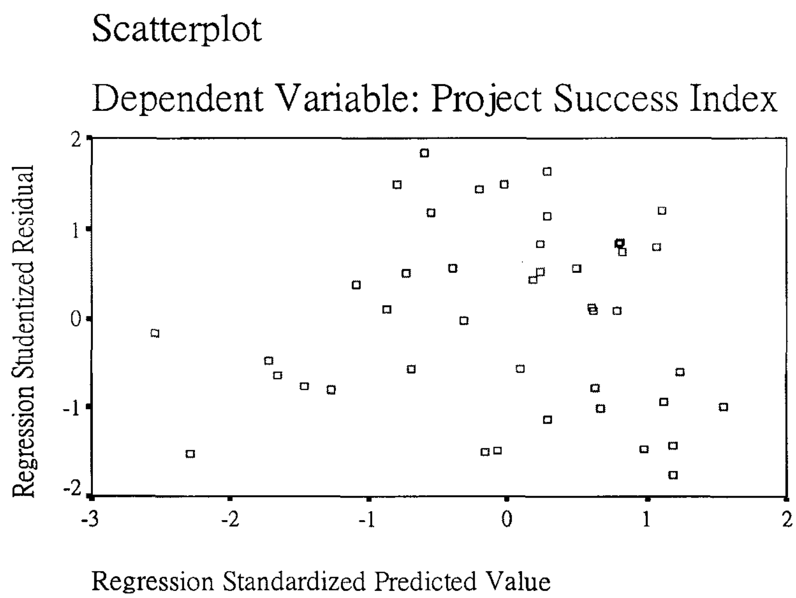


Figure 6.9 Scatterplot of residuals against predicted values

6.6.7.3 Multicollinearity - Tolerance value and Variance inflation factor (VIF)

A key issue in interpreting the regression variate is the correlation among the independent variables. The ideal situation for a researcher is to have a number of independent variables highly correlated with the dependent variable, but with little correlation among themselves (Hair et al., 1995). However, in most situations, multicollinearity occurs when any single independent variable is highly correlated with other independent variable(s). When this occurs, the process of separating the effects of individual variables becomes more difficult. Therefore, the degree of multicollinearity needs to be assessed. The assessment of multicollinearity should be undertaken in two steps: (1) identification of the extent of collinearity and (2) assessment of the degree to which the estimated coefficients are affected. Two common measures, namely the tolerance value and its inverse – the variance inflation factor (VIF), are used to assess the multiple variable collinearity by showing the degree to which each independent variable is explained by the other independent variable. A common cutoff threshold of these measures is a tolerance value of 0.10 and a VIF value of above 10, respectively (Hair et al., 1995). Therefore, if the tolerance value is larger than 0.1 and the VIF is smaller than 10, there is a low level of collinearity in the model.

Table 6.3 shows the values of tolerance and VIF in the collinearity statistics on the regression equation for the project success index. The tolerance values all exceed 0.50, indicating low levels of collinearity. Likewise, the VIF values are all quite close to 1.5. These results indicate that the interpretation of the regression variate coefficients should not be affected adversely by multicollinearity. The tolerance values and VIF values for other variables can be found in Appendices G1 to G10.

Table 6.3 Tolerance and VIF values

	Collinearity Statistics	
Independent Variables	**Tolerance**	**VIF**
Project management action	0.539	1.855
Client's representatives' capabilities	0.607	1.649
Construction team leaders' capabilities	0.720	1.388
Design team leaders' capabilities	0.790	1.267
Application of innovative project management techniques	0.720	1.388

6.6.7.4 Normality - Normal probability plots of the residuals

Another most frequently encountered violation of the assumption of normality is the non-normality of the independent or dependent variables or both (Seer, 1984 as cited in Hair et al., 1995). Therefore, it is necessary to check the normality of the error term of the variate with a visual examination of the normal probability plots of the residuals. The normal distribution makes a straight diagonal line, and the plotted residuals are compared with the diagonal. If a distribution is normal, the residual line closely follows the diagonal (Hair et al., 1995).

Figure 6.10 is the normal probability plot for the project success index. As shown in Figure 6.10, the residual values fall along the diagonal with no substantial or systematic departure; thus, the residuals are considered to represent a normal distribution. Normal probability plots for the other measures of performance can be found in Appendices G1 to G10.

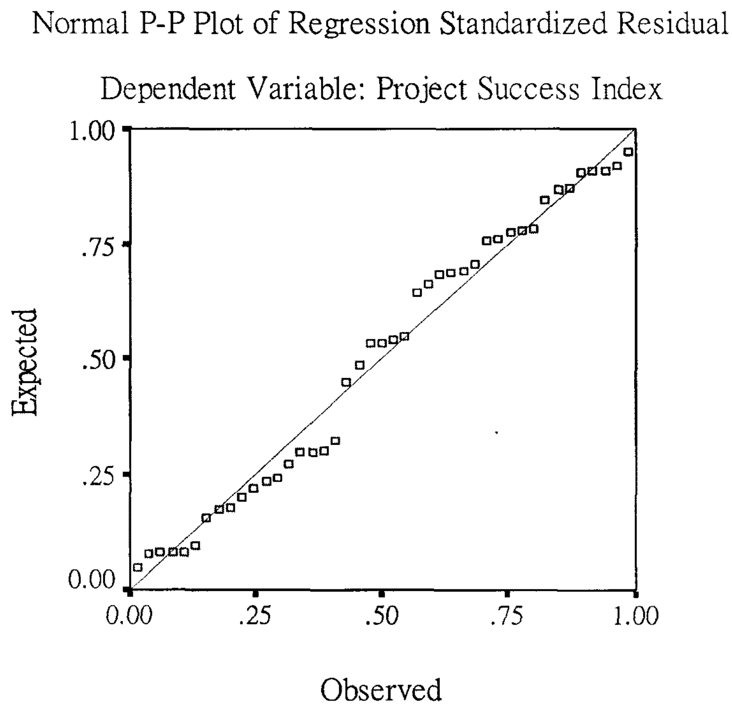


Figure 6.10 Normal probability plot: standardized residuals

6.7 SUMMARY OF THE CHAPTER

This chapter discussed the research framework of this study. The data collection methods and the development of the questionnaire were first described in detail. The size of the sample and the background information of the respondents were then presented. This was followed by a discussion of the methods of analysing data, including Kendall's coefficient of concordance, Spearman rank correlation coefficient, the Two-tailed t-test, Principal components analysis, Factor analysis, and Multiple regression analysis. Finally, the methods of assessing the assumptions of the regression analysis were discussed.

CHAPTER SEVEN

MAJOR PROLEMS IN RUNNING HEALTHCARE PROJECTS

7.1 INTRODUCTION

The construction of healthcare buildings is a challenging task for all of the participants in a project. If not managed properly, this can easily lead to project delays and cost overruns and large scope for rework (Chan and Kumaraswamy, 1996a & 1996b). The purpose of this chapter is to identify the major problems in running healthcare projects in Hong Kong by analysing the data collected from a questionnaire survey of local practitioners in the construction industry. Twenty-four problem statements were identified from the literature and, through a questionnaire survey, were ranked by a group of industry participants who had hands-on experience in running healthcare projects. The ranking of the problems, as assessed by the client and contractor groups, was first examined by the Kendall's coefficient of concordance (W), which is a means of measuring the agreement on the rankings by different respondents within an individual professional group. Then, the perceived problems were further evaluated by the Spearman rank correlation coefficient (r_s), which is a technique to measure the agreement between two different professional groups on their rankings.

7.2 RESEARCH METHODOLOGY

The common problems in managing healthcare projects as identified from Chapter 3 were converted into 24 statements and formed the basis of Part 3 in the empirical research questionnaire to examine the perceptions of project participants about the problems of running healthcare projects in Hong Kong (Table 7.1). The respondents were asked to assess their level of agreement with each of the identified problems according to a seven-point Likert scale scoring system, where '1' represented 'Highly disagree' and '7' represented 'Highly agree' with the statements. A total of 52 valid responses were received. The questionnaire design, data collection process, and the background information of the respondents were discussed in Chapter 6.

The data analysis made use of a number of statistical tools, namely, mean scores, Kendall's coefficient of concordance, and the Spearman rank correlation coefficient. The analyses were conducted with the help of the SPSS statistical package. This study divided the survey respondents into two categories: contractor and client groups. The client groups in this study include client representatives and various consultants. The seven-point Likert scale scoring system was used to calculate the mean score for each problem; the relative ranking of the problems by all of the respondents, and by clients and contractors separately can be determined by comparing the individual mean score for each problem.

Table 7.1 Empirical survey on the potential problems in running healthcare projects in Hong Kong

No.	Problems in Running Healthcare Projects* (Question No. in Questionnaire)	N	Min.	Max.	Mean	Standard Deviation
1	Highly complicated building services were required (1)	52	2	7	5.75	1.22
2	Tight time schedule (7)	52	2	7	5.40	1.16
3	The need to keep up with up-to-date technology (2)	52	1	7	5.35	1.23
4	Frequent changes were demanded by multi-headed clients and various end-users (6)	52	1	7	5.25	1.40
5	A flexible design was required (3)	52	2	7	5.06	1.35
6	Fixed budget (8)	52	2	7	5.04	1.20
7	Difficult to deal with various end-users (5)	52	2	7	5.02	1.50
8	Difficult to deal with large numbers of professionals or specialists (4)	52	2	7	4.71	1.38
9	High risk of project delays (12)	52	1	7	4.67	1.38
10	Facing great pressure from general public and client (9)	52	2	7	4.58	1.02
11	Coordination of architectural, structural, and building services engineering practices was difficult (21)	52	1	7	4.31	1.41
12	Inadequately designed and coordinated building services (22)	52	1	7	4.25	1.45
13	High risk of cost overruns (11)	52	1	7	4.23	1.37
14	Difficulties in connecting the procurement with the installation and commissioning of medical equipment (23)	52	1	7	4.23	1.45
15	Ambiguity in allocating design responsibilities for building services (24)	52	1	7	4.17	1.40
16	Unable to meet the schedule of the project (10)	52	1	7	3.90	1.46
17	High risk of producing poor-quality products (13)	52	1	7	3.87	1.33
18	Limited incorporation of new techniques (20)	52	2	7	3.85	1.26
19	High level of rework required to achieve the specifications (15)	52	1	7	3.79	1.35
20	Inadequate exchange of knowledge and skills between parties (19)	52	1	7	3.71	1.50
22	Large number of claims involved (17)	52	1	7	3.56	1.46
21	Insufficient cooperation between various project participants (18)	52	1	7	3.50	1.54
23	Productivity was comparatively low (14)	52	1	6	3.46	1.23
24	Exposure to litigation (16)	52	1	5	3.23	1.11

*Items were rated on a seven-point Likert scale scoring system from 1 to 7 (1=Strongly Disagree and 7=Strongly Agree)

7.3 PRESENTATION OF THE RESULTS OF THE ANALYSIS

After receiving the completed survey questionnaires, the perception of each respondent on the level of the importance of 24 identified problems was transformed into a matrix using the SPSS 11.0 as the input data for calculating the values of W and r_s.

7.3.1 Kendall's coefficient of concordance

The results of the computation of Kendall's coefficient of concordance and the rankings by the mean score of all of respondents, clients, and contractors are presented in Table 7.2. The Kendall's coefficient of concordance (W) for the rankings of problems among the various respondent groups of overall respondents, clients, and contractors was 0.295, 0.307, and 0.324, respectively (Table 7.2). The null hypothesis, that the respondents' ratings within a certain group are unrelated to each other, was rejected at the 0.0001 significance level; therefore, it can be concluded that there is substantial agreement among the respondents in each group on the rankings of the problems in their healthcare projects.

Table 7.2 Ranking and Kendall's Coefficient of Concordance for the problems of running healthcare projects in Hong Kong

No.	Item (Problems in Running Healthcare Projects)	All Respondents		Clients		Contractors	
		Mean	Rank	Mean	Rank	Mean	Rank
1	Highly complicated building services were required	5.75	1	5.60	1	5.95	1
2	Tight time schedule	5.40	2	5.27	3	5.59	2
3	The need to keep up with up-to-date technology	5.35	3	5.43	2	5.23	4
4	Frequent changes were demanded by multi-headed clients and various end-users	5.25	4	5.00	7	5.59	2
5	A flexible design was required	5.06	5	5.10	5	5.00	7
6	Fixed budget	5.04	6	5.17	4	4.86	9
7	Difficult to deal with various end-users	5.02	7	5.03	6	5.00	7
9	Difficult to deal with large numbers of professionals or specialists	4.71	8	4.47	10	5.05	6
8	High risk of project delays	4.67	9	4.30	11	5.18	5
10	Facing great pressure from general public and client	4.58	10	4.67	8	4.45	12
11	Coordination of architectural, structural, and building services engineering practices was difficult	4.31	11	4.50	9	4.05	16
12	Inadequately designed and coordinated building services	4.25	12	4.07	13	4.50	11
13	High risk of cost overruns	4.23	13	3.93	15	4.64	10
14	Difficulties in connecting the procurement with the installation and commissioning of medical equipment	4.23	13	4.10	12	4.41	14
15	Ambiguity in allocating design responsibilities for building services	4.17	15	3.97	14	4.45	12
16	Unable to meet the schedule of the project	3.90	16	3.67	20	4.23	15
17	High risk of producing poor-quality products	3.87	17	3.90	16	3.82	20
18	Limited incorporation of new techniques	3.85	18	3.70	19	4.05	16
19	High level of rework required to achieve the specifications	3.79	19	3.83	17	3.73	21
20	Inadequate exchange of knowledge and skills between parties	3.71	20	3.80	18	3.59	22
22	Large number of claims involved	3.56	21	3.30	22	3.91	18
21	Insufficient cooperation between various project participants	3.50	22	3.23	23	3.86	19
23	Productivity was comparatively low	3.46	23	3.43	21	3.50	23
24	Exposure to litigation	3.23	24	3.17	24	3.32	24
Number (N)		52		30		22	
Kendall's Coefficient of Concordance (W)		0.295		0.307		0.324	
Level of Significance		0.000		0.000		0.000	
where H_0 = respondents' ratings are unrelated to each other within each group							

7.3.2 Spearman rank correlation coefficient

After calculating the *W*, the Spearman rank correlation coefficient (r_s) was used to test the level of consensus on the ranking exercise between different groups of respondents. The result of the correlation is presented in Table 7.3. The computed r_s was 0.853, and the level of significance was 0.000. The null hypothesis that there would be 'no significant disagreement between clients and contractors on the ranking of problems in running healthcare projects' is therefore accepted. It can be concluded that there was a general agreement between the client group and the contractor group on the ranking of problems in managing healthcare projects, and the level of significance was 0.0001.

Table 7.3 Spearman rank correlation test between the responses of clients and contractors on the problems of running healthcare projects in Hong Kong

	r_s	Significance	Conclusion
Client ranking vs Contractor ranking	0.853**	0.000	Accept H_0
**. *Correlation is significant at the 0.01 level (2-tailed)*			
Where H_0 = No significant disagreement on the ranking			
Ha = significant disagreement on the ranking			

7.4 DISCUSSION OF THE RESULTS OF THE ANALYSIS

Table 7.2 shows that the value of Kendall's coefficient of concordance for all of the respondents was 0.295. When dividing the respondents into consultant group and contractor group and soliciting their individual perceptions of relevant problems, the values of Kendall's coefficient increased to 0.307 and 0.324, respectively. The increase in Kendall's coefficient indicates that a stronger agreement was achieved when the assessment was conducted separately within the client group and the contractor group.

When looking at the ranking exercise collectively, 'highly complicated building services' was considered as the most significant problem. A 'tight time schedule', 'the need to keep up with up-to-date technology', and 'frequent changes were demanded by multi-headed clients and various end-users' were also regarded as the second, third, and fourth most prominent problems. The results of the ranking also indicate that 'fixed budget' and 'requirement of flexible design' are common difficulties encountered in healthcare projects. 'Productivity was comparatively low' and 'exposure to litigation' were, on the other hand, ranked as the least important problems by the respondents.

When the focus turned to individual groups, both the client group and the contractor group had a general concordance in ranking the top three problems; i.e., 'highly complicated building services', 'tight time schedule', and 'the need to keep up with up-to-date technology'. This indicates that most of the respondents faced similar problems, which stemmed from the unique features of healthcare projects.

7.4.1 Highly complicated building services

'Highly complicated building services' was the most significant problem identified by the client and contractor groups. Healthcare buildings, especially hospitals, are complex and highly serviced. The cost of building services can be as high as 40-50% of the total construction cost (Nelson, 1990). Lam et al. (1998) stated that the procurement of complex and highly serviced hospital buildings is always fraught with expensive and complex problems of inadequate coordination of building services and hospital equipment, and these problems are detrimental to the success of hospital projects.

7.4.2 Tight time schedule

'Tight time schedule' was identified as the second major problem by all of the respondents. Construction programmes allowed in hospital projects were usually very tight (Wong, 1983). The need to procure buildings within a tight timescale is one of the major problems that the participants in a project need to face, particularly in Hong Kong. Nearly all hospitals are publicly funded in Hong Kong. In order to maintain public accountability, a tight time schedule and defined budget are required.

7.4.3 The need to keep up with up-to-date technology

'The need to keep up with up-to-date technology' was considered the third major problem in running healthcare projects by all of the respondents. To provide the highest standard of medical health services, the healthcare profession needs to develop new knowledge and medical technology. The need to keep up with up-to-date technology is one of the main difficulties in healthcare projects. The project team works in a dynamic and turbulent environment. Hence, the design must take into account developments in clinical practices and rapid changes in medical technology. Because of the speedy changes in technology, the selection of medical equipment might have to be postponed to the last stage. This affects performance on the schedule and can easily lead to unnecessary delays.

7.4.4 Frequent changes demanded by multi-headed clients and various end-users

'Frequent changes demanded by multi-headed clients and various end-users' was ranked as fourth in the overall assessment; the client group ranked it as the seventh most important problem and the contractor group ranked it as the third. Chan et al. (2003a & 2003b) pointed out that the ultimate users of the healthcare building are not homogeneous but are comprised of an enormous range of end-users, including patients, nurses, doctors, physiotherapists, anaesthetists, and other specialists. Moreover, individual end-users play an important role in hospital design and in the selection of medical equipment. It is a time-consuming task to obtain a consensus from all of the end-users. In addition, requests for changes to cope with medical advances or changes in personal performance during the construction stage create significant problems for the contractors. Any abortive work and the necessity to re-work will have time implications for the contractors. With the increasing trend of using the design-build system to procure healthcare projects, contractors are responsible for both design and construction, and this 'multi-headed client' syndrome imposes a greater burden on contractors (Chan et al., 2003a & 2003b).

7.4.5 Disparities among the rankings of the two professional groups

Some apparent disparities were observed amongst the rankings of the client group and the contractor group in items 5, 8, 11, 13, and 21 (Figure 7.1). First, for item 5, 'fixed budget' was ranked fourth by clients and ninth by contractors. Item 11, 'coordination of architectural, structural, and building services engineering practices was difficult' was ranked ninth and sixteenth by the clients and contractors, respectively. For items 8, 13, and 21, clients assigned lower ranking than contractors, implying that contractors were more conscious about these three items; i.e., high risk of project delays, high risk of cost overruns, and inadequate cooperation between various project participants.

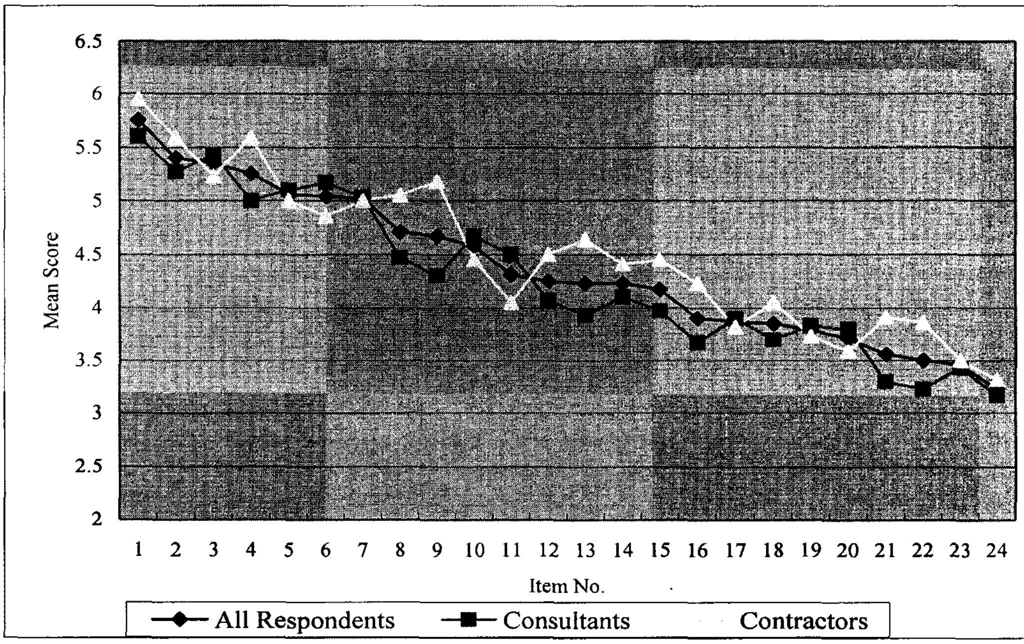


Figure 7.1 Profiles of the mean scores for the twenty-four problems

7.4.5.1 Fixed budget

The contractor group did not seem to be too concerned with the fixed budget in healthcare projects, as they assigned lower ranks for this item. Conversely, the clients assigned higher ranks. The pattern of the rankings on item 5 (fixed budget) reflects that the client group placed more emphasis on cost. Since the client group has a large representation of quantity surveyors (i.e., 12% out of a total of 45%), their relatively high concern about fixed budgets is understandable. Also, most hospital projects are publicly funded and the budget is under public scrutiny. Therefore, the clients are more concerned about managing costs.

7.4.5.2 Coordination of architectural, structural, and building services engineering practices was difficult

The result of the ranking of item 11 (coordination of architectural, structural, and building services engineering practices was difficult) can be explained by the professional duties of the respondents. Healthcare projects involve a large number of design consultants from various expert disciplines. A good system of coordination and integration is required for a properly coordinated, cost-effective design. And nearly all of these tasks are performed by the consultants. Therefore, the client group, which includes all consultants, ranked it higher.

7.4.5.3 High risk of project delays

It is understandable why contractors place a greater emphasis on the factor of time. Contractors will be subject to liquidated damages if they fail to deliver the project on schedule. This will have a great impact on the contractors' profit and their reputation in the construction field. The reputation of a contractor is important, as nearly all the public projects require the contractors to go through a pre-qualification procedure and show a good track record. As one of the factors taken into consideration in the pre-qualification exercise, therefore, the ability to complete projects on time has a long-term effect on the contractors.

7.4.5.4 High risk of cost overrun and inadequate cooperation between various project participants

Both item 13 (high risk of cost overrun) and item 21 (inadequate cooperation between various project participants) are closely related. Hospital projects require a huge number of professionals from various disciplines of construction, so the contractors find it difficult to coordinate the multi-headed clients, various end-users, different consulting engineers, design consultants, specialist contractors, and so forth who have their own professional opinions and judgments on the project. When there is insufficient cooperation, variations and changes from clients and end-users are more likely to be introduced. These will lead to cost overruns (item 13) and project delays (item 8) (Chan and Yeong, 1995).

7.4.6 Gaps between the literature and actual practices

It is interesting to note that the major problems mentioned in the literature, such as 'inadequately designed and coordinated building services', 'difficulties in connecting the procurement with the installation and commissioning of medical equipment', and 'ambiguity in allocating design responsibilities for building services', were not considered to be the top ten problems by the respondents in the empirical survey. Overall, they were ranked only 12th, 14th, and 15th, respectively. Perhaps these potential problems were overcome by the superb project management skills exercised by the client's representatives, consultants, and contractors involved in the healthcare sector. In fact, a clause of 'employing an extra experienced building services coordinator by the contractor' has been included in the contract conditions for public healthcare projects. This mandatory provision for an experienced coordinator has been demonstrated to be an effective measure to alleviate these problems inherent in healthcare projects.

7.5 SUMMARY OF THE CHAPTER

This chapter aims to identify and investigate the relative importance of the problems in running healthcare projects from the viewpoints of clients and contractors in Hong Kong. The ranking patterns and level of consensus among the respondents were analysed and compared by the mean score, the Kendall's coefficient of concordance (W), and the Spearman rank correlation coefficient (r_s). The statistical analyses revealed that there was substantial agreement both within and between the client group and the contractor group on the rankings of the problems in managing healthcare projects. Both groups agreed that 'highly complicated building services', 'tight time schedule' and 'the need to keep up with up-to-date technology' are the three most important problems found in healthcare buildings. These three potential problems are, in fact, some of the features unique to healthcare projects.

Apart from 'frequent changes demanded by multi-headed clients and various end-users', the following were also considered to be main problems faced by industry practitioners: 'fixed budget', 'flexible design was required', 'difficult to deal with various end-users', 'high risk of project delays', 'difficult to deal with a large number of professionals or specialists', and 'facing great pressure from general public and client'. Some disparities were found among the rankings of the client group and the contractor group. 'Fixed budget' and 'coordination of architectural, structural, and building services engineering practices was difficult' were ranked higher by the clients, while 'high risk of project delays', 'high risk of cost overruns' and 'inadequate cooperation between various project participants' were ranked higher by the contractors.

The survey demonstrated that a gap exists between what has been discussed in the literature and actual practices. 'Inadequately designed and coordinated building services', 'difficulties in connecting the procurement with the installation and commissioning of medical equipment', and 'ambiguity in allocating design responsibilities for building services' were the conspicuous problems identified in the previous literature. However, the empirical study found that these problems are less serious in the Hong Kong context.

CHAPTER EIGHT

CRITERIA FOR THE SUCCESS OF HEALTHCARE PROJECTS

8.1 INTRODUCTION

Healthcare buildings are essential to society and the general public (Chan et al., 2003b). The primary task in building a fit-for-purpose healthcare building is to establish commonly accepted criteria for success, with clearly defined targets for the project team to work towards. The topic of the success of a project has been widely discussed in academia and industry over the last ten years. However, it is difficult to develop a perfect model that can fit every project. This chapter aims to develop a model for successful healthcare projects in Hong Kong by analysing the opinions of different industry practitioners collected from the questionnaires. The first part of this chapter examines the ranking of the criteria, assessed by client and contractor groups, using Kendall's coefficient of concordance (W), the Spearman rank correlation coefficient (r_s), and the two-tailed t-test. The ranking of criteria will help to measure the level of agreement on the issue of project success and to pinpoint any significant differences that exist between the client and contractor groups. The second part of this chapter focuses on developing a project success index (PSI) for healthcare projects. A PSI formula is constructed by identifying the variables and calculating the weightings of each variable. Once the PSI is established, a powerful and reliable summary of measured data can be inputted to determine the critical success factors of a project.

8.2 RESEARCH METHODOLOGY

Based on a critical review of the related literature in Chapter 4, a total of twelve criteria for success were identified and formed the basis of a research questionnaire. Due to the similarity between the satisfaction and the expectations of the end-users, these two statements were grouped together under the heading of 'Various end-users are satisfied with the performance of the project'. In the end, 11 criteria for success in running healthcare projects were finally identified and ranked (Table 8.1).

Table 8.1 Ranking of criteria for the success in running healthcare projects in Hong Kong

Criteria for success in running healthcare projects	N	Min.	Max.	Mean	Standard deviation
The client is satisfied with the performance of the project	52	3	7	5.56	1.14
The project was completed to the required standard of quality	52	3	7	5.52	1.00
The project is achieving its purpose/function	52	3	7	5.50	1.16
The project was completed with a low accident rate	52	4	7	5.44	0.96
The project was completed on budget	52	3	7	5.42	1.00
Various end-users are satisfied with the performance of the project	52	3	7	5.25	0.99
The project was completed on time	52	1	7	5.25	1.34
Various participants are satisfied with the performance of the project	52	3	7	5.25	1.10
The project was completed in an environmentally friendly manner	52	3	7	5.13	0.86
The project can produce further/long-term gains	52	1	7	4.79	1.30
The project is profitable	52	1	7	4.65	1.36

The methodology of this ranking exercise was similar to that discussed in Chapter 7. The respondents were asked to assess their level of agreement with each of the identified criteria according to a seven-point Likert scale scoring system, where '1' represented 'Highly disagree' and '7' represented 'Highly agree' on the statements. The resulting data was analysed by mean scores, Kendall's coefficient of concordance, the Spearman rank correlation coefficient, and a two-tailed t-test. This study divided the respondents to the survey into two categories: contractor and client groups. The contractor group includes main contractors and subcontractors, and the client group includes client representatives and all consultants employed by the clients.

Again, Kendall's coefficient of concordance (*W*) was used to measure the agreement of different respondents on the rankings within individual groups, i.e. either within the client group or the contractor group. The Spearman rank correlation coefficient (r_s) was used to evaluate the degree of agreement between the rankings of these two groups. The two-tailed t-test was used to test the differences between the clients and contractors' ratings of each criterion.

8.3 PRESENTATION OF THE RESULTS OF THE ANALYSIS

The perceptions of each respondent of the level of importance of the 11 identified criteria were transformed into a matrix by using the SPSS 11.0 statistical software as the input data for calculating the values of W, r_s, and the p-value.

8.3.1 Kendall's coefficient of concordance

The Kendall's coefficient of concordance (*W*) for the rankings of criteria among various respondent groups of clients and contractors was 0.186 and 0.096, respectively (Table 8.2). The null hypothesis, that the respondents' ratings within a certain group are unrelated to each other, was rejected at a 0.05 significance level. Therefore, it can be concluded that there is substantial agreement among the respondents in each group on the rankings of the criteria for healthcare projects.

Table 8.2 Ranking and Kendall's Coefficient of Concordance for the criteria for the success of healthcare projects

Criteria	All Respondents		Clients		Contractors	
	Mean	Rank	Mean	Rank	Mean	Rank
The client is satisfied with the performance of the project	5.56	1	5.30	1	5.91	1
The project is completed to the required standard of quality	5.52	2	5.23	6	5.91	1
The project is basically achieving its purpose/function	5.50	3	5.27	3	5.82	3
The project was completed with a low accident rate	5.44	4	5.27	3	5.68	4
The project was completed on budget	5.42	5	5.30	1	5.59	6
The various end-users are satisfied with the performance of the project	5.25	6	5.27	3	5.23	9
The project was completed on time	5.25	6	5.00	7	5.59	6
The various participants are satisfied with the performance of the project	5.25	6	5.00	7	5.59	6
The project was completed in an environmentally friendly manner	5.13	9	5.00	7	5.32	11
The project can produce further/long-term gains	4.79	10	4.17	10	5.64	5
The project is profitable	4.65	11	4.13	11	5.36	10
Number (N)	52		30		22	
Kendall's Coefficient of Concordance (W)	0.097		0.186		0.096	
Level of Significance	0.000		0.000		0.021	
Where H_0 = the respondents' ratings are unrelated to each other with each group						

8.3.2 Spearman rank correlation coefficient

After calculating *W*, the Spearman rank correlation coefficient (r_s) was used to test the level of consensus on the ranking exercise between different groups of respondents. The correlation result is presented in Table 8.3. The computed r_s was 0.36 and the level of significance was 0.271. The null hypothesis (H_0) that there would be 'no significant disagreement between clients and contractors on the ranking of the criteria for the success of healthcare projects' is therefore rejected. It is concluded that there was significant disagreement between the client group and the contractor group on the criteria for the success of healthcare projects (H_a).

Table8.3. Spearman rank correlation test between the responses of clients and contractors on the criteria for the success of healthcare projects

	r_s	Significance	Conclusion
Client ranking vs contractor ranking	0.36**	0.271	Accept H_a
** Correlation is significant at the 0.01 level (2-tailed)			
Where H_0 = no significant disagreement on the ranking			
Ha = significant disagreement on the ranking			

8.3.3 Two-tailed t-test

Disagreement between the client and contractor groups on the criteria for the ranking of success was found in section 8.3.2. A two-tailed t-test was then used to identify the dissimilarities between them. By comparing the mean of each criterion for each group, it was found that clients and contractors hold different views on the criteria of 'the project was completed to a required standard of quality'; 'The project can create further/long-term gains' and 'The project is profitable', as their *p*-values equal 0.0150, 0.0000, and 0.0010, respectively (Table 8.4), all of which are less than the specified level of significance of 5%.

Table 8.4 Two-tailed t-test for the criteria for the success of healthcare projects

Criteria	t-test (two-tailed) p-value
The project is completed on budget	0.3030
The client is satisfied with the performance of the project	0.0570
The project was completed with a low accident rate	0.1240
The various end-users are satisfied with the performance of the project	0.8890
The project is achieving its purpose/function	0.0910
The project was completed to a required standard of quality	0.0150
The project was completed on time	0.1170
The project was completed in an environmentally friendly manner	0.1920
The various participants are satisfied with the performance of the project	0.0550
The project can produce further/long-term gains	0.0000
The project is profitable	0.0010

8.4 DISCUSSION OF THE RESULTS OF THE ANALYSIS

Table 8.2 shows that the value of Kendall's coefficient of concordance for all of the respondents was 0.097. After dividing the respondents into the client group and the contractor group and soliciting their individual perceptions of the criteria for success, the values of Kendall's coefficient changed to 0.186 and 0.096, respectively. The changes in Kendall's coefficient indicate that a stronger agreement was achieved when the assessment was conducted within the client group, but a slightly weaker agreement was noted in the contractor group.

Viewing the ranking exercise collectively, 'The client is satisfied with the performance of the project' was considered the most significant criterion of success. 'The project was completed to the required standard of quality', 'The project is achieving its purpose/function', and 'The project was completed with a low accident rate' were regarded as the second, third, and fourth most important criteria. 'The project is profitable' and 'The project can produce further/long-term gains' were, on the other hand, ranked as the least important criteria by the respondents.

Turning the focus to individual groups, the client and contractor group had a similar ranking on the top criterion, i.e. 'The client is satisfied with the performance of the project', and on the top - third and fourth criteria, i.e. 'The project is achieving its purpose/function' and 'The project was completed with a low accident rate'. This indicates that both the client group and contractor group assess the success of the healthcare projects from the level of the client's satisfaction, the number of site accidents, and the level of functionality of the completed buildings.

8.4.1 Client's satisfaction

The client's satisfaction was ranked as the most important criterion by both the client group and the contractor group. Shenhar et al. (1997) concluded that many projects have failed because they did not fulfil the expectations of the customer, even though they were well executed. This means that project managers must be sensitive and responsive to the requirements and to the real needs of the client. Chan et al. (2003a, 2003b) pointed out that the ultimate users of the healthcare building are not homogeneous but are comprised of a huge variety of end-users, including patients, nurses, doctors, physiotherapists, anaesthetists, and other specialists. Each end-user plays an important role in the design of the hospital and the selection of the medical equipment. It is laborious to fulfil the needs of every individual. Focusing on the client (the representative of the hospital) as the most powerful authority enables contractors and consultants to have a single point of responsibility and increases operational efficiency.

8.4.2 Standard of quality

'The project is completed to the required standard of quality' was ranked by the client group as the sixth most important criterion for success, but the contractor group ranked it as the top criterion. Standard of quality is one criterion within the Iron Triangle, and its importance cannot be underestimated. Although the client group ranked it sixth, the contractor group believed it was as important as the satisfaction of the client. Parfitt and Sanvido (1993) defined quality in the construction industry as the totality of the features required by a product or services to satisfy given needs, or fitness for purposes. Moreover, quality is the guarantee of the fitness of the products that convinces customers or end-users to purchase or use them (Chan and Chan, 2004). In healthcare buildings, there is a need to keep up with up-to-date technology in order to provide the highest standard of medical health services to the public, so the design and the construction must take into account developments in clinical practices and rapid changes in medical technology. The requirement for quality in construction is exceptionally high in healthcare projects as compared to other types of projects (Chan et al., 2003b).

The *p*-value of this criterion was 0.0150, which could indicate the existence of a disparity among the client and contractor groups (Table 8.4). This disparity may be attributable to the innovative procurement system that has recently been introduced to healthcare projects. The North District Hospital and Tseung Kwan O Hospital used the design-and-build approach (D&B) as the procurement system. It appears that clients may not expect contractors to produce innovative designs in D&B projects; therefore, they placed less emphasis on this criterion (Chan et al., 2000b). However, to contractors, quality has rapidly become a factor as critical as price in winning a project (Abdel-Razek, 1998). If the contractor has a track record of delivering a low-quality performance, this will greatly affect the contractors' chances of remaining in the pre-qualification/ tender list (Chan et al., 2003c). This can explain why contractors put such a high emphasis on quality.

8.4.3 Functionality

Hospital projects, unlike residential and commercial buildings, are treated as 'functional' buildings. The achievement of its proposed functions is critical. There would be of no point in undertaking a project if it does not fulfil its intended function at the end of the day (Kometa et al., 1995). Both the client and contractor groups ranked it as the third most important criterion. In any healthcare project, the building's services must satisfy the hospital's functional requirements (Lam et al., 1997b). The hospital's functions should satisfy the disparate demands of the general public and the highly trained operations staff; therefore, the requirement for functional performance is exceptionally high in healthcare buildings (Chan et al., 2003b).

8.4.4 Safety

Safety is receiving increasing attention and concern in the local construction industry. If accidents occur, both contractors and clients may be subjected to legal claims, as well as financial losses and delays in completing the project (Chan and Chan, 2004). When compared with constructing buildings on a green field site, projects related to the extension or refurbishment of existing healthcare buildings need special and extra attention because the potential safety hazards are much higher. As many patients, staff members, and citizens go in and out of the hospital every day, careful planning and special awareness of safety is of crucial importance. Moreover, under the Construction Sites (Safety) Regulations *[Reg. 38A]* (1997), contractors are required to ensure that every workplace in a construction site is safe; that there is suitable and adequate safe access to and egress from every workplace in a construction site; and that there is no unauthorised access to any unsafe place in a construction site. These stringent requirements could explain why the respondents put such high emphasis on safety in construction.

8.4.5 On budget

'The project was completed on budget' was ranked first by clients and sixth by contractors. This pattern of ranking would seem to reflect that contractors do not seem to be too concerned with the fixed budget, while clients place more emphasis on cost (Figure 8.1). Since quantity surveyors have a large representation within the client group (i.e., 12% out of a total of 45%), their concern about completing the project within the budget is understandable. Also, most hospital projects are publicly funded and the budget is under the scrutiny of the general public. Therefore, clients are more concerned about managing costs. The adoption of the D&B method in some recently completed hospitals also highlights the importance that clients place on cost certainty (Mo and Ng, 1997).

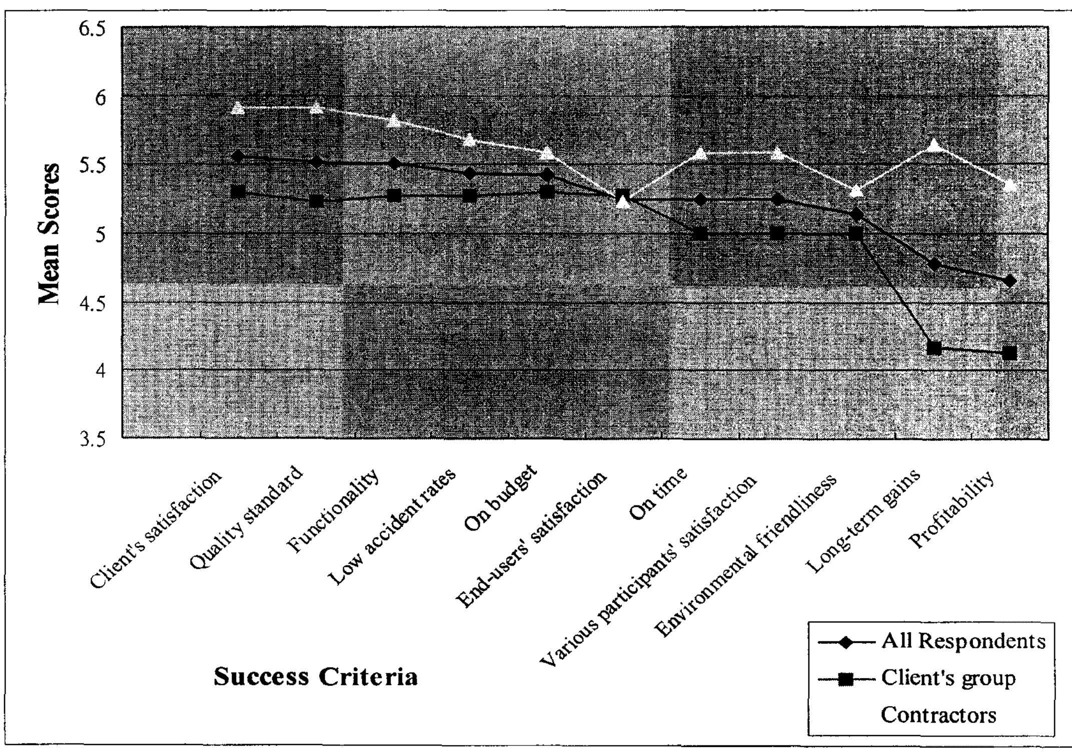


Figure 8.1 Profiles of the mean scores for the eleven criteria for the success of healthcare projects

8.4.6 Satisfaction of end-users

'The various end-users are satisfied with the project' was ranked third by the clients and ninth by the contractors. The contractor group did not consider satisfying the various end-users as the main criterion of healthcare projects (Figure 8.1). Since hospitals are built to serve and protect the health of the public, hospital projects involve a lot of special facilities and equipment. With such special equipment and facilities, only specialists, such as doctors and nurses with expertise and professional knowledge are able to comment on their suitability and adequacy (Chan et al., 2003a; 2003b and 2004). Lam et al. (1997b) also stated that the design and construction of a hospital requires input from many different participants and experts, and has to be managed and controlled effectively. Thus, the design consultants need to consult different specialists in order to thoroughly understand each function during the design stage. Usually a client representative is appointed to gather and digest the information from various end-users, and discuss with the consultants how to input the ideas into the drawings. This explains why the client group put more emphasis on meeting the expectations of end-users. Since contractors may not need to deal directly with the end-users, they put less emphasis on satisfying their requirements.

8.4.7 On schedule

It is interesting to note that 'completed on time' was not ranked among the top five criteria by the respondents in the empirical survey. It was ranked as the sixth most important criterion by all of the respondents. Most healthcare projects are highly complicated and involve state-of-the-art technology. Changes in healthcare projects are almost unavoidable, and can easily lead to an extension of the time needed to complete a project. Therefore, the timely completion of healthcare projects, although still an important criterion for success, is not the most significant in determining the success of healthcare projects.

8.4.8 Satisfaction of the participants

'The various participants are satisfied with the performance of the project' was ranked sixth by all of the respondents, in a tie with 'completed on time'. The client and contractor groups had similar rankings, as they ranked it seventh and sixth, respectively. Healthcare buildings are functional buildings and contain a great deal of medical equipment. This increases the difficulties faced by the project team. Successfully completing a healthcare project gives the project team a sense of achievement and satisfaction.

Hence, their level of satisfaction is also a good indicator of the success of a project.

8.4.9 Environmental friendliness

'The project was completed in an environmentally friendly manner' was ranked ninth by all of the respondents. The clients were more concerned than the contractors with this concept, ranking it seventh while the contractors ranked it eleventh. There are many ordinances to protect the environment and control pollution in Hong Kong, and the project team must follow these policies in order not to violate statutory requirements. Besides, as healthcare buildings are the sickbay for those who need medical treatment, their environment must be clean and pleasant.

8.4.10 Financial return

It was found that the contractor group considered the financial return ('The project is profitable' and 'The project can produce further/long-term gain') of the project to be an important criterion in assessing the success of a healthcare project, while the client group was neutral. The *p*-values of 'The project can produce further/long-term gains' and 'The project is profitable' are 0.0000 and 0.0010, respectively (Table 8.3). The mean scores of these two criteria for the contractor group are much higher than for the client group (Figure 8.1). This disparity is understandable since the contractors, like most private organisations, aim to make a profit. From the contractors' point of view, their main concern is to help their companies increase their financial return; therefore, profits are of ultimate importance to them. On the other hand, because most of healthcare projects are publicly funded, profitability and long-term gains are not the client group's major concerns.

8.5 PROJECT SUCCESS INDEX (PSI) FOR HEALTHCARE PROJECTS

The previous sections examined the relative importance of the identified measures of performance. However, these measures are quite diverse and are difficult to compare on an equal basis. It will be useful to construct an index that can reflect the overall performance of a hospital project. A composite index, if appropriately constructed, can provide powerful and reliable summaries of measured data (Babbie, 1973 as cited in Griffith et al., 1999). Gibson and Hamilton (1994) provided a sound basis upon which to develop a success index. In this section, the approach to developing a success index as advocated by Gibson and Hamilton (1994) is first reported. The procedures for developing a project success index (PSI) in this study are then presented.

8.5.1 Gibson and Hamilton (1994)

Gibson and Hamilton (1994) conducted a detailed study of capital construction projects to determine how the level of effort devoted to pre-project planning affected the success of the projects. In Gibson and Hamilton's report, a success index and pre-project planning index were constructed. The weightings of the variables in their research were determined from an open-ended question raised in a telephone interview – 'What are your main reasons for your assessment of the project's level of success?' The 131 responses were categorized into factors using techniques of qualitative analysis. This analysis reveals the specific variables and categories that participants considered to be significant to success and their relative level of importance. Tables 8.5 and 8.6 provide summaries of the calculations of the variables for the open-ended question (Griffith et al., 1999).

Table 8.5 outlines the calculations on the weightings of these variables based on the responses from the telephone interviews. Table 8.6 shows the frequency with which the respondents identified each of the variables for success and the use of this information to develop the weightings within the index.

Table 8.5 Calculations of the weightings of the variables for the open-ended question (Gibson and Hamilton, 1994 as cited in Griffith et al., 1999)

Success variable (1)	Sum of responses by project (2)	Weights (3)
Project controls	50	50/82=0.60
Operating characteristics	32	32/82=0.40
	Total 82	

Table 8.6 Calculations of the weightings by the respondents of the variables for the open-ended question (Gibson and Hamilton, 1994 as cited in Griffith et al., 1999)

Success variable (1)	Sum of responses by project (2)	Weights (3)
Project controls		
Budget achievement	*64*	*64/117=0.55*
Schedule achievement	*53*	*53/117=0.45*
	Total 117	
Operating characteristics		
Plant utilization	*6*	*6/20=0.30*
Design capacity	*14*	*14/20=0.70*
	Total 20	

Therefore, the formula for the index for success developed by Gibson and Hamilton (1994) is as follows:

Success Index Value = 0.60*(0.55 Budget Achievement Value + 0.45 Schedule Achievement Value) + 0.40*(0.70 Design Capacity Attained Value + 0.30 Plant Utilization Attained Value)

Gibson and Hamilton (1994) provided a valuable guide to developing the index. The method is to measure, using transcripts of the answers given to the open-ended questions, how frequently the respondents cited each of the areas of success on project controls and operating characteristics and how frequently they cited specific criteria for success (Griffith et al., 1999). A similar approach was also used to determine the pre-project planning index. The advantage is that averaging could be justified by the fact that the larger the number of levels to a variable, the more the differences among cases could be explained. One major limitation of this method, however, is that the weights are the same, regardless of the correlation between the variables (Kamanou-Goune, 1999).

Kamanou-Goune (1999) recommended that a reduction in the number of variables achieved by combining highly correlated ones could lead to a more efficient procedure. Therefore, the method that he developed uses the data to derive the weighting of each component of the index while ensuring that the transformed variables that enter the formula of the index are pairwise orthogonal. A useful statistical method of determining the weightings (or the importance) of the variables in a dataset is Principal Components Analysis. The aim in Principal Components Analysis is to select a smaller set of variables that explain most of the variance in the data. The analysis finds a set of standardized linear combinations (SLCs) called principal components, which are orthogonal to each other and which, when taken together, explain all of the variances in the orthogonal data (Kamanou-Goune, 1999). The mechanism of the Principal Components Analysis was presented in Chapter 6.

8.5.2 Development of PSI

The procedure for developing a project success index for later analysis is as follows:

(1) identify the individual variables;

(2) determine the weighting of each variable by using data obtained during the interviews and questionnaires;

(3) derive a formula for the success index; and

(4) calculate the success index value for each sample project using the developed formula.

8.5.2.1 Identifying variables

As shown in Table 8.1, eleven criteria were used to determine the level of success of healthcare projects. However, as identified in the pilot study, some criteria were considered inappropriate for inclusion in constructing the project success index of healthcare projects, especially those related to financial issues. For example, 'The project is profitable' and 'The project can produce further/long-term gains' were excluded because most healthcare projects in Hong Kong are publicly funded. The major aim of public hospitals is to serve the community rather than to make profits; therefore, these two criteria were eliminated. Furthermore, two similar measures, 'functionality' and 'satisfies the expectations of end-users' were closely correlated; therefore, 'functionality' was used as a proxy to measure 'satisfies the expectations of end-users' as well. As a result, eight measures of performance were used to construct the project success index. The eight criteria are summarized in Table 8.7.

Table 8.7 Consolidated criteria for determining the PSI for healthcare projects in Hong Kong

Criteria of success in running healthcare projects	N	Min.	Max.	Mean	Standard deviation
The client is satisfied with the performance of the project	52	3	7	5.56	1.14
The project was completed to the required standard of quality	52	3	7	5.52	1.00
The project is achieving its purpose/function	52	3	7	5.50	1.16
The project was completed with a low accident rate	52	4	7	5.44	0.96
The project was completed on budget	52	3	7	5.42	1.00
The project was completed on time	52	1	7	5.25	1.34
The various participants are satisfied with the performance of the project	52	3	7	5.25	1.10
The project was completed in an environmentally friendly manner	52	3	7	5.13	0.86

8.5.2.2 Weighting the variables

Weightings for the variables were computed from responses collected in Section 12 of the questionnaire. The respondents were asked to rate the importance of the criteria for success using a seven-point scale[1]. The data was then entered into the SAS System for Windows version 8 to conduct the principal component analysis.

In determining the number of principal components that should be retained, two

---

1

1	2	3	4	5	6	7
strongly disagree	disagree	slightly disagree	neutral	slightly agree	agree	strongly agree

common methods are adopted. The first one is the *'eigenvalue-greater-than-one rule'*, which suggests retaining only those components whose eigenvalues are greater than one in the standardized data (Sharma, 1996). The second method is the scree plot, which is to plot the percentage of variance accounted for by each principal component and look for an elbow. Figure 8.2 suggests that only Prin1 is retained, as the eigenvalue exceeds one (Prin1 is 5.56) and it explains 70% of the total variance.

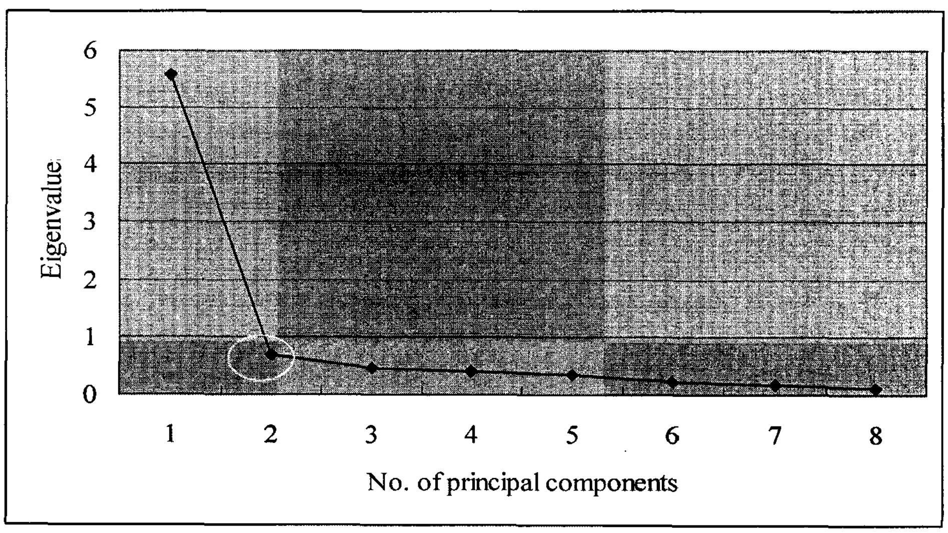


Figure 8.2 Scree plot of the eigenvalues

After identifying Prin1 as the principal component, the eigenvectors of Prin1 determine the weightings for forming the equation (i.e., the principal component) to compute the new variables. The weightings on different criteria in the equation are shown in Table 8.8.

Table 8.8 Weightings of criteria for success in running healthcare projects

Criteria for success in running healthcare projects	Weighting
The project was completed on time	0.373
The project was completed on budget	0.344
The project was completed to the required standard of quality	0.390
The project is achieving its purpose/function	0.357
The project was completed with a low accident rate	0.313
The project was completed in an environmentally friendly manner	0.308
The client is satisfied with the performance of the project	0.379
The various participants are satisfied with the performance of the project	0.357

Moreover, the loadings can be used to interpret the principal components. The higher the loading of a variable, the more influence it has in forming the principal component score. Traditionally, researchers would use a loading of 0.5 or above as the cut-off point in order to show that a given variable is influential in forming a principal component score. Table 8.9 shows that the loadings of all of the variables are larger than 0.5 in Prin1; therefore, the identified variables are all influential.

Table 8.9 Loadings of the criteria for success in running healthcare projects in Prin1

Criteria for success in running healthcare projects	Loadings
The project was completed on time	0.879
The project was completed on budget	0.811
The project was completed to the required standard of quality	0.918
The project is achieving its purpose/function	0.841
The project was completed with a low accident rate	0.739
The project was completed in an environmentally friendly manner	0.726
The client is satisfied with the performance of the project	0.893
The various participants are satisfied with the performance of the project	0.841

8.5.2.3 Project success index formula

The combination of the variables that were identified and the weightings that were given produces the following equation for determining the project success index for healthcare projects. The formula is as follows:

PSI = 0.390*Quality + 0.379*Client's Satisfaction + 0.373*Time + 0.357*Participants' Satisfaction + 0.357* Functionality + 0.344*Cost + 0.313*Safety + 0.308*Environmental Friendliness — Equation 8.1

Equation 8.1 was used to determine the PSI for each sample project. Table 8.10 summarizes the PSIs for all 52 samples. Details of the calculation and the results of principal components analysis appear in Appendix B.

Table 8.10 PSI scores for all 52 samples

Project No.	PSI Score	Project No.	PSI Score	Project No.	PSI Score	Project No.	PSI Score
1	14.702	14	15.898	27	14.579	40	15.065
2	15.308	15	10.193	28	15.113	41	16.149
3	14.250	16	13.946	29	14.694	42	10.911
4	9.499	17	9.830	30	15.113	43	11.686
5	13.555	18	12.215	31	9.490	44	14.377
6	16.193	19	15.343	32	16.206	45	12.435
7	12.572	20	14.918	33	11.879	46	13.352
8	15.113	21	15.492	34	11.663	47	14.528
9	17.194	22	8.017	35	9.133	48	14.396
10	13.015	23	7.378	36	13.388	49	15.113
11	14.934	24	16.709	37	14.497	50	15.457
12	15.233	25	15.583	38	13.286	51	13.362
13	12.009	26	12.968	39	14.519	52	16.162

The frequency distribution of the computed PSIs indicates that the maximum value is 17.19 and the minimum is 7.378 (Figure 8.3). The mean score is 13.63 and the median value is 14.45. The standard deviation is 2.31. The computed PSIs are skewed to the right, it means the overall performances of these 52 responses are good and the scores are higher than the mean. It is observed that most of the samples tended to achieve better than average results. It might be because of the involvement of experienced project team members in recent healthcare projects (over 60% of respondents had the previous experience in running 2 or more healthcare projects), the well-developed project management skills, and the adoption of innovative procurement methods. Figure 8.4 shows the percentile of distribution for the PSI scores. With this graph, the project team leaders can compare its respective project with other projects to assess its own performances. The computed PSI scores will be used as the dependant variable in the multiple regression analysis to determine the critical success factors.

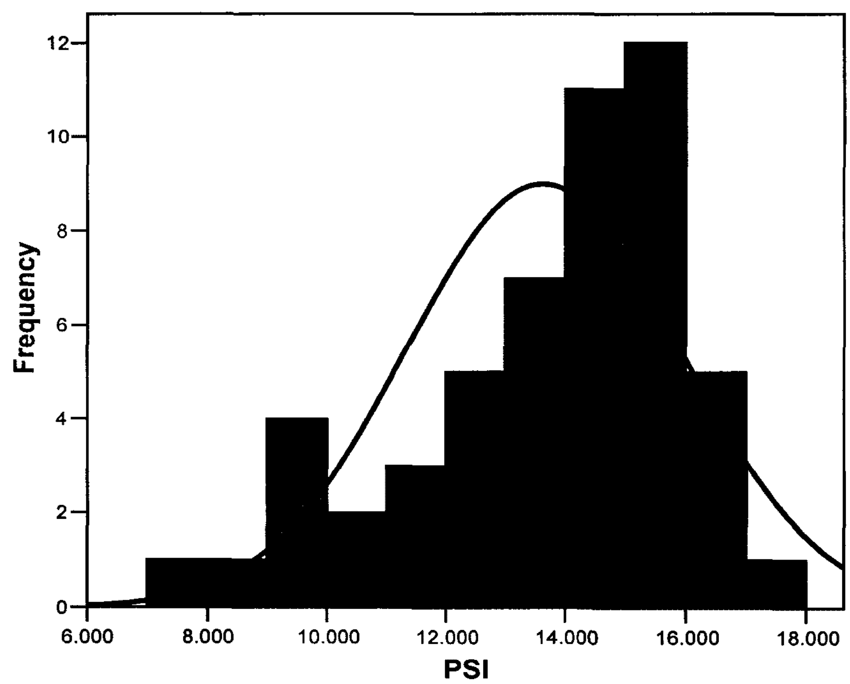


Figure 8.3 Frequency distribution for PSI scores

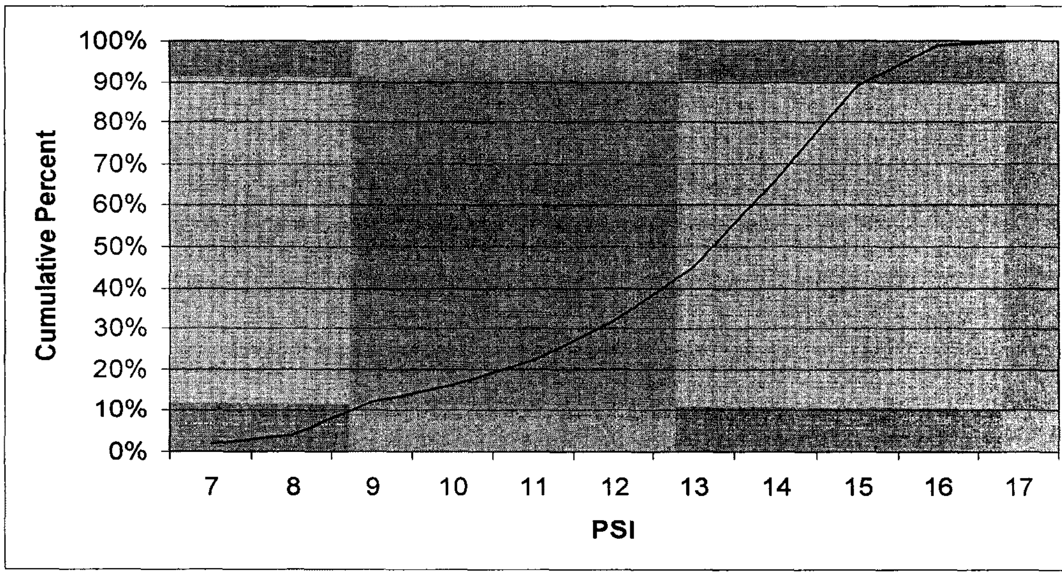


Figure 8.4 Percentile of the distribution for PSI scores

8.6 SUMMARY OF THE CHAPTER

The aim of this chapter was to identify the criteria for success and to develop a project success index for healthcare projects from the viewpoints of the clients and contractors. The statistical analyses revealed that there is agreement between the respective client group and contractor group, but disagreement between these two groups on the rankings of the criteria for the success of healthcare projects. Collectively, 'The client is satisfied with the performance of the project', 'The project is completed to the required standard of quality', and 'The project is achieving its function' were found to be the three most important criteria for success. Apart from these three criteria, 'The project was completed with a low accident rate', 'The project was completed on budget', 'The various end-users are satisfied with the performance of the project', and 'The project was completed on time' were also considered by the respondents to be important criteria for success. 'The project is profitable' and 'The project can produce further/long-term gains', on the other hands, were regarded as the least important criteria for success in healthcare projects.

By conducting interviews and issuing questionnaires, eight criteria, including time, cost, quality, functionality, safety, environmental friendliness, client's satisfaction and participants' satisfaction, were finally selected to assess the success of healthcare projects. By applying the Principal Components Analysis, an index was constructed to measure the level of success attained by each sample project. The computed PSI scores will be used as dependent variables for the multiple regression analysis to determine the critical success factors.

CHAPTER NINE

FACTOR ANALYSIS AND LINEAR REGRESSION ANALYSIS

9.1 INTRODUCTION

This chapter reports the results of the statistical tests undertaken on the data that was collected. The main statistical tools employed are factor analysis and multiple regression analysis. This chapter is divided into two main parts. The first identifies a relatively small number of factors that can represent relationships among sets of many interrelated variables by applying factor analysis. The second focuses on determining the independent variables that have a significant impact on dependent variable (PSI) by using multiple regression analysis.

The original research design solicited 45 independent variables, some possibly related to each other. Therefore, factor analysis is conducted to identify the underlying factors. Ten underlying factors are identified and their factor scores are then fed into the multiple regression models as independent variables. A total of ten multiple regression models are developed to identify the factors that are significant in determining the success of each dependent variable for healthcare projects. Having developed the formula, the project stakeholders can enhance the success of healthcare projects in future.

9.2 DATA MATRIX

A total of 73 independent variables could be identified in the questionnaires (Appendix A). Since the size of the sample was limited, to avoid affecting the results of the factor analysis, some similar independent variables were eliminated. From the category of level of complexity of the project (Section 4 in Appendix A), two variables were selected for inputting in the factor analysis. Four factors, namely 'inherent site conditions', 'access to or within site', 'level of design buildability', and 'overall characteristics of this particular project' were excluded due to the similarity in meaning of the 'physical environment' and 'level of design coordination'. Another factor, 'tendering method', was not included because nearly all of the healthcare projects adopted 'selective tendering', so it was predicted that this variable does not have much effect in differentiating on the performance level of healthcare projects. The variable of 'industrial relations environment' was excluded because industrial relations in Hong Kong have relatively stabilized. In addition, five variables, including the planning skills, organizational skills, coordinating skills, motivating skills, and controlling skills of three individual leaders of the project team; i.e., the designer, client's representative, and contractor were averaged to produce a composite score to measure the management skills of each respective project team leaders. The 'provision of resources from the parent company' was excluded as this idea has been incorporated in the variable 'support by parent company'. The main aim of variables included in the human-related factor was to measure the performance of the project team leaders, as the variables 'the commitment to meet cost, time, and quality' of these project team leaders was not related to the effectiveness of the leaders, therefore it was decided not to input them in the factor analysis. In the category of 'project management actions', two variables, i.e. 'control of sub-contractors' works' and 'holding of regular meetings' were incorporated in the variable of 'control mechanism' and 'communication system'; therefore, they were also excluded in the factor analysis. Moreover, variables relating to the clients were also eliminated because of the nature of healthcare projects in Hong Kong. Most healthcare projects in Hong Kong are publicly funded and under the control of the Hospital Authority or ASD. Therefore, the effects of these variables on the performance of such projects are also limited. Hence, a total of 45 independent variables were finally selected and inputted in the data matrix to run a factor analysis (Appendix C). A list of all 45 variables together with their mean values, standard deviations, and minimum and maximum values is given in Table 9.1. A data matrix indicating the background of the respondents and details of the cases under scrutiny can be found in Appendix D.

Table 9.1 List of independent variables

No.	Independent variables	Min	Max	Mean	Std. Deviation
1	Nature of project	1	3	1.44	0.67
2	Level of complexity in design coordination	1	6	2.92	1.40
3	Level of complexity of quality management procedures	2	6	3.40	1.11
4	Procurement method adopted	1	6	1.79	1.45
5	Management skill, such as partnering/VM	1	5	2.10	1.38
6	Physical environment	1	7	3.85	1.21
7	Prevailing economic environment	1	6	4.06	1.09
8	Social-political environment	2	6	4.12	0.88
9	Level of technology	1	6	3.62	1.12
10	Overall environment	2	6	3.79	0.87
11	Client's emphasis on low construction cost on project objectives	2	6	4.12	0.96
12	Client's emphasis on quick construction time on project objectives	2	7	4.73	1.19
13	Client's emphasis on high quality of construction on project objectives	3	7	5.40	0.96
14	Client's ability to effectively brief the design team	1	7	4.42	1.41
15	Client's ability to quickly make authoritative decisions	1	6	4.13	1.40
16	Client's ability to effectively define the roles of the participating organizations	1	7	4.23	1.28
17	Client's ability to contribute ideas to the design process	1	7	4.25	1.30
18	Client's ability to contribute ideas to the construction process	1	7	3.85	1.38
19	Client's representatives' technical skills	1	7	4.44	1.38
20	Client's representatives' experience and capabilities	1	7	4.75	1.28
21	Client's representatives' early and continued involvement in the project	1	7	4.77	1.31
22	Client's representatives' ability to adapt to changes in the project plan	1	7	4.37	1.17
23	Client's representatives' support from parent company	2	7	4.75	1.10
24	Design team leaders' technical skills	1	7	4.73	1.17
25	Design team leaders' experience and capabilities	2	7	4.88	1.25
26	Design team leaders' early and continued involvement in the project	2	7	4.75	1.19
27	Design team leaders' ability to adapt to changes in the project plan	2	6	4.54	1.13
28	Design team leaders' support by parent company	2	7	4.58	1.27
29	Construction team leaders' technical skills	3	7	4.96	0.95
30	Construction team leaders' experience and capabilities	2	7	4.96	1.10

Table 9.1 List of independent variables (Cont'd)

No.	Independent variables	Min	Max	Mean	Std. Deviation
31	Construction team leaders' ability to adapt to changes in the project plan	2	7	4.67	1.22
32	Construction team leaders' early and continued involvement in the project	2	7	4.94	1.13
33	Construction team leaders' support from parent company	1	7	4.88	1.22
34	Communication system for the project	1	7	4.96	1.19
35	Control mechanism, such as for monitoring and updating plans	1	7	4.88	1.28
36	Feedback capabilities	2	7	4.62	1.14
37	Up-front planning efforts	2	6	4.67	1.13
38	Developing an appropriate organizational structure	2	7	4.73	1.10
39	Implementing an effective quality assurance programme	2	7	4.85	1.13
40	Implementing an effective safety programme	3	7	5.00	1.17
41	Developing a good reporting system	2	6	4.98	0.98
42	Developing standard procedures	2	7	5.00	1.03
43	Client's representatives' management skills	2	6	4.44	1.06
44	Design team leaders' management skills	3	6	4.50	0.98
45	Construction team leaders' management skills	3	7	4.94	0.87

9.2.1 Cronbach's alpha

After identifying 45 variables, there is a need to check the internal consistency of the sample population. Therefore, Cronbach's alpha was adopted to test whether the respondents responded to all of the questions (45 variables) in a consistent way.

Cronbach's alpha is a coefficient of reliability (or consistency) to measure how well a set of items (or variables) measures a single unidimensional latent construct (Online 1, 2004). It assesses the reliability of a rating summarizing a group of test or survey answers that measure some underlying factor. A score is computed from each test item and the overall rating, called a 'scale', is defined by the sum of these scores over all of the test items. Then reliability is defined to be the square of the correlation between the measured scale and the underlying factor that the scale was supposed to measure (Online 2, 2004). The following is the formula for the standardized Cronbach's alpha:

Cronbach's $\alpha = (k/(k-1)*[1- \Sigma (S^2_i)/ S^2_{sum}]$

where k is the number of items (variables)

S^2_i is the variance of the ith item and

S^2_{sum} is the variance of the total score formed by summing all of the items

Alpha coefficients range in value from 0 to 1 and may be used to describe the reliability of factors extracted from dichotomous and/or multi-point formatted questionnaires or scales (Santos, 1999). If the items making up the score are all identical and perfectly correlated, the $\alpha = 1$; if the items are all independent, then

$\alpha = 0$. Therefore, the higher the score, the more reliable the generated scale is. Nunnaly (1978), as cited in Santos (1999), has indicated 0.7 to be an acceptable reliability coefficient.

The Cronbach's alpha for the 45 independent variables in this study is 0.933, which confirms that the reliability for these variables is very high and that the data can be used for subsequent analyses.

9.3 RESULTS OF FACTOR ANALYSIS

Factor analysis is a statistical technique used to identify a relatively small number of factors that can be used to represent relationships among sets of many interrelated variables (Norusis, 1993a). Since the presence of large inter-correlations between the independent variables could affect the results of a multiple regression analysis, prior to conducting the multiple regression analysis factor analysis is performed to group these interrelated variables into a smaller number of underlying factors (Chan, 1996). This technique was applied in this study to represent the relationship among these 45 independent variables. There are five basic steps in conducting a factor analysis (Norusis, 1993a):

(1) identify the independent variables through a literature review;

(2) compute a correlation matrix for all variables;

(3) extract the factors and ascertain how well the chosen model fits the data;

(4) rotate the factors to make them more interpretable; and

(5) interpret and label the factors.

From these five steps, the result of the first step, i.e. identifying the independent variables, was reported in Chapter 5 and the details consolidated in Table 9.1. The correlation matrix for all variables (step 2) was also computed and can be found in Appendix E. The most important steps in a factor analysis are: the extraction of the factors and the rotation of the factors. The former is carried out to determine how many dimensions there are, and the latter is performed to obtain a clearer picture of what these dimensions (or factors) represent (Norusis, 1993a as cited in Chan, 1996).

9.3.1 Evaluating the appropriateness of the factor model

In considering the use of factor analysis, the appropriateness of the factor model must first be evaluated. This can be achieved through the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's test. The KMO measure of sampling adequacy is an index comparing the magnitudes of the observed correlation coefficients to the magnitudes of the partial correlation coefficients (Norusis, 1993a). The KMO statistic varies from between 0 and 1. Small values for the KMO measure indicate that a factor analysis is an inappropriate method to use, since correlations between pairs of variables cannot be explained by the other variables. Kaiser (1974) recommended values of greater than 0.5 as acceptable. The level of acceptance is shown in Table 9.2.

Table 9.2 Acceptance level of KMO Value

KMO Value	Degree of Common Variance
0.90 – 1.00	Marvelous
0.80 – 0.89	Meritorious
0.70 – 0.79	Middling
0.60 – 0.69	Mediocre
0.50 – 0.59	Miserable
0.00 – 0.49	Don't Factor

Besides KMO, the factor analyst must also ensure that the data matrix has sufficient correlations to justify the application of factor analysis. Therefore, the

Bartlett test of sphericity, a statistical test for the presence of correlations among the variables, was used to examine all of the correlations among the variables and to provide the statistical probability that the correlation matrix has significant correlations among at least some of the variables (Hair et al., 1995). Bartlett's test of sphericity was used to test the hypothesis that the correlation matrix is an identity matrix, that is, that all diagonal terms are 1 and all off-diagonal terms are 0 (Norusis, 1993a).

The KMO measure of sampling adequacy was 0.665 which, as indicated in Table 9.3, is mediocre but acceptable. The value of the Bartlett's test of sphericity is 2561.959 and the associated significance level is small, so it appears unlikely that the population correlation matrix is an identity. Since the model met the requirements of both the KMO measure and Bartlett's test of sphericity, the factor analysis was considered an appropriate statistical method.

Table 9.3 Results of KMO and Barlett's test

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.665
Bartlett's Test of Sphericity	Approx. Chi-Square	2561.959
	Df	990
	Sig.	0.000

9.3.2 Factor extraction

The aim of factor extraction is to determine the factors. Principal components analysis was used to identify the underlying factors. Linear combinations of the observed variables are formed in principal components analysis. To determine how many factors will be needed to represent the data, the percentage of total variance explained by each needs to be examined. The total variance is the sum of the variance of each variable. Since there are 45 variables and each is standardized to have a variance of 1, the total variance is 45.

Table 9.4 contains the eigenvalue for each factor. The total variance explained by each factor was listed in the column with the heading 'Total'. The column headed '% of variance' contains the percentage of the total variance attributable to each factor. For example, the component 1 has a variance of 16.7092, which accounts for 37.1315% of the total variance of 45. The column 'Cumulative %' indicates the percentage of variance attributable to that factor and to those that precede it in the table. Table 9.4 shows that almost 82% of the total variance is attributable to the first 10 factors. The remaining 35 factors together account for only 18% of the total variance. Thus, a model with 10 factors is adequate to represent the data.

Several procedures have been proposed for determining the number of factors to use in a model. One criterion suggests that only factors that account for variances greater than one should be included. Factors with a variance of less than one are no better than a single variable, since each variable has a variance of one.

Table 9.4 Total Variance Explained

Initial Eigenvalues							
Component	Total	% of Variance	Cumulative %	Component	Total	% of Variance	Cumulative %
1	16.7092	37.1315	37.1315	24	0.2212	0.4915	97.0342
2	6.0825	13.5166	50.6480	25	0.2000	0.4445	97.4787
3	2.9629	6.5841	57.2322	26	0.1686	0.3746	97.8533
4	2.5804	5.7342	62.9663	27	0.1422	0.3159	98.1692
5	1.9763	4.3917	67.3580	28	0.1276	0.2836	98.4529
6	1.6532	3.6738	71.0318	29	0.1199	0.2665	98.7194
7	1.3193	2.9319	73.9637	30	0.0999	0.2220	98.9413
8	1.2669	2.8154	76.7791	31	0.0903	0.2006	99.1420
9	1.1465	2.5477	79.3268	32	0.0732	0.1628	99.3047
10	1.0297	2.2882	81.6150	33	0.0628	0.1395	99.4442
11	0.9283	2.0629	83.6778	34	0.0614	0.1364	99.5806
12	0.8257	1.8349	85.5127	35	0.0375	0.0834	99.6639
13	0.7573	1.6830	87.1957	36	0.0354	0.0787	99.7427
14	0.6357	1.4127	88.6084	37	0.0275	0.0611	99.8038
15	0.5633	1.2517	89.8602	38	0.0224	0.0497	99.8535
16	0.5068	1.1263	90.9864	39	0.0203	0.0452	99.8988
17	0.4639	1.0309	92.0174	40	0.0136	0.0303	99.9290
18	0.4306	0.9570	92.9744	41	0.0095	0.0210	99.9501
19	0.4058	0.9019	93.8762	42	0.0079	0.0175	99.9676
20	0.3665	0.8145	94.6907	43	0.0064	0.0143	99.9818
21	0.3115	0.6921	95.3829	44	0.0052	0.0116	99.9934
22	0.2784	0.6186	96.0015	45	0.0030	0.0066	100.0000
23	0.2435	0.5412	96.5426				

Figure 9.1 is a plot of total variance associated with each factor. The plot shows a distinct break between the steep slope of the large factors and the gradual trailing off of the rest. The gradual trailing off is called 'scree' because it resembles the rubble that forms at the foot of a mountain (Chan, 1996). The

figure confirms that a 10-factor model should be sufficient for the research model.

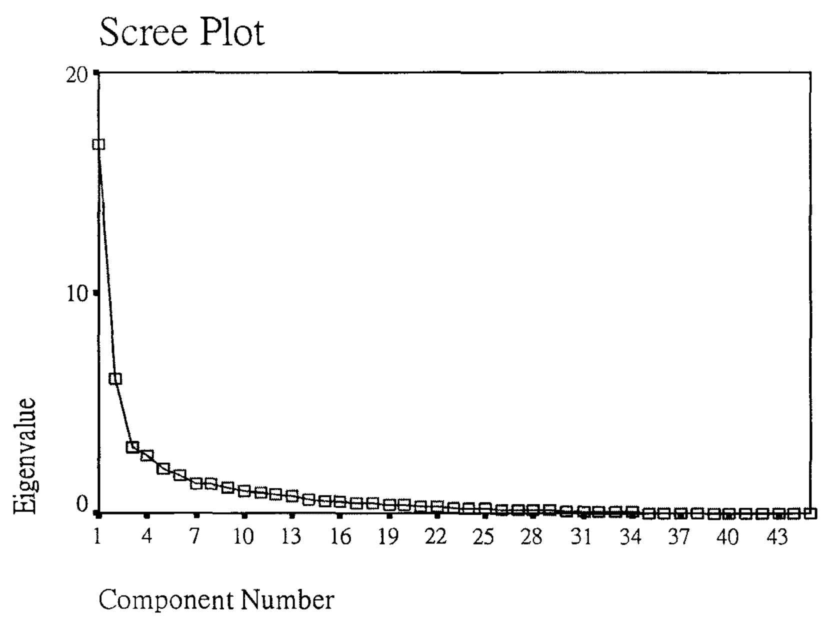


Figure 9.1 Factor Scree Plot

9.3.3 Factor rotation

To achieve the simplest possible factor structure in order to obtain more interpretable factors/dimensions, promax oblique rotation with a power (*Kappa*) of 4 was utilized. Promax oblique rotation was utilized since it allows correlated factors instead of maintaining independence between the rotated factors. In fact, this assumption concurs with the situation in real life, since one aspect of a performance should, to some extent, be related to other aspects (Soetanto and

Proverbs, 2002). In addition, Norusis (1993a) has claimed that promax oblique rotations have often been found to yield substantively meaningful factors, since it is likely that influences in nature are correlated. Promax rotation raises the factor loading to a higher power so that moderate and low loadings need to be lower, while the high loadings remain relatively high (Gorsuch, 1983). By raising the power of factor loadings, the factor structure becomes more interpretable. Therefore, as is evident from empirical studies, Promax has a reputation for quality (Gorsuch, 1983). The detailed calculation of the Factor Analysis was made through SPSS 11.0 and can be found in Appendix F.

9.4 FACTORS AFFECTING THE SUCCESS OF THE PROJECT

Principal components analysis with Promax rotation conducted on the 45 independent variables produced 10 underlying factors for success. Table 9.5 shows the factor structure on project success factors items. The total variance explained by each factor was listed in the column entitled 'factor loading'. The percentage of the variance and cumulative percentage of variance explained are also indicated in Table 9.5. The first factor accounted for 38%. All factor loadings were greater than 0.5. In general, the loadings and the interpretation of the factors that were extracted were reasonably consistent.

Table 9.5 Factor structure of principal factors extraction and Promax rotation on project success factors items

No.		Factor Loading	Percentage of variance explained	Cumulative percentage of variance explained
	Factor 1. Project Management Actions			
1	Providing feedback capabilities	0.892		
2	Developing an appropriate organizational structure	0.882		
3	Making up-front planning efforts	0.876		
4	Devising a control mechanism, such as monitoring and updating plans	0.873		
5	Implementing an effective quality assurance programme	0.871		
6	Developing a good reporting system	0.867		
7	Setting up a communication system for the project	0.784		
8	Implementing an effective safety programme	0.759		
9	Developing standard procedures	0.746	37.131	37.131
	Factor 2. Client's Abilities			
10	Client's ability to contribute ideas to the design process	0.908		
11	Client's ability to effectively define the roles of the participating organizations	0.876		
12	Client's ability to effectively brief the design team	0.873		
13	Client's ability to contribute ideas to the construction process	0.871		
14	Client's ability to quickly make authoritative decisions	0.862	13.517	50.648
	Factor 3. Design Team Leaders' Capabilities			
15	Design team leaders' management skills	0.856		
16	Design team leaders' ability to adapt to changes in the project plan	0.846		
17	Design team leaders' technical skills	0.791		
18	Design team leaders' support from parent company	0.748		
19	Design team leaders' early and continued involvement in the project	0.691	6.584	57.232
	Factor 4. External Environment			
20	Overall environment	0.860		
21	Physical environment	0.806		
22	Social-political environment	0.786		
23	Level of advanced technology	0.726		
24	Prevailing economic environment	0.643	5.734	62.966

Factor 5. Application of Innovative Project Management Techniques				
25	Procurement method adopted	0.802		
26	Client's emphasis on a high quality of construction in project objectives	0.731		
27	Complexity: Level of quality of management procedures	-0.679		
28	Management skills, such as Partnering/VM	0.676	4.392	67.358
Factor 6. Client's Representatives' Capabilities				
29	Client's representatives' early and continued involvement in the project	0.901		
30	Client's representatives' experience and capabilities	0.852		
31	Client's representatives' management skills	0.816		
32	Client's representatives' ability to adapt to changes in the project plan	0.741		
33	Client's representatives' technical sills	0.691	3.674	71.032
Factor 7. Construction Team Leaders' Capabilities				
34	Construction team leaders' technical skills	0.826		
35	Construction team leaders' management skills	0.769		
36	Construction team leaders' ability to adapt to changes in the project plan	0.742		
37	Construction team leaders' experience and capabilities	0.718		
38	Construction team leaders' support from parent company	0.709		
39	Construction team leaders' early and continued involvement in the project	0.661		
40	Design team leaders' experience and capabilities	0.653	2.932	73.964
Factor 8. Client's Emphasis on Cost and Time Performance				
41	Client's emphasis on low construction cost in project objectives	0.834		
42	Client's emphasis on quick construction time in project objectives	0.573	2.815	76.779
Factor 9. Nature of the Project				
43	Nature of the project	0.754		
44	Complexity: Level of design coordination	0.544	2.548	79.327
Factor 10. Support from the Parent Company				
45	Client's representative's support from parent company	0.831	2.288	81.615

9.4.1 Project management action (Factor 1)

This factor consists of nine items, which focus mainly on the management skills of the stakeholders in the project, such as feedback capabilities, organizational skills, planning effort, controlling skills, and so forth. Hence this factor is termed *project management action.*

9.4.2 Client abilities (Factor 2)

Factor 2 is predominantly represented by five items. These items are all related to the competency of the client, including the client's ability to contribute ideas to the design process, to effectively define the roles of the participating organizations, to effectively brief the design team, to quickly make authoritative decisions, and to contribute ideas to the construction process. Collectively, these items are termed *client's abilities*.

9.4.3 Design team leaders' capabilities (Factor 3)

Five items are the elements making up Factor 3, which concerns the management and technical skills of the leaders of the design team. Hence, this factor is called the *design team leaders' capabilities*.

9.4.4 External environment (Factor 4)

Factor 4 is mainly represented by the environment that cannot be controlled by the stakeholders in the project, including physical environment, social-political environment, prevailing economic environment, level of advanced technology, and overall environment. Therefore, this factor is named the *external* *environment.*

9.4.5 Application of innovative project management techniques (Factor 5)

Factor 5 includes four items, which are related to the procedures of the project and the quality of the management. The items include the procurement method, management skills adopted, level of complexity of quality management procedures, and the client's emphasis on a high quality of construction in project objectives. This factor is simply given the name *application of innovative project management techniques.*

9.4.6 Client's representatives' capabilities (Factor 6)

Factor 6 is represented by five items related to the management and technical skills of the client's representatives. Hence, this factor is called *client's representatives' capabilities.*

9.4.7 Construction team leaders' capabilities (Factor 7)

Factor 7 is predominately represented by seven items, all referring to the management and technical skills of the leaders of the construction team, except for one item on the experience and capabilities of the leaders of the design team. Hence, this factor is termed *construction team leaders' capabilities*.

9.4.8 Client's emphasis on cost and time performance (Factor 8)

There are two items in Factor 8, on the client's emphasis on low construction cost and quick construction time in project objectives. With the combination of these two items, this factor is named *client's emphasis on cost and time performance*.

9.4.9 Nature of the project (Factor 9)

This factor represents two items: the nature of the project and level of complexity in design coordination. These two items are in fact closely related to each other. The nature of a project, i.e. whether it is a new construction project, a refurbishment, extension, and so forth, largely affects the level of coordination required in the project, therefore, this factor is given the name *nature of the project*.

9.4.10 Support from parent company (Factor 10)

Factor 10 primarily represents only one factor, namely the support given by the parent company of the client's representatives. Therefore, this factor is given the name *support from parent company.*

9.5 REVISED RESEARCH MODEL

A revised research model (Figure 9.2), comprised of 10 factors, is developed to replace the original model developed in Chapter 7. The factor scores of each underlying factor (automatically generated by SPSS) will be considered as an independent variable and fed into a multiple regression model to determine its relationship to the success of the project. The success of the project will be measured both objectively and subjectively as stated in Chapter 7, and in terms of the following:

(1) project success index;

(2) time performance;

(3) cost performance;

(4) quality performance;

(5) functionality;

(6) level of safety;

(7) level of environmental friendliness;

(8) client's overall level of satisfaction; and

(9) project participants' overall level of satisfaction.

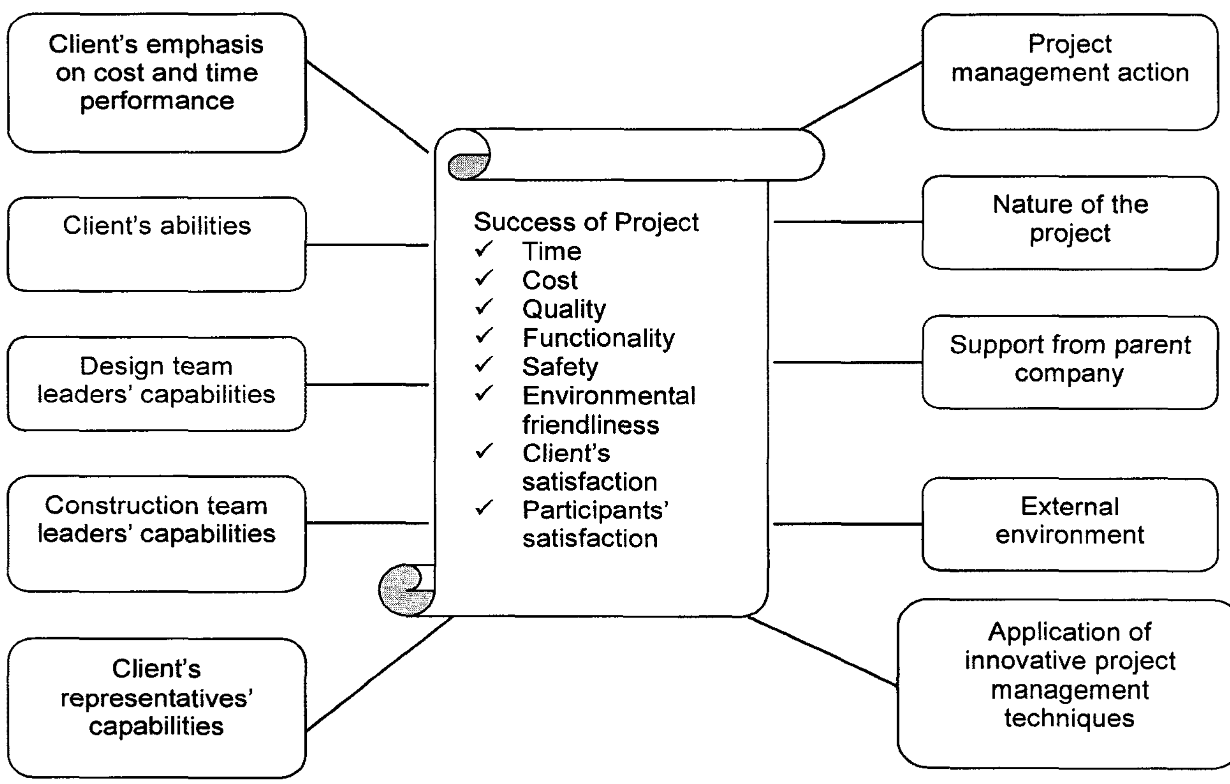


Figure 9.2 Revised model for the success of healthcare projects

9.6 RESULTS OF THE LINEAR REGRESSION ANALYSIS

Regression analysis is a technique for quantifying the relationship between a criterion variable (dependent variable) and one or more predictor variables (independent variables). It is used to predict the criterion variable based on specified values for the predictor variables and to understand how the predictor variables influence or relate to the criterion variable (Wittink, 1988). Multiple regression analysis, a form of general linear modelling, is a multivariate statistical technique used to examine the relationship between a single dependent variable and a set of independent variables (Hair et al., 1995).

To examine the relationship amongst the variables in the revised research model (Figure 9.1), the scores of project success index, and eight performance measures and the ten underlying factors as computed in the factor analysis were inputted as the dependent and independent variables, respectively, in the multiple regression analysis.

A stepwise regression analysis was applied to select variables for the model.

Stepwise selection is a combination of backward and forward procedures. The first variable considered for entry into the equation is the one with the largest positive or negative correlation with the dependent variable. If the variable fails to meet entry requirements (either FIN or PIN), the procedure terminates with no independent variables in the equation. If it passes the criterion for entry, the second variable is selected based on the highest partial correlation. It also enters the equation. After the first variable is entered, the first variable is examined to determine whether it should be removed according to the removal criterion (FOUT or POUT). In the next step, variables not in the equation are examined for entry. After each step, variables already in the equation are examined for removal. Variables are removed until none remain that meet the criterion for removal (Norusis, 1993b). The selection of variables terminates when no more variables meet the criteria for entry and removal.

Stepwise multiple regression was carried out for all independent variables identified from the factor analysis using the SPSS package (SPSS for Windows, 1993) for each dependent variable. A full regression analysis of each criterion can be found in Appendix G1 to G10.

9.6.1 Project success index

PSI, the project success index, is a dependent variable. It was obtained by substituting the objective and subjective scores to the PSI formula as developed in Chapter 8. A full regression analysis of PSI can be found in Appendix G1. A summary of the results is shown in Table 9.6.

Table 9.6 Multiple regression analysis of the project success index

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Project management action (Factor 1 - PMGT)	0.776	0.348	0.623	0.614	0.623	67.728	0.000
2. Client's representative's capabilities (Factor 6 – CR_CAP)	0.665	0.298	0.729	0.715	0.106	53.739	0.000
3. Construction team leaders' capabilities (Factor 7-CON_CAP)	0.604	0.265	0.797	0.782	0.069	51.136	0.000
4. Design team leaders' capabilities (Factor 3-DES_CAP)	0.588	0.231	0.822	0.804	0.025	44.007	0.000
5. Application of innovative project management techniques (Factor 5-INNO)	0.538	0.225	0.859	0.840	0.037	45.074	0.000

Constant Term: 13.601
Size of sample adopted, N=43, 9 cases are deleted as outliers with their standard residuals greater than 1.5

The strongest predictors of the PSI are **project management action, client representatives' capabilities, construction team leaders' capabilities, design team leaders' capabilities, and application of innovative project management**

techniques. As R^2 is 0.859, this means that about 86% of the variance in the PSI is explained by these variables (Chan, 1996). Of these variables, '*project management action*' has the highest beta coefficient (β=0.348) and hence is the most powerful predictor of the success of healthcare projects. Having the value of the standardized coefficient and the constant terms, the following multiple regression equation for PSI is developed:

Multiple Regression Equation for PSI Equation 9.1

$$PSI = 13.601 + 0.776PMGT + 0.665CR\_CAP + 0.604CON\_CAP + 0.588DES\_CAP + 0.538INNO$$

9.6.2 Time performance

TIME1 is a dependent variable expressed objectively as a percentage of the actual time ahead or behind the schedule. A full regression analysis of time performance can be found in Appendix G2. A summary of the results is shown in Table 9.7.

Table 9.7 Multiple regression analysis of time performance (objective)

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Client's representatives capabilities (Factor 6 – CR_CAP)	0.379	0.492	0.241	0.222	0.241	13.014	0.001
2. Client's emphasis on cost and time performance (Factor 8 – CLI_EMPH)	0.243	0.309	0.336	0.303	0.095	10.127	0.000

Constant Term: 3.787
Size of sample adopted, N=43, 9 cases are deleted as outliers with their standard residuals greater than 2

The strongest predictors of time performance are **client's representatives' capabilities, and client's emphasis on cost and time performance**. Of the two, '*client's representatives' capabilities*' is found to be the stronger predictor of time performance.

Multiple Regression Equation for TIME1 Equation 9.2

TIME1 = 3.787 + 0.379CR_CAP + 0.243CLI_EMPH

However, because of the low value of R^2, a set of subjective data (TIME2) was to replace the objective data as the dependent variable and the multiple regression was run again. A full regression analysis of the new set of time performance can be found in Appendix G3. A summary of the results is shown in Table 9.8.

Table 9.8 Multiple regression analysis of time performance (subjective)

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Project management action (Factor 1 – PMGT)	0.945	0.625	0.583	0.573	0.583	60.102	0.000
2. Client's abilities (Factor 2 – CLI_ABI)	0.555	0.373	0.703	0.689	0.120	49.775	0.000

Constant Term: 5.197
Size of sample adopted, N=45, 7 cases are deleted as outliners with their standard residuals greater than 1.5

For the subjective data set, the value of R^2 increases to 0.703, which means that about 70% of the variance in time performance is explained by **project management action and client's abilities**. Within these two variables, '*project management action*' is a more powerful predictor of time performance.

Multiple Regression Equation for TIME2 Equation 9.3

TIME2 = 5.197 + 0.945PMGT + 0.555CLI_ABI

9.6.3 Cost performance

COST is a dependent variable expressed objectively as a percentage of the final contract sum underrun or overrun by the original contract sum. A full regression analysis of cost performance can be found in Appendix G4. A summary of the results is shown in Table 9.9.

Table 9.9 Multiple regression analysis of cost performance

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Client's representatives' capabilities (Factor 6 – CR_CAP)	0.497	0.693	0.574	0.562	0.574	44.553	0.000
2. Design team leaders' capabilities (Factor 3 – DES_CAP)	0.406	0.536	0.857	0.848	0.283	96.091	0.000

Constant Term: 3.641
Size of sample adopted, N=35, 17 cases are deleted as outliners with their standard residuals greater than 2

Client's representatives' capabilities and design team leaders' capabilities are the strongest predictors of cost performance. Of these two independent variables, '*client's representatives' capabilities*' has a higher beta coefficient, and hence is the most powerful predictor of cost.

Multiple Regression Equation for COST — Equation 9.4

$$COST = 3.641 + 0.497CR\_CAP + 0.406DES\_CAP$$

9.6.4 Quality performance

QUALITY is a subjective measure of the satisfaction felt by the stakeholders in the project with the quality of performance. A full regression analysis of quality performance can be found in Appendix G5. A summary of the results is shown in Table 9.10.

Table 9.10 Multiple regression analysis of quality performance

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Project management action (Factor 1 – PMGT)	0.574	0.635	0.818	0.812	0.818	130.456	0.000
2. Design team leaders' capabilities (Factor 3 – DES_CAP)	0.309	0.326	0.865	0.855	0.047	89.535	0.000
3. Application of innovative project management techniques (Factor 5 – INNO)	0.309	0.361	0.957	0.952	0.092	198.263	0.000
4. Construction team leaders' capabilities (Factor 7 – CON_CAP)	0.09835	0.107	0.966	0.960	0.009	182.288	0.000

Constant Term: 5.132
Size of sample adopted, N=31, 21 cases are deleted as outliners with their standard residuals greater than 1.5

Increased quality performance for healthcare projects can be predicted by **better performance on project management action on the part of the stakeholders, the strong capabilities of the leaders of the design team, the application of innovative project management techniques and the strong capabilities of the leaders of the construction team.** Amongst these independent variables, '*project management action*' is found to be the most powerful predictor of better quality performance.

Multiple Regression Equation for QUALITY Equation 9.5

$$QUALITY = 5.132 + 0.574PMGT + 0.309DES\_CAP + 0.309INNO + 0.09835CON\_CAP$$

9.6.5 Level of functionality

FUNCT is a subjective measure of the satisfaction felt by the stakeholders' in the project with the functionality of the project. A full regression analysis of level of functionality can be found in Appendix G6. A summary of the results is shown in Table 9.11.

Table 9.11 Multiple regression analysis of functionality

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Project management action (Factor 1 – PMGT)	0.665	0.875	0.766	0.758	0.766	101.502	0.000

Constant Term: 5.349
Size of sample adopted, N=33, 19 cases are deleted as outliners with their standard residuals greater than 1.5

Only one independent variable, **project management action**, is used to predict the functionality of healthcare projects. This variable can explain almost 75% of the total variance. Hence, it is regarded as a strong predictor of the functionality of healthcare projects.

Multiple Regression Equation for FUNCT Equation 9.6

FUNCT = 5.349 + 0.665PMGT

9.6.6 Safety performance

SAFE is a subjective measure of the level of satisfaction felt by the stakeholders in the project regarding its safety performance. A full regression analysis of safety performance can be found in Appendix G7. A summary of the results is shown in Table 9.12.

Table 9.12 Multiple regression analysis of safety

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Project management action (Factor 1 – PMGT)	0.268	0.314	0.348	0.326	0.348	15.511	0.000
2. Nature of project (Factor 9 – NATURE)	-0.568	-0.715	0.639	0.613	0.290	24.764	0.000
3. Design team leaders' capabilities (Factor 3 – DES_CAP)	0.511	0.636	0.821	0.801	0.182	41.165	0.000
4. Application of innovative project management techniques (Factor 5 – INNO)	0.350	0.431	0.900	0.885	0.080	58.718	0.000

Constant Term: 5.44
Size of sample adopted, N=31, 21 cases are deleted as outliners with their standard residuals greater than 1.5

Effective project management action, a new work contract, strong capabilities of leaders of the design team and application of innovative

techniques can improve the safety performance of healthcare projects. With the highest beta coefficient, '*nature of project*' is the most powerful predictor of safety performance.

Multiple Regression Equation for SAFE Equation 9.7

SAFE = 5.44 + 0.268PMGT – 0.568NATURE + 0.511DES_CAP + 0.35INNO

9.6.7 Level of environmental friendliness

ENVIRON is a subjective measure of the project stakeholders' satisfaction with the environmental friendliness of the project. A full regression analysis of environmental performance can be found in Appendix G8. A summary of the results is shown in Table 9.13.

Table 9.13 Multiple regression analysis of environmental friendliness

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Project management action (Factor 1 – PMGT)	0.548	0.533	0.487	0.470	0.487	29.394	0.000
2. Design team leaders' capabilities (Factor 3 – DES_CAP)	0.471	0.512	0.688	0.668	0.202	33.137	0.000
3. Nature of project (Factor 9 – NATURE)	-0.326	-0.373	0.825	0.807	0.136	45.531	0.000

Constant Term: 5.167
Size of sample adopted, N=33, 19 cases are deleted as outliners with their standard residuals greater than 1.5

The strongest predictors of the environmental friendliness of the project are **project management action, design team leaders' capabilities, and nature of the project.** Of these variables, '*project management action*' has the highest beta coefficient. Therefore, it is the most powerful predictor of the environmental friendliness of healthcare projects.

Multiple Regression Equation for ENVIRON Equation 9.8

$$\text{ENVIRON} = 5.167 + 0.548\text{PMGT} + 0.471\text{DES\_CAP} - 0.326\text{NATURE}$$

9.6.8 Client's overall level of satisfaction

CLIOVER is a subjective measure of the client's overall satisfaction with the project performance. A full regression analysis of client satisfaction can be found in Appendix G9. A summary of the results is shown in Table 9.14.

Table 9.14 Multiple regression analysis of client's overall satisfaction

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Project management action (Factor 1 – PMGT)	0.484	0.704	0.711	0.701	0.711	71.291	0.000
2. Client abilities (Factor 2 – CLI_ABI)	0.173	0.258	0.849	0.839	0.139	79.018	0.000
3. Design team leaders' capabilities (Factor 3 – DES_CAP)	0.156	0.213	0.903	0.892	0.053	83.621	0.000
4. Construction team leaders' capabilities (Factor 7 – CON_CAP)	0.122	0.162	0.921	0.908	0.018	75.413	0.000

Constant Term: 5.121
Size of sample adopted, N=31, 21 cases are deleted as outliners with their standard residuals greater than 1.5

The increase in the client's overall satisfaction can be predicted by the effective project management action of stakeholders in the project, strong client abilities, the capabilities of the leaders of the design team, and the capabilities of the leaders of the construction team. Of these four independent variables, '*project management action*' is the most powerful predictor of the client's satisfaction with the overall performance of the project.

Multiple Regression Equation for CLIOVER — Equation 9.9

CLIOVER = 5.121 + 0.484PMGT + 0.173CLI_ABI + 0.156DES_CAP + 0.122CON_CAP

9.6.9 Project participants' overall level of satisfaction

PPOVER is a subjective measure of the project participants' overall satisfaction with the performance of the project. A full regression analysis of the project participants' satisfaction can be found in Appendix G10. A summary of the results is shown in Table 9.15.

Table 9.15 Multiple regression analysis of project participants' overall satisfaction

Order of Variable Entry	Standardized Coefficients	Beta Coefficient	R^2	Adjusted R^2	$\triangle R^2$	F Ratio	Sig.
1. Construction team leaders' capabilities (Factor 7 – CON_CAP)	0.732	0.583	0.661	0.652	0.661	70.341	0.000
2. Client's representatives' capabilities (Factor 6 – CR_CAP)	0.342	0.299	0.812	0.801	0.151	75.673	0.000
3. Project management action (Factor 1 - PMGT)	0.341	0.264	0.854	0.841	0.041	66.092	0.004

Constant Term: 5.312
Size of sample adopted, N=38, 14 cases are deleted as outliners with their standard residuals greater than 1.5

The increase in the project participants' overall satisfaction can be predicted by the effective project management action of the stakeholders in the project, the strong capabilities of the client's representatives, and the capabilities of the leaders of the construction team. Of these independent variables, '*construction team leaders' capabilities*' is the most powerful predictor of the client's satisfaction with the overall performance of the project.

Multiple Regression Equation for PPOVER Equation 9.10

PPOVER = 5.312 + 0.732CON_CAP + 0.342CR_CAP + 0.341PMGT

9.7 SUMMARY OF THE CHAPTER

This chapter reports the statistical results for this study. Ten underlying factors were extracted by a factor analysis of the 45 variables developed through a synthesis of empirical studies. They were: project management action (Factor 1), client abilities (Factor 2), design team leaders' capabilities (Factor 3), external environment (Factor 4), application of innovative project management technique (Factor 5), client's representatives' capabilities (Factor 6), construction team leaders' capabilities (Factor 7), client emphasis on cost and time performance (Factor 8), nature of the project (Factor 9), and support from parent company (Factor 10). These ten underlying factors formed a sound basis for the performance evaluation of healthcare projects. To examine the relationship amongst the dependent and independent variables, the scores of the performance measures and the factor scores of ten underlying factors were inputted into multiple regression analysis. These performance measures were: project success index (PSI), time performance, cost performance, quality performance, level of functionality, level of safety, level of environmental friendliness, client's overall level of satisfaction level, and project participants' overall satisfaction level. From the multiple regression analysis, seven out of ten underlying factors were found to have significant associations with the performance variables. The exceptions are external environment (Factor 4) and support from parent company (Factor 10). A summary of the determining factors of various measure of performance is shown in Table 9.16. Ten prediction models were developed as tools that are useful in planning measures to meet the accelerated demand for healthcare projects in the future.

Table 9.16 Summary of determining factors of various measures of performance

Independent variables / Dependent Variables	Project management action	Client abilities	Design team leaders' capabilities	External environment	Application of innovative project management techniques	Client's representatives' capabilities	Construction team leaders' capabilities	Client's emphasis on cost and time	Nature of project	Support from Parent Company	Total number of variables
PSI	■		□		□	□	□				*5*
Time (subjective data)	■	□									*2*
Cost			□			■					*2*
Quality	□		■		□		□				*4*
Functionality	■										*1*
Safety	□		□		□				■		*4*
Environmental friendliness	■		□						□		*3*
Client's overall satisfaction	■	□	□				□				*4*
Project participants' satisfaction	□					□	■				*3*
Total	*8*	*2*	*6*	*0*	*3*	*3*	*4*	*0*	*2*	*0*	

■ **The factor concerned has the highest beta coefficient of all of the factors in the same row**

□ **The factor concerned was found to have significant associations with the performance variable found in the same row**

CHAPTER TEN

DISCUSSION OF THE RESULTS

10.1 INTRODUCTION

In Chapter 9 ten multiple regression equations for ensuring the success of healthcare projects were developed, in terms of the overall success of the project, time performance, cost performance, quality performance, level of functionality, level of safety, level of environmental friendliness, and the overall satisfaction of the client and the participants in the project. A set of relationships between the criteria for success (dependent variable) and the underlying factors (independent variables) were identified. Therefore, the goals in this chapter are to examine the reasons for the significant results reported in Chapter 9, and to discuss the orders of significance of the identified factors. The relationship of this study to previous studies is highlighted.

10.2 FACTORS AFFECTING THE SUCCESS OF HEALTHCARE PROJECTS

By conducting a factor analysis, 10 underlying factors were identified, including project management action, client's abilities, design team leaders' capabilities, external environment, application of innovative project management techniques, client's representatives' capabilities, construction team leaders' capabilities, client's emphasis on cost and time performance, nature of the project, and support from the parent company (Refer to Figure 9.2 for a revised model of the success of healthcare projects). However, no direct relationships are shown simply by applying factor analysis. Therefore, a multiple regression analysis was conducted to identify the significant association between the criteria and identified variables. From the results of regression, it was found that the performance of the project is significantly associated with 7 of the 10 advocated variables (Refer to Table 9.16 for summary of the determining factors for various measures of performance). It should be noted that some of performance measures are based on the perceptions of the respondents, and that this subjective assessment does not provide any absolute values by which the success of the project is recognized.

However, these perceptual measures, together with objective measures, will provide more insights to better organize and implement project management practices in the construction industry (Chan, 1996). A detailed discussion of how each of these factors affects the performance of healthcare projects will be given in the following section. It is stressed that factors affecting time performance in the discussion section refers to subjective measures, not objective measures. This is because the adjusted R^2 of the multiple regression equation for time performance (TIME1), measured by objective data, is too low (adjusted R^2=0.303) for interpretation.

10.2.1 Project management action

Project management action is associated with eight of the nine identified measures of performance. This factor is regarded as overall project management skills by the stakeholders and is predominately represented by the following nine variables: ensuring feedback capabilities, developing an appropriate organizational structure, making up-front planning efforts, establishing a control mechanism, implementing an effective quality assurance programme, developing a good reporting system, developing a communication system for the project, implementing an effective safety programme, and developing standard procedures (Table 9.5). Project management action was found to be highly associated with the performance measures of project success index, time performance, quality performance, level of functionality, level of safety, level of environmental friendliness, client's overall satisfaction, and project participants' satisfaction.

It was found that **better project management action taken by the stakeholders in the project will result in better time and quality performance, improved functionality, improved performance in safety and environmental friendliness, a higher level of satisfaction for client's and project participants, and a better overall project success index.**

Kog et al. (1999) mentioned that managerial action has long been considered as critical to achieving project success, particularly in the case of large and complex fast-track projects. Chua et al. (1999) identified the interactive process (project management action) as the most significant for all project objectives, especially for quality and time performance. A number of previous studies have supported the view of the importance of project management action in the success of a project (Beale and Freeman, 1991; Pinto and Pinto, 1991; Hamburger, 1992; Sanvido et al., 1992; Parfitt and Sanvido, 1993; Walker, 1995; Chua et al., 1999; Kog et al., 1999). This study concludes that the success of healthcare projects, similar with that of general construction projects, is greatly dependent on the project management action taken during the execution of the project.

10.2.2 Client's abilities

This factor is predominantly represented by five variables to measure the client's abilities, including the ability to contribute ideas to the design process, to effectively define the roles of the participating organizations, to effectively brief the design team, to contribute ideas to the construction process, and to make authoritative decisions quickly. This factor was found to be significantly associated with the client's overall satisfaction and with time performance.

The result shows that **if the clients possess a higher level of abilities, there is a greater likelihood of an increase in the client's overall level of satisfaction and better time performance.** This is supported by the findings of various studies, especially those focused on the construction of healthcare buildings. Many problems affecting the performance of the project originate in the phase of inception, particularly in the preparation of the strategic and design briefs. Chan and Kumaraswamy (1997) also found that client-initiated variations are a major cause of delays. Therefore, a greater ability on the part of the client to effectively brief the design team and contribute ideas during the design stage can improve the performance of healthcare projects (Smith and Wilkin, 1995; 1996; Wilkins an Smith, 1994; 1996; Lam et al., 1997a). This study also supports the findings of previous studies that a higher level of client competency will result in an increase in the client's overall satisfaction with the project (Choy and Sidwell, 1991; Chan and Yeong, 1995; Walker, 1995; Chan, 1996).

10.2.3 Design team leaders' capabilities

The following five variables were designed to measure the capabilities of the leaders of the design team: their management and technical skills, their ability to adapt to changes, their early and continued involvement in the project, and the support from the parent company. The capabilities of the leaders of the design team were found to be associated with six of the nine identified measures of performance.

The result shows that **a higher level of capability on the part of the leaders of the design team will lead to better cost performance, satisfaction with the level of safety and environmental friendliness, an increase in the client's overall satisfaction, PSI, and especially, to higher quality performance.**

Designers play an important role in a project, especially in traditional projects, as they usually act as project managers. Chan and Kumaraswamy (1997) recommended that in order to succeed in a project, documents of the design, including drawings and specifications, should be provided to the contractor with a clearly defined basis. Moreover, one of the unique features of healthcare projects is highly complicated building services. This feature, in turn, leads to problems with coordination and will adversely affect the quality and cost performance of the project. Lam et al. (1997a) have emphasized that the success of a building services design is greatly influenced by the contribution of the designers, together with the managed and coordinated input of the client representing the users of the building. Therefore, the competency of designers is critical to the success of healthcare projects. The result further reinforces the findings of Tam (1992), Walker (1994), Chan (1996), and Kog et al. (1999).

10.2.4 Application of innovative project management techniques

This factor is predominantly represented by four variables, namely the procurement method adopted, the client's emphasis on the high quality of construction in project objectives, the level of complexity of quality management procedures, and the application of innovative management skills. This factor was found to be associated with quality performance, level of safety, and PSI. In this study, a project utilizing traditional procurement methods is given a score of 1, and projects using fast-track methods such as design and build are given a higher score. A project applying value management or the partnering technique is also assigned for higher scores. Therefore, **projects using non-traditional procurement systems and that apply innovative management skills, such as partnering and value management, and in which the client places greater emphasis on quality will lead to improved quality performance, better safety levels, and a higher PSI.**

It is always a common misconception that non-traditional systems of procurement automatically equate to poor quality (Bennett's et al., 1996 and Mo and Ng, 1997). The results of this study clear up this misconception, and implying that the application of innovative management skills can improve the quality performance of the project.

The result reinforces the findings of Wilkins and Smith (1994), Smith and Wilkins (1996), and Lam et al. (1997a), and Lam (2000) that the use of non-traditional procurement arrangements can deliver better project performance for healthcare projects. This has been proved by the excellent performance of two recently built hospitals in Hong Kong; i.e., North District Hospital and Tseung Kwan O Hospital (Chan et al., 2003a and 2003b).

Besides non-traditional systems of procurement, it was found that the adoption of an innovative management skill, such as Partnering and Value Management (VM), can enhance the success of healthcare projects. Chan et al. (2003d) identified a number of benefits contributed by Partnering in Hong Kong. Chan and Kumaraswamy (1997) recommended that value management techniques may be useful in limiting any variations. Lam et al. (1997a) stated that the success of a project can be enhanced by engendering 'team spirit' – a high degree of cooperation between the participants in a project. Team spirit can be achieved in practice by adopting partnering skills. Fan and Hon (2002) found that sophisticated projects with high technological requirement are more likely to lead to the formation of strategic alliances (partnering). The contribution of the application of those management skills to success was again proven by North District Hospital and Tseung Kwan O Hospital.

Moreover, the result also confirms that the low level of complexity of quality management procedures and the client's emphasis on quality also lead to a more successful outcome in project performance.

10.2.5 Client's representatives' capabilities

This factor is predominantly represented by five variables, which are related specifically to the technical and management capabilities of the client's representatives. It was found to be significantly associated with the PSI, with the satisfaction felt by the participants in the project, and especially with cost and time performance. It was shown that a **higher level of capabilities on the part of the client's representatives' will result in better time and cost performance, an increase in the overall level of satisfaction felt by the participants in the**

project , and a higher PSI score.

The result of this research reinforces the findings of previous studies (Walker, 1994; 1995 and 1996; Chan, 1996; Chan and Kumaraswamy, 1997; Kog et al., 1999). Walker (1995) suggested that the client's representative contributes to the granting of extensions of time from changes in scope, therefore indicating that this is a factor affecting construction time performance. The client's representatives play a more significant role in healthcare projects than in other types of projects. Many end-users are involved in healthcare projects, particularly in the case of publicly funded hospitals; hence, it is difficult to gather the opinions of all of the end-users. Time and cost overruns can easily occur when changes are made during the design and construction stages (Chan et al., 2003a and 2003b). Therefore, the capability of the client's representatives is critical to the success of healthcare projects.

10.2.6 Construction team leaders' capabilities

The factor of construction team leaders' capabilities involves seven variables relating to the management and technical skills of the contractors. A significant relationship was found to exist between this factor and quality performance, the overall level of satisfaction of the client and project participants, and the PSI.

It was revealed that the **increased capabilities of leaders of the construction team will result in an improvement in the quality of the performance, a higher level of overall satisfaction on the part of the client and the project participants, and a better PSI score.**

The construction team also plays an important role in a construction project. Walker (1995) has stated that with their ability to work effectively with the design team to get decisions made, construction management teams have a strong influence on construction time. Lam et al. (1997a) highlighted the importance of contractors having 'hands-on' experience of hospital projects. Previous experience and feedback significantly improve the coordination of building services and enhance the success of the project. The result of this research support previous studies by Walker (1994), Chan (1996) ,and Kog et al. (1999).

10.2.7 Nature of the project

This factor primarily represents two variables: the nature of the project and the level of complexity in the coordination of the design. This factor was found to be associated with the level of safety and the level of environmental friendliness. In this study, a new work contract is given a score of 1, while the refurbishment and extension projects are given a score of 2 and 3, respectively. The nature of the project also affects the level of complexity in design coordination. One of the key requirements of extension project is that the new block usually needs to connect with the existing buildings; therefore, the complexity involved in coordinating the design is much greater. **It was found that an extension or refurbishment project and a higher level of complexity in the coordination of the design will result in decreases in levels of safety and environmental friendliness.**

The result supports the findings in the works of Cordell (1995), Rawlinson (1995) and Chan (1996). This factor is more important in healthcare projects. When compared with constructing buildings on a piece of new land, the danger is far higher when engaging in construction in a place that is full of people. As many patients, staff, and citizens pass in and out of the hospital every day, careful planning and special awareness of safety is crucial. If the hospital receives patients with psychological problems who like to walk around and are not aware of the potential danger, this would certainly pose a threat to the level of safety. Although the new building is under construction, the existing hospital still needs to maintain full operations; hence, it is essential to prevent interruptions to normal hospital services. Special measures on the disconnection, diversion, and maintenance of existing building services are required. The level of complexity involved in coordinating the design will inevitably be greater. This will therefore have an adverse effect on the success of the project.

10.3 ORDER OF SIGNIFICANCE

The relationship associated with each independent variable and performance measures were identified and explained in Section 10.2. Seven out of the 10 postulated factors were identified as being significantly associated with the various measures of performance; however, the level of importance of each factor was not discussed. Therefore, the relative strength of these factors on the success of healthcare projects will be established in this section. The method used is to compare the beta weights (coefficients) of each variable. If an independent variable has the highest beta coefficient of all other independent variables, this variable is considered to be the most important determinant in the regression model (Tam, 1992 as cited in Chan, 1996).

Applying the same principle as Chan (1996), the factor with the highest number of highest beta coefficients is considered to have the first order of significance affecting the success of a healthcare building. Those factors with the next-highest number of highest beta coefficients are considered to be of the second order of significance, and so on, until no further classifications can be made.

By examining the beta coefficient, three orders of significance were established. The impact of each factor to various performance variables are shown, especially with those having highest beta coefficients.

10.3.1 First order of significance

The factor *project management action of project stakeholders* is considered to have the first order of significance affecting the success of healthcare projects. It is associated with seven of the nine identified measures of performance. It also has the five highest beta coefficients of all other determining factors. Figure 10.1 shows the impact of this factor on various performance variables.

↑ Project management action ⇨

⇑ PSI
⇑ Construction time
⇑ Functionality
⇑ Environmental friendliness
⇑ Client's overall satisfaction
↑ Quality
↑ Safety

Legend: ↑ = increase in magnitude
⇑ = increase in magnitude (with highest beta coefficient)
⇨ = results in

Figure 10.1 Impact of project management action on performance variables

10.3.2 Second order of significance

A total of four factors are considered as belonging to the second order of significance affecting the success for healthcare projects, including *design team leaders' capabilities, client's representatives' capabilities, construction team* *leaders' capabilities, and nature of the project.* Each of these factors has one of the highest beta coefficients. Figures 10.2 to 10.5 show the impact of each factor on the various measures of performance.

↑ Design team leaders' capabilities	⇨	⇑ Quality ↑ Client's overall satisfaction ↑ Cost performance ↑ Environmental friendliness ↑ Safety ↑ PSI

Legend: ↑ = increase in magnitude
⇑ = increase in magnitude (with highest beta coefficient)
⇨ = results in

Figure 10.2 Impact of design team leaders' capabilities on performance variables

↑ Client's representatives' capabilities	⇨	⇑ Cost performance ↑ Project participants' satisfaction ↑ PSI

Legend: ↑ = increase in magnitude
⇑ = increase in magnitude (with highest beta coefficient)
⇨ = results in

Figure 10.3 Impact of client representatives' capabilities on performance variables

↑ Construction team leaders' capabilities	⇨	⇑ Project participants' satisfaction ↑ Client's overall satisfaction ↑ Quality ↑ PSI

Legend: ↑ = increase in magnitude
⇑ = increase in magnitude (with highest beta coefficient)
⇨ = results in

Figure 10.4 Impact of construction team leaders' capabilities on performance variables

Refurbishment/extension projects (high level of complexity in design coordination)	⇨	⇓ Safety ↓ Environmental friendliness

Legend: ↓ = decrease in magnitude
⇓ = decrease in magnitude (with highest beta coefficient)
⇨ = results in

Figure 10.5 Impact of the nature of the project on performance variables

10.3.3 Third order of significance

Two other factors, namely *client's abilities and application of innovative project management techniques*, are considered to be the third order of significance. In this study, they do not possess any of the highest beta coefficients. Figures 10.6 and 10.7 show the impact of these two factors on the measures of performance.

Figure 10.8 provides a refined model of the success of healthcare projects.

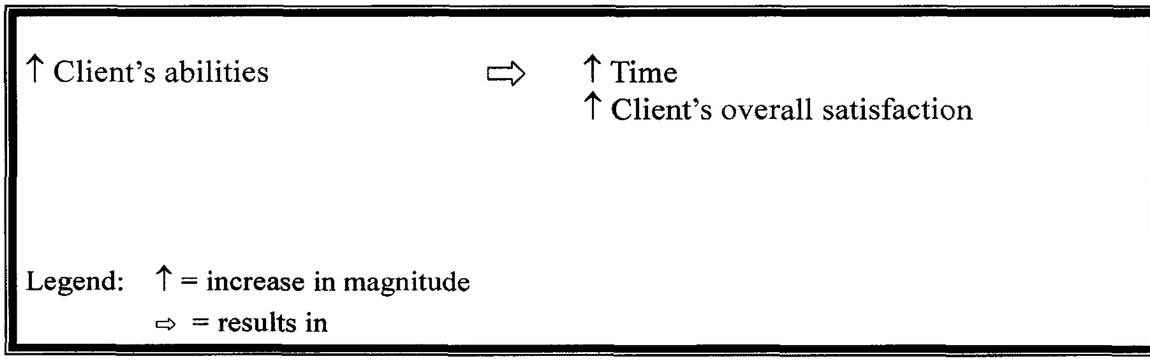


Figure 10.6 Impact of the client's abilities on performance variables

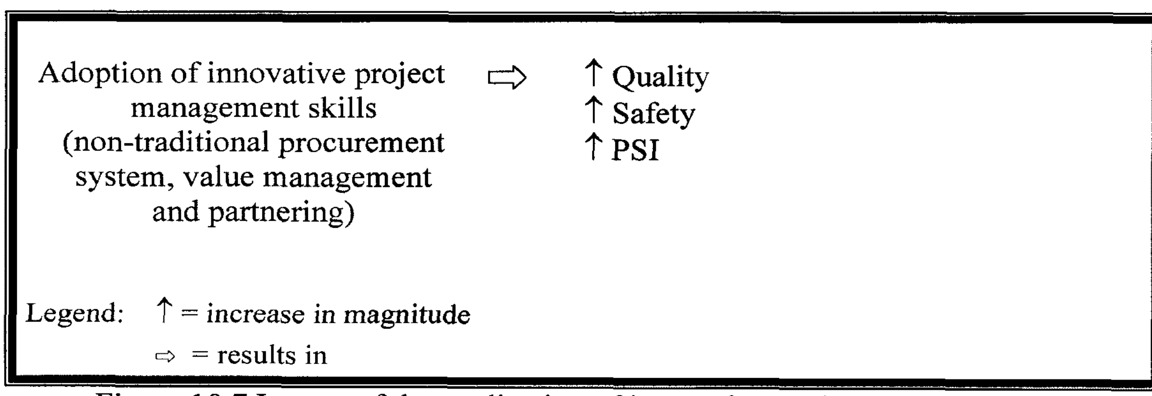
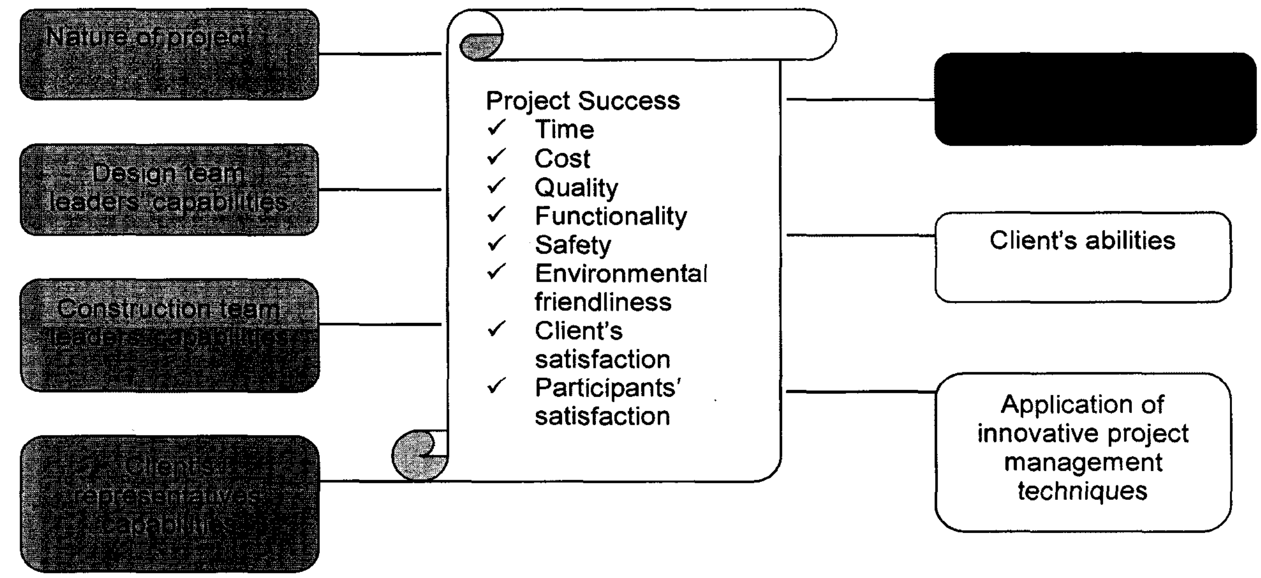


Figure 10.7 Impact of the application of innovative project management techniques on performance variables



First order of significance
Second order of significance
Third order of significance

Figure 10.8 Refined model of the success of healthcare projects

10.4 FACTORS NOT AFFECTING THE SUCCESS OF HEALTHCARE PROJECTS

Three factors, namely external environment, support from the parent company and the client's emphasis on time and cost performance, are found to be insignificantly associated with the success of healthcare projects. The main reason for this is due to the publicly funded nature of healthcare projects in Hong Kong.

10.4.1 External environment

One of the factors that was not found to be significantly associated with the success of healthcare projects is *external environment*, which includes five variables, namely physical environment, social-political environment, prevailing economic environment, level of advance technology, and overall environment. The insignificance of this factor is due to the relatively stable environment of the Hong Kong construction industry compared with the situation in other developing and developed countries (Lam, 1990 as cited in Chan, 1996). The result also supports the findings of previous studies, such as Chan's (1996) and Walker's (1994), which show that the impact of general environmental factors prevailing during the period of construction has no significant correlation with the success of the project. Moreover, as healthcare projects in Hong Kong are usually publicly funded, the external environment will not have a large impact on the projects.

10.4.2 Support from parent company

The second factor that not found to be significantly associated with the success of healthcare projects is *support from parent company*. This factor only includes a single variable, namely the support given to the client's representatives by the parent company. This result is surprising and revokes the previous findings of Slevin and Pinto (1986); Pinto and Prescott (1988) and Chan (1996). The reason for this unexpected result lies in the structure of the client organization in the healthcare sector. Healthcare projects in Hong Kong are usually publicly funded; therefore, once the construction of a hospital is announced, the time and budget for the project are bounded and not easy to change. It is difficult and time-consuming to gain approval for any major changes in design, time, and cost. Therefore, support from the client's representatives' company, i.e. the Hospital Authority or the Government, is difficult to obtain.

10.4.3 Client's emphasis on cost and time performance

The last factor found to be insignificant in the success of healthcare projects is the *client's emphasis on cost and time performance.* This factor includes two variables: the client's emphasis on a low construction cost in project objectives and the client's emphasis on quick construction time in project objectives. This factor was originally included as one of the significant factors in developing the equation for success when the dependent variable of time performance was measured by objective data. However, because of the low adjusted R^2, this equation was not adopted. Thus, this factor was finally excluded from the group of factors affecting the success of healthcare projects. The result of this research differs from that of Chan (1996), who found that the client's emphasis on cost and time performance is related to the success of the project. The nature of healthcare projects in Hong Kong again contributes to the existence of a gap between the findings here and those of previous studies. Most hospital projects in Hong Kong are publicly funded, and the budget and time allotted to the project are under public scrutiny. Hence, this factor is not significantly associated with the success of healthcare projects because all stakeholders in the project are expected to be concerned with cost and time.

10.5 SUMMARY OF THE CHAPTER

This chapter provides the justification for the predictive model on the success of healthcare projects that was developed using factor analysis and multiple regression analysis. Seven of the 10 factors are identified as being significantly associated with the various measures of performance. Table 10.1 provides a summary of the multiple regression equations for predicting the success of healthcare projects.

Table 10.1 Summary of the multiple regression equations

PSI	= 13.601 + 0.776PMGT + 0.665CR_CAP + 0.604CON_CAP + 0.588DES_CAP + 0.538INNO
TIME	= 5.197 + 0.945PMGT + 0.555CLI_ABI
COST	= 3.641 + 0.497CR_CAP + 0.406DES_CAP
QUALITY	= 5.132 + 0.574PMGT + 0.309DES_CAP + 0.309INNO + 0.09835CON_CAP
FUNCT	= 5.349 + 0.665PMGT
SAFE	= 5.44 + 0.268PMGT – 0.568NATURE + 0.511DES_CAP + 0.35INNO
ENVIRON	= 5.167 + 0.548PMGT + 0.471DES_CAP – 0.326NATURE
CLIOVER	= 5.121 + 0.484PMGT + 0.173CLI_ABI + 0.156DES_CAP + 0.122CON_CAP
PPOVER	= 5.312 + 0.732CON_CAP + 0.342CR_CAP + 0.341PMGT

The research findings show that project management action is the best predictor of the success of healthcare projects. Design team leaders' capabilities, client's representatives' capabilities, construction team leaders' capabilities, and the nature of the project were also found to be strongly associated with the success of the project, but to a lesser degree than project management action. They are followed by client's abilities and the application of innovative project management techniques. On the other hand, three factors, namely external environment, support from the parent company, and client's emphasis on cost and time performance, were shown to be insignificantly associated with the success of healthcare projects.

Most of the research findings are found to be in line with those of previous studies (Walker, 1994 and Chan, 1996), except for the results showing that the support from the parent company and the client's emphasis on cost and time performance are not factors affecting the success of the project. The reason for these surprising results mainly lie in the publicly funded nature of healthcare projects in Hong Kong.

The results also suggest that the application of innovative management techniques, such as non-traditional procurement system, value management and partnering, can improve the performance of healthcare projects, especially in terms of quality. This conclusion is proved by the excellent outcomes of two completed projects, i.e. the North District Hospital and the Tseung Kwan O Hospital, which adopted a number of innovative measures, namely, enhanced design and build system of procurement practice, and value management (Chan, 2000).

CHAPTER ELEVEN

TESTING THE MODEL

11.1 INTRODUCTION

Chapters 9 and 10 provided a detailed discussion of the results generated by factor analysis and multiple regression analysis. A model for predicting the success of healthcare projects on various measures of performance was developed. This chapter aims to test the reliability and sensitivity of the developed model by conducting a Paired-Samples t-test. The Paired-Samples t-test is used in a test group to test the regression model against the predictive model. The test group is comprised of five responses from various projects that are not used to estimate the regression model. It can ensure the significance of the developed model to the success of healthcare projects.

11.2 PAIRED SAMPLES T-TEST

A statistical analysis, called the *Paired Samples t-test,* is used to check the reliability of the predicted model. Ten questionnaires for validation were sent to the targeted industry practitioners, who are working on on-going healthcare projects. The revised questionnaire was designed to collect information to test the model only. It is therefore much shorter than the empirical questionnaire (Appendix H). Five returned questionnaires, which were not used to estimate the regression model, were used to test the reliability of the model. On the basis of the data received, a null hypothesis (H_0: $\mu_1=\mu_2$, meaning that the mean of the population of actual values equals the mean of the population of predicted values) was tested (Sheskin, 2004). Section 11.2 shows how the validation of the predictive model by statistical analysis was performed.

11.2.1 Computing the factor scores

To complete the validation test, the same information as was sought from the test cases used to develop the predictive model is needed. One piece of information sought is the factor score. Factor scores for 10 identified factors were inputted as the independent variables in the multiple regression analysis; therefore, the first task is to calculate the factor scores for each case. The factor score for each case can be obtained by using Equation 11.1.

$$F_{jk} = \sum_{i=1}^{p} W_{ji} X_{ik}$$ Equation 11.1

where X_{ik} is the standardized value of the *i*th variable for case *k* and W_{ji} is the factor scores coefficient for the *j*th factor and the *i*th variable.

For each factor, the factor scores are obtained by multiplying the standardized values by the corresponding factor score coefficients. Table 11.1 contains the standardized values of the original 45 variables for testing case 1, and the factor score coefficient for the Factor 1-PMGT (Project Management Actions). Thus, the value for factor 1 of case 1, namely, Project Management Actions is:

Value for factor 1	=	(0.00545)(-1.09545)+(-0.02551)(-0.23905)+(-0.04794)(0.44721)+(-0.03811)(1.78885)+(0.05924)(1.07349)+ …+(0.10832)(0.67082)+(0.11091)(0.95618)+(0.06760)(0.81650)+(0.14217)(0.67082)+(0.09563)(0.44721)
	=	**0.277766**

Table 11.1 Standardized values and factor score

Variables	Factor score coefficient (1)	Standardised value (2)	(3)=(1)*(2)
Nature of the project	0.00545	-1.09545	-0.00597
Complexity: Level of design coordination	-0.02551	-0.23905	0.00610
Complexity: Level of quality of the management procedures	-0.04794	0.44721	-0.02144
Procurement Method Adopted	-0.03811	1.78885	-0.06817
Management skill, such as Partnering/VM	0.05924	1.07349	0.06360
Physical environment	0.00382	0.95618	0.00365
Prevailing economic environment	-0.09183	1.09545	-0.10060
Social-political environment	-0.02640	0.67082	-0.01771
Level of advanced technology	0.01972	-1.41421	-0.02789
Overall environment	0.03950	0.00000	0.00000
Client's emphasis on low construction cost in project objectives	0.00078	1.41421	0.00111
Client's emphasis on quick construction time in project objectives	0.00093	0.73030	0.00068
Client's emphasis on the high quality of construction on project objectives	-0.01029	-0.44721	0.00460
Client's ability to effectively brief the design team	-0.02883	1.43427	-0.04136
Client's ability to quickly make authoritative decisions	0.01555	1.64317	0.02555
Client's ability to effectively define the roles of the participating organizations	0.00242	0.73030	0.00177
Client's ability to contribute ideas to the design process	-0.01788	0.73030	-0.01306
Client's ability to contribute ideas to the construction process	0.01166	0.73030	0.00852
Client's representatives' technical skills	0.02154	0.73030	0.01573
Client representatives' management skills	0.01044	-0.44721	-0.00467
Client's representatives' experience and capabilities	-0.02941	0.67082	-0.01973
Client's representatives' early and continued involvement in the project	-0.01524	0.67082	-0.01022
Client's representatives' ability to adapt to changes in the project plan	0.01926	-0.23905	-0.00460
Client's representatives' support from parent company	-0.00187	0.95618	-0.00179
Design team leaders' technical skills	-0.03583	0.44721	-0.01602
Design team leaders' management skills	0.04368	-0.67082	-0.02930
Design team leaders' experience and capabilities	-0.06485	0.44721	-0.02900
Design team leaders' early and continued involvement in the project	-0.05962	0.00000	0.00000
Design team leaders' ability to adapt to changes in the project plan	0.01815	-1.09545	-0.01988
Design team leaders' support from parent company	0.03225	0.00000	0.00000
Construction team leaders' technical skills	0.01101	0.67082	0.00739
Construction team leaders' management skills	0.00095	0.00000	0.00000
Construction team leaders' experience and capabilities	0.01276	0.00000	0.00000
Construction team leaders' early and continued involvement in the project	0.04408	-1.09545	-0.04829
Construction team leaders' ability to adapt to changes in the project plan	0.02128	-1.04350	-0.02221
Construction team leaders' support from parent company	0.00114	0.44721	0.00051
Setting up a communication system for the project	0.07923	0.44721	0.03543
Devising a control mechanism, such as monitoring and updating plans	0.13008	0.44721	0.05817
Providing feedback capabilities	0.18298	0.44721	0.08183
Making up-front planning efforts	0.11388	0.81650	0.09299
Developing an appropriate organizational structure	0.10832	0.67082	0.07266
Implementing an effective quality assurance programme	0.11091	0.95618	0.10605
Implementing an effective safety programme	0.06760	0.81650	0.05520
Developing of a good reporting system	0.14217	0.67082	0.09537
Developing standard procedures	0.09563	0.44721	0.04277
		Factor Score:	**0.277766**

Using the same principle, the factor scores for each of the five test cases were calculated and shown in Table 11.2.

Table 11.2 Factor scores for the test cases

	Factor 1 PMGT	Factor 2 CLI_ABI	Factor 3 DES_CAP	Factor 4 ENVIOR	Factor 5 INNO
Case 1	0.277766	1.234438	-0.538070	0.354607	1.219460
Case 2	0.637946	-0.524401	0.560941	-0.206597	-0.405202
Case 3	-1.406381	-0.684611	-1.248697	-1.252546	0.673398
Case 4	-0.356959	-0.432147	0.271772	0.605466	-0.759202
Case 5	0.447915	0.377668	1.055012	0.646003	-0.906123

	Factor 6 CR_CAP	Factor 7 CON_CAP	Factor 8 CLI_EMPH	Factor 9 NATURE	Factor 10 SUPPORT
Case 1	0.385509	0.257310	0.089839	-0.152153	-0.184173
Case 2	0.394001	0.833507	0.401665	0.610304	-0.357641
Case 3	-1.488517	-1.582535	-0.709931	-0.258089	-0.260712
Case 4	1.091977	0.111380	0.819055	-0.147812	-1.166490
Case 5	-0.086931	0.169326	-0.168996	0.344603	1.629733

The factor scores were then substituted into the multiple regression equations as shown in Table 10.1 to compute the predicted values for various measures of performance. The computed performance values for the five test cases were shown in Table 11.3.

Table 11.3 Computed performance values for the five test cases

	PSI	TIME	COST	QUALITY	FUNCT	SAFE	ENVIRON	CLIOVER	PPOVER
Case 1	14.57	6.15	3.61	5.53	5.53	5.75	5.12	5.42	5.73
Case 2	14.97	5.51	4.06	5.63	5.77	5.41	5.58	5.53	6.27
Case 3	10.19	3.48	2.39	3.99	4.41	4.81	3.89	3.93	3.16
Case 4	13.87	4.62	4.29	4.79	5.11	5.30	5.15	4.93	5.65
Case 5	14.13	5.83	4.03	5.45	5.65	5.59	5.80	5.59	5.56

11.2.2 Analysis of paired data

After calculating the computed performance values for each case for various measures of performance, a matrix of paired data for the performance variables of various measures is developed (Table 11.4). An analysis of paired data was then performed to test whether there is a significant difference between the computed values and the actual values.

A null hypothesis (H_0: $\mu_1=\mu_2$, meaning that the mean of the population of actual values equals the mean of the population of predicted values) is first formulated (Sheskin, 2004). Then, a test statistic as shown in Equation 11.2 is chosen to evaluate the null hypothesis. The probability, if the null hypothesis is true, of obtaining a test value at least as extreme as the one observed is determined. If the observed level of significance is judged to be small enough (two-tailed probability $\leqq$ 0.05), the null hypothesis is rejected.

$$t = \frac{\overline{D}}{S_D / \sqrt{N}} \qquad \text{Equation 11.2}$$

where $\overline{D}$ is the observed difference between the two means and S_D is the standard deviation of the differences between the paired observations. The sampling distribution of t, if the differences are normally distributed with a mean of 0, is Student's t with N-1 degrees of freedom, where N is the number of pairs (Norusis, 1993b).

Table 11.4 Paired comparison of computed values and actual values

	PSI	TIME	COST	QUALITY	FUNCT	SAFE	ENVIRON	CLIOVER	PPOVER
Case 1									
Actual	15.49	7.00	4.00	6.00	6.00	6.00	6.00	6.00	6.00
Computed	14.57	6.15	3.61	5.53	5.53	5.75	5.12	5.42	5.73
Case 2									
Actual	15.23	6.00	4.00	5.50	6.00	7.00	6.00	5.00	6.00
Computed	14.97	5.51	4.06	5.63	5.77	5.41	5.58	5.53	6.27
Case 3									
Actual	13.01	4.00	4.00	5.00	5.00	5.00	5.00	4.00	5.00
Computed	10.19	3.48	2.39	3.99	4.41	4.81	3.89	3.93	3.16
Case 4									
Actual	14.74	5.00	4.00	6.00	6.00	6.00	6.00	5.00	6.00
Computed	13.87	4.62	4.29	4.79	5.11	5.30	5.15	4.93	5.65
Case 5									
Actual	13.39	3.00	4.00	5.00	5.00	5.00	5.00	5.00	5.00
Computed	14.13	5.83	4.03	5.45	5.65	5.59	5.80	5.59	5.56

Table 11.5 shows a summary of the comparison between all of the performance measures. The mean difference is the difference between the mean scores of the computed values and actual values of each pair of performance measures. The *t* value is the mean difference divided by the standard error of the difference. The two-tailed probability of each pair for this test is larger than 0.05. The null hypotheses that the computed values and the actual values have similar mean scores cannot be rejected at the 95% confidence level; hence, it can be concluded that the multiple regression equations developed in this study are good predictors of various types of performance.

Table 11.5 Summary of the results of paired comparisons

	Paired diff. Mean	Std. Deviation	Std. Error of diff.	t-value	Degree of freedom	2-tailed significance
PSI	0.8260	1.3000	0.5814	1.421	4	0.228
TIME	-0.1180	1.5262	0.6825	-0.173	4	0.871
COST	0.3240	0.7596	0.3397	0.954	4	0.394
QUALITY	0.4220	0.7131	0.3189	1.323	4	0.256
FUNCT	0.3060	0.5849	0.2616	1.170	4	0.307
SAFE	0.4280	0.7983	0.3570	1.199	4	0.297
ENVIRON	0.4920	0.7641	0.3417	1.440	4	0.223
CLIOVER	-0.800	0.4856	0.2172	-0.368	4	0.731
PPOVER	0.3260	0.9268	0.4145	0.786	4	0.476

11.3 SUMMARY OF THE CHAPTER

A test of the reliability and sensitivity of the model for predicting the success of healthcare projects using various measures of performance was conducted. A test group comprised of five projects that were not used to estimate the regression model was obtained. The same information from the test cases as that used to develop the model was sought and used to test against the predictive model. The values of the individual variables were converted into factor scores and inputted into the multiple regression equations to compute the predicted values for various measures of performance. A *Paired Samples t-test*, an analysis of paired data, was then carried out to test whether there is a significant difference between the computed values and the actual values. The null hypotheses that the computed values and the actual values have similar mean scores cannot be rejected at the 95% confidence level. Hence, the conclusion that can be drawn from the results is that the multiple regression equations developed in this study are good predictors of various types of performance.

CHAPTER TWELVE

CONCLUSIONS

12.1 INTRODUCTION

With a rapidly ageing population and given possible future outbreaks of epidemics such as SARS, there is predicted to be a great demand for healthcare services and facilities in Hong Kong. The primary objective of this research was to develop a conceptual model for achieving successful healthcare projects. A comprehensive literature review, a series of interviews, and a questionnaire survey were conducted to investigate the major problems in running healthcare projects, success criteria, and factors affecting the performance of projects. This chapter summarizes the conclusions of the study and presents recommendations for further studies. The research objectives and hypotheses are first reviewed. The general conclusions of the research are then discussed, followed by a discussion of the value of this study. Finally, potential areas for further study are identified.

12.2 REVIEW OF THE OBJECTIVES AND HYPOTHESES

As identified in Chapter 1, the primary objective of this research was to develop a conceptual model for achieving successful healthcare projects. The specific goals were to identify the major problems in running healthcare projects; to develop a framework and a project success index (PSI) for measuring the success of healthcare projects; to identify those factors with strong correlations to the success of the project; and to develop a conceptual model to link the critical success factors (CSFs) to the performance of the project. The ultimate goal is to provide clients, designers, and contractors with valuable information on how to achieve excellent performance in their healthcare projects.

To achieve the research objectives, two hypotheses were formulated:

(1) 'A successful healthcare project is one that is completed on budget, on schedule, meets the required standard of quality, is environmentally friendly and safe, achieves its intended functions, conforms to the expectations and satisfaction of the users, clients, and project participants, and produces profits and long-term gains'.

(2) 'The success of a healthcare project is a function of project-related factors, project procedures, project management action, human-related factors, and external environment, and all of these factors are inter-related and intra-related'.

12.3GENERAL CONCLUSION

Several statistical tools were applied to achieve the objectives of the research, including Kendall's coefficient of concordance, the Spearman rank correlation coefficient, a Two-tailed t-test, Principal components analysis, Factor analysis, and Stepwise multiple regression analysis. The results were discussed in Chapters 7 – 10. The general conclusions are as follows:

12.3.1 Major problems in running healthcare projects

Twenty-four problem statements on the problems in running healthcare projects were identified from the literature. Through a questionnaire survey these were ranked by a group of industry participants with hands-on experience in running healthcare projects. The rankings of the problems, as assessed by the client and contractor groups were first examined by Kendall's coefficient of concordance (W). The perceived problems were further evaluated by the Spearman rank correlation coefficient (r_s), which is a technique to measure the agreement between two different professional groups on their rankings. The statistical analyses revealed that there was a great deal of agreement both within and between the client group and the contractor group on the rankings of the problems in managing healthcare projects. Both groups agreed that 'highly complicated building services', 'tight time schedule' and 'the need to keep up with up-to-date technology' are three of the most important problems found in running healthcare buildings. 'Frequent changes demanded by multi-headed clients and various end-users', 'fixed budget', 'flexible design was required', 'difficult to deal with various end-users', 'high risk of project delays', 'difficult to deal with large numbers of professionals or specialists' and 'facing great pressure from general public and client' were also considered to be main problems faced by industry practitioners. However, some disparities were found amongst the rankings of the client group and the contractor group. 'Fixed budget' and 'coordination of architectural, structural, and building services engineering practices was difficult' were ranked higher by the clients, while 'high risk of project delays', 'high risk of cost overruns' and 'inadequate cooperation between various project participants' were ranked higher by the contractors. The survey also showed there to be a gap between the literature review and actual practices. 'Inadequately designed and coordinated building services', 'difficulties in connecting the procurement with the installation and commissioning of medical equipment' and 'ambiguity in allocating design responsibilities for building services' were the conspicuous problems identified in the previous literature. However, the empirical study found that these problems have a less adverse effect in the present Hong Kong context.

12.3.2 Criteria for the success of healthcare projects

Based on a critical review of the related literature, a total of 12 criteria for success were identified. These formed the basis of this research. The statistical results of Kendall's coefficient of concordance (W), the Spearman rank correlation coefficient (r_s), and the two-tailed t-test showed that there is overall agreement between the respective client group and contractor group, but a divergence was found between the groups on the rankings of the success criteria for healthcare projects. Collectively, 'the client is satisfied with the performance of the project', 'the project was completed to the required standard of quality' and 'the project is achieving its function' were found to be the three most important criteria for success. Apart from these three criteria, the respondents also considered the following to be important criteria for the success of a project: 'the project was completed with a low accident rate', 'the project was completed on budget', 'the various end-users are satisfied with the performance of the project' and 'the project was completed on time'. 'The project is profitable' and 'the project can produce further/long-term gains', on the other hand, are regarded as the least important criteria for the success of healthcare projects.

Based on the results of the interviews and questionnaires, the following eight criteria were selected for use in assessing the success of healthcare projects: time, cost, quality, functionality, safety, environmental friendliness, client's satisfaction, and participants' satisfaction. Applying the Principal Component Analysis, a PSI equation was formulated to measure the level of success of healthcare projects. It is summarized as follows:

PSI =	0.390*Quality + 0.379*Client's Satisfaction + 0.373*Time + 0.357*Participants' Satisfaction + 0.357* Functionality + 0.344*Cost + 0.313*Safety + 0.308*Environmental Friendliness

12.3.3 Factors affecting the success of healthcare projects

A factor analysis was conducted to identify the underlying factors from 45 independent variables. Ten underlying factors were identified and their factor scores were then inputted into the multiple regression models as independent variables. Using a stepwise multiple regression analysis, a total of nine multiple regression equations were developed to identify the determining factors of each dependent variable for the success of healthcare projects (Table 12.1).

Table 12.1 Summary of multiple regression equations

PSI	= 13.601 + 0.776PMGT + 0.665CR_CAP + 0.604CON_CAP + 0.588DES_CAP + 0.538INNO
TIME	= 5.197 + 0.945PMGT + 0.555CLI_ABI
COST	= 3.641 + 0.497CR_CAP + 0.406DES_CAP
QUALITY	= 5.132 + 0.574PMGT + 0.309DES_CAP + 0.309INNO + 0.09835CON_CAP
FUNCT	= 5.349 + 0.665PMGT
SAFE	= 5.44 + 0.268PMGT – 0.568NATURE + 0.511DES_CAP + 0.35INNO
ENVIRON	= 5.167 + 0.548PMGT + 0.471DES_CAP – 0.326NATURE
CLIOVER	= 5.121 + 0.484PMGT + 0.173CLI_ABI + 0.156DES_CAP + 0.122CON_CAP
PPOVER	= 5.312 + 0.732CON_CAP + 0.342CR_CAP + 0.341PMGT

The findings of the research show that project management action is the best predictor of the success of healthcare projects, followed by the design team leaders' capabilities, client's representatives' capabilities, construction team leaders' capabilities, and the nature of the project. Client's abilities and the application of innovative project management techniques are also found to be strong predictors of project success, but to a lesser degree. Three factors, namely external environment, support from the parent company, and client's emphasis on cost and time performance, are shown to be insignificantly associated with the success of healthcare projects. Based on the above results, the following conclusions are drawn:

a. Better project management action taken by project stakeholders will result in better time and quality performance, an improved level of functionality, a higher level of safety and of environmental friendliness, a higher level of satisfaction felt by the clients and project participants and a better overall project success index.

b. If the client possesses greater abilities, there is a greater likelihood of increasing the client's overall level of satisfaction and of achieving better time performance.

c. A higher level of capability on the part of the design team leaders will lead to better cost performance, greater satisfaction with the level of safety and environmental friendliness, an increase in the client's overall satisfaction and PSI and, especially, a higher quality of performance.

d. Projects using non-traditional procurement systems and those that apply innovative management skills, such as partnering and value management, and those in which the client places a greater emphasis on quality will result in improved quality performance, better safety levels, and a higher PSI.

e. A higher level of capability on the part of the client's representatives will result in better time and cost performance, an increase in the overall level of satisfaction felt by the project participants, and a higher PSI score.

f. An increased level of capability on the part of the construction team leaders will result in an improvement in quality performance, a higher level of overall satisfaction on the part of the client and project participants, and a better PSI score.

g. An extension or refurbishment project and a higher level of complexity in the design coordination will result in decreased levels of safety and environmental friendliness.

An independent test group consisting of five projects that had not been used in developing the regression model was obtained to test the reliability and sensitivity of the predictive model. The conclusion that the multiple regression equations developed in this study are good predictors of various performances can be drawn from the Paired Samples t-test with a 95% confidence level.

12.4 PARTICULAR VALUE OF THE RESEARCH

This research was exploratory in nature and contributes to the body of knowledge by developing a measure for the success of healthcare projects and by linking various variables with the success of healthcare projects. A PSI equation with eight criteria was formulated to measure the level of success of healthcare projects. The findings of this research reveal that the success of healthcare projects is affected by:

a. Project management action, such as the effectiveness of feedback capabilities, up-front planning efforts, the control mechanism, communication system, organizational structure, etc.

b. Human-related factors, including the management and technical skills of the client's representatives, design team leaders, and construction team leaders; their experience and capabilities; their ability to adapt to changes; their early and continued involvement in the project' and the support received from the parent company.

c. Project procedures, such as the adoption of non-traditional procurement systems and innovative management skills; i.e., value management and partnering.

Based on 52 samples, a set of regression models linked with various criteria for success was developed. A number of researchers have studied the concept of project success and developed a group of project success variables. However, their data were mainly collected in the 1990s and were based on a general construction project. Therefore, this research not only aims to update the project success variables by linking previous findings obtained in earlier years to those of recent years, but also to provide a specific and in-depth study on healthcare projects, which are regarded as among the most difficult of various types of construction projects. The specific value of this research is listed below:

a. The identification of major problems in running healthcare projects enables the stakeholders in the project to minimize possible difficulties they may encounter during implementation. Once these problems are prevented, the chances of achieving better project performance can be enhanced.

b. An indexed measure of success for healthcare projects was developed using principal components analysis. The construction of these indices provides a single measure for dependent and independent variables. It also provides powerful and reliable summaries of measured data and improves the reliability of the data. This research has also provided an invaluable methodology for establishing an index for follow-up studies.

c. This research provides greater insight on the key factors/criteria relationships that may have an impact on the running of healthcare projects. The variables of project management action are benchmarked through the calibration of an indexed measure and a regression analysis formula. This provides the construction industry with a means of determining its level of effort compared to that of others.

d. The research findings are also useful for selecting project team members, identifying the project needs and for forecasting the level of performance of the project.

e. A predictive model was developed to assess the level of success of healthcare projects before its start and during its course. It can help to set a benchmark to determine the performance of healthcare projects.

Apart from its practical applications, the research is also useful in the academic/educational field. The results of this study can enrich the content of management educational programmes for both students and project managers. Moreover, studies on managing healthcare projects are rarely conducted in Asian countries. Most of the previous studies were carried out in the United Kingdom and the United States. Therefore, the results of this research can be used as reference for other Asian countries. It can further be used as a solid basis for comparative studies involving Asia, Europe, and North America in collaboration with fellow researchers in these areas. This can help to strengthen our understanding of the management of healthcare projects in different countries.

12.5 RECOMMENDATION FOR FUTURE STUDIES

During the course of this research, several areas were highlighted as potential areas for further study, as follows.

a. This study is limited to the design and construction stages of healthcare projects. The constraint of time has precluded the inclusion of the planning stage in this study. It is hoped that the coverage can be extended to the planning stage as it is another critical stage in healthcare projects.

b. The study samples collected in this study focused on the construction of healthcare projects in Hong Kong. It is recommended that the research methodology adopted for this study be applied to develop similar useful models for other specific construction projects, such as hotels, commercial buildings, large sports centres, and so forth.

c. The data for this study was mainly collected from publicly funded healthcare projects, which are carried out in a more stable environment. Further research can be done to focus on privately funded projects, as their culture and environment is totally different from those of public projects, which may lead to a different set of determining variables.

d. The research findings are mainly dependent on the perceptions of invited participants and are subjective in nature. Therefore, there is a recognized need to develop a more objective method of quantifying interval-level measurement criteria for dependent and independent variables, which can reduce human bias and lead to fairer judgements about the success of a project.

e. Similar studies can also be carried out in other parts of the world to determine how regional and cultural factors may have influenced the findings of this research. This will help to establish a strong body of empirical knowledge related to success in running healthcare projects in different countries for comparison.

f. A non-traditional procurement system and innovative management skills, such as design and build, partnering, value management, and so forth have recently been widely adopted in the local construction industry. The effectiveness of these innovative measures on project performance is still under observation. It is therefore worth conducting further research linking these measures to project success to provide a sound conclusion for industry professionals.

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APPENDIX A

SAMPLE OF THE QUESTIONNAIRE

INSTRUCTION

It takes about 15-20 minutes to complete this questionnaire. Please answer all questions with reference to a *health-care project* you have involved. Kindly tick the appropriate box for your answer.

1. RESPONDENT'S INFORMATION

1. Job Title: ______________________

2. Professional affiliation: ❑ Architect ❑ Building surveyor ❑ Quantity surveyor ❑ Engineer
   ❑ Builder ❑ Others (*Please specify*): ______________

3. Highest academic qualification attained: ❑ Diploma/Certificate ❑ Professional Diploma
   ❑ Bachelor's Degree ❑ Master's Degree
   ❑ Doctorate Degree
   ❑ Others *(Please specify)*: ______________

4. Years of experience in the construction industry in:
   ❑ less than 5 years ❑ 5 to 9 years ❑ 10 to 14 years ❑ 15 to 19 years
   ❑ 20 years or more

5. Type of organization in which your are working in:
   ❑ Client's organization ❑ Main Contractor ❑ Architect firm
   ❑ Engineering consultant ❑ Project management consultant ❑ Q.S. consultant
   ❑ Sub-contractor ❑ Public utility ❑ Other:______________

6. Size of your organization: ❑ 100 staff or below ❑ 101-200 staff ❑ 201-300 staff
   ❑ 301-400 staff ❑ 401-500 staff ❑ Over 500 staff

7. Please indicate your experience in running health-care projects.
   ❑ Experience for one construction project.
   ❑ Experience for two construction projects.
   ❑ Experience for three or more construction projects.
   ❑ Others *(Please specify):* ______________________________

2. PROJECT DETAILS OF A HEALTH-CARE PROJECT (Optional)

1. Name of Project: ______________________________

2. Your position in the project: ❑ Architect ❑ Engineer ❑ Project manager ❑ Quantity surveyor
   ❑ Builder ❑ Others: ______________________

3. Classification of project: ❑ Clinic ❑ Health centre ❑ General hospital
   ❑ Teaching hospital ❑ Rehabilitation Hospital
   ❑ Others *(Please specify):* ______________________

4. Nature of project: ❑ New work ❑ Refurbishment ❑ Redevelopment
   ❑ Extension ❑ Others *(Please specify):* ______________
   Please specify your type of work: ______________________________

5. Maximum number of floors below ground level: ______________________

6. Maximum number of floors above ground level: ______________________

7. Original contract sum at tender award: HK $______________ million

8. Final contract sum at completion: HK $______________ million

9. Total rise and fall (price fluctuation): HK $______________ million

10. Project commencement date: ____________________________

11. Practical completion date: ____________________________

12. Original construction period at tender award: ___________________ (calendar days / working day*)

13. Total project duration: ________________ Days

14. Gross floor area: ________________ m^2

15. Total agreed E.O.T.: ___________________________ working days

16. Approximate number of claims and disputes that arose during the construction period: __________

17. Approximate number of accidents that arose during the construction period: __________________

3. DIFFICULTIES/PROBLEMS IN RUNNING A HEALTH-CARE PROJECT

Please rate the following difficulties that this health-care project had brought to you and other project participants.	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1. Highly complicated building services was required	❑	❑	❑	❑	❑	❑	❑
2. Up-to-date technology was required	❑	❑	❑	❑	❑	❑	❑
3. Flexible design was required	❑	❑	❑	❑	❑	❑	❑
4. Difficult to deal with large numbers of professionals or specialists	❑	❑	❑	❑	❑	❑	❑
5. Difficult to deal with various end-users	❑	❑	❑	❑	❑	❑	❑
6. Frequent changes were demanded by multi-head clients and various end-users	❑	❑	❑	❑	❑	❑	❑
7. Tight time schedule	❑	❑	❑	❑	❑	❑	❑
8. Fixed budget	❑	❑	❑	❑	❑	❑	❑
9. Facing great pressure by general public and client	❑	❑	❑	❑	❑	❑	❑
10. Unable to meet schedule of the project	❑	❑	❑	❑	❑	❑	❑
11. High risk of cost overruns	❑	❑	❑	❑	❑	❑	❑
12. High risk of project delays	❑	❑	❑	❑	❑	❑	❑
13. High risk of producing poor quality product	❑	❑	❑	❑	❑	❑	❑
14. Productivity is comparatively low	❑	❑	❑	❑	❑	❑	❑
15. High level of rework required for achieving the specifications	❑	❑	❑	❑	❑	❑	❑
16. Exposure to litigation	❑	❑	❑	❑	❑	❑	❑
17. Large number of claims involved	❑	❑	❑	❑	❑	❑	❑
18. Insufficient cooperation between various project participants	❑	❑	❑	❑	❑	❑	❑
19. Inadequate exchange of knowledge and skills between parties	❑	❑	❑	❑	❑	❑	❑
20. Limited incorporation of new technique	❑	❑	❑	❑	❑	❑	❑

Please rate the following difficulties that this health-care project had brought to you and other project participants.	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
21. Coordination of architectural, structural and building services engineering practices was difficult	❑	❑	❑	❑	❑	❑	❑
22. Inadequately designed and coordinated building services	❑	❑	❑	❑	❑	❑	❑
23. Difficulties in connecting the procurement with the installation and commissioning of medical equipment	❑	❑	❑	❑	❑	❑	❑
24. Ambiguity in allocating design responsible for building services	❑	❑	❑	❑	❑	❑	❑
25. Other *(Please specify):* ______							

4. PROJECT COMPLEXITY LEVEL

Please rate the following statements that contributed to the perception on the level of complexity of this project to construct.	Strongly complex	Complex	Slightly complex	Neutral	Slightly simple	Simple	Strongly simple
1. Inherent site conditions	❑	❑	❑	❑	❑	❑	❑
2. Level of design buildability	❑	❑	❑	❑	❑	❑	❑
3. Level of design coordination	❑	❑	❑	❑	❑	❑	❑
4. Level of quality management procedures	❑	❑	❑	❑	❑	❑	❑
5. Access to or within site	❑	❑	❑	❑	❑	❑	❑
6. Overall characteristics of this particular project	❑	❑	❑	❑	❑	❑	❑

5. ABOUT THE PROJECT PROCEDURE

1. What procurement system did the project adopt?
   - ❑ Sequential traditional system
   - ❑ Accelerated traditional system
   - ❑ Competitive design & build
   - ❑ Enhanced design & build
   - ❑ Novation
   - ❑ Management contracting
   - ❑ Guarantee maximum price
   - ❑ Do not know
   - ❑ Other *(Please specify):* ______

2. What type of tendering method was used?
   - ❑ Open tendering
   - ❑ Selective tendering
   - ❑ Negotiation tendering
   - ❑ Other *(Please specify):* ______

3. What other management skill(s) was used?
   - ❑ Partnering
   - ❑ Value Management/Engineering
   - ❑ Other *(Please specify):* ______

6. ABOUT THE PROJECT ENVIRONMENT AND TECHNOLOGY

Please rate the following statements that contributed to the perception on the level of complexity of this project to construct.	Strongly complex	Complex	Slightly complex	Neutral	Slightly simple	Simple	Strongly simple
1. Physical environment	❑	❑	❑	❑	❑	❑	❑
2. Prevailing economic environment	❑	❑	❑	❑	❑	❑	❑
3. Social-political environment	❑	❑	❑	❑	❑	❑	❑
4. Industrial relations environment	❑	❑	❑	❑	❑	❑	❑
5. Level of technology advanced	❑	❑	❑	❑	❑	❑	❑
6. Overall environment	❑	❑	❑	❑	❑	❑	❑

7. ABOUT THE CLIENT

7.1 Client's particular

1. Organization of client: ____________________

2. Type of client: ❑ Public ❑ Private ❑ Other : ____________

3. Years of experience with client
   ❑ less than 5 years ❑ 5 to 9 years ❑ 10 to 14 years ❑ 15 to 19 years
   ❑ 20 years or more

4. Size of client's organization
   ❑ Large corporation (500+ employees)
   ❑ Medium sized (50+ to 500 employees)
   ❑ Small sized (up to 50 employees)

5. Main business of client organization
   ❑ General construction
   ❑ Non-construction
   ❑ Multi-disciplinary

7.2 Client objectives

Please rate the following statements that best describe your opinion of the client's emphasis on project objectives, where:	Strongly low	Low	Slightly low	Average	Slightly high	High	Strongly high
1. Low construction cost	❑	❑	❑	❑	❑	❑	❑
2. Quick construction time	❑	❑	❑	❑	❑	❑	❑
3. High quality of construction	❑	❑	❑	❑	❑	❑	❑

7.3 Client competency measures

Please rate the following statements that best describe your opinion on the competency of client.	Strongly weak	Weak	Slightly weak	Average	Slightly strong	Strong	Strongly strong
1. Ability to effectively brief the design team	❑	❑	❑	❑	❑	❑	❑
2. Ability to quickly make authoritative decisions	❑	❑	❑	❑	❑	❑	❑
3. Ability to effectively define the roles of the participating organizations	❑	❑	❑	❑	❑	❑	❑
4. Ability to contribute ideas to the design process	❑	❑	❑	❑	❑	❑	❑
5. Ability to contribute ideas to the construction process	❑	❑	❑	❑	❑	❑	❑

8. ABOUT THE PROJECT TEAM LEADERS

In this section, the project team leaders involve the client's representative, design team leader and construction team leader. Please rate their effectiveness in terms of their technical skills, managerial skills, commitment on project, support by parent company, provision of resources and working relationship.

8.1 Client's representative

Please rate the following statements that best describe your opinion on the competency of client's representative.	Strongly weak	Weak	Slightly weak	Average	Slightly strong	Strong	Strongly strong
1. Technical skills	❑	❑	❑	❑	❑	❑	❑
2. Planning skills	❑	❑	❑	❑	❑	❑	❑
3. Organization skills	❑	❑	❑	❑	❑	❑	❑
4. Coordinating skills	❑	❑	❑	❑	❑	❑	❑
5. Motivating skills	❑	❑	❑	❑	❑	❑	❑
6. Controlling skills	❑	❑	❑	❑	❑	❑	❑
7. Experience and capabilities	❑	❑	❑	❑	❑	❑	❑
8. Commitment to meet cost, time and quality targets	❑	❑	❑	❑	❑	❑	❑
9. Early and continued involvement in the project	❑	❑	❑	❑	❑	❑	❑
10. Adaptability to changes in the project plan	❑	❑	❑	❑	❑	❑	❑
11. Working relationship with others	❑	❑	❑	❑	❑	❑	❑
12. Support by parent company	❑	❑	❑	❑	❑	❑	❑
13. Provision of resources from parent company	❑	❑	❑	❑	❑	❑	❑

8.2 Design team leader

Please rate the following statements that best describe your opinion on the competency of design team leader.	Strongly weak	Weak	Slightly weak	Average	Slightly strong	Strong	Strongly strong
1. Technical skills	❑	❑	❑	❑	❑	❑	❑
2. Planning skills	❑	❑	❑	❑	❑	❑	❑
3. Organization skills	❑	❑	❑	❑	❑	❑	❑
4. Coordinating skills	❑	❑	❑	❑	❑	❑	❑
5. Motivating skills	❑	❑	❑	❑	❑	❑	❑
6. Controlling skills	❑	❑	❑	❑	❑	❑	❑
7. Experience and capabilities	❑	❑	❑	❑	❑	❑	❑
8. Commitment to meet cost, time and quality targets	❑	❑	❑	❑	❑	❑	❑
9. Early and continued involvement in the project	❑	❑	❑	❑	❑	❑	❑
10. Adaptability to changes in the project plan	❑	❑	❑	❑	❑	❑	❑
11. Working relationship with others	❑	❑	❑	❑	❑	❑	❑
12. Support by parent company	❑	❑	❑	❑	❑	❑	❑
13. Provision of resources from parent company	❑	❑	❑	❑	❑	❑	❑

8.3 Construction team leader

Please rate the following statements that best describe your opinion on the competency of construction team leader.	Strongly weak	Weak	Slightly weak	Average	Slightly strong	Strong	Strongly strong
1. Technical skills	❑	❑	❑	❑	❑	❑	❑
2. Planning skills	❑	❑	❑	❑	❑	❑	❑
3. Organization skills	❑	❑	❑	❑	❑	❑	❑
4. Coordinating skills	❑	❑	❑	❑	❑	❑	❑
5. Motivating skills	❑	❑	❑	❑	❑	❑	❑
6. Controlling skills	❑	❑	❑	❑	❑	❑	❑
7. Experience and capabilities	❑	❑	❑	❑	❑	❑	❑
8. Commitment to meet cost, time and quality targets	❑	❑	❑	❑	❑	❑	❑
9. Early and continued involvement in the project	❑	❑	❑	❑	❑	❑	❑
10. Adaptability to changes in the project plan	❑	❑	❑	❑	❑	❑	❑
11. Working relationship with others	❑	❑	❑	❑	❑	❑	❑
12. Support by parent company	❑	❑	❑	❑	❑	❑	❑
13. Provision of resources from parent company	❑	❑	❑	❑	❑	❑	❑

9. ABOUT THE MANAGEMENT ACTIONS

Please rate the following statements that best describe your opinion of the effectiveness of managerial actions taken by the project team.	Strongly ineffective	Ineffective	Slightly ineffective	Neutral	Slightly effective	Effective	Strongly effective
1. Communication system for the project	❑	❑	❑	❑	❑	❑	❑
2. Control mechanism, such as monitoring and updating plans	❑	❑	❑	❑	❑	❑	❑
3. Feedback capabilities	❑	❑	❑	❑	❑	❑	❑
4. Up-front planning efforts	❑	❑	❑	❑	❑	❑	❑
5. Developing an appropriate organizational structure	❑	❑	❑	❑	❑	❑	❑
6. Implementing an effective quality assurance program	❑	❑	❑	❑	❑	❑	❑
7. Implementing an effective safety program	❑	❑	❑	❑	❑	❑	❑
8. Control of sub-contractors' works	❑	❑	❑	❑	❑	❑	❑
9. Development of a good reporting system	❑	❑	❑	❑	❑	❑	❑
10. Development of standard procedures	❑	❑	❑	❑	❑	❑	❑
11. Holding of regular meetings	❑	❑	❑	❑	❑	❑	❑

10. ABOUT THE PROJECT PERFORMANCE

Please indicate the performance of this health-care project.

1. Time performance:

❑ On schedule
❑ Ahead schedule by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%
❑ Behind schedule by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%

2. Cost performance:

❑ On budget
❑ Underrun budget by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%
❑ Overrun budget by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%

3. Disputes occurrence

❑ Indifferent to an average project
❑ Above an average project by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%
❑ Below an average project by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%

4. Claims occurrence

❑ Indifferent to an average project
❑ Above an average project by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%
❑ Below an average project by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%

5. Overall performance:

❑ very unsuccessful ❑ unsuccessful ❑ average ❑ successful ❑ very successful

11. LEVEL OF SATISFACTION (PROJECT LEVEL)

Please indicate the level of your satisfaction on the performance of this completed health-care project	Strongly dissatisfied	Dissatisfied	Slightly dissatisfied	Neutral	Slightly satisfied	Satisfied	Strongly satisfied
1. Time	❑	❑	❑	❑	❑	❑	❑
2. Cost	❑	❑	❑	❑	❑	❑	❑
3. Quality of design	❑	❑	❑	❑	❑	❑	❑
4. Quality of workmanship	❑	❑	❑	❑	❑	❑	❑
5. Safety record	❑	❑	❑	❑	❑	❑	❑
6. Overall performance	❑	❑	❑	❑	❑	❑	❑
7. Achieving functionality	❑	❑	❑	❑	❑	❑	❑
8. Achieving environmental friendliness	❑	❑	❑	❑	❑	❑	❑

12. PERSONAL VIEWS ON SUCCESS CRITERIA

Please rate the following criteria that you consider them for measuring success in a health-care project.	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1. Project is completed on time	❑	❑	❑	❑	❑	❑	❑
2. Project is completed on budget	❑	❑	❑	❑	❑	❑	❑
3. Project is completed on required quality standard	❑	❑	❑	❑	❑	❑	❑
4. Project is basically achieved its purpose/function	❑	❑	❑	❑	❑	❑	❑
5. Project is completed with a low accident rate	❑	❑	❑	❑	❑	❑	❑
6. Project is completed with environmental friendliness	❑	❑	❑	❑	❑	❑	❑
7. Performance of project is satisfied by client	❑	❑	❑	❑	❑	❑	❑
8. Performance of project is satisfied by various participants	❑	❑	❑	❑	❑	❑	❑
9. Performance of project is satisfied by various end-users	❑	❑	❑	❑	❑	❑	❑
10. Project is achieved with expectations of various end-users	❑	❑	❑	❑	❑	❑	❑
11. Project is profitable	❑	❑	❑	❑	❑	❑	❑
12. Project can create further/long-term gains	❑	❑	❑	❑	❑	❑	❑

End

Thank you for your contribution

Return Slip (Optional)

Those who wish to receive a summary of the research findings, please enter the details below:

Name:
Organization:
Address:
Telephone Number:
Fax Number:
Email:

APPENDIX B

CALCULATION OF PSI
&
RESULTS OF PRINCIPAL COMPONENTS ANALYSIS

No.	Time	Weighting (W)	Cost	W	Client's satisfaction	W	Quality	W	Safety	W	Participants' satisfaction	W	Functionality	W	Environmental Friendliness	Total
Case 1	7	0.373	4	0.344	5	0.379	5.5	0.39	5	0.313	5	0.357	5	0.357	5	14.702
Case 2	4	0.373	4	0.344	5	0.379	6.5	0.39	6	0.313	6	0.357	6	0.357	6	15.308
Case 3	4	0.373	4	0.344	6	0.379	6	0.39	4	0.313	6	0.357	6	0.357	4	14.250
Case 4	1	0.373	2	0.344	5	0.379	4	0.39	4	0.313	3	0.357	4	0.357	4	9.499
Case 5	4	0.373	4	0.344	5	0.379	4.5	0.39	6	0.313	6	0.357	5	0.357	4	13.555
Case 6	4	0.373	5	0.344	6	0.379	6	0.39	6	0.313	7	0.357	6	0.357	6	16.193
Case 7	4	0.373	4	0.344	5	0.379	4.5	0.39	4	0.313	5	0.357	5	0.357	4	12.572
Case 8	4	0.373	4	0.344	5	0.379	6	0.39	6	0.313	6	0.357	6	0.357	6	15.113
Case 9	4	0.373	7	0.344	6	0.379	6	0.39	7	0.313	7	0.357	6	0.357	6	17.194
Case 10	3	0.373	4	0.344	5	0.379	5	0.39	5	0.313	5	0.357	5	0.357	5	13.015
Case 11	5	0.373	4	0.344	5	0.379	5.5	0.39	6	0.313	5	0.357	6	0.357	6	14.934
Case 12	4	0.373	4	0.344	6	0.379	6	0.39	6	0.313	7	0.357	6	0.357	4	15.233
Case 13	4	0.373	4	0.344	3	0.379	5	0.39	4	0.313	5	0.357	5	0.357	4	12.009
Case 14	4	0.373	4	0.344	6	0.379	6	0.39	6	0.313	7	0.357	7	0.357	5	15.898
Case 15	4	0.373	3	0.344	4	0.379	3	0.39	4	0.313	3	0.357	4	0.357	4	10.193
Case 16	7	0.373	3	0.344	4	0.379	4.5	0.39	5	0.313	6	0.357	5	0.357	5	13.946
Case 17	5	0.373	3	0.344	3	0.379	3	0.39	4	0.313	3	0.357	3	0.357	4	9.830
Case 18	4	0.373	4	0.344	5	0.379	4.5	0.39	4	0.313	5	0.357	4	0.357	4	12.215
Case 19	4	0.373	3	0.344	6	0.379	6.5	0.39	6	0.313	6	0.357	6	0.357	6	15.343

No.	Time	Weighting (W)	Cost	W	Client's satisfaction	W	Quality	W	Safety	W	Participants' satisfaction	W	Functionality	W	Environmental Friendliness	Total
Case 20	4	0.373	4	0.344	5	0.379	5.5	0.39	6	0.313	6	0.357	6	0.357	6	14.918
Case 21	4	0.373	4	0.344	6	0.379	6	0.39	6	0.313	6	0.357	6	0.357	6	15.492
Case 22	1	0.373	1	0.344	3	0.379	3	0.39	6	0.313	3	0.357	4	0.357	2	8.017
Case 23	1	0.373	2	0.344	3	0.379	3	0.39	4	0.313	2	0.357	4	0.357	2	7.378
Case 24	4	0.373	4	0.344	6	0.379	6.5	0.39	6	0.313	7	0.357	7	0.357	7	16.709
Case 25	4	0.373	4	0.344	5	0.379	5.5	0.39	6	0.313	6	0.357	7	0.357	7	15.583
Case 26	4	0.373	5	0.344	4	0.379	4	0.39	6	0.313	5	0.357	5	0.357	4	12.968
Case 27	4	0.373	3	0.344	5	0.379	5.5	0.39	7	0.313	6	0.357	6	0.357	5	14.579
Case 28	4	0.373	4	0.344	5	0.379	6	0.39	6	0.313	6	0.357	6	0.357	6	15.113
Case 29	3	0.373	5	0.344	5	0.379	5	0.39	6	0.313	6	0.357	6	0.357	6	14.694
Case 30	4	0.373	4	0.344	5	0.379	6	0.39	6	0.313	6	0.357	6	0.357	6	15.113
Case 31	1	0.373	1	0.344	4	0.379	4	0.39	4	0.313	4	0.357	5	0.357	4	9.490
Case 32	4	0.373	4	0.344	6	0.379	6	0.39	6	0.313	7	0.357	7	0.357	6	16.206
Case 33	1	0.373	4	0.344	5	0.379	4	0.39	5	0.313	5	0.357	5	0.357	5	11.879
Case 34	4	0.373	4	0.344	5	0.379	4	0.39	4	0.313	4	0.357	4	0.357	4	11.663
Case 35	1	0.373	1	0.344	4	0.379	4	0.39	4	0.313	4	0.357	4	0.357	4	9.133
Case 36	4	0.373	4	0.344	5	0.379	5	0.39	5	0.313	5	0.357	5	0.357	5	13.388
Case 37	4	0.373	4	0.344	5	0.379	6	0.39	6	0.313	6	0.357	6	0.357	4	14.497
Case 38	4	0.373	3	0.344	4	0.379	5	0.39	6	0.313	4	0.357	6	0.357	6	13.286

No.	Time	Weighting (W)	Cost	W	Client's satisfaction	W	Quality	W	Safety	W	Participants' satisfaction	W	Functionality	W	Environmental Friendliness	Total
Case 39	4	0.373	4	0.344	6	0.379	6	0.39	6	0.313	6	0.357	5	0.357	4	14.519
Case 40	6	0.373	4	0.344	6	0.379	5.5	0.39	5	0.313	6	0.357	5	0.357	5	15.065
Case 41	4	0.373	5	0.344	6	0.379	6	0.39	7	0.313	6	0.357	6	0.357	6	16.149
Case 42	3	0.373	4	0.344	4	0.379	4	0.39	4	0.313	4	0.357	4	0.357	4	10.911
Case 43	6	0.373	3	0.344	4	0.379	4	0.39	4	0.313	4	0.357	4	0.357	4	11.686
Case 44	4	0.373	4	0.344	4	0.379	6	0.39	6	0.313	5	0.357	6	0.357	6	14.377
Case 45	4	0.373	4	0.344	3	0.379	4.5	0.39	5	0.313	5	0.357	5	0.357	5	12.435
Case 46	6	0.373	5	0.344	4	0.379	4	0.39	5	0.313	5	0.357	4	0.357	5	13.352
Case 47	4	0.373	5	0.344	5	0.379	6	0.39	5	0.313	6	0.357	6	0.357	4	14.528
Case 48	3	0.373	3	0.344	5	0.379	6	0.39	6	0.313	6	0.357	6	0.357	6	14.396
Case 49	4	0.373	4	0.344	5	0.379	6	0.39	6	0.313	6	0.357	6	0.357	6	15.113
Case 50	4	0.373	5	0.344	5	0.379	6	0.39	6	0.313	6	0.357	6	0.357	6	15.457
Case 51	4	0.373	3	0.344	5	0.379	5	0.39	7	0.313	6	0.357	4	0.357	4	13.362
Case 52	4	0.373	4	0.344	6	0.379	6	0.39	7	0.313	7	0.357	6	0.357	6	16.162

Results of principal components analysis on standardized data

The SAS System

The PRINCOMP Procedure

Observations	52
Variables	8

Simple Statistics

	Time(A)	Cost(B)	Quality(C)	Function(D)
Mean	5.250000000	5.423076923	5.519230769	5.500000000
StD	1.341275366	0.996978845	0.999811445	1.163159996

	Safety(E)	Environ(F)	Client(G)	Participants(H)
Mean	5.442307692	5.153846154	5.538461538	5.250000000
StD	0.958214466	0.825681308	1.128273685	1.100356448

Correlation Matrix

	A	B	C	D	E	F	G	H
A	1.0000	0.6965	0.8517	0.6724	0.5683	0.5843	0.7774	0.6610
B	0.6965	1.0000	0.7195	0.6763	0.5392	0.5387	0.6302	0.5988
C	0.8517	0.7195	1.0000	0.7503	0.6357	0.6139	0.7728	0.7352
D	0.6724	0.6763	0.7503	1.0000	0.4838	0.5104	0.7321	0.7430
E	0.5683	0.5392	0.6357	0.4838	1.0000	0.6062	0.6097	0.5440
F	0.5843	0.5387	0.6139	0.5104	0.6062	1.0000	0.5829	0.4748
G	0.7774	0.6302	0.7728	0.7321	0.6097	0.5829	1.0000	0.8055
H	0.6610	0.5988	0.7352	0.7430	0.5440	0.4748	0.8055	1.0000

Eigenvalues of the Correlation Matrix

	Eigenvalue	Difference	Proportion	Cumulative
1	5.55913795	4.86211119	0.6949	0.6949
2	0.69702677	0.23109993	0.0871	0.7820
3	0.46592684	0.07549199	0.0582	0.8403
4	0.39043484	0.03916905	0.0488	0.8891
5	0.35126579	0.11205287	0.0439	0.9330
6	0.23921292	0.05733497	0.0299	0.9629
7	0.18187795	0.06676102	0.0227	0.9856
8	0.11511694		0.0144	1.0000

Eigenvectors

	Prin1	Prin2	Prin3	Prin4	Prin5	Prin6	Prin7
A	0.372756	-.063967	-.231314	-.049484	-.668421	-.071945	-.084519
B	0.343990	-.052648	-.634978	-.402063	0.361138	0.422895	-.045629
C	0.389515	-.058696	-.111258	-.075435	-.309372	-.324422	0.479173
D	0.356781	-.359138	-.052297	0.196306	0.466330	-.633557	-.248111
E	0.313458	0.568629	0.425877	-.566417	0.139414	-.197781	-.079480
F	0.308037	0.629739	-.171361	0.663452	0.131622	0.104061	0.096954
G	0.378722	-.149219	0.315529	0.148858	-.192163	0.335561	-.640288
H	0.356563	-.344289	0.466786	0.092271	0.189555	0.383136	0.523376

	Prin8
A	0.584723
B	-.052000
C	-.629442
D	0.148455
E	0.106467
F	0.038157
G	-.391268
H	0.266979

Pearson Correlation Coefficients, N = 52
Prob > |r| under H0: Rho=0

	A	B	C	D	E
Prin1	0.87888	0.81105	0.91839	0.84121	0.73907
Prin2	-0.05340	-0.04395	-0.04900	-0.29984	0.47474

	F	G	H
Prin1	0.72628	0.89294	0.84070
Prin2	0.52576	-0.12458	-0.28744

APPENDIX C

MATRIX – SELECTION OF 45 VARIABLES FROM 73 VARIABLES FOR FACTOR ANALYSIS

1	Nature of project	
2	Complexity: Inherent site condition	
3	Complexity: Level of design buildability	
4	Complexity: Level of design coordination	
5	Complexity: Level of quality management procedures	
6	Complexity: Access or within site	
7	Complexity: Overall characteristics of this particular project	
8	Procurement method	
9	Tendering method	
10	Management skills	
11	Physical environment	
12	Prevailing economic environment	
13	Social-political environment	
14	Industrial relations environment	
15	Level of technology advanced	1. Nature of project
16	Overall environment	2. Level of complexity in design coordination
17	Type of client	3. Level of complexity of quality management procedures
18	Size of client's organization	4. Procurement method adopted
19	Client emphasis on low construction cost	5. Management skill, such as partnering/VM
20	Client emphasis on quick construction time	6. Physical environment
21	Client emphasis on high quality of construction	7. Prevailing economic environment
22	Client's ability to effectively brief the design team	8. Social-political environment
23	Client's ability to quickly make authoritative decisions	9. Level of technology
24	Client's ability to effectively define the roles of the participating organizations	10. Overall environment
25	Client's ability to contribute ideas to the design process	11. Client emphasis on low construction cost on project objectives
26	Client's ability to contribute ideas to the construction process	12. Client emphasis on quick construction time on project objectives
27	Client's representatives' technical skills	13. Client emphasis on high quality of construction on project objectives
28	Client's representatives' planning skills	14. Client's ability to effectively brief the design team
29	Client's representatives' organizational skills	15. Client's ability to quickly make authoritative decisions
30	Client's representatives' coordinating skills	16. Client's ability to effectively define the roles of the participating organizations
31	Client's representatives' motivating skills	17. Client's ability to contribute ideas to the design process
32	Client's representatives' controlling skills	18. Client's ability to contribute ideas to the construction process
33	Client's representatives' experience and capabilities	19. Client's representatives' technical skills
34	Client's representatives' early and continued involvement in the project	20. Client's representatives' management skills
35	Client's representatives' commitment to time, cost and quality	21. Client's representatives' experience and capabilities
36	Client's representatives' adaptability to changes in the project plan	22. Client's representatives' early and continued involvement in the project
37	Client's representatives' support by parent company	23. Client's representatives' adaptability to changes in the project plan
38	Client's representatives' provision of resources from parent company	24. Client's representatives' support by parent company

39	Design team leaders' technical skills
40	Design team leaders' planning skills
41	Design team leaders' organizational skills
42	Design team leaders' coordinating skills
43	Design team leaders' motivating skills
44	Design team leaders' controlling skills
45	Design team leaders' experience and capabilities
46	Design team leaders' early and continued involvement in the project
47	Design team leaders' commitment to time, cost and quality
48	Design team leaders' adaptability to changes in the project plan
49	Design team leaders' support by parent company
50	Design team leaders' provision of resources from parent company
51	Construction team leaders' technical skills
52	Construction team leaders' planning skills
53	Construction team leaders' organizational skills
54	Construction team leaders' coordinating skills
55	Construction team leaders' motivating skills
56	Construction team leaders' controlling skills
57	Construction team leaders' experience and capabilities
58	Construction team leaders' commitment to time, cost and quality
59	Construction team leaders' early and continued involvement in the project
60	Construction team leaders' adaptability to changes in the project plan
61	Construction team leaders' support by parent company
62	Construction team leaders' provision of resources from parent company
63	Communication system for the project
64	Control mechanism, such as for monitoring and updating plans
65	Feedback capabilities
66	Up-front planning efforts
67	Developing an appropriate organizational structure
68	Implementing an effective quality assurance programme
69	Implementing an effective safety programme
70	Control of sub-contractors' works
71	Developing a good reporting system
72	Developing standard procedures
73	Holding of regular meetings

25. Design team leaders' technical skills
26. Design team leaders' management skills
27. Design team leaders' experience and capabilities
28. Design team leaders' early and continued involvement in the project
29. Design team leaders' adaptability to changes in the project plan
30. Design team leaders' support by parent company
31. Construction team leaders' technical skills
32. Construction team leaders' management skills
33. Construction team leaders' experience and capabilities
34. Construction team leaders' early and continued involvement in the project
35. Construction team leaders' adaptability to changes in the project plan
36. Construction team leaders' support from parent company
37. Communication system for the project
38. Control mechanism, such as for monitoring and updating plans
39. Feedback capabilities
40. Up-front planning efforts
41. Developing an appropriate organizational structure
42. Implementing an effective quality assurance programme
43. Implementing an effective safety programme
44. Developing a good reporting system
45. Developing standard procedures

APPENDIX D

DATA MATRIX - BACKGROUND OF THE RESPONDENTS AND DETAILS OF THE CASES

Appendix D- data matrix for background

	ref	a1jobtit	a2prof	a3acad	a4expcon	a5org	a6size
1	1.00	Assistan	Builder	Master's D	10-14 year	Main Con	over 500 st
2	2.00		Buiding Sur	Master's D	15-19 year	client's or	100 staff or
3	3.00	Cyberpor	Builder	Master's D	15-19 year	Main Con	over 500 st
4	4.00	Quantity	Quantity S	Bachelor's	5-9 years	client's or	101-200 st
5	5.00	Site Age	Builder	Diploma/C	15-19 year	Main Con	401-500 st
6	6.00	Project	Engineer	Bachelor's	20 years or	Main Con	over 500 st
7	7.00	Architec	Architect	Master's D	5-9 years	Architect	101-200 st
8	8.00	Contract	Builder	Diploma/C	20 years or	Main Con	301-400 st
9	9.00	Senior C	Engineer	Bachelor's	20 years or	Main Con	over 500 st
10	10.00		Engineer	Master's D	15-19 year	Governm	over 500 st
11	11.00		Engineer	Bachelor's	5-9 years	Engineeri	over 500 st
12	12.00	Instruct	Engineer	Master's D	20 years or	Main Con	over 500 st
13	13.00	Senior Q	Quantity S	Profession	20 years or	Governm	over 500 st
14	14.00	Architec	Architect	Master's D	15-19 year	client's or	over 500 st
15	15.00	Manager-	Builder	Bachelor's	15-19 year	Main Con	100 staff or
16	16.00	General	Builder	Master's D	10-14 year	Sub-contr	100 staff or
17	17.00	Asst Pro	Architect	Master's D	10-14 year	Project M	100 staff or
18	18.00		Quantity S	Master's D	15-19 year	Main Con	over 500 st
19	19.00	North Di	Builder	Diploma/C	20 years or	Main Con	over 500 st
20	20.00	Project	Engineer	Master's D	20 years or	Project M	over 500 st
21	21.00	Site Age	Builder	Master's D	10-14 year	Main Con	100 staff or
22	22.00	St.Teres	Builder	Bachelor's	less than 5	Main Con	100 staff or
23	23.00	St.Teres	Quantity S	Bachelor's	5-9 years	Quantity	100 staff or
24	24.00	Senior M	Builder	Diploma/C	20 years or	Main Con	over 500 st
25	25.00	Senior M	Engineer	Bachelor's	20 years or	Main Con	over 500 st
26	26.00	Quantity	Quantity S	Bachelor's	5-9 years	Quantity	100 staff or
27	27.00	Site Age	Engineer	Master's D	10-14 year	Main Con	over 500 st
28	28.00	Senior C	Builder	Profession	20 years or	Main Con	over 500 st
29	29.00	Construc	Engineer	Diploma/C	20 years or	Main Con	over 500 st
30	30.00	Contract	Builder	Diploma/C	20 years or	Main Con	301-400 st
31	31.00	Resident	Quantity S	Master's D	20 years or	Engineeri	100 staff or
32	32.00	architec	Architect	Master's D	15-19 year	client's or	over 500 st
33	33.00	Asst Pro	Engineer	Bachelor's	15-19 year	Main Con	100 staff or
34	34.00	Senior Q	Quantity S	Master's D	5-9 years	Quantity	201-300 st
35	35.00	Product	Others	Bachelor's	10-14 year	Sub-contr	101-200 st
36	36.00	Associat	Engineer	Profession	10-14 year	Engineeri	over 500 st
37	37.00	Executiv	Engineer	Master's D	20 years or	Engineeri	over 500 st
38	38.00	Tung Wah	Quantity S	Bachelor's	less than 5	Quantity	100 staff or
39	39.00	Project	Architect	Bachelor's	10-14 year	Governm	over 500 st
40	40.00	site man	Engineer	Diploma/C	20 years or	Main Con	over 500 st
41	41.00	senior Q	Quantity S	Diploma/C	20 years or	Quantity	201-300 st
42	42.00	Term Mai	Buiding Sur	Bachelor's	less than 5	BS consu	100 staff or
43	43.00	HA Term	Buiding Sur	Bachelor's	5-9 years	BS consu	100 staff or

Appendix D- data matrix for background

	a7exphc	b1pronam	b2posit	b3class	b4nature	b5maxflb
1	1	Kowloon	Others	General Ho	Extension	1.00
2	3		Project Ma	General Ho	Redevelop	.00
3	3	Tse On E	Builder	Others	Redevelop	2.00
4	3	Tai Po H	Quantity S	General Ho	New work	.
5	3	Relocati	Builder	General Ho	Refurbishm	3.00
6	2	Extensio	Project Ma	General Ho	Extension	1.00
7	1	Cancer P	Architect	Others	Extension	.00
8	3	Tuen Mun	Project Ma	Clinic	New work	.00
9	3	Public H	Project Ma	Health cent	New work	.00
10	3		Engineer	Rehabilitati	Redevelop	1.00
11	2		Engineer	General Ho	Refurbishm	5.00
12	2	TKO	Builder	General Ho	New work	.00
13	3		Quantity S	General Ho	New work	.00
14	3	TKO	Architect	General Ho	New work	.00
15	1	Ha Kwai	Project Ma	Clinic	New work	.00
16	1	Pamela Y	Builder	General Ho	New work	.00
17	1	Developm	Architect	Clinic	New work	.00
18	1		Builder	General Ho	New work	5.00
19	1	ND	Project Ma	General Ho	New work	1.00
20	2	ND	Project Ma	General Ho	New work	1.00
21	2	ND	Others	General Ho	New work	1.00
22	1	St. Tere	Others	General Ho	New work	3.00
23	1	St. Tere	Quantity S	General Ho	New work	3.00
24	3	TKO	Builder	General Ho	New work	.00
25	2	TKO	Engineer	General Ho	New work	.00
26	1	Fitting	Quantity S	Others	Refurbishm	1.00
27	1	Tuen Mun	Engineer	Clinic	New work	.00
28	2	Sai Ying	Project Ma	Clinic	New work	6.00
29	3	Public H	Project Ma	Health cent	New work	.00
30	2	Haven of	Builder	Teaching H	Redevelop	1.00
31	3	St. Tere	Engineer	General Ho	Extension	3.00
32	3	ND	Architect	General Ho	New work	1.00
33	1	St. Tere	Builder	General Ho	New work	3.00
34	1	Care & A	Quantity S	Health cent	New work	.00
35	3	QEH	Project Ma	General Ho	Redevelop	.00
36	1	ND	Engineer	General Ho	New work	1.00
37	2	United C	Engineer	General Ho	New work	4.00
38	1	Expansio	Quantity S	Rehabilitati	Refurbishm	.00
39	3	Redevelo	Architect	Others	New work	.00
40	2	United C	Builder	General Ho	New work	5.00
41	3	TKO	Quantity S	General Ho	New work	.00
42	1	Renovati	Others	General Ho	Redevelop	.
43	2	Renovati	Others	General Ho	Refurbishm	.

Appendix D- data matrix for background

	b6maxfla	b7orgcs	b8fincs	b9pfluc	b10comme	b11compl
1	11.00	$573.00	$560.00	-$5.00	23-10-99	16-2-02
2	2.00	$126.00	$119.20	.	13-10-97	18-2-99
3	4.00	$200.00	$205.00	$5.00	1-3-97	31-8-98
4	.	$645.00	.	.	10-94	6-97
5	10.00	$10.13	$10.13	$.00	4-5-01	26-1-03
6	6.00	$407.00	$401.00	$6.00	3-95	7-97
7	1.00	$6.80	$7.00	$.20	7-01	8-02
8	10.00	$366.00	$350.00	-$16.00	30-1-99	22-3-01
9	12.00	$650.00	$620.00	-$30.00	28-7-99	20-8-00
10	6.00	$470.00	.	.	10-9-01	7-3-05
11	20.00	$30.00	$30.00	$.00	11-00	11-01
12	10.00	$1100.00	$1100.00	$.00	12-4-96	16-4-99
13	11.00	$397.80	$398.20	$.00	31-5-95	2-2-97
14	10.00	$1100.00	$1100.00	$.00	12-4-96	16-4-99
15	5.00	$90.00	$100.00	$.00	3-94	9-96
16	17.00	$4.50	$4.80	$.30	5-90	10-92
17	7.00	$151.00	$160.00	$.00	2-98	4-99
18	17.00	$776.00	$670.00	-$106.00	1-92	12-94
19	5.00	$960.00	$994.00	$34.00	8-9-94	31-5-97
20	5.00	$960.00	$994.00	$34.00	8-9-94	31-5-97
21	5.00	$960.00	$994.00	$34.00	8-9-94	31-5-97
22	10.00	$556.00	$637.00	$81.00	6-1-99	28-2-02
23	10.00	$556.00	$637.00	$81.00	6-1-99	28-2-02
24	10.00	$1100.00	$1100.00	$.00	12-4-96	16-4-99
25	10.00	$1100.00	$1100.00	$.00	12-4-96	16-4-99
26	1.00	$197.00	$189.00	-$8.00	27-3-96	27-3-99
27	10.00	$366.00	$350.00	-$16.00	30-1-99	22-3-01
28	9.00	$292.00	$291.00	$.00	5-8-97	15-9-99
29	12.00	$650.00	$620.00	-$30.00	28-7-99	20-8-00
30	6.00	$407.00	$401.00	$6.00	3-95	7-97
31	10.00	$556.00	$637.00	$81.00	6-1-99	28-2-02
32	5.00	$960.00	$994.00	$34.00	8-9-94	31-5-97
33	10.00	$556.00	$637.00	$81.00	6-1-99	28-2-02
34	6.00	$88.00	$87.00	$.00	25-11-97	26-2-99
35	8.00	$12.00	$12.60	$.60	5-96	8-97
36	6.00	$600.00	$600.00	$.00	95	97
37	10.00	$700.00	$705.00	$5.00	1-7-92	1-2-95
38	5.00	$18.20	$22.00	$.00	9-00	9-01
39	8.00	$396.88	$375.00	$21.88	2-97	11-98
40	12.00	$800.00	$850.00	$50.00	1993	1996
41	10.00	$1100.00	$1100.00	$.00	12-4-96	16-4-99
42	.	.	.	.		
43	.	.	.	.		

APPENDIX E

CORRELATION MATRIX FOR FACTOR ANALYSIS

Correlation Matrix

		Nature of project	Complexity: Level of design coordination	Complexity: Level of quality management procedures	Physical environment	Prevailing economic environment	Social-political environment	Level of technology advanced	Overall environment
Correlation	Nature of project	1	0.39345	0.28354	0.03724	-0.08928	-0.02183	0.30919	0.13010
	Complexity: Level of design coordination	0.39345	1	0.66646	0.34035	0.31116	0.23102	0.50534	0.32458
	Complexity: Level of quality management procedures	0.28354	0.66646	1	0.35440	0.35332	0.45543	0.58474	0.35473
	Physical environment	0.03724	0.34035	0.35440	1	0.45169	0.51507	0.37385	0.65660
	Prevailing economic environment	-0.08928	0.31116	0.35332	0.45169	1	0.60645	0.45015	0.50792
	Social-political environment	-0.02183	0.23102	0.45543	0.51507	0.60645	1	0.52325	0.72505
	Level of technology advanced	0.30919	0.50534	0.58474	0.37385	0.45015	0.52325	1	0.61699
	Overall environment	0.13010	0.32458	0.35473	0.65660	0.50792	0.72505	0.61699	1
	Client's emphasis on low construction cost on project objectives	-0.01990	0.02128	0.06577	-0.06855	-0.11830	-0.03924	0.15062	0.00629
	Client's emphasis on quick construction time on project objectives	-0.06915	-0.13054	-0.24325	-0.36950	-0.36498	-0.25119	-0.21106	-0.39660
	Client's emphasis on high quality of construction on project objectives	-0.19298	-0.34339	-0.52812	-0.09782	-0.21077	-0.36067	-0.36426	-0.27249
	Client's Ability to effectively brief the design team	-0.03610	-0.03301	-0.22541	0.08511	-0.00344	-0.23109	-0.20553	-0.19785
	Client's Ability to quickly make authoritative decisions	-0.02294	0.03543	-0.09896	0.02401	-0.00518	-0.15639	-0.14097	-0.20126
	Client's Ability to effectively define the roles of the participating organizations	-0.16765	-0.06671	-0.19195	0.01073	-0.06595	-0.16407	-0.29230	-0.16677
	Client's Ability to contribute ideas to the design process	-0.10736	-0.04326	-0.12633	0.00000	0.03115	-0.11196	-0.28279	-0.12590
	Client's Ability to contribute ideas to the construction process	0.01146	0.14645	0.05439	0.13836	0.03208	-0.00125	-0.14042	-0.01132
	Client's representative's Technical skills	-0.17385	0.01801	-0.11938	0.06509	0.03483	-0.05923	-0.09066	-0.13293
	Client's representative's Experience and capabilities	-0.16581	-0.13133	-0.28676	-0.20219	-0.14361	-0.16557	-0.35428	-0.25918
	Client's representative's Early and continued involvement in the project	-0.14997	-0.21364	-0.31353	-0.23336	-0.27879	-0.21544	-0.43547	-0.31918

		Nature of project	Complexity: Level of design coordination	Complexity: Level of quality management procedures	Physical environment	Prevailing economic environment	Social-political environment	Level of technology advanced	Overall environment
Correlation	Client's representative's Adaptability to changes in the project plan	0.06492	-0.17396	-0.20660	-0.11160	-0.18530	-0.17517	-0.27849	-0.17254
	Client's representative's Support by parent company	-0.03329	-0.12745	-0.14083	0.05887	-0.08566	0.07104	-0.03174	0.20975
	design team leader Technical skills	0.17963	0.14249	-0.08068	-0.07112	0.11946	-0.04539	0.06868	-0.11439
	design team leader Experience and capabilities	0.10938	0.09603	-0.00819	-0.01199	0.13456	0.03031	0.09371	-0.00486
	design team leader Early and continued involvement in the project	0.21621	0.15371	-0.02613	-0.02731	0.08704	-0.12239	-0.07361	-0.07119
	design team leader Adaptability to changes in the project plan	0.22380	0.30023	0.18352	-0.00994	0.16525	0.09441	0.27500	0.07829
	design team leader Support by parent company	0.01682	0.03643	0.09575	0.02054	0.31400	0.25500	0.37764	0.23600
	construction team leader Technical skills	0.18175	-0.13529	-0.17155	-0.03938	0.09679	0.09958	0.07785	0.06115
	construction team leader Experience and capabilities	0.15652	-0.06560	-0.22810	-0.07800	-0.01441	-0.15748	-0.02804	-0.15169
	construction team leader Early and continued involvement in the project	-0.14747	-0.35117	-0.18517	0.06519	0.03461	0.08610	-0.00238	0.08718
	construction team leader Adaptability to changes in the project plan	0.03661	-0.21110	-0.19125	-0.11471	-0.07409	0.03602	-0.05080	0.06302
	construction team leader Support by parent company	0.13636	-0.27077	-0.28531	-0.11891	-0.08354	-0.15269	-0.26308	-0.22735
	Communication system for the project	0.09587	-0.19077	-0.40551	-0.15420	-0.17968	-0.31538	-0.32009	-0.15971
	Control mechanism, such as monitoring and updating plans	-0.00794	-0.22453	-0.43754	-0.12573	-0.34633	-0.26750	-0.22280	-0.16330
	Feedback capabilities	0.07316	-0.26491	-0.46475	-0.25673	-0.39123	-0.24861	-0.17906	-0.16254
	Up-front planning efforts	0.03931	-0.17714	-0.39295	-0.15176	-0.31730	-0.31622	-0.25494	-0.15099
	Developing an appropriate organizational structure	-0.07449	-0.31838	-0.42238	-0.13420	-0.24693	-0.25040	-0.33804	-0.18267
	Implementing an effective quality assurance program	-0.11603	-0.33122	-0.46782	-0.00332	-0.23163	-0.14026	-0.31109	-0.11374
	Implementing an effective safety program	-0.15010	-0.47883	-0.54419	-0.23498	-0.27585	-0.28596	-0.44714	-0.21142
	Development of a good reporting system	-0.19612	-0.34455	-0.49869	-0.25041	-0.20047	-0.24806	-0.27412	-0.16570

		Nature of project	Complexity: Level of design coordination	Complexity: Level of quality management procedures	Physical environment	Prevailing economic environment	Social-political environment	Level of technology advanced	Overall environment
Correlation	Development of a standard procedures	-0.14241	-0.55880	-0.51632	-0.14164	-0.20938	-0.15194	-0.37333	-0.19694
	Procurement Method Adopted	-0.22564	-0.28942	-0.45990	-0.00775	-0.17834	-0.21205	-0.42537	-0.23863
	Management Skill, such as Partnering/VM	-0.28146	-0.41405	-0.50230	0.02083	-0.33004	-0.28536	-0.43254	-0.13000
	Client representative management skills	-0.06034	0.10322	-0.12228	0.00826	-0.07360	-0.03499	-0.10180	-0.06687
	Design team leader management skills	0.22425	0.21462	-0.02710	0.16521	0.06411	0.04557	0.24940	0.14932
	Construction team leader management skills	0.04457	-0.11622	-0.17838	-0.11992	0.04472	-0.06793	-0.02309	-0.06799

Correlation Matrix

		Client's emphasis on low construction cost on project objectives	Client's emphasis on quick construction time on project objectives	Client's emphasis on high quality of construction on project objectives	Client's Ability to effectively brief the design team	Client's Ability to quickly make authoritative decisions	Client's Ability to effectively define the roles of the participating organizations
Correlation	Nature of project	-0.01990	-0.06915	-0.19298	-0.03610	-0.02294	-0.16765
	Complexity: Level of design coordination	0.02128	-0.13054	-0.34339	-0.03301	0.03543	-0.06671
	Complexity: Level of quality management procedures	0.06577	-0.24325	-0.52812	-0.22541	-0.09896	-0.19195
	Physical environment	-0.06855	-0.36950	-0.09782	0.08511	0.02401	0.01073
	Prevailing economic environment	-0.11830	-0.36498	-0.21077	-0.00344	-0.00518	-0.06595
	Social-political environment	-0.03924	-0.25119	-0.36067	-0.23109	-0.15639	-0.16407
	Level of technology advanced	0.15062	-0.21106	-0.36426	-0.20553	-0.14097	-0.29230
	Overall environment	0.00629	-0.39660	-0.27249	-0.19785	-0.20126	-0.16677
	Client's emphasis on low construction cost on project objectives	1	0.45531	-0.09428	0.18055	0.16268	0.16917
	Client's emphasis on quick construction time on project objectives	0.45531	1	0.37356	0.19844	0.11627	0.14485
	Client's emphasis on high quality of construction on project objectives	-0.09428	0.37356	1	0.25008	-0.01212	0.14711
	Client's Ability to effectively brief the design team	0.18055	0.19844	0.25008	1	0.75755	0.82934
	Client's Ability to quickly make authoritative decisions	0.16268	0.11627	-0.01212	0.75755	1	0.82607
	Client's Ability to effectively define the roles of the participating organizations	0.16917	0.14485	0.14711	0.82934	0.82607	1
	Client's Ability to contribute ideas to the design process	0.03925	-0.03177	0.15437	0.76947	0.71523	0.81675
	Client's Ability to contribute ideas to the construction process	0.02842	-0.07361	-0.04127	0.65225	0.66135	0.70027
	Client's representative's Technical skills	0.10854	0.18166	0.12980	0.58000	0.56796	0.60924
	Client's representative's Experience and capabilities	0.10327	0.26357	0.16422	0.63704	0.57624	0.76656
	Client's representative's Early and continued involvement in the project	0.00599	0.27425	0.07608	0.58767	0.54178	0.70146

		Client's emphasis on low construction cost on project objectives	Client's emphasis on quick construction time on project objectives	Client's emphasis on high quality of construction on project objectives	Client's Ability to effectively brief the design team	Client's Ability to quickly make authoritative decisions	Client's Ability to effectively define the roles of the participating organizations
Correlation	Client's representative's Adaptability to changes in the project plan	0.10088	0.15626	0.07579	0.59485	0.63831	0.66285
	Client's representative's Support by parent company	0.10176	-0.06738	0.04198	0.34875	0.34031	0.39057
	design team leader Technical skills	-0.16281	-0.09504	-0.09353	0.33205	0.34457	0.26461
	design team leader Experience and capabilities	0.06028	-0.02134	0.00697	0.46483	0.40197	0.50938
	design team leader Early and continued involvement in the project	0.07724	-0.14585	-0.08222	0.50001	0.48094	0.45291
	design team leader Adaptability to changes in the project plan	0.08606	-0.10896	-0.20576	0.28637	0.39989	0.38823
	design team leader Support by parent company	-0.05534	-0.27073	-0.19534	0.11296	0.25243	0.19379
	construction team leader Technical skills	0.15513	0.09483	0.10402	0.32126	0.26951	0.33096
	construction team leader Experience and capabilities	0.11512	0.14147	0.07094	0.65659	0.49889	0.53575
	construction team leader Early and continued involvement in the project	-0.01181	-0.07026	0.07669	0.32514	0.40234	0.51314
	construction team leader Adaptability to changes in the project plan	0.15001	0.10056	0.03149	0.35788	0.44069	0.52906
	construction team leader Support by parent company	0.01160	0.12724	0.04094	0.51147	0.49315	0.48484
	Communication system for the project	0.05539	0.14514	0.06583	0.53873	0.45112	0.54881
	Control mechanism, such as monitoring and updating plans	0.09067	0.28857	0.11924	0.51904	0.50173	0.53303
	Feedback capabilities	0.02335	0.22564	0.16343	0.31161	0.33998	0.34481
	Up-front planning efforts	0.10714	0.20978	0.16068	0.54440	0.54731	0.62224
	Developing an appropriate organizational structure	0.04820	0.18243	0.12367	0.49171	0.55614	0.62848
	Implementing an effective quality assurance program	-0.12785	0.15857	0.27747	0.50007	0.49783	0.55632
	Implementing an effective safety program	-0.31279	0.05625	0.35048	0.36924	0.34652	0.45854
	Development of a good reporting system	0.14782	0.21403	0.30175	0.39049	0.40189	0.48913

		Client's emphasis on low construction cost on project objectives	Client's emphasis on quick construction time on project objectives	Client's emphasis on high quality of construction on project objectives	Client's Ability to effectively brief the design team	Client's Ability to quickly make authoritative decisions	Client's Ability to effectively define the roles of the participating organizations
Correlation	Development of a standard procedures	-0.11871	0.16012	0.31923	0.35260	0.27209	0.37291
	Procurement Method Adopted	0.03194	0.30803	0.36117	0.45980	0.25632	0.34532
	Management Skill, such as Partnering/VM	0.10985	0.25565	0.46235	0.34371	0.14579	0.38878
	Client representative management skills	0.19954	0.28396	0.07219	0.63811	0.64855	0.67893
	Design team leader management skills	0.02077	-0.11766	-0.11520	0.42710	0.44987	0.40713
	Construction team leader management skills	0.17141	0.07916	0.07557	0.54807	0.50384	0.52232

Correlation Matrix

		Client's Ability to contribute ideas to the design process	Client's Ability to contribute ideas to the construction process	Client's representative's Technical skills	Client's representative's Experience and capabilities	Client's representative's Early and continued involvement in the project	Client's representative's Adaptability to changes in the project plan
Correlation	Nature of project	-0.10736	0.01146	-0.17385	-0.16581	-0.14997	0.06492
	Complexity: Level of design coordination	-0.04326	0.14645	0.01801	-0.13133	-0.21364	-0.17396
	Complexity: Level of quality management procedures	-0.12633	0.05439	-0.11938	-0.28676	-0.31353	-0.20660
	Physical environment	0.00000	0.13836	0.06509	-0.20219	-0.23336	-0.11160
	Prevailing economic environment	0.03115	0.03208	0.03483	-0.14361	-0.27879	-0.18530
	Social-political environment	-0.11196	-0.00125	-0.05923	-0.16557	-0.21544	-0.17517
	Level of technology advanced	-0.28279	-0.14042	-0.09066	-0.35428	-0.43547	-0.27849
	Overall environment	-0.12590	-0.01132	-0.13293	-0.25918	-0.31918	-0.17254
	Client's emphasis on low construction cost on project objectives	0.03925	0.02842	0.10854	0.10327	0.00599	0.10088
	Client's emphasis on quick construction time on project objectives	-0.03177	-0.07361	0.18166	0.26357	0.27425	0.15626
	Client's emphasis on high quality of construction on project objectives	0.15437	-0.04127	0.12980	0.16422	0.07608	0.07579
	Client's Ability to effectively brief the design team	0.76947	0.65225	0.58000	0.63704	0.58767	0.59485
	Client's Ability to quickly make authoritative decisions	0.71523	0.66135	0.56796	0.57624	0.54178	0.63831
	Client's Ability to effectively define the roles of the participating organizations	0.81675	0.70027	0.60924	0.76656	0.70146	0.66285
	Client's Ability to contribute ideas to the design process	1	0.84529	0.48562	0.66376	0.54343	0.55801
	Client's Ability to contribute ideas to the construction process	0.84529	1	0.60475	0.61094	0.44793	0.48487
	Client's representative's Technical skills	0.48562	0.60475	1	0.69682	0.58004	0.56575
	Client's representative's Experience and capabilities	0.66376	0.61094	0.69682	1	0.85407	0.71477
	Client's representative's Early and continued involvement in the project	0.54343	0.44793	0.58004	0.85407	1	0.74685

		Client's Ability to contribute ideas to the design process	Client's Ability to contribute ideas to the construction process	Client's representative's Technical skills	Client's representative's Experience and capabilities	Client's representative's Early and continued involvement in the project	Client's representative's Adaptability to changes in the project plan
Correlation	Client's representative's Adaptability to changes in the project plan	0.55801	0.48487	0.56575	0.71477	0.74685	1
	Client's representative's Support by parent company	0.47068	0.27166	0.07436	0.41369	0.36788	0.31548
	design team leader Technical skills	0.30282	0.31352	0.39038	0.41073	0.39311	0.42934
	design team leader Experience and capabilities	0.46686	0.46889	0.38404	0.61964	0.48831	0.31114
	design team leader Early and continued involvement in the project	0.57689	0.56405	0.24895	0.48698	0.42977	0.41961
	design team leader Adaptability to changes in the project plan	0.38867	0.39499	0.31046	0.44753	0.33834	0.47106
	design team leader Support by parent company	0.29095	0.18574	0.14227	0.16222	0.10506	0.22386
	construction team leader Technical skills	0.29481	0.25040	0.35818	0.47568	0.30870	0.27734
	construction team leader Experience and capabilities	0.41856	0.39649	0.54092	0.59016	0.55158	0.54249
	construction team leader Early and continued involvement in the project	0.46608	0.43607	0.42065	0.53268	0.41633	0.34272
	construction team leader Adaptability to changes in the project plan	0.41340	0.34391	0.35708	0.66362	0.59264	0.60814
	construction team leader Support by parent company	0.42932	0.49290	0.44095	0.58552	0.62449	0.60841
	Communication system for the project	0.37564	0.43982	0.53786	0.59914	0.58755	0.53154
	Control mechanism, such as monitoring and updating plans	0.38452	0.49091	0.56399	0.56867	0.60548	0.53919
	Feedback capabilities	0.27850	0.29865	0.32256	0.34890	0.41267	0.40066
	Up-front planning efforts	0.47056	0.41952	0.49646	0.63148	0.68926	0.63818
	Developing an appropriate organizational structure	0.45859	0.42327	0.49201	0.65796	0.63478	0.59240
	Implementing an effective quality assurance program	0.50990	0.45181	0.51190	0.55668	0.61403	0.45906
	Implementing an effective safety program	0.41303	0.26730	0.35225	0.48324	0.63986	0.44267
	Development of a good reporting system	0.42047	0.31732	0.42752	0.51134	0.42483	0.41594

		Client's Ability to contribute ideas to the design process	Client's Ability to contribute ideas to the construction process	Client's representative's Technical skills	Client's representative's Experience and capabilities	Client's representative's Early and continued involvement in the project	Client's representative's Adaptability to changes in the project plan
Correlation	Development of a standard procedures	0.35269	0.20750	0.27659	0.40149	0.40797	0.32517
	Procurement Method Adopted	0.24832	0.13098	0.22498	0.23540	0.38835	0.16217
	Management Skill, such as Partnering/VM	0.25007	0.18386	0.37020	0.32533	0.40491	0.31829
	Client representative management skills	0.51929	0.57364	0.73913	0.76463	0.70033	0.56415
	Design team leader management skills	0.36254	0.43567	0.38472	0.44489	0.36709	0.43523
	Construction team leader management skills	0.53292	0.38401	0.42937	0.54801	0.55514	0.46201

Correlation Matrix

		Client's representative's Support by parent company	design team leader Technical skills	design team leader Experience and capabilities	design team leader Early and continued involvement in the project	design team leader Adaptability to changes in the project plan	design team leader Support by parent company	construction team leader Technical skills
Correlation	Nature of project	-0.03329	0.17963	0.10938	0.21621	0.22380	0.01682	0.18175
	Complexity: Level of design coordination	-0.12745	0.14249	0.09603	0.15371	0.30023	0.03643	-0.13529
	Complexity: Level of quality management procedures	-0.14083	-0.08068	-0.00819	-0.02613	0.18352	0.09575	-0.17155
	Physical environment	0.05887	-0.07112	-0.01199	-0.02731	-0.00994	0.02054	-0.03938
	Prevailing economic environment	-0.08566	0.11946	0.13456	0.08704	0.16525	0.31400	0.09679
	Social-political environment	0.07104	-0.04539	0.03031	-0.12239	0.09441	0.25500	0.09958
	Level of technology advanced	-0.03174	0.06868	0.09371	-0.07361	0.27500	0.37764	0.07785
	Overall environment	0.20975	-0.11439	-0.00486	-0.07119	0.07829	0.23600	0.06115
	Client's emphasis on low construction cost on project objectives	0.10176	-0.16281	0.06028	0.07724	0.08606	-0.05534	0.15513
	Client's emphasis on quick construction time on project objectives	-0.06738	-0.09504	-0.02134	-0.14585	-0.10896	-0.27073	0.09483
	Client's emphasis on high quality of construction on project objectives	0.04198	-0.09353	0.00697	-0.08222	-0.20576	-0.19534	0.10402
	Client's Ability to effectively brief the design team	0.34875	0.33205	0.46483	0.50001	0.28637	0.11296	0.32126
	Client's Ability to quickly make authoritative decisions	0.34031	0.34457	0.40197	0.48094	0.39989	0.25243	0.26951
	Client's Ability to effectively define the roles of the participating organizations	0.39057	0.26461	0.50938	0.45291	0.38823	0.19379	0.33096
	Client's Ability to contribute ideas to the design process	0.47068	0.30282	0.46686	0.57689	0.38867	0.29095	0.29481
	Client's Ability to contribute ideas to the construction process	0.27166	0.31352	0.46889	0.56405	0.39499	0.18574	0.25040
	Client's representative's Technical skills	0.07436	0.39038	0.38404	0.24895	0.31046	0.14227	0.35818
	Client's representative's Experience and capabilities	0.41369	0.41073	0.61964	0.48698	0.44753	0.16222	0.47568
	Client's representative's Early and continued involvement in the project	0.36788	0.39311	0.48831	0.42977	0.33834	0.10506	0.30870

		Client's representative's Support by parent company	design team leader Technical skills	design team leader Experience and capabilities	design team leader Early and continued involvement in the project	design team leader Adaptability to changes in the project plan	design team leader Support by parent company	construction team leader Technical skills
Correlation	Client's representative's Adaptability to changes in the project plan	0.31548	0.42934	0.31114	0.41961	0.47106	0.22386	0.27734
	Client's representative's Support by parent company	1	0.15944	0.42155	0.50704	0.28429	0.34286	0.29107
	design team leader Technical skills	0.15944	1	0.51432	0.61279	0.58554	0.51277	0.37790
	design team leader Experience and capabilities	0.42155	0.51432	1	0.68271	0.60247	0.33911	0.59270
	design team leader Early and continued involvement in the project	0.50704	0.61279	0.68271	1	0.67398	0.46088	0.42681
	design team leader Adaptability to changes in the project plan	0.28429	0.58554	0.60247	0.67398	1	0.70759	0.51420
	design team leader Support by parent company	0.34286	0.51277	0.33911	0.46088	0.70759	1	0.42441
	construction team leader Technical skills	0.29107	0.37790	0.59270	0.42681	0.51420	0.42441	1
	construction team leader Experience and capabilities	0.29918	0.52257	0.58177	0.57760	0.56899	0.32357	0.65489
	construction team leader Early and continued involvement in the project	0.46231	0.12141	0.49725	0.31158	0.36401	0.43338	0.60270
	construction team leader Adaptability to changes in the project plan	0.47983	0.26684	0.56933	0.43154	0.58804	0.36473	0.73642
	construction team leader Support by parent company	0.19797	0.45905	0.43099	0.57817	0.41804	0.19593	0.57423
	Communication system for the project	0.24759	0.35825	0.48685	0.42458	0.32308	0.04090	0.52066
	Control mechanism, such as monitoring and updating plans	0.17428	0.30572	0.34826	0.27809	0.30228	0.06580	0.46513
	Feedback capabilities	0.17191	0.25813	0.18882	0.24647	0.30131	0.23685	0.45723
	Up-front planning efforts	0.38934	0.30125	0.38919	0.39038	0.41658	0.17410	0.49883
	Developing an appropriate organizational structure	0.33070	0.23039	0.43251	0.33672	0.37032	0.15441	0.56981
	Implementing an effective quality assurance program	0.36368	0.26460	0.40570	0.26404	0.26690	0.18604	0.52610
	Implementing an effective safety program	0.39546	0.28524	0.34895	0.26810	0.13350	0.14458	0.33511
	Development of a good reporting system	0.34093	0.13181	0.23882	0.24881	0.34648	0.22904	0.50523

		Client's representative's Support by parent company	design team leader Technical skills	design team leader Experience and capabilities	design team leader Early and continued involvement in the project	design team leader Adaptability to changes in the project plan	design team leader Support by parent company	construction team leader Technical skills
Correlation	Development of a standard procedures	0.39830	0.11367	0.16809	0.12852	0.08444	0.11972	0.36146
	Procurement Method Adopted	0.17558	-0.08043	-0.08990	0.00286	-0.31335	-0.34768	-0.09177
	Management Skill, such as Partnering/VM	0.23639	-0.08082	0.06374	0.05107	-0.08454	-0.12184	0.09301
	Client representative management skills	0.35029	0.27214	0.51620	0.40326	0.37233	0.05442	0.38925
	Design team leader management skills	0.37268	0.69891	0.64166	0.69991	0.70919	0.56555	0.44270
	Construction team leader management skills	0.45441	0.46328	0.53439	0.59207	0.53011	0.41881	0.66036

Correlation Matrix

		construction team leader Experience and capabilities	construction team leader Early and continued involvement in the project	construction team leader Adaptability to changes in the project plan	construction team leader Support by parent company	Communication system for the project	Control mechanism, such as monitoring and updating plans
Correlation	Nature of project	0.15652	-0.14747	0.03661	0.13636	0.09587	-0.00794
	Complexity: Level of design coordination	-0.06560	-0.35117	-0.21110	-0.27077	-0.19077	-0.22453
	Complexity: Level of quality management procedures	-0.22810	-0.18517	-0.19125	-0.28531	-0.40551	-0.43754
	Physical environment	-0.07800	0.06519	-0.11471	-0.11891	-0.15420	-0.12573
	Prevailing economic environment	-0.01441	0.03461	-0.07409	-0.08354	-0.17968	-0.34633
	Social-political environment	-0.15748	0.08610	0.03602	-0.15269	-0.31538	-0.26750
	Level of technology advanced	-0.02804	-0.00238	-0.05080	-0.26308	-0.32009	-0.22280
	Overall environment	-0.15169	0.08718	0.06302	-0.22735	-0.15971	-0.16330
	Client's emphasis on low construction cost on project objectives	0.11512	-0.01181	0.15001	0.01160	0.05539	0.09067
	Client's emphasis on quick construction time on project objectives	0.14147	-0.07026	0.10056	0.12724	0.14514	0.28857
	Client's emphasis on high quality of construction on project objectives	0.07094	0.07669	0.03149	0.04094	0.06583	0.11924
	Client's Ability to effectively brief the design team	0.65659	0.32514	0.35788	0.51147	0.53873	0.51904
	Client's Ability to quickly make authoritative decisions	0.49889	0.40234	0.44069	0.49315	0.45112	0.50173
	Client's Ability to effectively define the roles of the participating organizations	0.53575	0.51314	0.52906	0.48484	0.54881	0.53303
	Client's Ability to contribute ideas to the design process	0.41856	0.46608	0.41340	0.42932	0.37564	0.38452
	Client's Ability to contribute ideas to the construction process	0.39649	0.43607	0.34391	0.49290	0.43982	0.49091
	Client's representative's Technical skills	0.54092	0.42065	0.35708	0.44095	0.53786	0.56399
	Client's representative's Experience and capabilities	0.59016	0.53268	0.66362	0.58552	0.59914	0.56867
	Client's representative's Early and continued involvement in the project	0.55158	0.41633	0.59264	0.62449	0.58755	0.60548

		construction team leader Experience and capabilities	construction team leader Early and continued involvement in the project	construction team leader Adaptability to changes in the project plan	construction team leader Support by parent company	Communication system for the project	Control mechanism, such as monitoring and updating plans
Correlation	Client's representative's Adaptability to changes in the project plan	0.54249	0.34272	0.60814	0.60841	0.53154	0.53919
	Client's representative's Support by parent company	0.29918	0.46231	0.47983	0.19797	0.24759	0.17428
	design team leader Technical skills	0.52257	0.12141	0.26684	0.45905	0.35825	0.30572
	design team leader Experience and capabilities	0.58177	0.49725	0.56933	0.43099	0.48685	0.34826
	design team leader Early and continued involvement in the project	0.57760	0.31158	0.43154	0.57817	0.42458	0.27809
	design team leader Adaptability to changes in the project plan	0.56899	0.36401	0.58804	0.41804	0.32308	0.30228
	design team leader Support by parent company	0.32357	0.43338	0.36473	0.19593	0.04090	0.06580
	construction team leader Technical skills	0.65489	0.60270	0.73642	0.57423	0.52066	0.46513
	construction team leader Experience and capabilities	1	0.44011	0.60492	0.72881	0.70311	0.62332
	construction team leader Early and continued involvement in the project	0.44011	1	0.70094	0.46734	0.37908	0.41712
	construction team leader Adaptability to changes in the project plan	0.60492	0.70094	1	0.63733	0.56130	0.56811
	construction team leader Support by parent company	0.72881	0.46734	0.63733	1	0.66266	0.67302
	Communication system for the project	0.70311	0.37908	0.56130	0.66266	1	0.81091
	Control mechanism, such as monitoring and updating plans	0.62332	0.41712	0.56811	0.67302	0.81091	1
	Feedback capabilities	0.53421	0.37897	0.41655	0.53340	0.65496	0.80314
	Up-front planning efforts	0.69663	0.49159	0.66096	0.64156	0.77757	0.77250
	Developing an appropriate organizational structure	0.63569	0.58556	0.70671	0.64835	0.82900	0.78310
	Implementing an effective quality assurance program	0.57938	0.57931	0.56342	0.57384	0.65481	0.77702
	Implementing an effective safety program	0.48604	0.46019	0.48163	0.53715	0.62011	0.61547
	Development of a good reporting system	0.54403	0.51362	0.53749	0.47559	0.65643	0.67135

		construction team leader Experience and capabilities	construction team leader Early and continued involvement in the project	construction team leader Adaptability to changes in the project plan	construction team leader Support by parent company	Communication system for the project	Control mechanism, such as monitoring and updating plans
Correlation	Development of a standard procedures	0.44962	0.49014	0.32901	0.47044	0.49743	0.50692
	Procurement Method Adopted	0.11783	0.01642	0.00450	0.24245	0.22350	0.29417
	Management Skill, such as Partnering/VM	0.17064	0.30705	0.23010	0.22962	0.42238	0.49712
	Client representative management skills	0.53750	0.40080	0.52720	0.46858	0.56130	0.57632
	Design team leader management skills	0.58093	0.36373	0.40296	0.42801	0.43797	0.42259
	Construction team leader management skills	0.79302	0.49486	0.62857	0.64086	0.52767	0.50382

Correlation Matrix

		Feedback capabilities	Up-front planning efforts	Developing an appropriate organizational structure	Implementing an effective quality assurance program	Implementing an effective safety program	Development of a good reporting system	Development of a standard procedures
Correlation	Nature of project	0.07316	0.03931	-0.07449	-0.11603	-0.15010	-0.19612	-0.14241
	Complexity: Level of design coordination	-0.26491	-0.17714	-0.31838	-0.33122	-0.47883	-0.34455	-0.55880
	Complexity: Level of quality management procedures	-0.46475	-0.39295	-0.42238	-0.46782	-0.54419	-0.49869	-0.51632
	Physical environment	-0.25673	-0.15176	-0.13420	-0.00332	-0.23498	-0.25041	-0.14164
	Prevailing economic environment	-0.39123	-0.31730	-0.24693	-0.23163	-0.27585	-0.20047	-0.20938
	Social-political environment	-0.24861	-0.31622	-0.25040	-0.14026	-0.28596	-0.24806	-0.15194
	Level of technology advanced	-0.17906	-0.25494	-0.33804	-0.31109	-0.44714	-0.27412	-0.37333
	Overall environment	-0.16254	-0.15099	-0.18267	-0.11374	-0.21142	-0.16570	-0.19694
	Client's emphasis on low construction cost on project objectives	0.02335	0.10714	0.04820	-0.12785	-0.31279	0.14782	-0.11871
	Client's emphasis on quick construction time on project objectives	0.22564	0.20978	0.18243	0.15857	0.05625	0.21403	0.16012
	Client's emphasis on high quality of construction on project objectives	0.16343	0.16068	0.12367	0.27747	0.35048	0.30175	0.31923
	Client's Ability to effectively brief the design team	0.31161	0.54440	0.49171	0.50007	0.36924	0.39049	0.35260
	Client's Ability to quickly make authoritative decisions	0.33998	0.54731	0.55614	0.49783	0.34652	0.40189	0.27209
	Client's Ability to effectively define the roles of the participating organizations	0.34481	0.62224	0.62848	0.55632	0.45854	0.48913	0.37291
	Client's Ability to contribute ideas to the design process	0.27850	0.47056	0.45859	0.50990	0.41303	0.42047	0.35269
	Client's Ability to contribute ideas to the construction process	0.29865	0.41952	0.42327	0.45181	0.26730	0.31732	0.20750
	Client's representative's Technical skills	0.32256	0.49646	0.49201	0.51190	0.35225	0.42752	0.27659
	Client's representative's Experience and capabilities	0.34890	0.63148	0.65796	0.55668	0.48324	0.51134	0.40149
	Client's representative's Early and continued involvement in the project	0.41267	0.68926	0.63478	0.61403	0.63986	0.42483	0.40797

		Feedback capabilities	Up-front planning efforts	Developing an appropriate organizational structure	Implementing an effective quality assurance program	Implementing an effective safety program	Development of a good reporting system	Development of a standard procedures
Correlation	Client's representative's Adaptability to changes in the project plan	0.40066	0.63818	0.59240	0.45906	0.44267	0.41594	0.32517
	Client's representative's Support by parent company	0.17191	0.38934	0.33070	0.36368	0.39546	0.34093	0.39830
	design team leader Technical skills	0.25813	0.30125	0.23039	0.26460	0.28524	0.13181	0.11367
	design team leader Experience and capabilities	0.18882	0.38919	0.43251	0.40570	0.34895	0.23882	0.16809
	design team leader Early and continued involvement in the project	0.24647	0.39038	0.33672	0.26404	0.26810	0.24881	0.12852
	design team leader Adaptability to changes in the project plan	0.30131	0.41658	0.37032	0.26690	0.13350	0.34648	0.08444
	design team leader Support by parent company	0.23685	0.17410	0.15441	0.18604	0.14458	0.22904	0.11972
	construction team leader Technical skills	0.45723	0.49883	0.56981	0.52610	0.33511	0.50523	0.36146
	construction team leader Experience and capabilities	0.53421	0.69663	0.63569	0.57938	0.48604	0.54403	0.44962
	construction team leader Early and continued involvement in the project	0.37897	0.49159	0.58556	0.57931	0.46019	0.51362	0.49014
	construction team leader Adaptability to changes in the project plan	0.41655	0.66096	0.70671	0.56342	0.48163	0.53749	0.32901
	construction team leader Support by parent company	0.53340	0.64156	0.64835	0.57384	0.53715	0.47559	0.47044
	Communication system for the project	0.65496	0.77757	0.82900	0.65481	0.62011	0.65643	0.49743
	Control mechanism, such as monitoring and updating plans	0.80314	0.77250	0.78310	0.77702	0.61547	0.67135	0.50692
	Feedback capabilities	1	0.75086	0.71011	0.71601	0.58712	0.74778	0.60162
	Up-front planning efforts	0.75086	1	0.85281	0.75854	0.67964	0.75372	0.57194
	Developing an appropriate organizational structure	0.71011	0.85281	1	0.78514	0.66665	0.75586	0.60377
	Implementing an effective quality assurance program	0.71601	0.75854	0.78514	1	0.81683	0.70744	0.76091
	Implementing an effective safety program	0.58712	0.67964	0.66665	0.81683	1	0.61481	0.71566
	Development of a good reporting system	0.74778	0.75372	0.75586	0.70744	0.61481	1	0.71944

		Feedback capabilities	Up-front planning efforts	Developing an appropriate organizational structure	Implementing an effective quality assurance program	Implementing an effective safety program	Development of a good reporting system	Development of a standard procedures
Correlation	Development of a standard procedures	0.60162	0.57194	0.60377	0.76091	0.71566	0.71944	1
	Procurement Method Adopted	0.09238	0.23224	0.20912	0.34056	0.33560	0.13542	0.34257
	Management Skill, such as Partnering/VM	0.33654	0.38546	0.43027	0.49034	0.43797	0.40863	0.37399
	Client representative management skills	0.35589	0.63164	0.59179	0.55282	0.33296	0.44433	0.28883
	Design team leader management skills	0.43859	0.46797	0.43462	0.39052	0.23905	0.31639	0.19440
	Construction team leader management skills	0.48968	0.67488	0.57354	0.56909	0.55627	0.57195	0.43678

Correlation Matrix

	Procurement Method Adopted	Management Skill, such as Partnering/VM	Client representative management skills	Design team leader management skills	Construction team leader management skills
Correlation Nature of project	-0.22564	-0.28146	-0.06034	0.22425	0.04457
Complexity: Level of design coordination	-0.28942	-0.41405	0.10322	0.21462	-0.11622
Complexity: Level of quality management procedures	-0.45990	-0.50230	-0.12228	-0.02710	-0.17838
Physical environment	-0.00775	0.02083	0.00826	0.16521	-0.11992
Prevailing economic environment	-0.17834	-0.33004	-0.07360	0.06411	0.04472
Social-political environment	-0.21205	-0.28536	-0.03499	0.04557	-0.06793
Level of technology advanced	-0.42537	-0.43254	-0.10180	0.24940	-0.02309
Overall environment	-0.23863	-0.13000	-0.06687	0.14932	-0.06799
Client's emphasis on low construction cost on project objectives	0.03194	0.10985	0.19954	0.02077	0.17141
Client's emphasis on quick construction time on project objectives	0.30803	0.25565	0.28396	-0.11766	0.07916
Client's emphasis on high quality of construction on project objectives	0.36117	0.46235	0.07219	-0.11520	0.07557
Client's Ability to effectively brief the design team	0.45980	0.34371	0.63811	0.42710	0.54807
Client's Ability to quickly make authoritative decisions	0.25632	0.14579	0.64855	0.44987	0.50384
Client's Ability to effectively define the roles of the participating organizations	0.34532	0.38878	0.67893	0.40713	0.52232
Client's Ability to contribute ideas to the design process	0.24832	0.25007	0.51929	0.36254	0.53292
Client's Ability to contribute ideas to the construction process	0.13098	0.18386	0.57364	0.43567	0.38401
Client's representative's Technical skills	0.22498	0.37020	0.73913	0.38472	0.42937
Client's representative's Experience and capabilities	0.23540	0.32533	0.76463	0.44489	0.54801
Client's representative's Early and continued involvement in the project	0.38835	0.40491	0.70033	0.36709	0.55514

		Procurement Method Adopted	Management Skill, such as Partnering/VM	Client representative management skills	Design team leader management skills	Construction team leader management skills
Correlation	Client's representative's Adaptability to changes in the project plan	0.16217	0.31829	0.56415	0.43523	0.46201
	Client's representative's Support by parent company	0.17558	0.23639	0.35029	0.37268	0.45441
	design team leader Technical skills	-0.08043	-0.08082	0.27214	0.69891	0.46328
	design team leader Experience and capabilities	-0.08990	0.06374	0.51620	0.64166	0.53439
	design team leader Early and continued involvement in the project	0.00286	0.05107	0.40326	0.69991	0.59207
	design team leader Adaptability to changes in the project plan	-0.31335	-0.08454	0.37233	0.70919	0.53011
	design team leader Support by parent company	-0.34768	-0.12184	0.05442	0.56555	0.41881
	Construction team leader Technical skills	-0.09177	0.09301	0.38925	0.44270	0.66036
	Construction team leader Experience and capabilities	0.11783	0.17064	0.53750	0.58093	0.79302
	construction team leader Early and continued involvement in the project	0.01642	0.30705	0.40080	0.36373	0.49486
	construction team leader Adaptability to changes in the project plan	0.00450	0.23010	0.52720	0.40296	0.62857
	Construction team leader Support by parent company	0.24245	0.22962	0.46858	0.42801	0.64086
	Communication system for the project	0.22350	0.42238	0.56130	0.43797	0.52767
	Control mechanism, such as monitoring and updating plans	0.29417	0.49712	0.57632	0.42259	0.50382
	Feedback capabilities	0.09238	0.33654	0.35589	0.43859	0.48968
	Up-front planning efforts	0.23224	0.38546	0.63164	0.46797	0.67488
	Developing an appropriate organizational structure	0.20912	0.43027	0.59179	0.43462	0.57354
	Implementing an effective quality assurance program	0.34056	0.49034	0.55282	0.39052	0.56909
	Implementing an effective safety program	0.33560	0.43797	0.33296	0.23905	0.55627
	Development of a good reporting system	0.13542	0.40863	0.44433	0.31639	0.57195

	Procurement Method Adopted	Management Skill, such as Partnering/VM	Client representative management skills	Design team leader management skills	Construction team leader management skills
Correlation Development of a standard procedures	0.34257	0.37399	0.28883	0.19440	0.43678
Procurement Method Adopted	1	0.60174	0.34506	-0.11757	0.16106
Management Skill, such as Partnering/VM	0.60174	1	0.34821	0.06543	0.13539
Client representative management skills	0.34506	0.34821	1	0.50219	0.49661
Design team leader management skills	-0.11757	0.06543	0.50219	1	0.49292
Construction team leader management skills	0.16106	0.13539	0.49661	0.49292	1

APPENDIX F

CALCULATION OF FACTOR ANALYSIS

Factor Analysis

KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.665
Bartlett's Test of Sphericity	Approx. Chi-Square	2561.959
	df	990
	Sig.	.000

Communalities

	Initial	Extraction
Nature of project	1.000	.759
Complexity: Level of design coordination	1.000	.776
Complexity: Level of quality management procedures	1.000	.756
Physical environment	1.000	.790
Prevailing economic environment	1.000	.817
Social-political environment	1.000	.772
Level of technology advanced	1.000	.815
Overall environment	1.000	.873
Client's emphasis on low construction cost on project objectives	1.000	.807
Client's emphasis on quick construction time on project objectives	1.000	.753
Client's emphasis on high quality of construction on project objectives	1.000	.663
Client's Ability to effectively brief the design team	1.000	.892
Client's Ability to quickly make authoritative decisions	1.000	.789
Client's Ability to effectively define the roles of the participating organizations	1.000	.881
Client's Ability to contribute ideas to the design process	1.000	.909
Client's Ability to contribute ideas to the construction process	1.000	.810
Client's representative's Technical skills	1.000	.831
Client's representative's Experience and capabilities	1.000	.901
Client's representative's Early and continued involvement in the project	1.000	.899
Client's representative's Adaptability to changes in the project plan	1.000	.675
Client's representative's Support by parent company	1.000	.859
Design team leader Technical skills	1.000	.845
Design team leader Experience and capabilities	1.000	.709
Design team leader Early and continued involvement in the project	1.000	.857
Design team leader Adaptability to changes in the project plan	1.000	.837
Design team leader Support by parent company	1.000	.854
Construction team leader Technical skills	1.000	.836
Construction team leader Experience and capabilities	1.000	.836
Construction team leader Early and continued involvement in the project	1.000	.750
Construction team leader Adaptability to changes in the project plan	1.000	.877
Construction team leader Support by parent company	1.000	.792
Communication system for the project	1.000	.801
Control mechanism, such as monitoring and updating plans	1.000	.876
Feedback capabilities	1.000	.889
Up-front planning efforts	1.000	.859
Developing an appropriate organizational structure	1.000	.862
Implementing an effective quality assurance program	1.000	.861
Implementing an effective safety program	1.000	.836
Development of a good reporting system	1.000	.856
Development of a standard procedures	1.000	.739
Procurement Method Adopted	1.000	.754
Management Skill, such as Partnering/VM	1.000	.731
Client representative management skills	1.000	.819
Design team leader management skills	1.000	.866
Construction team leader management skills	1.000	.759

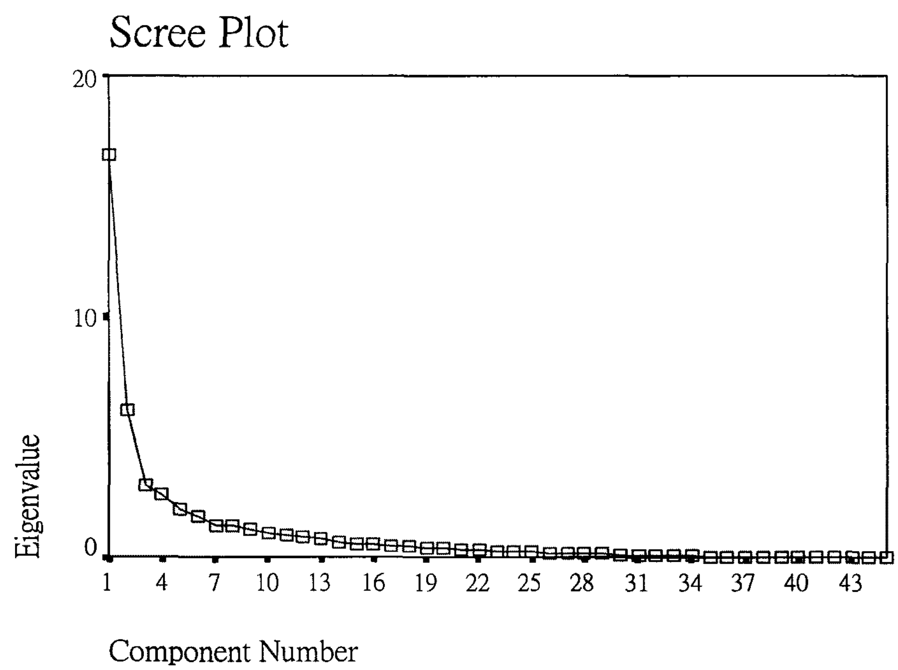
Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	16.709	37.131	37.131	16.709	37.131	37.131	12.642
2	6.082	13.517	50.648	6.082	13.517	50.648	10.333
3	2.963	6.584	57.232	2.963	6.584	57.232	6.608
4	2.580	5.734	62.966	2.580	5.734	62.966	4.967
5	1.976	4.392	67.358	1.976	4.392	67.358	5.453
6	1.653	3.674	71.032	1.653	3.674	71.032	10.648
7	1.319	2.932	73.964	1.319	2.932	73.964	8.633
8	1.267	2.815	76.779	1.267	2.815	76.779	2.041
9	1.146	2.548	79.327	1.146	2.548	79.327	2.117
10	1.030	2.288	81.615	1.030	2.288	81.615	3.705
11	.928	2.063	83.678				
12	.826	1.835	85.513				
13	.757	1.683	87.196				
14	.636	1.413	88.608				
15	.563	1.252	89.860				
16	.507	1.126	90.986				
17	.464	1.031	92.017				
18	.431	.957	92.974				
19	.406	.902	93.876				
20	.367	.815	94.691				
21	.311	.692	95.383				
22	.278	.619	96.001				
23	.244	.541	96.543				
24	.221	.492	97.034				
25	.200	.445	97.479				
26	.169	.375	97.853				
27	.142	.316	98.169				
28	.128	.284	98.453				
29	.120	.266	98.719				
30	9.990E-02	.222	98.941				
31	9.028E-02	.201	99.142				
32	7.325E-02	.163	99.305				
33	6.276E-02	.139	99.444				
34	6.137E-02	.136	99.581				
35	3.751E-02	8.335E-02	99.664				
36	3.542E-02	7.872E-02	99.743				
37	2.751E-02	6.113E-02	99.804				
38	2.239E-02	4.975E-02	99.854				
39	2.035E-02	4.522E-02	99.899				
40	1.363E-02	3.028E-02	99.929				
41	9.468E-03	2.104E-02	99.950				
42	7.859E-03	1.746E-02	99.968				
43	6.418E-03	1.426E-02	99.982				
44	5.213E-03	1.158E-02	99.993				
45	2.971E-03	6.603E-03	100.000				

Extraction Method: Principal Component Analysis.

a When components are correlated, sums of squared loadings cannot be added to obtain a total variance.


Scree Plot
20
10
0
Eigenvalue
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43
Component Number

Component Matrix[a]

	Component									
	1	2	3	4	5	6	7	8	9	10
Up-front planning efforts	.863	-.102	-.144	-6.422E-02	.186	.128	-5.651E-02	-.154	1.651E-02	2.742E-02
Developing an appropriate organizational structure	.856	-.140	-.186	4.135E-02	.156	8.564E-02	-.189	-6.225E-02	-2.549E-02	-3.982E-02
Client's representative's Experience and capabilities	.834	1.974E-02	.264	-2.959E-02	-4.362E-02	-.202	-.160	.139	-.173	.129
Implementing an effective quality assurance program	.818	-.184	-.211	.251	2.902E-02	.215	-1.742E-02	3.078E-03	4.586E-02	1.386E-02
Control mechanism, such as monitoring and updating plans	.804	-.177	-.109	-5.113E-02	.291	.294	-9.087E-02	7.493E-03	4.250E-02	5.263E-02
Communication system for the project	.802	-9.960E-02	-.113	-.115	.160	.274	-2.817E-02	1.279E-02	-.121	-7.607E-02
Client's representative's Early and continued involvement in the project	.802	-.122	.221	-6.968E-02	-8.714E-02	-5.494E-02	-.181	6.624E-02	-.309	.208
Client's Ability to effectively define the roles of the participating organizations	.797	5.322E-02	.428	.145	-4.076E-02	-8.790E-02	-8.654E-02	-8.802E-02	.108	-5.891E-02
construction team leader Experience and capabilities	.794	.200	-.126	-.188	9.260E-02	5.555E-02	.190	.175	-3.512E-02	-.185
construction team leader Support by parent company	.769	3.880E-02	-.105	-.150	-2.676E-02	.116	-2.007E-02	.130	-.230	-.285
Construction team leader management skills	.759	.219	-.161	-4.612E-02	-3.539E-03	-.155	.188	5.582E-02	6.369E-04	-.213
construction team leader Adaptability to changes in the project plan	.742	.195	-.245	4.976E-02	.150	-.294	-.162	-4.761E-02	-.296	-2.233E-02
Development of a good reporting system	.739	-.219	-.314	9.713E-02	.157	-6.703E-02	-5.696E-02	-4.805E-02	.342	-3.719E-02
Client's Ability to effectively brief the design team	.737	4.767E-02	.473	6.340E-02	-2.450E-02	4.469E-02	.254	-7.945E-04	.127	-.187
Client representative management skills	.737	.112	.365	5.932E-02	.276	1.644E-02	-3.569E-02	7.890E-02	-.112	.175
Client's representative's Adaptability to changes in the project plan	.735	4.046E-02	.207	-.122	-2.763E-02	-1.658E-03	-.201	-5.135E-02	-9.932E-02	.148
Implementing an effective safety program	.717	-.325	-.285	.154	-.274	.160	-1.229E-02	-8.772E-03	-.102	3.681E-02
Client's Ability to quickly make authoritative decisions	.707	.168	.408	1.733E-03	-2.719E-02	1.138E-02	-.101	-.113	.224	-.143
Client's Ability to contribute ideas to the design process	.699	.148	.395	.172	-.299	-9.534E-02	-2.672E-02	-.188	.209	-.186
Feedback capabilities	.679	-.191	-.409	-.125	.203	.253	-4.937E-02	-.116	.290	5.243E-02
Client's representative's Technical skills	.666	8.293E-02	.334	9.707E-02	.174	.128	-.153	.397	.120	.134
construction team leader Early and continued involvement in the project	.637	.154	-.249	.389	-2.493E-02	-.258	-.184	-2.780E-02	-2.254E-02	-7.242E-02
Client's Ability to contribute ideas to the construction process	.631	.279	.430	.111	-.107	.165	-.172	-.134	.156	-.162
construction team leader Technical skills	.624	.282	-.404	-8.167E-03	.192	-.199	.134	.207	-.113	-.233
Development of a standard procedures	.620	-.349	-.339	.269	-9.458E-02	5.514E-02	5.201E-02	-4.097E-02	.111	-.127
design team leader Experience and capabilities	.616	.439	9.963E-03	-8.721E-02	-.116	-.165	.154	.100	-.229	4.039E-02
design team leader Early and continued involvement in the project	.597	.454	8.115E-02	-.253	-.333	-7.004E-02	.269	-.172	-6.977E-02	-3.163E-02

	Component									
	1	2	3	4	5	6	7	8	9	10
Design team leader management skills	.591	.539	-9.658E-02	-.148	-5.212E-02	.164	.205	-3.622E-02	.109	.331
design team leader Technical skills	.474	.413	-5.773E-02	-.357	-.341	.171	.159	.306	1.214E-02	.234
Level of technology advanced	-.308	.712	-.181	6.453E-02	.357	5.257E-03	.132	4.099E-02	.143	9.189E-02
Complexity: Level of quality management procedures	-.415	.654	.234	-5.721E-02	.163	1.928E-02	-.222	-.103	-4.787E-02	-9.855E-02
design team leader Adaptability to changes in the project plan	.527	.639	-.142	-.264	-4.562E-02	-.123	-3.991E-02	1.030E-03	.126	.162
Complexity: Level of design coordination	-.247	.628	.349	-.231	.206	.283	7.420E-02	-6.777E-02	6.536E-02	9.533E-02
Prevailing economic environment	-.192	.599	4.488E-02	.392	-.103	-1.413E-02	8.103E-02	.432	5.556E-02	-.240
design team leader Support by parent company	.307	.590	-.360	3.553E-02	-.266	-.236	-9.575E-03	3.692E-02	.337	.199
Social-political environment	-.244	.571	-.101	.527	.172	-4.289E-02	-.114	.165	-.164	1.646E-02
Overall environment	-.220	.568	-.191	.562	.263	.142	7.824E-02	-.162	-.110	.122
Client's emphasis on high quality of construction on project objectives	.201	-.527	1.543E-02	.160	-8.385E-02	-8.709E-02	.488	.198	.156	4.307E-02
Procurement Method Adopted	.301	-.511	.379	.281	6.291E-03	.118	.359	2.437E-02	-.187	-1.866E-02
Management Skill, such as Partnering/VM	.452	-.487	.107	.328	.122	5.006E-02	.206	-6.454E-02	-4.595E-02	.322
Physical environment	-.149	.439	.162	.593	.153	.368	.184	-3.929E-02	-4.613E-02	1.255E-03
Nature of project	-4.464E-02	.344	-.142	-.464	.164	.341	.238	-.313	-.239	-.220
Client's emphasis on low construction cost on project objectives	8.969E-02	3.557E-02	.223	-.154	.624	-.509	.155	-.166	.143	-6.107E-02
Client's emphasis on quick construction time on project objectives	.204	-.439	.186	-.267	.503	-.293	.179	.187	2.833E-02	8.145E-02
Client's representative's Support by parent company	.479	.176	-6.907E-02	.293	-.172	-.319	.239	-.512	-.169	.169

Extraction Method: Principal Component Analysis.

a 10 components extracted.

Pattern Matrix[a]

	Component									
	1	2	3	4	5	6	7	8	9	10
Feedback capabilities	1.076	-2.339E-02	.153	-.101	-6.425E-02	-.229	-7.941E-02	1.456E-02	.101	-.116
Development of a good reporting system	.853	.173	3.297E-02	-9.812E-02	2.648E-02	-.232	7.855E-02	.177	-.197	-2.607E-02
Control mechanism, such as monitoring and updating plans	.841	4.729E-02	-2.157E-02	5.424E-02	-1.218E-02	.198	1.023E-02	7.201E-03	.115	-.187
Implementing an effective quality assurance program	.758	9.539E-02	1.738E-03	.183	.162	5.820E-02	7.795E-02	-.176	-5.042E-02	-9.128E-04
Developing an appropriate organizational structure	.733	.108	-.116	-4.991E-03	-.148	.214	.156	-1.595E-02	2.495E-02	-1.742E-02
Up-front planning efforts	.725	.114	2.033E-02	-3.102E-02	-5.420E-02	.150	5.390E-02	5.982E-02	.155	7.059E-02
Development of a standard procedures	.680	7.451E-02	-.101	1.689E-02	.230	-.249	.182	-.136	-8.736E-02	8.178E-02
Communication system for the project	.644	3.062E-02	-4.652E-02	9.260E-03	-1.741E-02	.199	.233	-8.151E-02	.272	-.131
Implementing an effective safety program	.518	-6.486E-02	7.956E-02	-5.443E-02	.188	.135	8.426E-02	-.386	-4.423E-02	.118
construction team leader Early and continued involvement in the project	.328	.144	-6.887E-02	.217	-.149	.130	.323	-7.747E-03	-.285	.223
Client's Ability to contribute ideas to the design process	-2.032E-02	.957	9.257E-03	-.109	7.704E-03	-6.475E-02	-5.420E-02	-3.449E-02	-.115	.196
Client's Ability to contribute ideas to the construction process	.160	.900	-6.633E-02	6.192E-02	-.209	6.856E-02	-.128	-.117	1.843E-02	-4.658E-02
Client's Ability to quickly make authoritative decisions	.164	.852	-1.197E-02	-.104	-.119	4.249E-02	-7.207E-02	9.455E-02	-3.235E-02	-3.145E-02
Client's Ability to effectively define the roles of the participating organizations	7.372E-02	.760	-4.994E-02	-3.534E-02	1.958E-02	.251	-5.215E-02	.103	-.156	9.579E-02
Client's Ability to effectively brief the design team	3.973E-03	.748	1.400E-02	8.957E-03	.364	-3.879E-02	.131	.149	8.670E-02	1.016E-02
Design team leader Technical skills	-.111	-.121	.899	-.164	.111	.247	8.541E-02	-.315	1.141E-02	-.175
Design team leader management skills	.214	-1.620E-02	.815	.161	9.331E-02	.132	-.114	-7.164E-02	.115	.161
Design team leader Support by parent company	.102	2.948E-02	.778	1.004E-02	-.157	-.177	1.677E-02	-6.109E-02	-.349	.163
Design team leader Adaptability to changes in the project plan	8.725E-02	7.129E-02	.670	-7.310E-02	-.295	.145	.104	6.437E-02	-1.332E-02	7.693E-02
Design team leader Early and continued involvement in the project	-.238	.302	.525	-.171	7.159E-02	1.392E-02	.208	-5.786E-02	.307	.362
Overall environment	.142	-.197	-2.848E-02	.952	-1.704E-02	-7.128E-02	-7.335E-03	-4.409E-02	9.540E-02	.310
Physical environment	4.266E-02	.176	-.116	.938	.230	-.132	-7.917E-02	-.173	.130	8.146E-02
Social-political environment	-.146	-.167	-9.153E-02	.784	-.156	.153	.244	-7.329E-02	-.192	1.428E-02

	Component									
	1	2	3	4	5	6	7	8	9	10
Level of technology advanced	2.998E-02	-.210	.307	.532	-.127	-.243	.105	.247	8.653E-02	-2.322E-02
Prevailing economic environment	-.345	.174	8.287E-02	.531	6.640E-02	-.217	.470	-.156	-.233	-.302
Client's emphasis on high quality of construction on project objectives	-2.423E-03	-6.984E-02	.140	-8.082E-02	.869	-.246	8.392E-02	.145	-.201	4.065E-02
Procurement Method Adopted	-.116	.164	-.280	.161	.745	.158	2.800E-03	2.664E-02	6.901E-02	.145
Management Skill, such as Partnering/VM	.255	-8.460E-02	-4.011E-03	.209	.608	.311	-.287	8.339E-02	-.172	.278
Complexity: Level of quality management procedures	-.329	.238	-.112	.253	-.558	4.659E-02	-3.346E-02	7.018E-02	.175	-6.393E-02
Client's representative's Early and continued involvement in the project	-3.441E-02	6.748E-02	.105	-.160	-1.512E-02	.857	1.048E-02	-.104	-.120	9.528E-02
Client's representative's Experience and capabilities	-9.983E-02	.229	.140	-.147	-2.075E-02	.734	.132	5.295E-02	-.243	4.219E-02
Client representative management skills	8.938E-02	.248	6.102E-02	.198	9.306E-02	.631	-2.956E-03	.196	-6.607E-02	-8.933E-03
Client's representative's Adaptability to changes in the project plan	.126	.263	.138	-.158	-.167	.573	-9.584E-02	-3.433E-02	-4.792E-02	6.186E-02
Client's representative's Technical skills	.207	.323	.158	.149	7.229E-02	.499	-1.914E-02	1.870E-02	-.358	-.449
construction team leader Technical skills	.313	-.205	9.554E-02	.139	1.164E-02	-5.187E-02	.840	.198	.100	-3.438E-02
construction team leader Support by parent company	.320	9.529E-02	-7.717E-02	-9.203E-02	-7.929E-02	.165	.582	-.139	.272	-.159
Construction team leader management skills	.221	.165	.178	-2.788E-02	.106	-.102	.579	.141	.117	8.463E-02
construction team leader Experience and capabilities	.335	7.276E-02	.219	-2.172E-02	.113	-6.620E-03	.570	8.154E-02	.234	-.146
construction team leader Adaptability to changes in the project plan	.222	-.132	-3.585E-02	7.897E-02	-.253	.462	.495	.145	2.110E-03	.263
design team leader Experience and capabilities	-.241	-2.746E-03	.414	5.749E-02	7.171E-02	.361	.424	1.175E-02	7.988E-02	.199
Client's emphasis on low construction cost on project objectives	-.101	.169	-.205	-8.498E-02	3.740E-02	-5.460E-02	.175	.956	4.284E-02	.190
Client's emphasis on quick construction time on project objectives	-1.715E-02	-.180	-9.842E-02	-.281	.345	.239	.153	.685	-8.505E-02	-.148
Nature of project	.156	-.147	-1.082E-03	2.907E-02	-.196	-.280	.250	3.294E-03	.933	.111
Complexity: Level of design coordination	-.219	.213	.261	.257	-.190	1.289E-02	-.250	8.149E-02	.340	-.126
Client's representative's Support by parent company	-.119	.103	.182	.194	.219	.105	-3.031E-02	.110	8.804E-02	.946

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization.
a Rotation converged in 10 iterations.

Structure Matrix

	Component									
	1	2	3	4	5	6	7	8	9	10
Feedback capabilities	.892	.255	.273	-.283	.219	.358	.294	.033	.041	.187
Developing an appropriate organizational structure	.882	.487	.188	-.244	.245	.662	.538	-.048	-.034	.328
Up-front planning efforts	.876	.511	.288	-.247	.276	.663	.465	.041	.118	.315
Control mechanism, such as monitoring and updating plans	.873	.446	.217	-.195	.350	.679	.356	.052	.150	.084
Implementing an effective quality assurance program	.871	.477	.173	-.154	.422	.560	.494	-.217	-.117	.332
Development of a good reporting system	.867	.378	.194	-.281	.267	.359	.462	.074	-.269	.343
Communication system for the project	.784	.472	.245	-.227	.325	.675	.488	-.066	.240	.131
Implementing an effective safety program	.759	.327	.073	-.392	.465	.491	.485	-.475	-.159	.443
Development of a standard procedures	.746	.279	-.023	-.307	.433	.276	.461	-.288	-.280	.423
Client's Ability to contribute ideas to the design process	.388	.908	.310	-.106	.206	.446	.444	-.135	-.069	.369
Client's Ability to effectively define the roles of the participating organizations	.520	.876	.267	-.102	.289	.674	.430	.038	-.032	.271
Client's Ability to effectively brief the design team	.431	.873	.306	-.085	.479	.575	.423	.062	.184	.098
Client's Ability to contribute ideas to the construction process	.359	.871	.344	.089	.063	.498	.315	-.072	.133	.113
Client's Ability to quickly make authoritative decisions	.446	.862	.356	-.066	.149	.542	.362	.081	.097	.138
Design team leader management skills	.405	.478	.856	.196	-.052	.384	.356	.063	.259	.170
design team leader Adaptability to changes in the project plan	.300	.445	.846	.130	-.352	.301	.487	.164	.108	.195
design team leader Technical skills	.211	.375	.791	-.055	.026	.350	.404	-.183	.234	-.058
design team leader Support by parent company	.187	.243	.748	.199	-.391	-.080	.428	-.024	-.300	.339
design team leader Early and continued involvement in the project	.238	.628	.691	-.085	.007	.367	.541	-.092	.306	.358
Overall environment	-.165	-.117	.144	.860	-.387	-.249	-.050	.074	-.035	.133
Physical environment	-.194	.142	.069	.806	-.068	-.131	-.119	-.050	.102	-.094
Social-political environment	-.296	-.101	.101	.786	-.450	-.199	.101	.030	-.227	-.010
Level of technology advanced	-.309	-.172	.431	.726	-.564	-.370	-.065	.407	.111	-.196
Prevailing economic environment	-.397	.122	.253	.643	-.282	-.297	.258	-.099	-.202	-.218
Procurement Method Adopted	.236	.280	-.339	-.199	.802	.403	.024	-.123	.065	.068
Client's emphasis on high quality of construction on project objectives	.245	.039	-.163	-.332	.731	.067	.086	-.057	-.207	.071
Complexity: Level of quality management procedures	-.556	-.013	.171	.571	-.679	-.253	-.210	.249	.244	-.260
Management Skill, such as Partnering/VM	.525	.200	-.171	-.175	.676	.479	.019	-.014	-.133	.264
Client's representative's Early and continued involvement in the project	.575	.564	.210	-.324	.341	.901	.453	-.118	.036	.274
Client's representative's Experience and capabilities	.540	.674	.324	-.231	.262	.852	.562	.014	-.061	.260
Client representative management skills	.507	.659	.323	.072	.275	.816	.347	.239	.146	.061

	Component									
	1	2	3	4	5	6	7	8	9	10
Client's representative's Adaptability to changes in the project plan	.537	.602	.325	-.212	.160	.741	.370	-.006	.103	.221
Client's representative's Technical skills	.475	.633	.338	.079	.281	.691	.324	.117	-.037	-.199
construction team leader Technical skills	.524	.293	.444	.035	-.018	.323	.826	.113	-.053	.256
Construction team leader management skills	.565	.558	.491	-.108	.143	.426	.769	.031	.023	.332
construction team leader Adaptability to changes in the project plan	.611	.389	.324	-.056	-.069	.606	.742	.071	-.108	.509
construction team leader Experience and capabilities	.615	.556	.538	-.116	.210	.539	.718	.053	.216	.107
construction team leader Support by parent company	.612	.520	.291	-.247	.222	.607	.709	-.179	.190	.162
construction team leader Early and continued involvement in the project	.566	.422	.221	.059	-.028	.356	.661	-.111	-.414	.551
design team leader Experience and capabilities	.282	.512	.609	.057	.001	.498	.653	-.004	.122	.281
Client's emphasis on low construction cost on project objectives	.035	.110	.028	.030	-.051	.109	.027	.834	.069	.017
Client's emphasis on quick construction time on project objectives	.229	-.017	-.149	-.345	.415	.346	.001	.573	.051	-.189
Nature of project	-.059	-.040	.263	.099	-.241	-.058	.013	.102	.754	-.097
Complexity: Level of design coordination	-.413	.126	.408	.532	-.391	-.089	-.308	.326	.544	-.429
Client's representative's Support by parent company	.328	.375	.255	.031	.082	.273	.380	-.055	-.102	.831

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

Component Correlation Matrix

Component	1	2	3	4	5	6	7	8	9	10
1	1.000	.369	.173	-.296	.344	.552	.432	-3.797E-02	-8.288E-02	.345
2	.369	1.000	.404	2.616E-02	.202	.546	.433	-2.499E-02	.125	.149
3	.173	.404	1.000	.229	-.259	.176	.367	.149	.207	2.367E-02
4	-.296	2.616E-02	.229	1.000	-.384	-.192	-9.491E-02	.188	3.647E-02	-.174
5	.344	.202	-.259	-.384	1.000	.361	3.481E-02	-.165	3.877E-02	-1.864E-02
6	.552	.546	.176	-.192	.361	1.000	.349	4.733E-02	.208	9.651E-02
7	.432	.433	.367	-9.491E-02	3.481E-02	.349	1.000	-.164	-.188	.379
8	-3.797E-02	-2.499E-02	.149	.188	-.165	4.733E-02	-.164	1.000	.154	-.230
9	-8.288E-02	.125	.207	3.647E-02	3.877E-02	.208	-.188	.154	1.000	-.328
10	.345	.149	2.367E-02	-.174	-1.864E-02	9.651E-02	.379	-.230	-.328	1.000

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.

Component Score Coefficient Matrix

	Component									
	1	2	3	4	5	6	7	8	9	10
Nature of project	.005	-.005	-.009	-.007	-.004	-.007	.017	-.009	.429	.019
Complexity: Level of design coordination	-.026	.057	.117	.114	-.014	.037	-.152	.114	.218	-.146
Complexity: Level of quality management procedures	-.048	.058	-.025	.082	-.175	.025	-.017	.059	.070	-.033
Physical environment	.004	.058	-.016	.259	.100	-.003	-.057	-.049	.096	-.038
Prevailing economic environment	-.092	.079	.025	.136	.041	-.089	.210	-.086	-.140	-.171
Social-political environment	-.026	-.038	-.039	.207	-.069	.049	.087	-.018	-.119	-.003
Level of technology advanced	.020	-.037	.133	.169	-.049	-.061	-.035	.195	.009	-.068
Overall environment	.040	-.045	-.004	.251	-.026	.009	-.051	.025	.022	.110
Client's emphasis on low construction cost on project objectives	.001	.023	-.007	.009	-.038	-.030	.002	.447	-.003	.052
Client's emphasis on quick construction time on project objectives	.001	-.061	.016	-.031	.106	.078	-.002	.323	.006	-.127
Client's emphasis on high quality of construction on project objectives	-.010	.000	.066	-.022	.287	-.085	.035	.039	-.062	-.038
Client's Ability to effectively brief the design team	-.029	.182	.016	.013	.145	-.036	.041	.037	.085	-.060
Client's Ability to quickly make authoritative decisions	.016	.187	.006	-.012	-.039	-.033	-.024	.043	-.002	-.024
Client's Ability to effectively define the roles of the participating organizations	.002	.155	-.020	.001	-.007	.026	-.007	.030	-.048	.035
Client's Ability to contribute ideas to the design process	-.018	.219	-.011	-.043	-.013	-.085	.028	-.056	-.063	.105
Client's Ability to contribute ideas to the construction process	.012	.202	-.021	.026	-.056	-.014	-.033	-.054	.029	-.026
Client's representative's Technical skills	.022	.051	.069	.095	.047	.122	-.037	.061	-.091	-.270
Client's representative's Experience and capabilities	-.029	.015	.004	-.029	-.015	.179	.051	.004	-.072	.012
Client's representative's Early and continued involvement in the project	-.015	-.027	-.020	-.037	.000	.241	.002	-.070	.008	.040
Client's representative's Adaptability to changes in the project plan	.019	.025	.015	-.028	-.055	.149	-.051	-.008	.019	.028
Client's representative's Support by parent company	-.002	.002	.006	.006	.010	.004	-.014	.007	.005	.450
design team leader Technical skills	-.036	-.023	.246	-.029	.088	.055	.004	-.105	.051	-.142
design team leader Experience and capabilities	-.065	-.005	.078	.002	.033	.087	.137	-.024	.039	.058
design team leader Early and continued involvement in the project	-.060	.079	.116	-.071	.041	-.021	.069	-.061	.138	.140
design team leader Adaptability to changes in the project plan	.018	.002	.190	-.007	-.109	-.001	-.008	.082	-.035	.023
design team leader Support by parent company	.032	.001	.226	-.002	-.100	-.131	.002	.028	-.239	.095
construction team leader Technical skills	.011	-.036	.004	.017	-.005	-.030	.264	.054	-.027	-.016
construction team leader Experience and capabilities	.013	.029	.054	-.006	.068	-.007	.157	.019	.099	-.106
construction team leader Early and continued involvement in the project	.044	.014	-.059	.030	-.107	-.014	.133	-.033	-.209	.162
construction team leader Adaptability to changes in the project plan	.021	-.060	-.066	-.001	-.122	.117	.155	.029	-.051	.162
construction team leader Support by parent company	.001	.030	-.068	-.045	.010	.055	.199	-.123	.115	-.064

	Component									
	1	2	3	4	5	6	7	8	9	10
Communication system for the project	.079	-.002	-.029	.008	.025	.080	.027	-.039	.147	-.074
Control mechanism, such as monitoring and updating plans	.130	-.011	.006	.042	.011	.073	-.073	.045	.084	-.108
Feedback capabilities	.183	-.019	.072	-.009	-.030	-.072	-.107	.069	.022	-.042
Up-front planning efforts	.114	.003	.001	-.001	-.024	.043	-.043	.045	.072	.034
Developing an appropriate organizational structure	.108	.000	-.052	-.001	-.062	.053	.018	-.006	-.004	.021
Implementing an effective quality assurance program	.111	.009	-.010	.046	.049	.008	-.004	-.074	-.024	.002
Implementing an effective safety program	.068	-.025	-.023	-.045	.062	.029	.039	-.209	-.024	.089
Development of a good reporting system	.142	.025	.032	-.020	-.036	-.114	-.008	.107	-.147	.019
Development of a standard procedures	.096	.019	-.044	-.023	.053	-.097	.070	-.093	-.087	.077
Procurement Method Adopted	-.038	.042	-.085	.040	.274	.076	.006	-.046	.121	-.001
Management Skill, such as Partnering/VM	.059	-.049	.008	.071	.184	.101	-.139	.052	-.007	.077
Client representative management skills	.010	.023	.020	.092	.040	.184	-.054	.116	.045	-.071
Design team leader management skills	.044	-.014	.245	.066	.046	.026	-.120	.045	.084	.001
Construction team leader management skills	.001	.049	.031	-.027	.031	-.060	.188	.023	.006	.032

Extraction Method: Principal Component Analysis. Rotation Method: Promax with Kaiser Normalization. Component Scores.

Component Score Covariance Matrix

Component	1	2	3	4	5	6	7	8	9	10
1	3.257	2.657	2.504	-1.193	1.976	3.381	3.146	1.053	.508	2.197
2	2.657	2.775	1.725	-.505	2.779	2.412	2.556	1.103	2.334	1.911
3	2.504	1.725	4.159	-.168	2.074	2.994	3.753	1.344	2.710	2.326
4	-1.193	-.505	-.168	1.724	1.608	1.243	-1.573	.141	3.406	2.537
5	1.976	2.779	2.074	1.608	4.910	2.538	1.062	.852	4.061	3.349
6	3.381	2.412	2.994	1.243	2.538	5.573	1.992	.531	1.582	4.100
7	3.146	2.556	3.753	-1.573	1.062	1.992	4.009	.475	-.363	-.106
8	1.053	1.103	1.344	.141	.852	.531	.475	1.908	.464	.191
9	.508	2.334	2.710	3.406	4.061	1.582	-.363	.464	6.835	2.161
10	2.197	1.911	2.326	2.537	3.349	4.100	-.106	.191	2.161	5.067

Extraction Method: Principal Component Analysis.
Rotation Method: Promax with Kaiser Normalization.
Component Scores.

APPENDIX G1 - G10

CALCULATION OF MULTIPLE REGRESSION ANALYSIS

Descriptive Statistics

	Mean	Std. Deviation	N
Project Success Index	13.68530	2.352962	43
Project management action	.0330066	1.05537220	43
Client abilities	-.0973237	1.01960303	43
Design team leader's capabilities	-.0745254	.92402401	43
External environment	-.0444181	.97720334	43
Application of innovative PM technique	.0499184	.98525261	43
Client's representatives capabilities	.0792086	1.05310991	43
Construction team leader's capabilities	.0387484	1.03230895	43
Client's emphasis on cost and time performance	-.1305312	1.00018953	43
Nature of Project	-.0272871	.97921583	43
Support by parent company	.1342151	.95393847	43

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Project management action	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Client's representatives capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Construction team leader's capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Design team leader's capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
5	Application of innovative PM technique	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Project Success Index

Model Summary[f]

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.789	.623	.614	1.462409	.623	67.728	1	41	.000
2	.854	.729	.715	1.255668	.106	15.612	1	40	.000
3	.893	.797	.782	1.099327	.069	13.186	1	39	.001
4	.907	.822	.804	1.042325	.025	5.382	1	38	.026
5	.927	.859	.840	.941414	.037	9.583	1	37	.004

a Predictors: (Constant), Project management action
b Predictors: (Constant), Project management action, Client's representatives capabilities
c Predictors: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities
d Predictors: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities, Design team leader's capabilities
e Predictors: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities, Design team leader's capabilities, Application of innovative PM technique
f Dependent Variable: Project Success Index

ANOVA[f]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	144.846	1	144.846	67.728	.000[a]
	Residual	87.684	41	2.139		
	Total	232.530	42			
2	Regression	169.462	2	84.731	53.739	.000[b]
	Residual	63.068	40	1.577		
	Total	232.530	42			
3	Regression	185.398	3	61.799	51.136	.000[c]
	Residual	47.132	39	1.209		
	Total	232.530	42			
4	Regression	191.245	4	47.811	44.007	.000[d]
	Residual	41.285	38	1.086		
	Total	232.530	42			
5	Regression	199.738	5	39.948	45.074	.000[e]
	Residual	32.792	37	.886		
	Total	232.530	42			

a Predictors: (Constant), Project management action
b Predictors: (Constant), Project management action, Client's representatives capabilities
c Predictors: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities
d Predictors: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities, Design team leader's capabilities
e Predictors: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities, Design team leader's capabilities, Application of innovative PM technique
f Dependent Variable: Project Success Index

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	13.627	.223		61.074	.000		
	Project management action	1.760	.214	.789	8.230	.000	1.000	1.000
2	(Constant)	13.574	.192		70.673	.000		
	Project management action	1.250	.224	.560	5.568	.000	.669	1.494
	Client's representatives capabilities	.889	.225	.398	3.951	.000	.669	1.494
3	(Constant)	13.561	.168		80.634	.000		
	Project management action	.981	.210	.440	4.671	.000	.586	1.707
	Client's representatives capabilities	.827	.198	.370	4.185	.000	.664	1.505
	Construction team leader's capabilities	.675	.186	.296	3.631	.001	.782	1.279
4	(Constant)	13.600	.160		84.821	.000		
	Project management action	.926	.200	.415	4.616	.000	.578	1.731
	Client's representatives capabilities	.826	.187	.370	4.410	.000	.664	1.505
	Construction team leader's capabilities	.561	.183	.246	3.067	.004	.725	1.378
	Design team leader's capabilities	.437	.188	.172	2.320	.026	.855	1.170
5	(Constant)	13.601	.145		93.916	.000		
	Project management action	.776	.187	.348	4.138	.000	.539	1.855
	Client's representatives capabilities	.665	.177	.298	3.754	.001	.607	1.649
	Construction team leader's capabilities	.604	.166	.265	3.644	.001	.720	1.388
	Design team leader's capabilities	.588	.177	.231	3.325	.002	.790	1.267
	Application of innovative PM technique	.538	.174	.225	3.096	.004	.720	1.388

a Dependent Variable: Project Success Index

Excluded Variables[f]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance	VIF	Minimum Tolerance
1	Client abilities	.265[a]	2.575	.014	.377	.766	1.306	.766
	Design team leader's capabilities	.241[a]	2.568	.014	.376	.922	1.085	.922
	External environment	-.037[a]	-.371	.712	-.059	.944	1.059	.944
	Application of innovative PM technique	.194[a]	1.943	.059	.294	.863	1.159	.863
	Client's representatives capabilities	.398[a]	3.951	.000	.530	.669	1.494	.669
	Construction team leader's capabilities	.325[a]	3.369	.002	.470	.788	1.270	.788
	Client's emphasis on cost and time performance	.022[a]	.230	.819	.036	.998	1.002	.998
	Nature of Project	.141[a]	1.483	.146	.228	.986	1.014	.986
	Support by parent company	-.108[a]	-1.080	.286	-.168	.916	1.091	.916
2	Client abilities	.093[b]	.836	.408	.133	.549	1.821	.480
	Design team leader's capabilities	.232[b]	2.959	.005	.428	.921	1.085	.637
	External environment	.001[b]	.007	.994	.001	.932	1.073	.657
	Application of innovative PM technique	.108[b]	1.176	.247	.185	.800	1.250	.621
	Construction team leader's capabilities	.296[b]	3.631	.001	.503	.782	1.279	.586
	Client's emphasis on cost and time performance	-.007[b]	-.081	.936	-.013	.990	1.010	.664
	Nature of Project	.020[b]	.226	.822	.036	.846	1.182	.574
	Support by parent company	-.038[b]	-.422	.675	-.067	.875	1.143	.585
3	Client abilities	-.026[c]	-.245	.808	-.040	.490	2.041	.474
	Design team leader's capabilities	.172[c]	2.320	.026	.352	.855	1.170	.578
	External environment	-.002[c]	-.029	.977	-.005	.932	1.073	.576
	Application of innovative PM technique	.158[c]	2.014	.051	.311	.780	1.282	.558
	Client's emphasis on cost and time performance	.056[c]	.745	.461	.120	.939	1.065	.583
	Nature of Project	.095[c]	1.180	.245	.188	.797	1.255	.554
	Support by parent company	-.113[c]	-1.440	.158	-.227	.822	1.216	.545
4	Client abilities	-.068[d]	-.679	.502	-.111	.475	2.107	.470
	External environment	-.022[d]	-.298	.767	-.049	.919	1.088	.566
	Application of innovative PM technique	.225[d]	3.096	.004	.454	.720	1.388	.539
	Client's emphasis on cost and time performance	.045[d]	.627	.535	.102	.935	1.070	.576
	Nature of Project	.022[d]	.259	.797	.042	.648	1.544	.524
	Support by parent company	-.098[d]	-1.313	.197	-.211	.816	1.225	.534
5	Client abilities	-.093[e]	-1.033	.308	-.170	.471	2.123	.450
	External environment	.028[e]	.411	.684	.068	.867	1.153	.536
	Client's emphasis on cost and time performance	.110[e]	1.685	.101	.270	.859	1.163	.529
	Nature of Project	.057[e]	.725	.473	.120	.635	1.574	.481
	Support by parent company	-.083[e]	-1.213	.233	-.198	.811	1.233	.496

a Predictors in the Model: (Constant), Project management action
b Predictors in the Model: (Constant), Project management action, Client's representatives capabilities
c Predictors in the Model: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities
d Predictors in the Model: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities, Design team leader's capabilities
e Predictors in the Model: (Constant), Project management action, Client's representatives capabilities, Construction team leader's capabilities, Design team leader's capabilities, Application of innovative PM technique
f Dependent Variable: Project Success Index

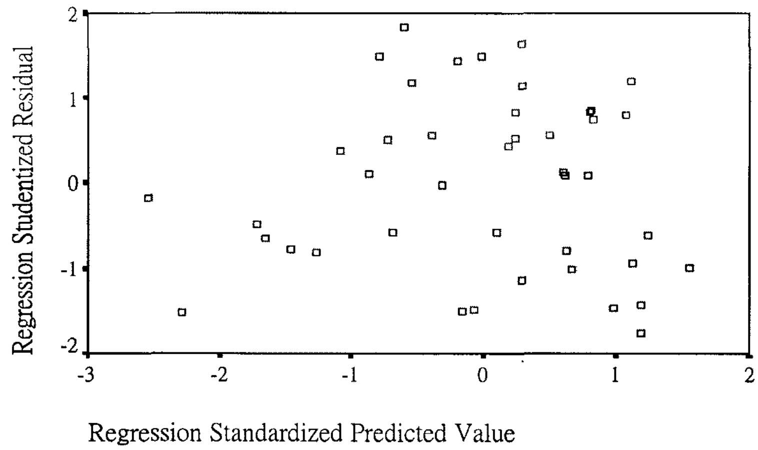
Coefficient Correlations[a]

Model			Project management action	Client's representatives capabilities	Construction team leader's capabilities	Design team leader's capabilities	Application of innovative PM technique
1	Correlations	Project management action	1.000				
	Covariances	Project management action	4.572E-02				
2	Correlations	Project management action	1.000	-.575			
		Client's representatives capabilities	-.575	1.000			
	Covariances	Project management action	5.037E-02	-2.903E-02			
		Client's representatives capabilities	-2.903E-02	5.058E-02			
3	Correlations	Project management action	1.000	-.506	-.353		
		Client's representatives capabilities	-.506	1.000	-.086		
		Construction team leader's capabilities	-.353	-.086	1.000		
	Covariances	Project management action	4.409E-02	-2.100E-02	-1.376E-02		
		Client's representatives capabilities	-2.100E-02	3.906E-02	-3.150E-03		
		Construction team leader's capabilities	-1.376E-02	-3.150E-03	3.454E-02		
4	Correlations	Project management action	1.000	-.502	-.306	-.119	
		Client's representatives capabilities	-.502	1.000	-.082	-.002	
		Construction team leader's capabilities	-.306	-.082	1.000	-.268	
		Design team leader's capabilities	-.119	-.002	-.268	1.000	
	Covariances	Project management action	4.020E-02	-1.887E-02	-1.121E-02	-4.473E-03	
		Client's representatives capabilities	-1.887E-02	3.511E-02	-2.815E-03	-6.463E-05	
		Construction team leader's capabilities	-1.121E-02	-2.815E-03	3.346E-02	-9.241E-03	
		Design team leader's capabilities	-4.473E-03	-6.463E-05	-9.241E-03	3.544E-02	
5	Correlations	Project management action	1.000	-.388	-.316	-.181	-.258
		Client's representatives capabilities	-.388	1.000	-.103	-.083	-.295
		Construction team leader's capabilities	-.316	-.103	1.000	-.234	.084
		Design team leader's capabilities	-.181	-.083	-.234	1.000	.277
		Application of innovative PM technique	-.258	-.295	.084	.277	1.000
	Covariances	Project management action	3.514E-02	-1.286E-02	-9.815E-03	-6.018E-03	-8.411E-03
		Client's representatives capabilities	-1.286E-02	3.137E-02	-3.024E-03	-2.606E-03	-9.065E-03
		Construction team leader's capabilities	-9.815E-03	-3.024E-03	2.749E-02	-6.856E-03	2.421E-03
		Design team leader's capabilities	-6.018E-03	-2.606E-03	-6.856E-03	3.130E-02	8.500E-03
		Application of innovative PM technique	-8.411E-03	-9.065E-03	2.421E-03	8.500E-03	3.018E-02

a Dependent Variable: Project Success Index

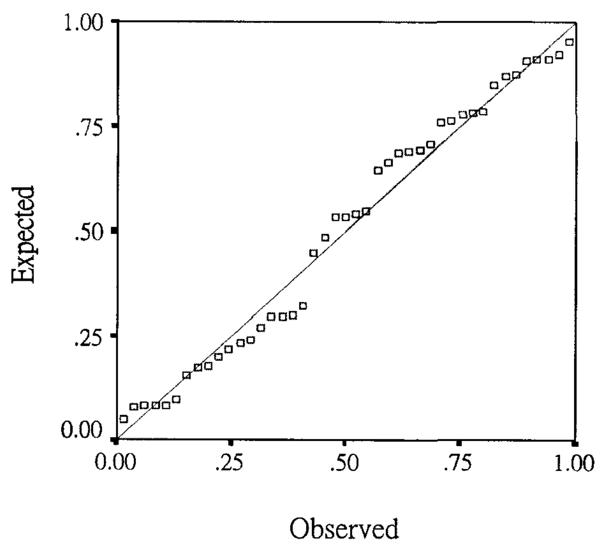
Scatterplot

Dependent Variable: Project Success Index



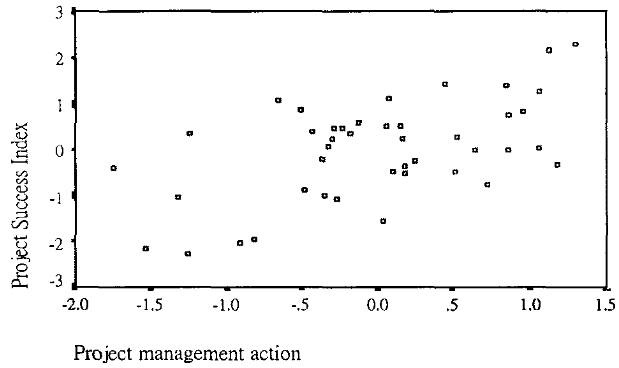
Normal P-P Plot of Regression Standardized Residual

Dependent Variable: Project Success Index



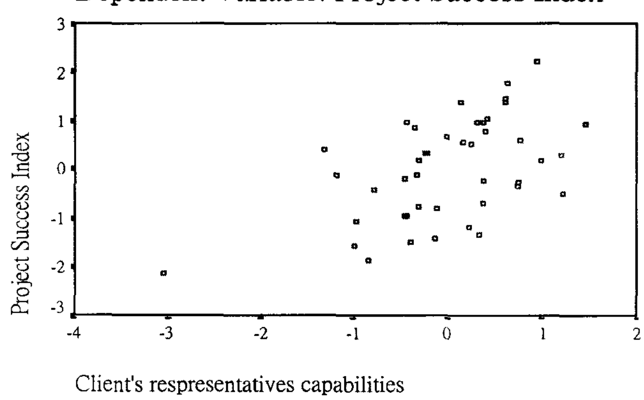
Partial Regression Plot

Dependent Variable: Project Success Index



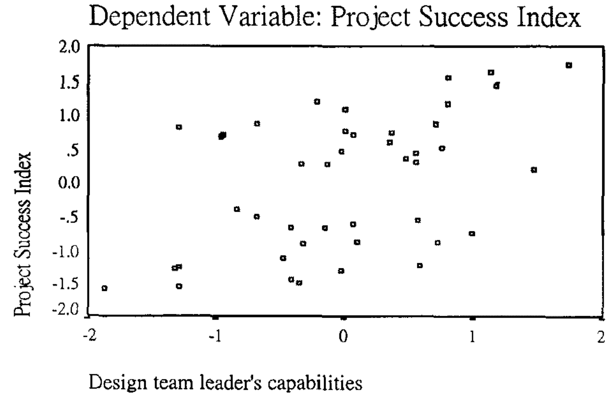
Partial Regression Plot

Dependent Variable: Project Success Index



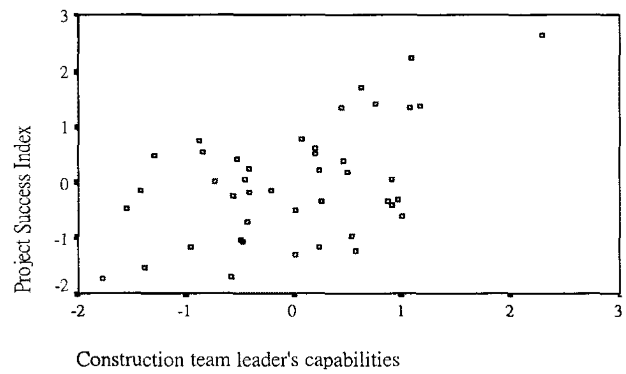
Partial Regression Plot

Dependent Variable: Project Success Index



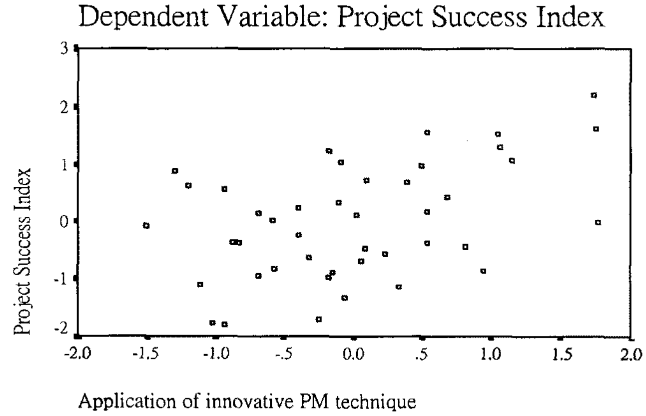
Partial Regression Plot

Dependent Variable: Project Success Index



Partial Regression Plot

Dependent Variable: Project Success Index



Descriptive Statistics

	Mean	Std. Deviation	N
Time Performance	3.8372	.78468	43
Project Management Actions	.0712010	1.01464457	43
Client Abilities	.0776396	1.01806007	43
Design team leader's Capabilities	.1042976	1.04022321	43
External Environment	.0551890	1.05779608	43
Application of Innovative PM Technique	.0520216	.95393122	43
Client representatives' Capabilities	.1071463	1.01808006	43
Construction team leader's Capabilities	.0708035	.93148427	43
Client emphasis on cost and time performance	.0374546	.99517133	43
Nature of Project	-.0727222	.92062724	43
Support by Parent Company	.0380697	.99399344	43

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Client representatives' Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Client emphasis on cost and time performance	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Time Performance

Model Summary[c]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.491	.241	.222	.69193	.241	13.014	1	41	.001
2	.580	.336	.303	.65512	.095	5.737	1	40	.021

a Predictors: (Constant), Client representatives' Capabilities
b Predictors: (Constant), Client representatives' Capabilities, Client emphasis on cost and time performance
c Dependent Variable: Time Performance

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	6.231	1	6.231	13.014	.001[a]
	Residual	19.630	41	.479		
	Total	25.860	42			
2	Regression	8.693	2	4.346	10.127	.000[b]
	Residual	17.168	40	.429		
	Total	25.860	42			

a Predictors: (Constant), Client representatives' Capabilities
b Predictors: (Constant), Client representatives' Capabilities, Client emphasis on cost and time performance
c Dependent Variable: Time Performance

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	3.797	.106		35.779	.000		
	Client representatives' Capabilities	.378	.105	.491	3.608	.001	1.000	1.000
2	(Constant)	3.787	.101		37.670	.000		
	Client representatives' Capabilities	.379	.099	.492	3.817	.000	1.000	1.000
	Client emphasis on cost and time performance	.243	.102	.309	2.395	.021	1.000	1.000

a Dependent Variable: Time Performance

Excluded Variables[c]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance	Collinearity Statistics VIF	Collinearity Statistics Minimum Tolerance
1	Project Management Actions	.070[a]	.434	.667	.068	.729	1.372	.729
	Client Abilities	.019[a]	.120	.905	.019	.732	1.367	.732
	Design team leader's Capabilities	.040[a]	.288	.775	.045	.991	1.009	.991
	External Environment	-.091[a]	-.645	.522	-.102	.943	1.061	.943
	Application of Innovative PM Technique	-.010[a]	-.063	.950	-.010	.823	1.215	.823
	Construction team leader's Capabilities	.046[a]	.325	.747	.051	.937	1.067	.937
	Client emphasis on cost and time performance	.309[a]	2.395	.021	.354	1.000	1.000	1.000
	Nature of Project	.235[a]	1.652	.106	.253	.879	1.137	.879
	Support by Parent Company	-.165[a]	-1.216	.231	-.189	.995	1.005	.995
2	Project Management Actions	.078[b]	.513	.611	.082	.728	1.373	.728
	Client Abilities	.065[b]	.424	.674	.068	.720	1.388	.720
	Design team leader's Capabilities	-.019[b]	-.140	.889	-.022	.957	1.045	.957
	External Environment	-.154[b]	-1.148	.258	-.181	.911	1.097	.911
	Application of Innovative PM Technique	.117[b]	.771	.446	.122	.732	1.366	.732
	Construction team leader's Capabilities	.126[b]	.918	.364	.145	.888	1.126	.888
	Nature of Project	.182[b]	1.317	.196	.206	.852	1.174	.852
	Support by Parent Company	-.112[b]	-.848	.401	-.135	.962	1.040	.962

a Predictors in the Model: (Constant), Client representatives' Capabilities
b Predictors in the Model: (Constant), Client representatives' Capabilities, Client emphasis on cost and time performance
c Dependent Variable: Time Performance

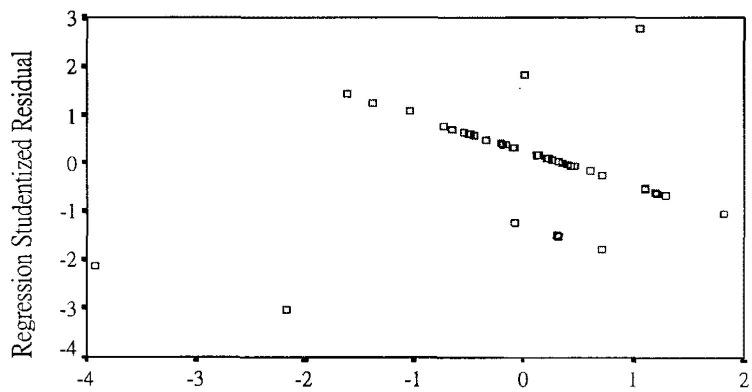
Coefficient Correlations[a]

Model			Client representatives' Capabilities	Client emphasis on cost and time performance
1	Correlations	Client representatives' Capabilities	1.000	
	Covariances	Client representatives' Capabilities	1.100E-02	
2	Correlations	Client representatives' Capabilities	1.000	.003
		Client emphasis on cost and time performance	.003	1.000
	Covariances	Client representatives' Capabilities	9.859E-03	2.971E-05
		Client emphasis on cost and time performance	2.971E-05	1.032E-02

a Dependent Variable: Time Performance

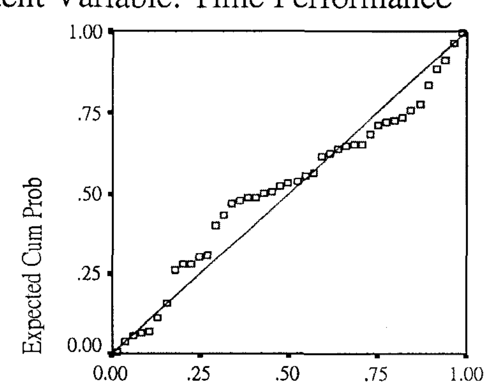
Scatterplot

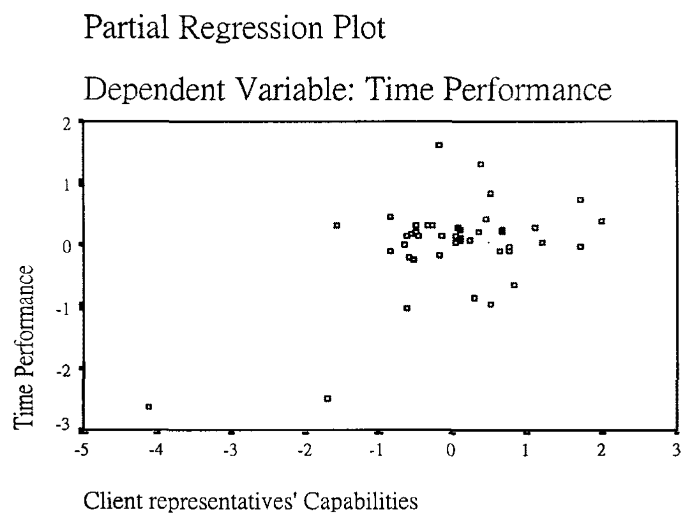
Dependent Variable: Time Performance

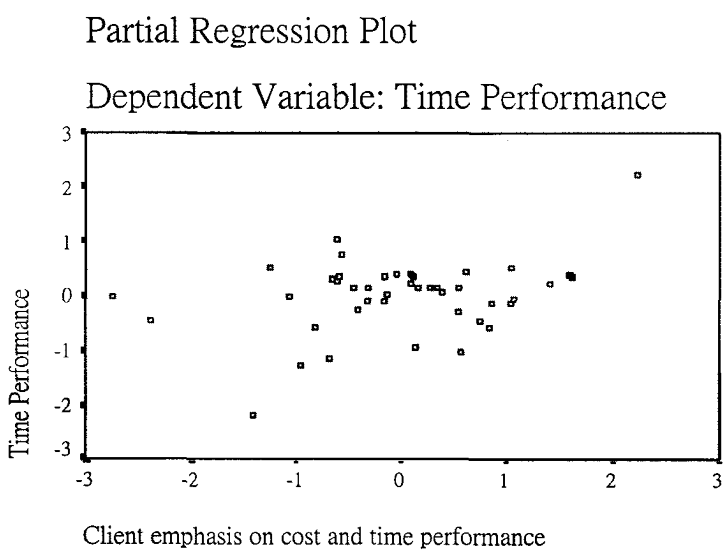


P Plot of Regression Standardized Residual

Dependent Variable: Time Performance




Partial Regression Plot
Dependent Variable: Time Performance
Time Performance
2
1
0
-1
-2
-3
-5
-4
-3
-2
-1
0
1
2
3
Client representatives' Capabilities


Partial Regression Plot
Dependent Variable: Time Performance
Time Performance
3
2
1
0
-1
-2
-3
-3
-2
-1
0
1
2
3
Client emphasis on cost and time performance

Descriptive Statistics

	Mean	Std. Deviation	N
Time Performance	5.2000	1.54626	45
Project management Action	.0167248	1.02327504	45
Client Abilities	-.0229989	1.04030220	45
Design team leader's Capabilities	-.0923968	1.00776274	45
External Environment	-.0108344	1.03652465	45
Application of Innovative PM Technique	.0206918	1.04461582	45
Client's Representative's Capabilities	-.0497605	1.03301387	45
Construction Team Leaders Capabilities	-.0259115	1.00291898	45
Client emphasis on cost and time performance	.0890950	1.02218547	45
Nature of Project	-.0594188	1.00450339	45
Support by parent company	.0535060	.98998200	45

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Project management Action	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Client Abilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Time Performance

Model Summary

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.764	.583	.573	1.01012	.583	60.102	1	43	.000
2	.839	.703	.689	.86209	.120	17.035	1	42	.000

a Predictors: (Constant), Project management Action
b Predictors: (Constant), Project management Action, Client Abilities
c Dependent Variable: Time Performance

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	61.325	1	61.325	60.102	.000[a]
	Residual	43.875	43	1.020		
	Total	105.200	44			
2	Regression	73.986	2	36.993	49.775	.000[b]
	Residual	31.214	42	.743		
	Total	105.200	44			

a Predictors: (Constant), Project management Action
b Predictors: (Constant), Project management Action, Client Abilities
c Dependent Variable: Time Performance

Coefficients

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	5.181	.151		34.400	.000		
	Project management Action	1.154	.149	.764	7.753	.000	1.000	1.000
2	(Constant)	5.197	.129		40.415	.000		
	Project management Action	.945	.137	.625	6.912	.000	.863	1.159
	Client Abilities	.555	.134	.373	4.127	.000	.863	1.159

a Dependent Variable: Time Performance

Excluded Variables

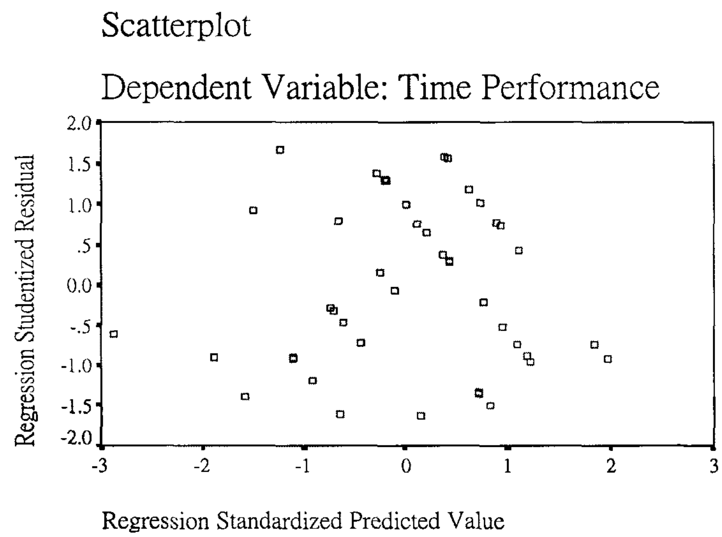
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance	Collinearity Statistics VIF	Collinearity Statistics Minimum Tolerance
1	Client Abilities	.373[a]	4.127	.000	.537	.863	1.159	.863
	Design team leader's Capabilities	.248[a]	2.663	.011	.380	.976	1.025	.976
	External Environment	.024[a]	.234	.816	.036	.917	1.090	.917
	Application of Innovative PM Technique	.153[a]	1.472	.148	.222	.877	1.140	.877
	Client's Representative's Capabilities	.341[a]	3.121	.003	.434	.677	1.478	.677
	Construction Team Leaders Capabilities	.022[a]	.200	.843	.031	.820	1.219	.820
	Client emphasis on cost and time performance	.112[a]	1.131	.264	.172	.991	1.009	.991
	Nature of Project	.066[a]	.666	.509	.102	.995	1.005	.995
	Support by parent company	-.148[a]	-1.459	.152	-.220	.919	1.088	.919
2	Design team leader's Capabilities	.126[b]	1.363	.180	.208	.812	1.231	.718
	External Environment	-.019[b]	-.214	.832	-.033	.904	1.106	.781
	Application of Innovative PM Technique	.116[b]	1.291	.204	.198	.868	1.152	.787
	Client's Representative's Capabilities	.185[b]	1.634	.110	.247	.531	1.883	.531
	Construction Team Leaders Capabilities	-.101[b]	-1.035	.307	-.160	.748	1.337	.748
	Client emphasis on cost and time performance	.102[b]	1.216	.231	.187	.991	1.009	.855
	Nature of Project	-.001[b]	-.017	.986	-.003	.958	1.044	.830
	Support by parent company	-.161[b]	-1.897	.065	-.284	.918	1.089	.808

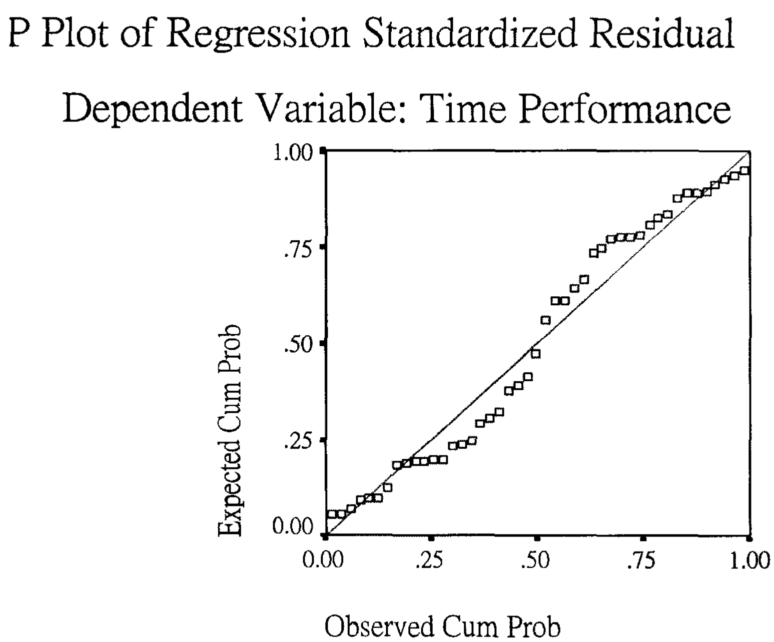
a Predictors in the Model: (Constant), Project management Action
b Predictors in the Model: (Constant), Project management Action, Client Abilities
c Dependent Variable: Time Performance

Coefficient Correlations

Model			Project management Action	Client Abilities
1	Correlations	Project management Action	1.000	
	Covariances	Project management Action	2.215E-02	
2	Correlations	Project management Action	1.000	-.370
		Client Abilities	-.370	1.000
	Covariances	Project management Action	1.869E-02	-6.803E-03
		Client Abilities	-6.803E-03	1.808E-02

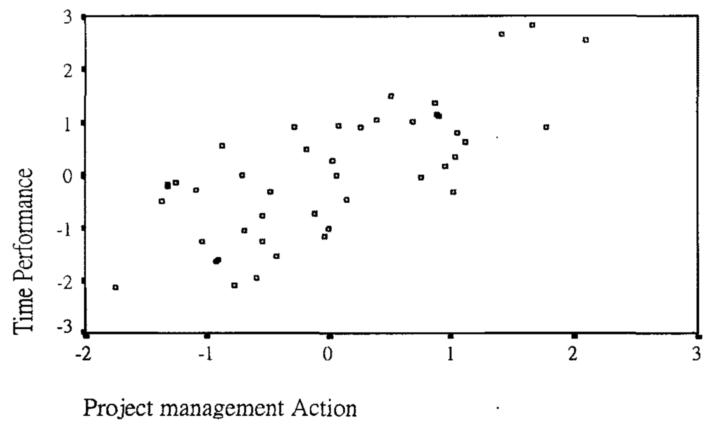
a Dependent Variable: Time Performance


Scatterplot
Dependent Variable: Time Performance
Regression Studentized Residual
2.0
1.5
1.0
.5
0.0
-.5
-1.0
-1.5
-2.0
-3
-2
-1
0
1
2
3
Regression Standardized Predicted Value


P Plot of Regression Standardized Residual
Dependent Variable: Time Performance
Expected Cum Prob
1.00
.75
.50
.25
0.00
0.00
.25
.50
.75
1.00
Observed Cum Prob

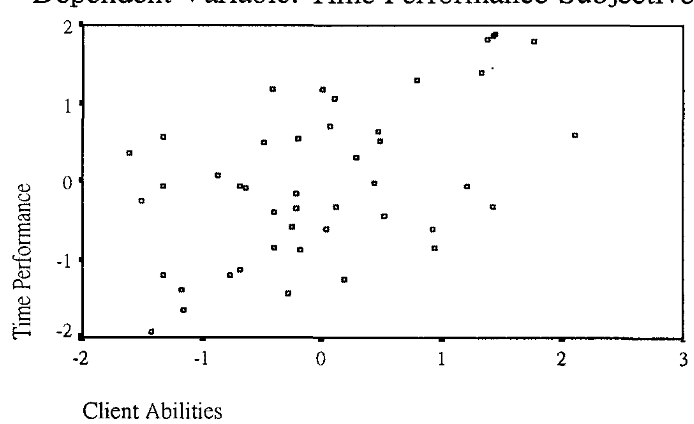
Partial Regression Plot

Dependent Variable: Time Performance (subjective)



Partial Regression Plot

Dependent Variable: Time Performance Subjective



Descriptive Statistics

	Mean	Std. Deviation	N
Cost Performance	3.7429	.74134	35
Project Management Actions	.0458210	1.01698390	35
Client Abilities	.0734795	1.00889516	35
Design team leader's Capabilities	.1384112	.97780867	35
External Environment	-.0503491	.92650832	35
Application of Innovative PM Technique	.0130698	.88111739	35
Client representatives' Capabilities	.0908843	1.03341723	35
Construction team leader's Capabilities	.1280611	1.01091256	35
Client emphasis on cost and time performance	.0085995	.95575853	35
Nature of Project	-.0176103	.99100912	35
Support by Parent Company	.1856664	.89575587	35

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Client representatives' Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Design team leader's Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Cost Performance

Model Summary[c]

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.758	.574	.562	.49086	.574	44.553	1	33	.000
2	.926	.857	.848	.28871	.283	63.393	1	32	.000

a Predictors: (Constant), Client representatives' Capabilities
b Predictors: (Constant), Client representatives' Capabilities, Design team leader's Capabilities
c Dependent Variable: Cost Performance

ANOVA[c]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	10.735	1	10.735	44.553	.000[a]
	Residual	7.951	33	.241		
	Total	18.686	34			
2	Regression	16.018	2	8.009	96.091	.000[b]
	Residual	2.667	32	.083		
	Total	18.686	34			

a Predictors: (Constant), Client representatives' Capabilities
b Predictors: (Constant), Client representatives' Capabilities, Design team leader's Capabilities
c Dependent Variable: Cost Performance

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	3.693	.083		44.339	.000		
	Client representatives' Capabilities	.544	.081	.758	6.675	.000	1.000	1.000
2	(Constant)	3.641	.049		73.674	.000		
	Client representatives' Capabilities	.497	.048	.693	10.298	.000	.985	1.015
	Design team leader's Capabilities	.406	.051	.536	7.962	.000	.985	1.015

a Dependent Variable: Cost Performance

Excluded Variables[c]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance	Collinearity Statistics VIF	Collinearity Statistics Minimum Tolerance
1	Project Management Actions	.326[a]	2.550	.016	.411	.677	1.476	.677
	Client Abilities	.244[a]	1.638	.111	.278	.554	1.806	.554
	Design team leader's Capabilities	.536[a]	7.962	.000	.815	.985	1.015	.985
	External Environment	.086[a]	.717	.479	.126	.919	1.088	.919
	Application of Innovative PM Technique	-.046[a]	-.357	.723	-.063	.796	1.256	.796
	Construction team leader's Capabilities	.134[a]	1.132	.266	.196	.907	1.102	.907
	Client emphasis on cost and time performance	.022[a]	.189	.851	.033	.999	1.001	.999
	Nature of Project	.149[a]	1.248	.221	.215	.894	1.119	.894
	Support by Parent Company	-.099[a]	-.868	.392	-.152	.999	1.001	.999
2	Project Management Actions	.126[b]	1.495	.145	.259	.604	1.657	.604
	Client Abilities	.048[b]	.510	.614	.091	.511	1.958	.511
	External Environment	.044[b]	.624	.537	.111	.914	1.094	.901
	Application of Innovative PM Technique	.067[b]	.880	.386	.156	.769	1.301	.767
	Construction team leader's Capabilities	-.046[b]	-.613	.544	-.109	.818	1.223	.818
	Client emphasis on cost and time performance	.013[b]	.187	.853	.034	.999	1.001	.984
	Nature of Project	.011[b]	.143	.888	.026	.840	1.191	.840
	Support by Parent Company	-.048[b]	-.708	.484	-.126	.990	1.010	.976

a Predictors in the Model: (Constant), Client representatives' Capabilities
b Predictors in the Model: (Constant), Client representatives' Capabilities, Design team leader's Capabilities
c Dependent Variable: Cost Performance

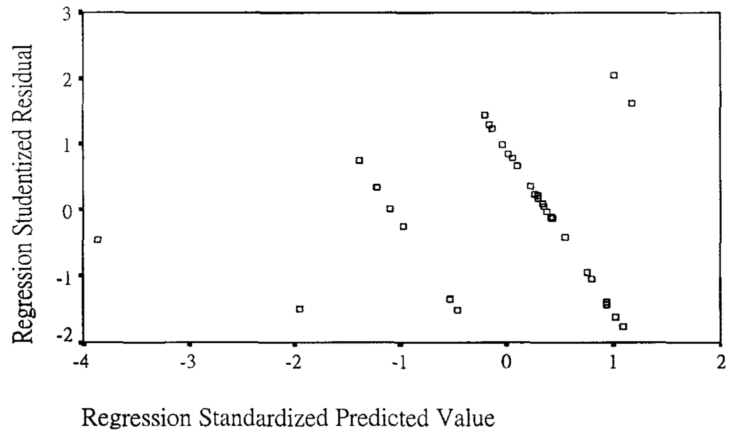
Coefficient Correlations[a]

Model			Client representatives' Capabilities	Design team leader's Capabilities
1	Correlations	Client representatives' Capabilities	1.000	
	Covariances	Client representatives' Capabilities	6.636E-03	
2	Correlations	Client representatives' Capabilities	1.000	-.121
		Design team leader's Capabilities	-.121	1.000
	Covariances	Client representatives' Capabilities	2.330E-03	-2.989E-04
		Design team leader's Capabilities	-2.989E-04	2.602E-03

a Dependent Variable: Cost Performance

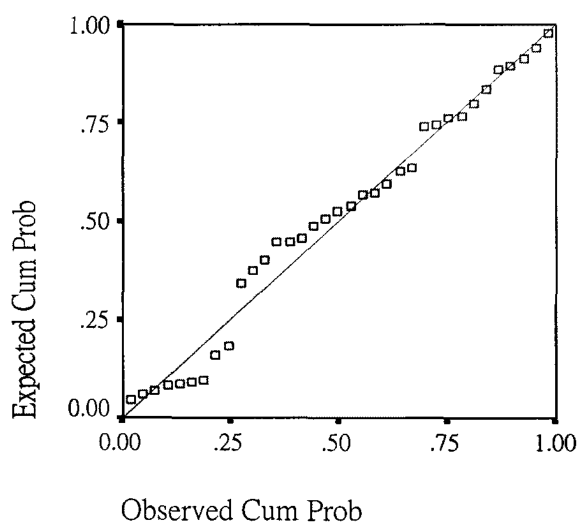
Scatterplot

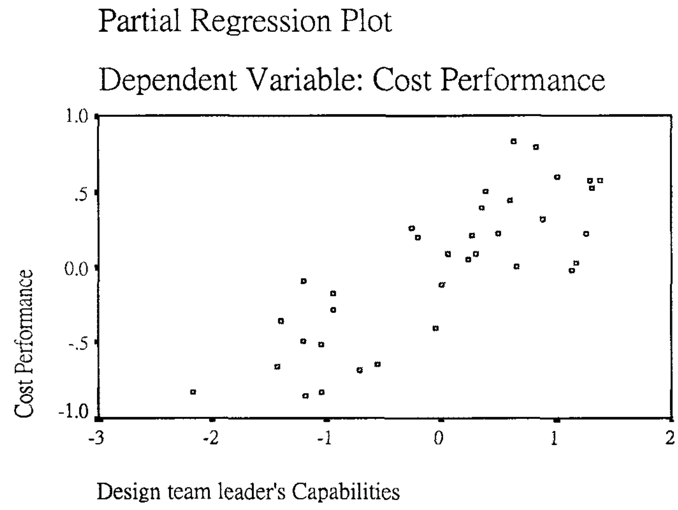
Dependent Variable: Cost Performance

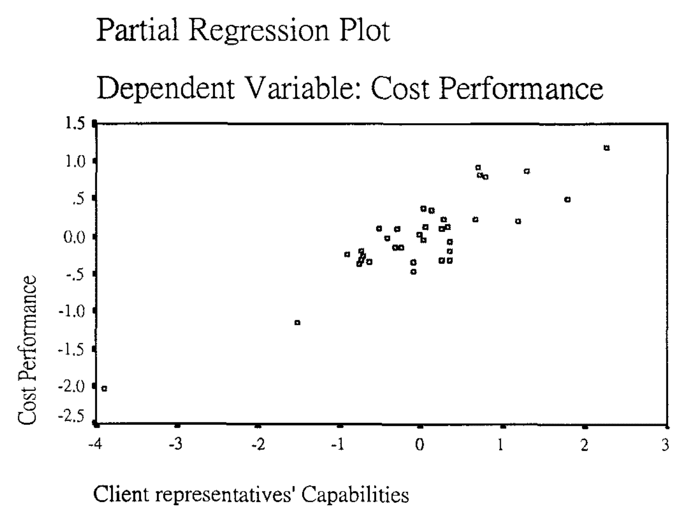


P Plot of Regression Standardized Residual

Dependent Variable: Cost Performance




Partial Regression Plot
Dependent Variable: Cost Performance
Cost Performance
1.0
.5
0.0
-.5
-1.0
-3
-2
-1
0
1
2
Design team leader's Capabilities


Partial Regression Plot
Dependent Variable: Cost Performance
Cost Performance
1.5
1.0
.5
0.0
-.5
-1.0
-1.5
-2.0
-2.5
-4
-3
-2
-1
0
1
2
3
Client representatives' Capabilities

Descriptive Statistics

	Mean	Std. Deviation	N
Quality	5.3065	.91903	31
Project Management Actions	.2024604	1.01725285	31
Client Abilities	.0102799	1.08139163	31
Design team leader's Capabilities	-.0533271	.97103515	31
External Environment	-.1778971	.93496484	31
Application of Innovative PM Technique	.2178378	1.07365533	31
Client representatives' Capabilities	.1943771	.93022335	31
Construction team leader's Capabilities	.0707733	.99563490	31
Client emphasis on cost and time performance	-.2394599	1.01644170	31
Nature of Project	.0639077	.86820519	31
Support by Parent Company	.2462573	.88874251	31

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Project Management Actions	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Design team leader's Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Application of Innovative PM Technique	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Construction team leader's Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Quality

Model Summary[e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.905	.818	.812	.39863	.818	130.456	1	29	.000
2	.930	.865	.855	.34981	.047	9.659	1	28	.004
3	.978	.957	.952	.20187	.092	57.078	1	27	.000
4	.983	.966	.960	.18318	.009	6.791	1	26	.015

a Predictors: (Constant), Project Management Actions
b Predictors: (Constant), Project Management Actions, Design team leader's Capabilities
c Predictors: (Constant), Project Management Actions, Design team leader's Capabilities, Application of Innovative PM Technique
d Predictors: (Constant), Project Management Actions, Design team leader's Capabilities, Application of Innovative PM Technique, Construction team leader's Capabilities
e Dependent Variable: Quality

ANOVA[e]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	20.730	1	20.730	130.456	.000[a]
	Residual	4.608	29	.159		
	Total	25.339	30			
2	Regression	21.912	2	10.956	89.535	.000[b]
	Residual	3.426	28	.122		
	Total	25.339	30			
3	Regression	24.238	3	8.079	198.263	.000[c]
	Residual	1.100	27	.041		
	Total	25.339	30			
4	Regression	24.466	4	6.117	182.288	.000[d]
	Residual	.872	26	.034		
	Total	25.339	30			

a Predictors: (Constant), Project Management Actions
b Predictors: (Constant), Project Management Actions, Design team leader's Capabilities
c Predictors: (Constant), Project Management Actions, Design team leader's Capabilities, Application of Innovative PM Technique
d Predictors: (Constant), Project Management Actions, Design team leader's Capabilities, Application of Innovative PM Technique, Construction team leader's Capabilities
e Dependent Variable: Quality

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	5.141	.073		70.379	.000		
	Project Management Actions	.817	.072	.905	11.422	.000	1.000	1.000
2	(Constant)	5.161	.064		80.119	.000		
	Project Management Actions	.775	.064	.858	12.066	.000	.955	1.047
	Design team leader's Capabilities	.209	.067	.221	3.108	.004	.955	1.047
3	(Constant)	5.133	.037		137.415	.000		
	Project Management Actions	.610	.043	.675	14.174	.000	.709	1.411
	Design team leader's Capabilities	.328	.042	.346	7.825	.000	.821	1.218
	Application of Innovative PM Technique	.310	.041	.362	7.555	.000	.699	1.430
4	(Constant)	5.132	.034		151.420	.000		
	Project Management Actions	.574	.041	.635	13.852	.000	.630	1.588
	Design team leader's Capabilities	.309	.039	.326	7.978	.000	.792	1.263
	Application of Innovative PM Technique	.309	.037	.361	8.303	.000	.699	1.430
	Construction team leader's Capabilities	9.835E-02	.038	.107	2.606	.015	.792	1.262

a Dependent Variable: Quality

Excluded Variables[e]

Model		Beta In	t	Sig	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Client Abilities	.100 [a]	1.146	.261	.212	.816	1.226	.816
	Design team leader's Capabilities	.221 [a]	3.108	.004	.506	.955	1.047	.955
	External Environment	-.141 [a]	-1.842	.076	-.329	.993	1.007	.993
	Application of Innovative PM Technique	.222 [a]	2.808	.009	.469	.814	1.229	.814
	Client representatives' Capabilities	.055 [a]	.533	.598	.100	.600	1.667	.600
	Construction team leader's Capabilities	.153 [a]	1.817	.080	.325	.825	1.212	.825
	Client emphasis on cost and time performance	-.055 [a]	-.668	.510	-.125	.929	1.076	.929
	Nature of Project	-.029 [a]	-.361	.720	-.068	.974	1.027	.974
	Support by Parent Company	-.011 [a]	-.127	.900	-.024	.939	1.065	.939
2	Client Abilities	.066 [b]	.841	.407	.160	.798	1.254	.798
	External Environment	-.149 [b]	-2.297	.030	-.404	.992	1.008	.948
	Application of Innovative PM Technique	.362 [b]	7.555	.000	.824	.699	1.430	.699
	Client representatives' Capabilities	.128 [b]	1.411	.170	.262	.566	1.765	.542
	Construction team leader's Capabilities	.109 [b]	1.427	.165	.265	.792	1.262	.792
	Client emphasis on cost and time performance	-.076 [b]	-1.058	.299	-.200	.922	1.085	.899
	Nature of Project	-.093 [b]	-1.289	.208	-.241	.907	1.102	.890
	Support by Parent Company	-.034 [b]	-.465	.645	-.089	.929	1.077	.908
3	Client Abilities	.007 [c]	.152	.880	.030	.774	1.293	.653
	External Environment	-.037 [c]	-.853	.402	-.165	.844	1.185	.595
	Client representatives' Capabilities	.005 [c]	.087	.931	.017	.513	1.949	.509
	Construction team leader's Capabilities	.107 [c]	2.606	.015	.455	.792	1.262	.630
	Client emphasis on cost and time performance	-.010 [c]	-.228	.821	-.045	.880	1.136	.639
	Nature of Project	-.048 [c]	-1.132	.268	-.217	.888	1.126	.685
	Support by Parent Company	-.012 [c]	-.287	.776	-.056	.924	1.082	.672
4	Client Abilities	-.027 [d]	-.618	.542	-.123	.706	1.416	.609
	External Environment	-.025 [d]	-.629	.535	-.125	.832	1.202	.594
	Client representatives' Capabilities	.005 [d]	.101	.921	.020	.513	1.949	.467
	Client emphasis on cost and time performance	.024 [d]	.583	.565	.116	.794	1.260	.528
	Nature of Project	-.011 [d]	-.247	.807	-.049	.755	1.324	.630
	Support by Parent Company	-.037 [d]	-.956	.348	-.188	.874	1.144	.617

a Predictors in the Model: (Constant), Project Management Actions
b Predictors in the Model: (Constant), Project Management Actions, Design team leader's Capabilities
c Predictors in the Model: (Constant), Project Management Actions, Design team leader's Capabilities, Application of Innovative PM Technique
d Predictors in the Model: (Constant), Project Management Actions, Design team leader's Capabilities, Application of Innovative PM Technique, Construction team leader's Capabilities
e Dependent Variable: Quality

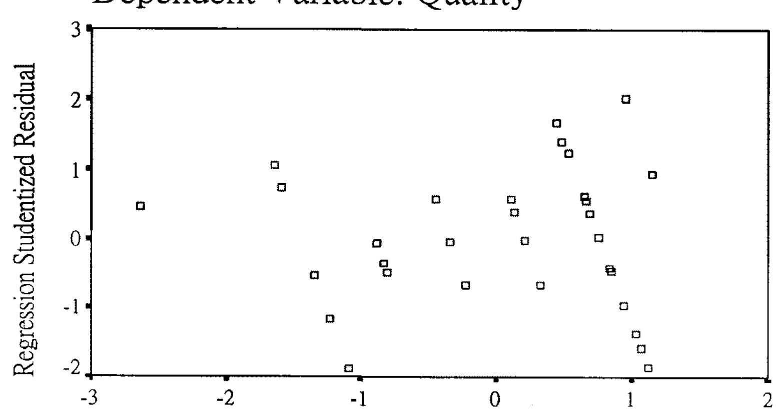
Coefficient Correlations[a]

Model			Project Management Actions	Design team leader's Capabilities	Application of Innovative PM Technique	Construction team leader's Capabilities
1	Correlations	Project Management Actions	1.000			
	Covariances	Project Management Actions	5.119E-03			
2	Correlations	Project Management Actions	1.000	-.211		
		Design team leader's Capabilities	-.211	1.000		
	Covariances	Project Management Actions	4.126E-03	-9.124E-04		
		Design team leader's Capabilities	-9.124E-04	4.528E-03		
3	Correlations	Project Management Actions	1.000	-.359	-.508	
		Design team leader's Capabilities	-.359	1.000	.375	
		Application of Innovative PM Technique	-.508	.375	1.000	
	Covariances	Project Management Actions	1.852E-03	-6.470E-04	-8.971E-04	
		Design team leader's Capabilities	-6.470E-04	1.754E-03	6.445E-04	
		Application of Innovative PM Technique	-8.971E-04	6.445E-04	1.685E-03	
4	Correlations	Project Management Actions	1.000	-.269	-.476	-.334
		Design team leader's Capabilities	-.269	1.000	.370	-.188
		Application of Innovative PM Technique	-.476	.370	1.000	-.009
		Construction team leader's Capabilities	-.334	-.188	-.009	1.000
	Covariances	Project Management Actions	1.716E-03	-4.318E-04	-7.343E-04	-5.224E-04
		Design team leader's Capabilities	-4.318E-04	1.498E-03	5.330E-04	-2.752E-04
		Application of Innovative PM Technique	-7.343E-04	5.330E-04	1.387E-03	-1.197E-05
		Construction team leader's Capabilities	-5.224E-04	-2.752E-04	-1.197E-05	1.424E-03

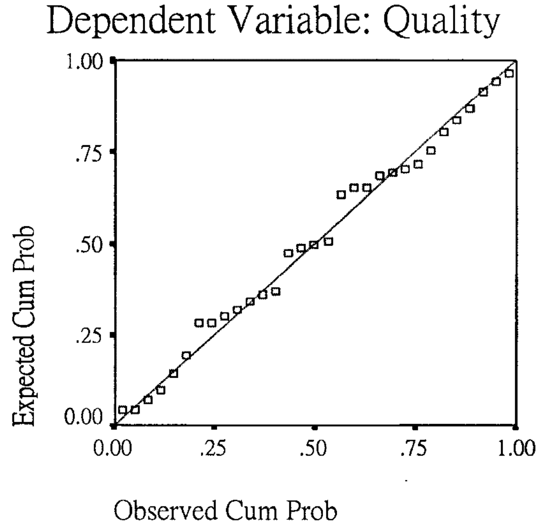
a Dependent Variable: Quality

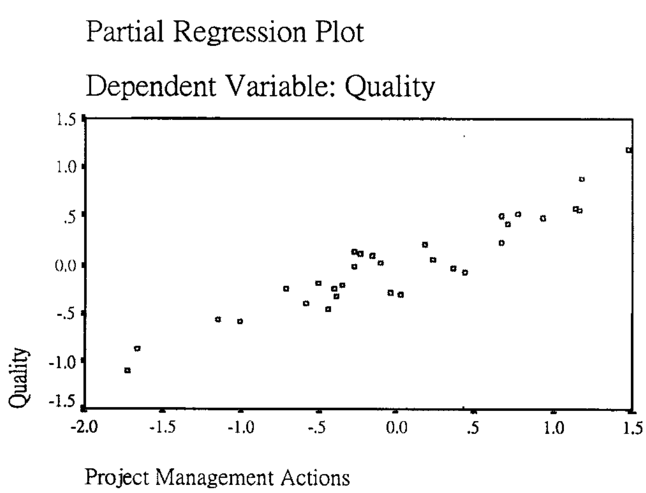
Scatterplot

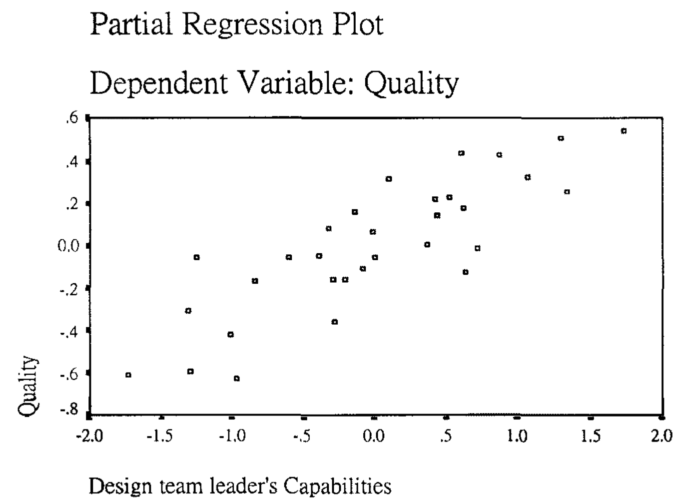
Dependent Variable: Quality

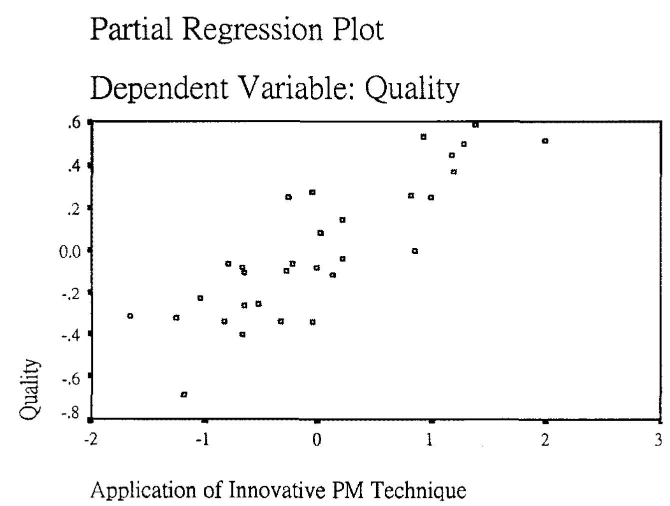


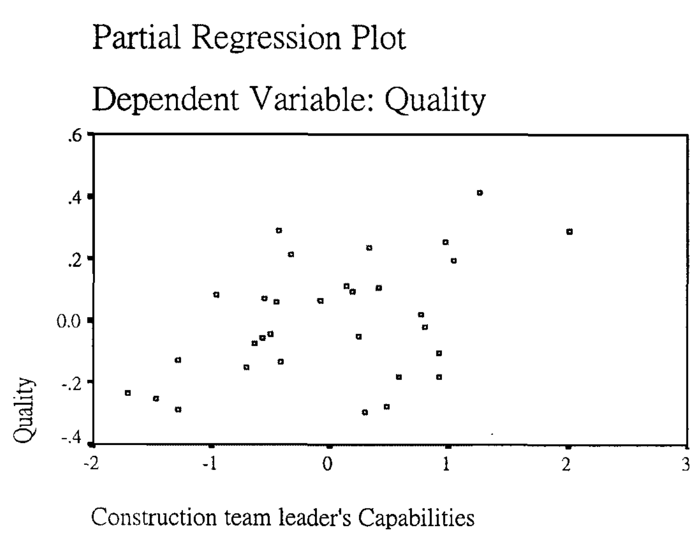
P Plot of Regression Standardized Residual






Partial Regression Plot
Dependent Variable: Quality
Quality
.6
.4
.2
0.0
-.2
-.4
-.6
-.8
-2.0
-1.5
-1.0
-.5
0.0
.5
1.0
1.5
2.0
Design team leader's Capabilities


Partial Regression Plot
Dependent Variable: Quality
Quality
.6
.4
.2
0.0
-.2
-.4
-.6
-.8
-2
-1
0
1
2
3
Application of Innovative PM Technique


Partial Regression Plot
Dependent Variable: Quality
Quality
.6
.4
.2
0.0
-.2
-.4
-2
-1
0
1
2
3
Construction team leader's Capabilities

Descriptive Statistics

	Mean	Std. Deviation	N
Functionality	5.4242	.79177	33
Project Management Actions	.1125775	1.04168823	33
Client Abilities	-.1277237	1.02289226	33
Design team leader's Capabilities	-.0724421	1.02721107	33
External Environment	-.0204746	1.01387039	33
Application of Innovative PM Technique	-.1032239	.90781448	33
Client representatives' Capabilities	-.0195689	1.15864332	33
Construction team leader's Capabilities	-.1643772	.95720741	33
Client emphasis on cost and time performance	-.0460691	.76654717	33
Nature of Project	-.0190855	1.07412485	33
Support by Parent Company	.1228528	.79280587	33

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Project Management Actions	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Functionality

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.875	.766	.758	.38910	.766	101.502	1	31	.000

a Predictors: (Constant), Project Management Actions
b Dependent Variable: Functionality

ANOVA[b]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	15.367	1	15.367	101.502	.000[a]
	Residual	4.693	31	.151		
	Total	20.061	32			

a Predictors: (Constant), Project Management Actions
b Dependent Variable: Functionality

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	5.349	.068		78.505	.000		
	Project Management Actions	.665	.066	.875	10.075	.000	1.000	1.000

a Dependent Variable: Functionality

Excluded Variables[b]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Client Abilities	-.035[a]	-.339	.737	-.062	.727	1.376	.727
	Design team leader's Capabilities	.090[a]	1.019	.317	.183	.961	1.041	.961
	External Environment	-.134[a]	-1.494	.146	-.263	.897	1.115	.897
	Application of Innovative PM Technique	.104[a]	1.033	.310	.185	.749	1.335	.749
	Client representatives' Capabilities	.132[a]	1.192	.242	.213	.609	1.641	.609
	Construction team leader's Capabilities	.041[a]	.418	.679	.076	.814	1.229	.814
	Client emphasis on cost and time performance	.009[a]	.097	.924	.018	.943	1.061	.943
	Nature of Project	-.013[a]	-.146	.885	-.027	1.000	1.000	1.000
	Support by Parent Company	-.006[a]	-.071	.944	-.013	.963	1.039	.963

a Predictors in the Model: (Constant), Project Management Actions
b Dependent Variable: Functionality

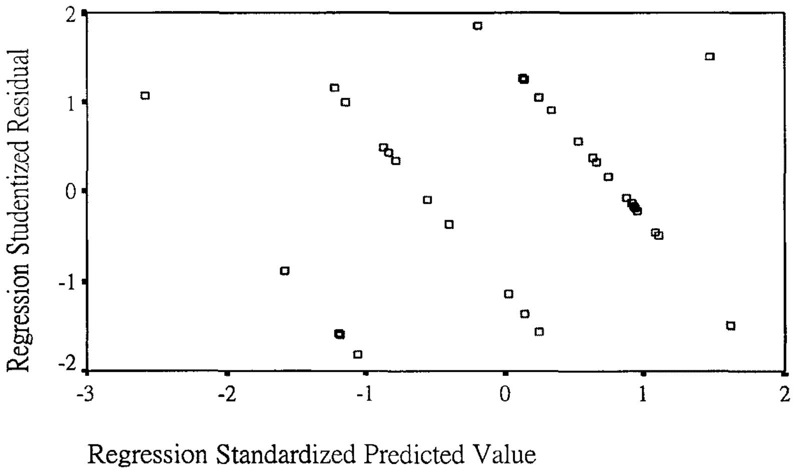
Coefficient Correlations

Model			Project Management Actions
1	Correlations	Project Management Actions	1.000
	Covariances	Project Management Actions	4.360E-03

a Dependent Variable: Functionality

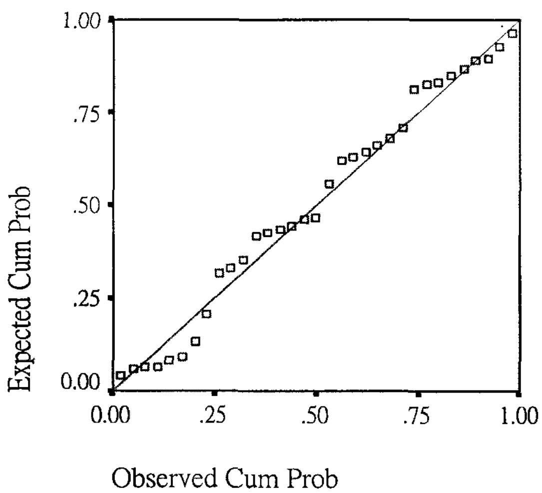
Scatterplot

Dependent Variable: Functionality



P Plot of Regression Standardized Residual

Dependent Variable: Functionality



Descriptive Statistics

	Mean	Std. Deviation	N
Safety	5.4839	.88961	31
Project Management Actions	.0483596	1.04225608	31
Client Abilities	.0661540	1.17259718	31
Design team leader's Capabilities	-.0604713	1.10653177	31
External Environment	.0585258	1.00489925	31
Application of Innovative PM Technique	.0693218	1.09718869	31
Client representatives' Capabilities	-.0819826	1.17342495	31
Construction team leader's Capabilities	-.0137128	.92237353	31
Client emphasis on cost and time performance	.0451362	1.06796636	31
Nature of Project	-.0660464	1.12013566	31
Support by Parent Company	.0661957	1.04782226	31

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Project Management Actions	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Nature of Project	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Design team leader's Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Application of Innovative PM Technique	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Safety

Model Summary[e]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.590	.348	.326	.73034	.348	15.511	1	29	.000
2	.799	.639	.613	.55339	.290	22.511	1	28	.000
3	.906	.821	.801	.39719	.182	27.353	1	27	.000
4	.949	.900	.885	.30168	.080	20.802	1	26	.000

a Predictors: (Constant), Project Management Actions
b Predictors: (Constant), Project Management Actions, Nature of Project
c Predictors: (Constant), Project Management Actions, Nature of Project, Design team leader's Capabilities
d Predictors: (Constant), Project Management Actions, Nature of Project, Design team leader's Capabilities, Application of Innovative PM Technique
e Dependent Variable: Safety

ANOVA[e]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	8.274	1	8.274	15.511	.000[a]
	Residual	15.468	29	.533		
	Total	23.742	30			
2	Regression	15.167	2	7.584	24.764	.000[b]
	Residual	8.575	28	.306		
	Total	23.742	30			
3	Regression	19.482	3	6.494	41.165	.000[c]
	Residual	4.259	27	.158		
	Total	23.742	30			
4	Regression	21.376	4	5.344	58.718	.000[d]
	Residual	2.366	26	.091		
	Total	23.742	30			

a Predictors: (Constant), Project Management Actions
b Predictors: (Constant), Project Management Actions, Nature of Project
c Predictors: (Constant), Project Management Actions, Nature of Project, Design team leader's Capabilities
d Predictors: (Constant), Project Management Actions, Nature of Project, Design team leader's Capabilities, Application of Innovative PM Technique
e Dependent Variable: Safety

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	5.460	.131		41.575	.000		
	Project Management Actions	.504	.128	.590	3.938	.000	1.000	1.000
2	(Constant)	5.430	.100		54.471	.000		
	Project Management Actions	.523	.097	.612	5.388	.000	.998	1.002
	Nature of Project	-.428	.090	-.539	-4.745	.000	.998	1.002
3	(Constant)	5.449	.072		76.057	.000		
	Project Management Actions	.495	.070	.580	7.083	.000	.992	1.008
	Nature of Project	-.492	.066	-.619	-7.458	.000	.965	1.037
	Design team leader's Capabilities	.350	.067	.435	5.230	.000	.960	1.042
4	(Constant)	5.440	.054		99.920	.000		
	Project Management Actions	.268	.073	.314	3.689	.001	.529	1.891
	Nature of Project	-.568	.053	-.715	-10.759	.000	.868	1.153
	Design team leader's Capabilities	.511	.062	.636	8.257	.000	.646	1.548
	Application of Innovative PM Technique	.350	.077	.431	4.561	.000	.429	2.331

a Dependent Variable: Safety

Excluded Variables[e]

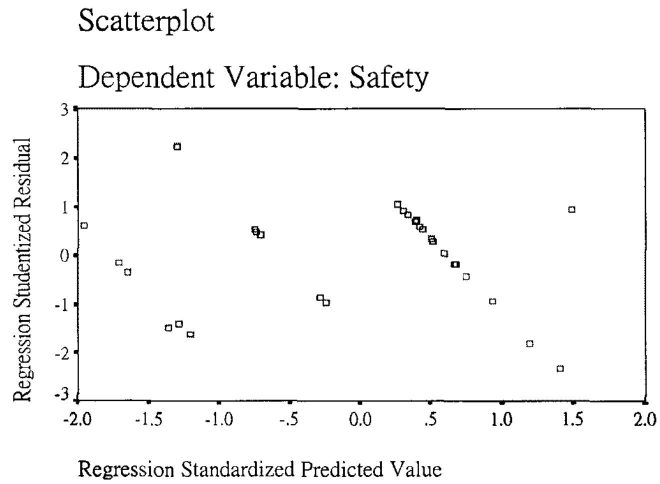
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Client Abilities	.076[a]	.460	.649	.087	.851	1.176	.851
	Design team leader's Capabilities	.321[a]	2.286	.030	.397	.993	1.007	.993
	External Environment	.110[a]	.681	.501	.128	.884	1.132	.884
	Application of Innovative PM Technique	-.128[a]	-.683	.500	-.128	.656	1.524	.656
	Client representatives' Capabilities	-.199[a]	-.905	.373	-.169	.470	2.129	.470
	Construction team leader's Capabilities	.243[a]	1.536	.136	.279	.856	1.168	.856
	Client emphasis on cost and time performance	.003[a]	.017	.987	.003	1.000	1.000	1.000
	Nature of Project	-.539[a]	-4.745	.000	-.668	.998	1.002	.998
	Support by Parent Company	.031[a]	.199	.844	.038	.960	1.042	.960
2	Client Abilities	.218[b]	1.795	.084	.327	.808	1.238	.808
	Design team leader's Capabilities	.435[b]	5.230	.000	.709	.960	1.042	.960
	External Environment	.042[b]	.339	.737	.065	.871	1.148	.871
	Application of Innovative PM Technique	-.015[b]	-.104	.918	-.020	.637	1.569	.637
	Client representatives' Capabilities	-.055[b]	-.319	.752	-.061	.454	2.205	.454
	Construction team leader's Capabilities	.099[b]	.771	.448	.147	.799	1.252	.799
	Client emphasis on cost and time performance	.077[b]	.665	.512	.127	.982	1.019	.980
	Support by Parent Company	-.187[b]	-1.545	.134	-.285	.840	1.191	.840
3	Client Abilities	.048[c]	.487	.630	.095	.695	1.438	.695
	External Environment	-.086[c]	-.943	.354	-.182	.810	1.235	.810
	Application of Innovative PM Technique	.431[c]	4.561	.000	.667	.429	2.331	.429
	Client representatives' Capabilities	.007[c]	.060	.952	.012	.449	2.226	.449
	Construction team leader's Capabilities	-.013[c]	-.139	.891	-.027	.755	1.324	.755
	Client emphasis on cost and time performance	.001[c]	.011	.991	.002	.951	1.052	.930
	Support by Parent Company	-.153[c]	-1.782	.086	-.330	.835	1.198	.835
4	Client Abilities	.022[d]	.286	.777	.057	.691	1.447	.426
	External Environment	-.010[d]	-.133	.895	-.027	.761	1.313	.404
	Client representatives' Capabilities	-.006[d]	-.061	.952	-.012	.449	2.228	.332
	Construction team leader's Capabilities	.014[d]	.197	.845	.039	.750	1.334	.426
	Client emphasis on cost and time performance	-.002[d]	-.031	.975	-.006	.951	1.052	.429
	Support by Parent Company	-.031[d]	-.407	.687	-.081	.693	1.443	.356

a Predictors in the Model: (Constant), Project Management Actions
b Predictors in the Model: (Constant), Project Management Actions, Nature of Project
c Predictors in the Model: (Constant), Project Management Actions, Nature of Project, Design team leader's Capabilities
d Predictors in the Model: (Constant), Project Management Actions, Nature of Project, Design team leader's Capabilities, Application of Innovative PM Technique
e Dependent Variable: Safety

Coefficient Correlations[a]

Model			Project Management Actions	Nature of Project	Design team leader's Capabilities	Application of Innovative PM Technique
1	Correlations	Project Management Actions	1.000			
	Covariances	Project Management Actions	1.637E-02			
2	Correlations	Project Management Actions	1.000	-.041		
		Nature of Project	-.041	1.000		
	Covariances	Project Management Actions	9.413E-03	-3.584E-04		
		Nature of Project	-3.584E-04	8.149E-03		
3	Correlations	Project Management Actions	1.000	-.026	-.077	
		Nature of Project	-.026	1.000	-.184	
		Design team leader's Capabilities	-.077	-.184	1.000	
	Covariances	Project Management Actions	4.878E-03	-1.198E-04	-3.583E-04	
		Nature of Project	-1.198E-04	4.345E-03	-8.096E-04	
		Design team leader's Capabilities	-3.583E-04	-8.096E-04	4.475E-03	
4	Correlations	Project Management Actions	1.000	.199	-.437	-.684
		Nature of Project	.199	1.000	-.324	-.317
		Design team leader's Capabilities	-.437	-.324	1.000	.572
		Application of Innovative PM Technique	-.684	-.317	.572	1.000
	Covariances	Project Management Actions	5.282E-03	7.629E-04	-1.965E-03	-3.807E-03
		Nature of Project	7.629E-04	2.787E-03	-1.060E-03	-1.284E-03
		Design team leader's Capabilities	-1.965E-03	-1.060E-03	3.835E-03	2.713E-03
		Application of Innovative PM Technique	-3.807E-03	-1.284E-03	2.713E-03	5.873E-03

a Dependent Variable: Safety


Scatterplot
Dependent Variable: Safety
Regression Studentized Residual
3
2
1
0
-1
-2
-3
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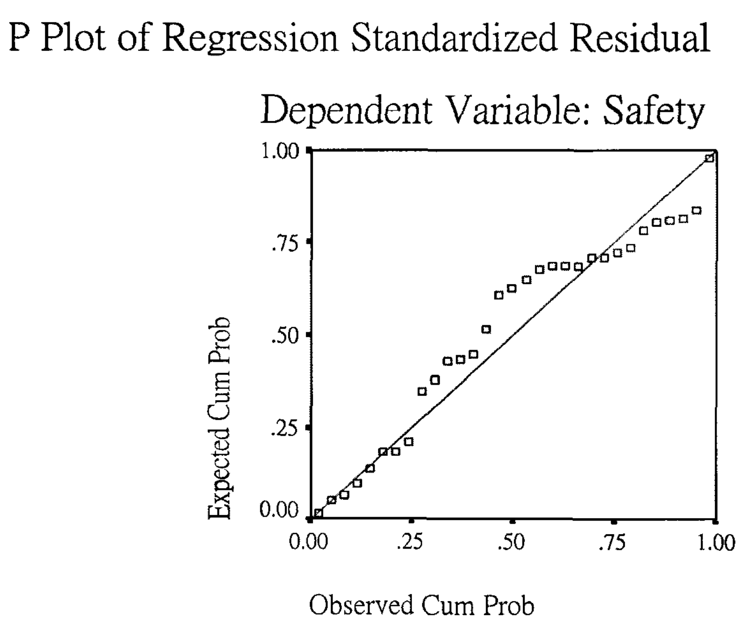
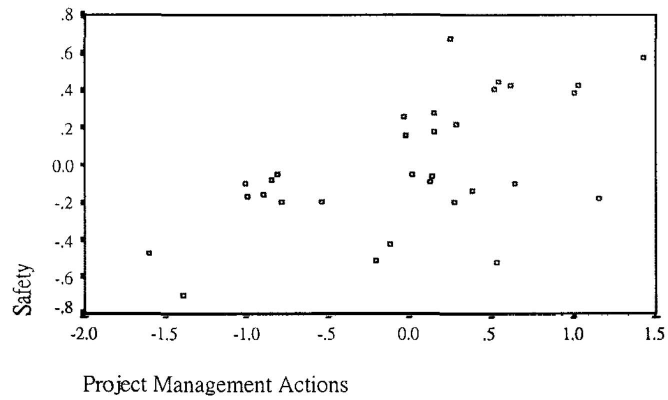
-1.5
-1.0
-.5
0.0
.5
1.0
1.5
2.0
Regression Standardized Predicted Value


P Plot of Regression Standardized Residual
Dependent Variable: Safety
Expected Cum Prob
1.00
.75
.50
.25
0.00
0.00
.25
.50
.75
1.00
Observed Cum Prob

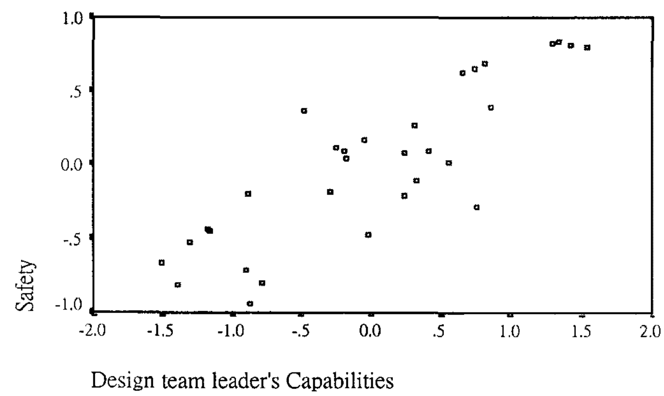
Partial Regression Plot

Dependent Variable: Safety



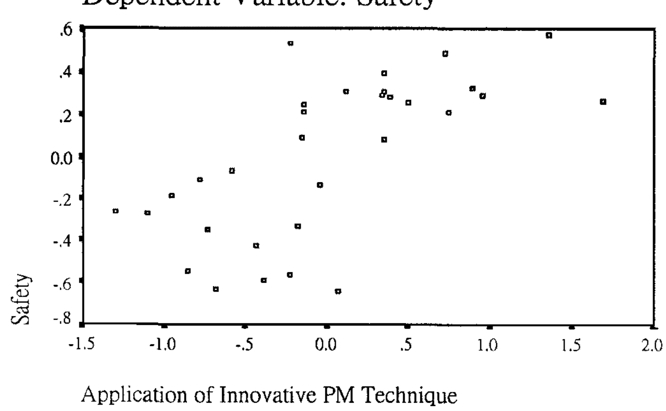
Partial Regression Plot

Dependent Variable: Safety



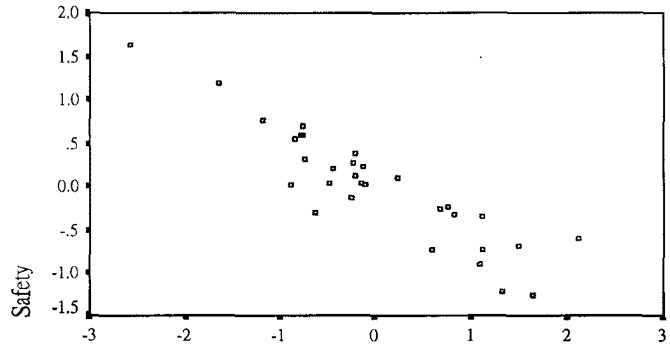
Partial Regression Plot

Dependent Variable: Safety



Partial Regression Plot

Dependent Variable: Safety



Nature of Project

Descriptive Statistics

	Mean	Std. Deviation	N
Environmental Friendliness	5.1212	.89294	33
Project Management Actions	-.0910702	.86834530	33
Client Abilities	.2573087	.97278767	33
Design team leader's Capabilities	.1163370	.96935109	33
External Environment	.1162858	1.10319012	33
Application of Innovative PM Technique	-.1137471	.97841051	33
Client representatives' Capabilities	.0817562	.83969686	33
Construction team leader's Capabilities	-.0635073	.91375585	33
Client emphasis on cost and time performance	.1082794	1.09820631	33
Nature of Project	.1559829	1.02285813	33
Support by Parent Company	.0059308	.98659372	33

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Project Management Actions	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Design team leader's Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Nature of Project	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Environmental Friendliness

Model Summary[d]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.698[a]	.487	.470	.64998	.487	29.394	1	31	.000
2	.830[b]	.688	.668	.51481	.202	19.417	1	30	.000
3	.908[c]	.825	.807	.39253	.136	22.600	1	29	.000

a Predictors: (Constant), Project Management Actions
b Predictors: (Constant), Project Management Actions, Design team leader's Capabilities
c Predictors: (Constant), Project Management Actions, Design team leader's Capabilities, Nature of Project
d Dependent Variable: Environmental Friendliness

ANOVA[d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	12.418	1	12.418	29.394	.000[a]
	Residual	13.097	31	.422		
	Total	25.515	32			
2	Regression	17.564	2	8.782	33.137	.000[b]
	Residual	7.951	30	.265		
	Total	25.515	32			
3	Regression	21.047	3	7.016	45.531	.000[c]
	Residual	4.468	29	.154		
	Total	25.515	32			

a Predictors: (Constant), Project Management Actions
b Predictors: (Constant), Project Management Actions, Design team leader's Capabilities
c Predictors: (Constant), Project Management Actions, Design team leader's Capabilities, Nature of Project
d Dependent Variable: Environmental Friendliness

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	5.187	.114		45.581	.000		
	Project Management Actions	.717	.132	.698	5.422	.000	1.000	1.000
2	(Constant)	5.125	.091		56.189	.000		
	Project Management Actions	.588	.109	.572	5.404	.000	.927	1.078
	Design team leader's Capabilities	.430	.097	.466	4.406	.000	.927	1.078
3	(Constant)	5.167	.070		73.699	.000		
	Project Management Actions	.548	.083	.533	6.575	.000	.918	1.089
	Design team leader's Capabilities	.471	.075	.512	6.299	.000	.914	1.094
	Nature of Project	-.326	.068	-.373	-4.754	.000	.981	1.019

a. Dependent Variable: Environmental Friendliness

Excluded Variables[d]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance	Collinearity Statistics VIF	Collinearity Statistics Minimum Tolerance
1	Client Abilities	.224[a]	1.687	.102	.294	.883	1.132	.883
	Design team leader's Capabilities	.466[a]	4.406	.000	.627	.927	1.078	.927
	External Environment	.161[a]	1.232	.227	.220	.950	1.053	.950
	Application of Innovative PM Technique	-.156[a]	-1.165	.253	-.208	.907	1.103	.907
	Client representatives' Capabilities	.069[a]	.410	.685	.075	.602	1.661	.602
	Construction team leader's Capabilities	.190[a]	1.217	.233	.217	.672	1.488	.672
	Client emphasis on cost and time performance	.195[a]	1.519	.139	.267	.964	1.037	.964
	Nature of Project	-.315[a]	-2.671	.012	-.438	.995	1.005	.995
	Support by Parent Company	-.092[a]	-.605	.550	-.110	.725	1.380	.725
2	Client Abilities	.077[b]	.662	.513	.122	.789	1.267	.789
	External Environment	-.026[b]	-.223	.825	-.041	.800	1.250	.781
	Application of Innovative PM Technique	.003[b]	.027	.979	.005	.804	1.244	.786
	Client representatives' Capabilities	.146[b]	1.108	.277	.202	.592	1.690	.552
	Construction team leader's Capabilities	.128[b]	1.020	.316	.186	.663	1.509	.654
	Client emphasis on cost and time performance	.123[b]	1.175	.250	.213	.938	1.066	.879
	Nature of Project	-.373[b]	-4.754	.000	-.662	.981	1.019	.914
	Support by Parent Company	.031[b]	.249	.805	.046	.686	1.458	.638
3	Client Abilities	.071[c]	.806	.427	.151	.789	1.267	.789
	External Environment	-.006[c]	-.070	.945	-.013	.798	1.253	.775
	Application of Innovative PM Technique	.076[c]	.861	.397	.161	.780	1.282	.766
	Client representatives' Capabilities	.096[c]	.947	.352	.176	.585	1.709	.552
	Construction team leader's Capabilities	.009[c]	.093	.927	.018	.617	1.620	.617
	Client emphasis on cost and time performance	.107[c]	1.349	.188	.247	.936	1.068	.869
	Support by Parent Company	-.125[c]	-1.276	.212	-.234	.615	1.626	.615

a Predictors in the Model: (Constant), Project Management Actions
b Predictors in the Model: (Constant), Project Management Actions, Design team leader's Capabilities
c Predictors in the Model: (Constant), Project Management Actions, Design team leader's Capabilities, Nature of Project
d Dependent Variable: Environmental Friendliness

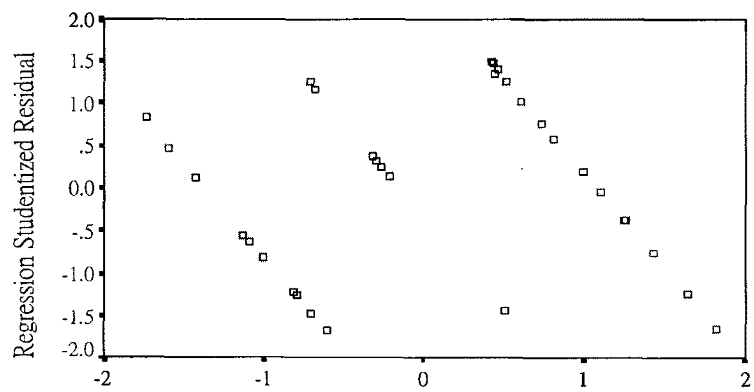
Coefficient Correlations[a]

Model			Project Management Actions	Design team leader's Capabilities	Nature of Project
1	Correlations	Project Management Actions	1.000		
	Covariances	Project Management Actions	1.751E-02		
2	Correlations	Project Management Actions	1.000	-.270	
		Design team leader's Capabilities	-.270	1.000	
	Covariances	Project Management Actions	1.184E-02	-2.860E-03	
		Design team leader's Capabilities	-2.860E-03	9.505E-03	
3	Correlations	Project Management Actions	1.000	-.278	.100
		Design team leader's Capabilities	-.278	1.000	-.118
		Nature of Project	.100	-.118	1.000
	Covariances	Project Management Actions	6.956E-03	-1.736E-03	5.724E-04
		Design team leader's Capabilities	-1.736E-03	5.604E-03	-6.036E-04
		Nature of Project	5.724E-04	-6.036E-04	4.690E-03

a Dependent Variable: Environmental Friendliness

Scatterplot

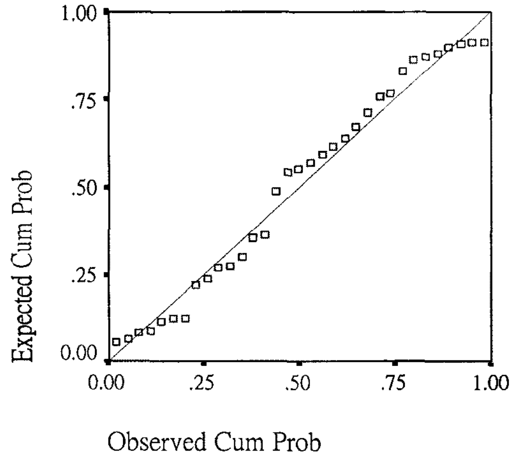
Dependent Variable: Environmental Friendliness



Regression Standardized Predicted Value

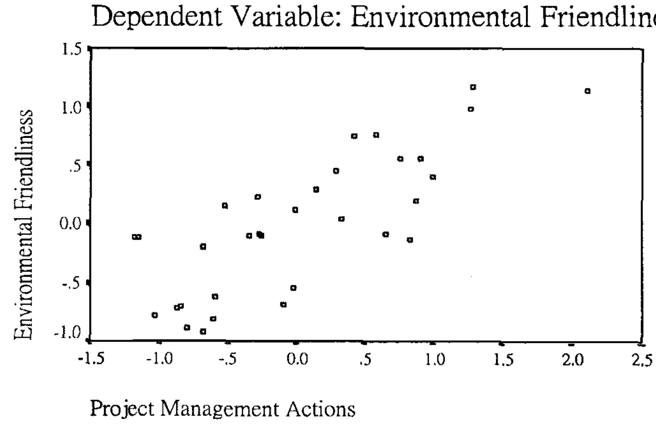
P Plot of Regression Standardized Residual

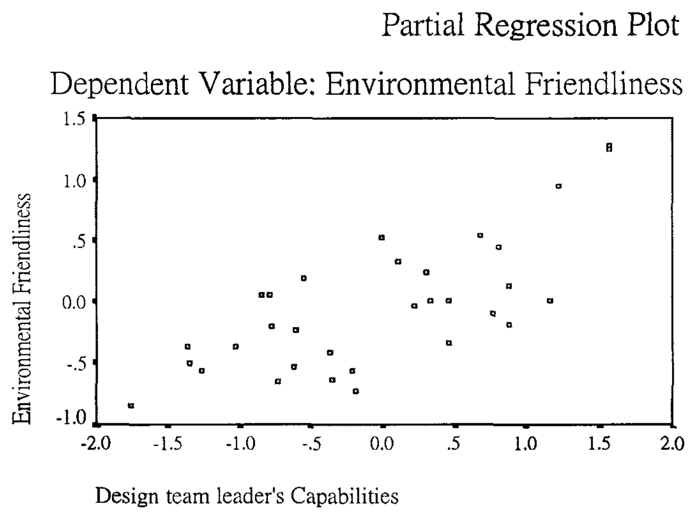
ıdent Variable: Environmental Friendliness

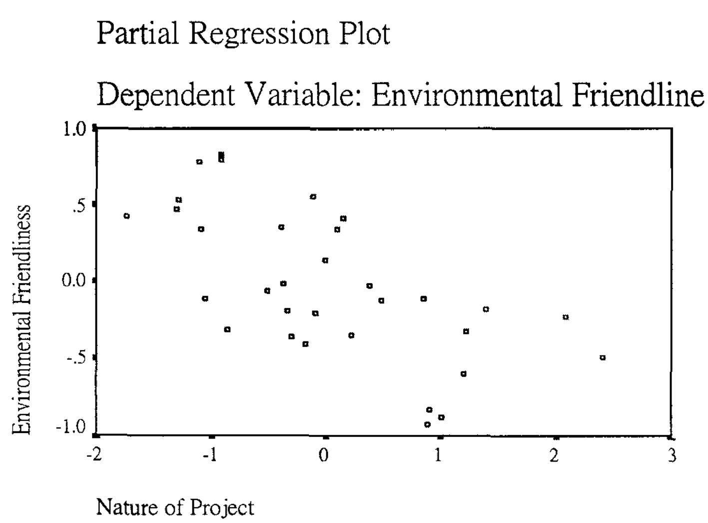


Partial Regression Plot

Dependent Variable: Environmental Friendlines




Partial Regression Plot
Dependent Variable: Environmental Friendliness
Environmental Friendliness
1.5
1.0
.5
0.0
-.5
-1.0
-2.0
-1.5
-1.0
-.5
0.0
.5
1.0
1.5
2.0
Design team leader's Capabilities


Partial Regression Plot
Dependent Variable: Environmental Friendline
Environmental Friendliness
1.0
.5
0.0
-.5
-1.0
-2
-1
0
1
2
3
Nature of Project

Descriptive Statistics

	Mean	Std. Deviation	N
Client Satisfaction	5.1613	.73470	31
Project Management Actions	.0516340	1.06931256	31
Client Abilities	.0717735	1.09682110	31
Design team leader's Capabilities	-.0708450	1.00437834	31
External Environment	-.2259332	.89811927	31
Application of Innovative PM Technique	.0860289	.97886878	31
Client representatives' Capabilities	.1400615	.93758315	31
Construction team leader's Capabilities	.1167500	.97647338	31
Client emphasis on cost and time performance	-.1829309	1.02074088	31
Nature of Project	-.1058956	.89709251	31
Support by Parent Company	-.0811379	1.02026450	31

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Project Management Actions	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Client Abilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Design team leader's Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
4	Construction team leader's Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Client Satisfaction

Model Summary[e]

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.843	.711	.701	.40183	.711	71.291	1	29	.000
2	.922	.849	.839	.29503	.139	25.794	1	28	.000
3	.950	.903	.892	.24141	.053	14.821	1	27	.001
4	.960	.921	.908	.22231	.018	5.838	1	26	.023

a Predictors: (Constant), Project Management Actions
b Predictors: (Constant), Project Management Actions, Client Abilities
c Predictors: (Constant), Project Management Actions, Client Abilities, Design team leader's Capabilities
d Predictors: (Constant), Project Management Actions, Client Abilities, Design team leader's Capabilities, Construction team leader's Capabilities
e Dependent Variable: Client Satisfaction

ANOVA[e]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	11.511	1	11.511	71.291	.000[a]
	Residual	4.682	29	.161		
	Total	16.194	30			
2	Regression	13.756	2	6.878	79.018	.000[b]
	Residual	2.437	28	.087		
	Total	16.194	30			
3	Regression	14.620	3	4.873	83.621	.000[c]
	Residual	1.574	27	.058		
	Total	16.194	30			
4	Regression	14.909	4	3.727	75.413	.000[d]
	Residual	1.285	26	.049		
	Total	16.194	30			

a Predictors: (Constant), Project Management Actions
b Predictors: (Constant), Project Management Actions, Client Abilities
c Predictors: (Constant), Project Management Actions, Client Abilities, Design team leader's Capabilities
d Predictors: (Constant), Project Management Actions, Client Abilities, Design team leader's Capabilities, Construction team leader's Capabilities
e Dependent Variable: Client Satisfaction

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	5.131	.072		71.016	.000		
	Project Management Actions	.579	.069	.843	8.443	.000	1.000	1.000
2	(Constant)	5.117	.053		96.317	.000		
	Project Management Actions	.487	.054	.708	9.088	.000	.884	1.131
	Client Abilities	.265	.052	.396	5.079	.000	.884	1.131
3	(Constant)	5.133	.044		117.548	.000		
	Project Management Actions	.525	.045	.764	11.681	.000	.842	1.188
	Client Abilities	.197	.046	.295	4.272	.000	.756	1.323
	Design team leader's Capabilities	.183	.048	.251	3.850	.001	.849	1.178
4	(Constant)	5.121	.041		126.333	.000		
	Project Management Actions	.484	.045	.704	10.806	.000	.719	1.390
	Client Abilities	.173	.044	.258	3.946	.001	.715	1.399
	Design team leader's Capabilities	.156	.045	.213	3.432	.002	.794	1.259
	Construction team leader's Capabilities	.122	.050	.162	2.416	.023	.679	1.474

a Dependent Variable: Client Satisfaction

Excluded Variables[e]

Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics		
						Tolerance	VIF	Minimum Tolerance
1	Client Abilities	.396[a]	5.079	.000	.692	.884	1.131	.884
	Design team leader's Capabilities	.357[a]	4.660	.000	.661	.993	1.007	.993
	External Environment	.116[a]	1.115	.274	.206	.920	1.087	.920
	Application of Innovative PM Technique	.077[a]	.705	.487	.132	.857	1.167	.857
	Client representatives' Capabilities	.262[a]	2.261	.032	.393	.650	1.538	.650
	Construction team leader's Capabilities	.334[a]	3.583	.001	.561	.817	1.224	.817
	Client emphasis on cost and time performance	.012[a]	.121	.904	.023	.989	1.011	.989
	Nature of Project	-.042[a]	-.396	.695	-.075	.918	1.089	.918
	Support by Parent Company	.088[a]	.799	.431	.149	.831	1.203	.831
2	Design team leader's Capabilities	.251[b]	3.850	.001	.595	.849	1.178	.756
	External Environment	.002[b]	.020	.984	.004	.840	1.190	.765
	Application of Innovative PM Technique	.017[b]	.209	.836	.040	.838	1.194	.794
	Client representatives' Capabilities	.012[b]	.105	.917	.020	.454	2.205	.454
	Construction team leader's Capabilities	.220[b]	2.871	.008	.484	.725	1.379	.725
	Client emphasis on cost and time performance	.039[b]	.525	.604	.100	.984	1.016	.879
	Nature of Project	-.054[b]	-.701	.489	-.134	.917	1.090	.815
	Support by Parent Company	.003[b]	.036	.971	.007	.795	1.258	.782
3	External Environment	-.099[c]	-1.448	.160	-.273	.736	1.358	.736
	Application of Innovative PM Technique	.147[c]	2.179	.039	.393	.693	1.442	.683
	Client representatives' Capabilities	.078[c]	.861	.397	.166	.438	2.284	.438
	Construction team leader's Capabilities	.162[c]	2.416	.023	.428	.679	1.474	.679
	Client emphasis on cost and time performance	-.037[c]	-.573	.572	-.112	.888	1.126	.728
	Nature of Project	-.079[c]	-1.273	.214	-.242	.908	1.101	.756
	Support by Parent Company	.023[c]	.339	.737	.066	.790	1.266	.719
4	External Environment	-.060[d]	-.884	.385	-.174	.676	1.479	.623
	Application of Innovative PM Technique	.113[d]	1.699	.102	.322	.646	1.549	.622
	Client representatives' Capabilities	.060[d]	.708	.486	.140	.434	2.305	.434
	Client emphasis on cost and time performance	.022[d]	.336	.740	.067	.752	1.329	.575
	Nature of Project	-.053[d]	-.889	.383	-.175	.870	1.149	.650
	Support by Parent Company	-.003[d]	-.053	.958	-.011	.765	1.306	.657

a Predictors in the Model: (Constant), Project Management Actions
b Predictors in the Model: (Constant), Project Management Actions, Client Abilities
c Predictors in the Model: (Constant), Project Management Actions, Client Abilities, Design team leader's Capabilities
d Predictors in the Model: (Constant), Project Management Actions, Client Abilities, Design team leader's Capabilities, Construction team leader's Capabilities
e Dependent Variable: Client Satisfaction

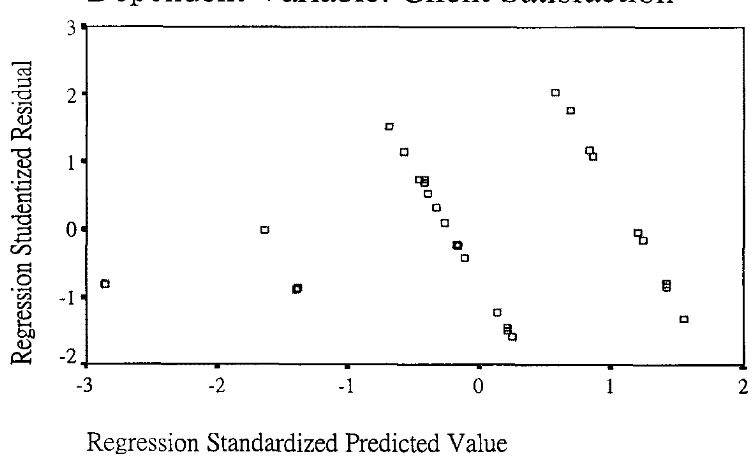
Coefficient Correlations[a]

Model			Project Management Actions	Client Abilities	Design team leader's Capabilities	Construction team leader's Capabilities
1	Correlations	Project Management Actions	1.000			
	Covariances	Project Management Actions	4.707E-03			
2	Correlations	Project Management Actions	1.000	-.340		
		Client Abilities	-.340	1.000		
	Covariances	Project Management Actions	2.869E-03	-9.510E-04		
		Client Abilities	-9.510E-04	2.727E-03		
3	Correlations	Project Management Actions	1.000	-.390	.220	
		Client Abilities	-.390	1.000	-.381	
		Design team leader's Capabilities	.220	-.381	1.000	
	Covariances	Project Management Actions	2.018E-03	-8.105E-04	4.699E-04	
		Client Abilities	-8.105E-04	2.136E-03	-8.388E-04	
		Design team leader's Capabilities	4.699E-04	-8.388E-04	2.269E-03	
4	Correlations	Project Management Actions	1.000	-.262	.293	-.381
		Client Abilities	-.262	1.000	-.299	-.233
		Design team leader's Capabilities	.293	-.299	1.000	-.253
		Construction team leader's Capabilities	-.381	-.233	-.253	1.000
	Covariances	Project Management Actions	2.003E-03	-5.130E-04	5.943E-04	-8.608E-04
		Client Abilities	-5.130E-04	1.916E-03	-5.940E-04	-5.156E-04
		Design team leader's Capabilities	5.943E-04	-5.940E-04	2.056E-03	-5.793E-04
		Construction team leader's Capabilities	-8.608E-04	-5.156E-04	-5.793E-04	2.546E-03

a Dependent Variable: Client Satisfaction

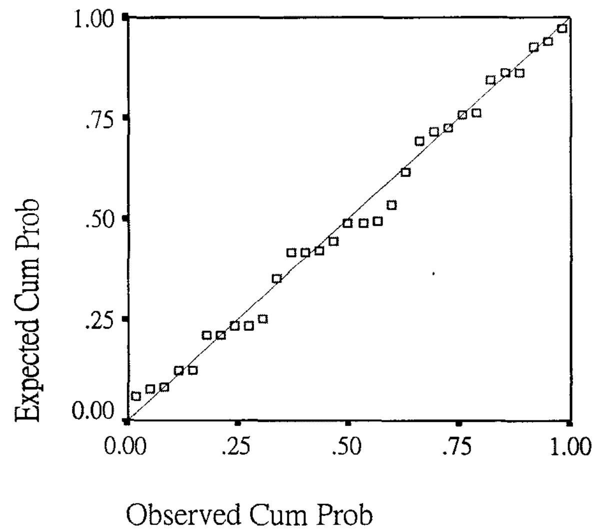
Scatterplot

Dependent Variable: Client Satisfaction



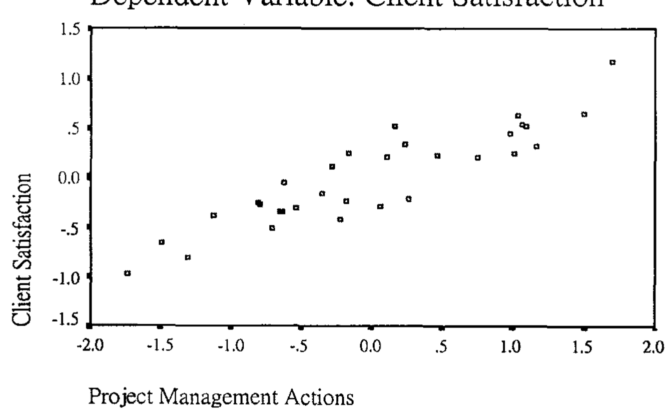
P Plot of Regression Standardized Residual

Dependent Variable: Client Satisfaction



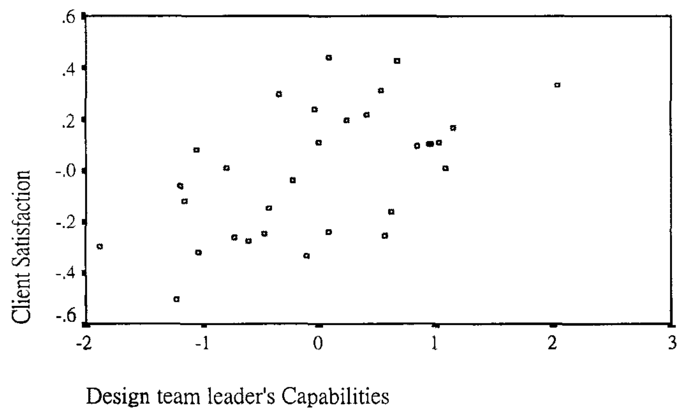
Partial Regression Plot

Dependent Variable: Client Satisfaction



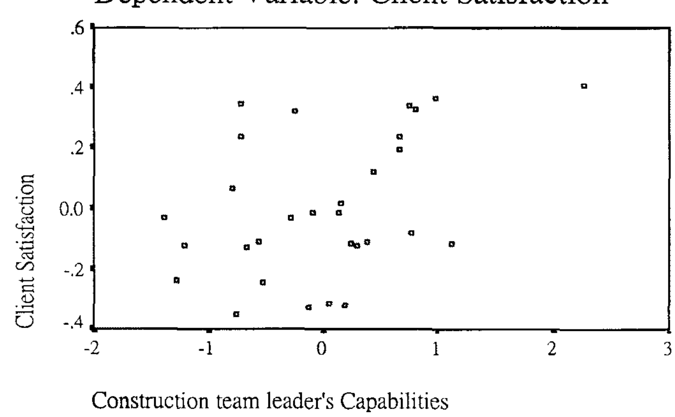
Partial Regression Plot

Dependent Variable: Client Satisfaction



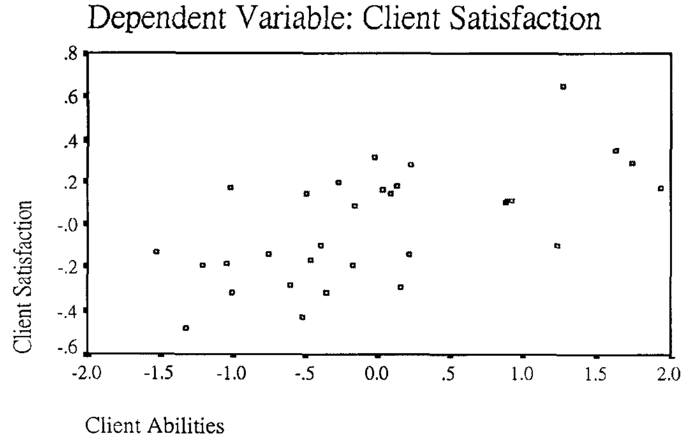
Partial Regression Plot

Dependent Variable: Client Satisfaction



Partial Regression Plot

Dependent Variable: Client Satisfaction



Descriptive Statistics

	Mean	Std. Deviation	N
Participants' Satisfaction	5.3421	1.21425	38
Project Management Actions	-.0240752	.94261470	38
Client Abilities	-.0452926	.96011475	38
Design team leader's Capabilities	-.0162323	.89525662	38
External Environment	-.0802069	1.02948926	38
Application of Innovative PM Technique	.0930168	1.02402994	38
Client representatives' Capabilities	.0195535	1.06316990	38
Construction team leader's Capabilities	.0428200	.96801825	38
Client emphasis on cost and time performance	-.1207166	.95870752	38
Nature of Project	.0325647	1.10272978	38
Support by Parent Company	-.0063442	1.02265295	38

Variables Entered/Removed[a]

Model	Variables Entered	Variables Removed	Method
1	Construction team leader's Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
2	Client representatives' Capabilities	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).
3	Project Management Actions	.	Stepwise (Criteria: Probability-of-F-to-enter <= .050, Probability-of-F-to-remove >= .100).

a Dependent Variable: Participants' Satisfaction

Model Summary[d]

					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.813	.661	.652	.71624	.661	70.341	1	36	.000
2	.901	.812	.801	.54106	.151	28.085	1	35	.000
3	.924	.854	.841	.48462	.041	9.627	1	34	.004

a Predictors: (Constant), Construction team leader's Capabilities
b Predictors: (Constant), Construction team leader's Capabilities, Client representatives' Capabilities
c Predictors: (Constant), Construction team leader's Capabilities, Client representatives' Capabilities, Project Management Actions
d Dependent Variable: Participants' Satisfaction

ANOVA[d]

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	36.085	1	36.085	70.341	.000[a]
	Residual	18.468	36	.513		
	Total	54.553	37			
2	Regression	44.306	2	22.153	75.673	.000[b]
	Residual	10.246	35	.293		
	Total	54.553	37			
3	Regression	46.567	3	15.522	66.092	.000[c]
	Residual	7.985	34	.235		
	Total	54.553	37			

a Predictors: (Constant), Construction team leader's Capabilities
b Predictors: (Constant), Construction team leader's Capabilities, Client representatives' Capabilities
c Predictors: (Constant), Construction team leader's Capabilities, Client representatives' Capabilities, Project Management Actions
d Dependent Variable: Participants' Satisfaction

Coefficients[a]

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.	Collinearity Statistics Tolerance	Collinearity Statistics VIF
1	(Constant)	5.298	.116		45.556	.000		
	Construction team leader's Capabilities	1.020	.122	.813	8.387	.000	1.000	1.000
2	(Constant)	5.296	.088		60.283	.000		
	Construction team leader's Capabilities	.851	.097	.679	8.753	.000	.893	1.120
	Client representatives' Capabilities	.469	.089	.411	5.300	.000	.893	1.120
3	(Constant)	5.312	.079		67.363	.000		
	Construction team leader's Capabilities	.732	.095	.583	7.681	.000	.746	1.340
	Client representatives' Capabilities	.342	.089	.299	3.829	.001	.704	1.420
	Project Management Actions	.341	.110	.264	3.103	.004	.593	1.687

a Dependent Variable: Participants' Satisfaction

Excluded Variables[d]

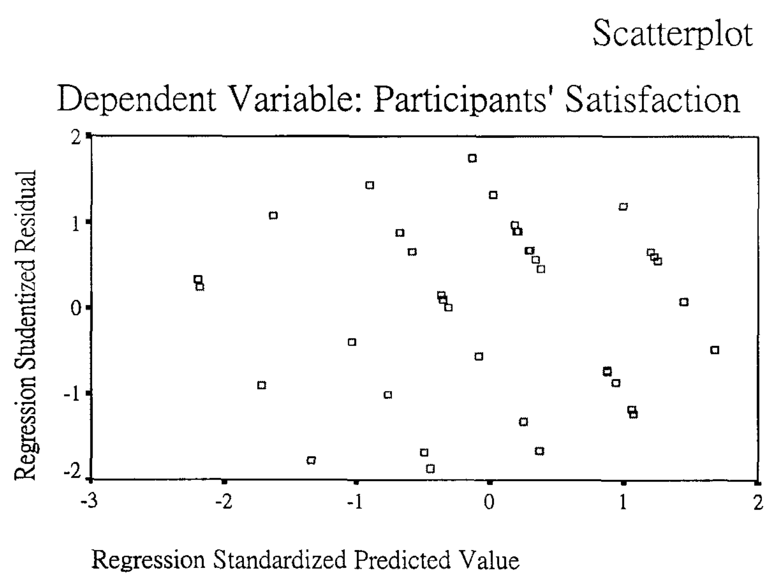
Model		Beta In	t	Sig.	Partial Correlation	Collinearity Statistics Tolerance	Collinearity Statistics VIF	Collinearity Statistics Minimum Tolerance
1	Project Management Actions	.414[a]	4.643	.000	.617	.751	1.331	.751
	Client Abilities	.291[a]	3.107	.004	.465	.863	1.159	.863
	Design team leader's Capabilities	.142[a]	1.440	.159	.236	.942	1.062	.942
	External Environment	-.114[a]	-1.168	.251	-.194	.977	1.024	.977
	Application of Innovative PM Technique	.154[a]	1.601	.118	.261	.970	1.031	.970
	Client representatives' Capabilities	.411[a]	5.300	.000	.667	.893	1.120	.893
	Client emphasis on cost and time performance	-.001[a]	-.014	.989	-.002	.958	1.044	.958
	Nature of Project	.031[a]	.302	.765	.051	.943	1.061	.943
	Support by Parent Company	.091[a]	.885	.382	.148	.890	1.123	.890
2	Project Management Actions	.264[b]	3.103	.004	.470	.593	1.687	.593
	Client Abilities	.073[b]	.749	.459	.127	.572	1.749	.572
	Design team leader's Capabilities	.083[b]	1.088	.284	.183	.920	1.087	.862
	External Environment	-.043[b]	-.568	.574	-.097	.944	1.060	.862
	Application of Innovative PM Technique	.032[b]	.408	.686	.070	.872	1.147	.803
	Client emphasis on cost and time performance	-.052[b]	-.690	.495	-.117	.943	1.061	.844
	Nature of Project	-.117[b]	-1.480	.148	-.246	.837	1.195	.788
	Support by Parent Company	.151[b]	2.014	.052	.327	.873	1.146	.779
3	Client Abilities	.030[c]	.339	.736	.059	.557	1.796	.533
	Design team leader's Capabilities	.047[c]	.676	.503	.117	.892	1.121	.575
	External Environment	-.029[c]	-.424	.675	-.074	.939	1.065	.590
	Application of Innovative PM Technique	.011[c]	.147	.884	.026	.863	1.158	.587
	Client emphasis on cost and time performance	-.066[c]	-.972	.338	-.167	.939	1.065	.590
	Nature of Project	-.089[c]	-1.238	.224	-.211	.822	1.216	.582
	Support by Parent Company	.099[c]	1.368	.181	.232	.806	1.241	.547

a Predictors in the Model: (Constant), Construction team leader's Capabilities
b Predictors in the Model: (Constant), Construction team leader's Capabilities, Client representatives' Capabilities
c Predictors in the Model: (Constant), Construction team leader's Capabilities, Client representatives' Capabilities, Project Management Actions
d Dependent Variable: Participants' Satisfaction

Coefficient Correlations

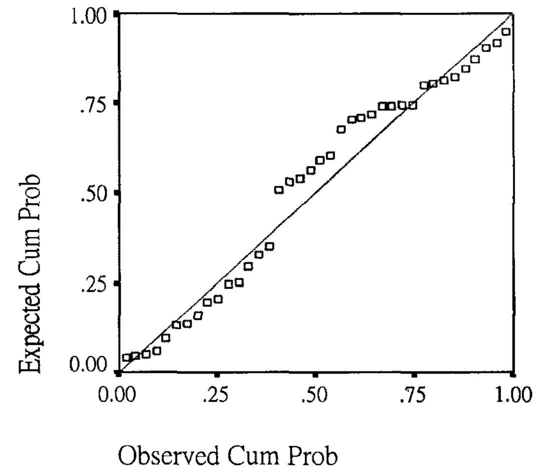
Model			Construction team leader's Capabilities	Client representatives' Capabilities	Project Management Actions
1	Correlations	Construction team leader's Capabilities	1.000		
	Covariances	Construction team leader's Capabilities	1.480E-02		
2	Correlations	Construction team leader's Capabilities	1.000	-.328	
		Client representatives' Capabilities	-.328	1.000	
	Covariances	Construction team leader's Capabilities	9.459E-03	-2.822E-03	
		Client representatives' Capabilities	-2.822E-03	7.842E-03	
3	Correlations	Construction team leader's Capabilities	1.000	-.080	-.405
		Client representatives' Capabilities	-.080	1.000	-.460
		Project Management Actions	-.405	-.460	1.000
	Covariances	Construction team leader's Capabilities	9.075E-03	-6.819E-04	-4.232E-03
		Client representatives' Capabilities	-6.819E-04	7.975E-03	-4.505E-03
		Project Management Actions	-4.232E-03	-4.505E-03	1.205E-02

a Dependent Variable: Participants' Satisfaction



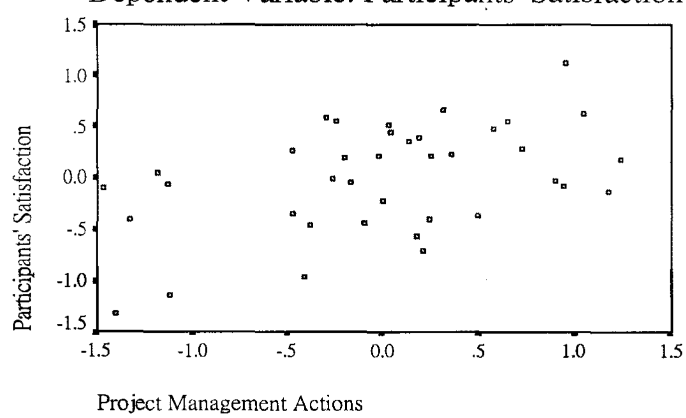
P Plot of Regression Standardized Residual

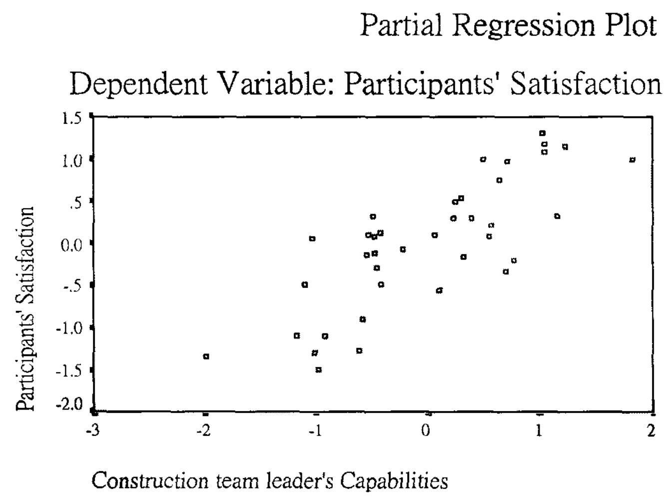
pendent Variable: Participants' Satisfaction

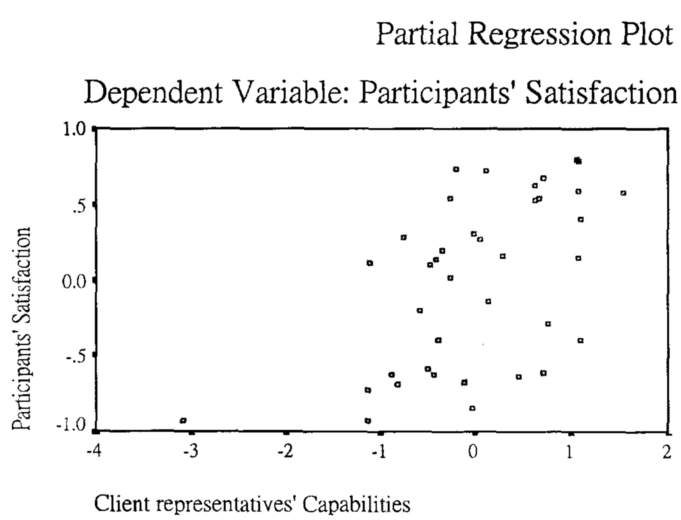


Partial Regression Plot

Dependent Variable: Participants' Satisfaction




Partial Regression Plot
Dependent Variable: Participants' Satisfaction
1.5
1.0
.5
0.0
-.5
-1.0
-1.5
-2.0
Participants' Satisfaction
-3
-2
-1
0
1
2
Construction team leader's Capabilities


Partial Regression Plot
Dependent Variable: Participants' Satisfaction
1.0
.5
0.0
-.5
-1.0
Participants' Satisfaction
-4
-3
-2
-1
0
1
2
Client representatives' Capabilities

APPENDIX H

SAMPLE OF THE REVISED QUESTIONNAIRE

INSTRUCTION

It takes about 10 minutes to complete this questionnaire. Please answer all questions with reference to a *healthcare project* you have involved. Kindly tick the appropriate box for your answer.

1. RESPONDENT'S INFORMATION

1. Professional affiliation: ❑ Architect ❑ Building surveyor ❑ Quantity surveyor ❑ Engineer ❑ Builder ❑ Others (*Please specify*): ____________

2. Type of organization in which your are working in:
   - ❑ Client's organization
   - ❑ Main Contractor
   - ❑ Architect firm
   - ❑ Engineering consultant
   - ❑ Project management consultant
   - ❑ Q.S. consultant
   - ❑ Sub-contractor
   - ❑ Public utility
   - ❑ Other: ____________

2. PROJECT DETAILS OF A HEALTHCARE PROJECT

1. Name of Project: ____________

2. Classification of project: ❑ Clinic ❑ Health centre ❑ General hospital ❑ Teaching hospital ❑ Rehabilitation Hospital ❑ Others *(Please specify)*: ____________

3. Nature of project: ❑ New work ❑ Refurbishment ❑ Redevelopment ❑ Extension ❑ Others *(Please specify)*: ____________
   Please specify your type of work: ____________

3. PROJECT COMPLEXITY LEVEL

Please rate the following statements that contributed to the perception on the level of complexity of this project to construct.	Strongly complex	Complex	Slightly complex	Neutral	Slightly simple	Simple	Strongly simple
1. Level of design coordination	❑	❑	❑	❑	❑	❑	❑
2. Level of quality management procedures	❑	❑	❑	❑	❑	❑	❑
3. Overall characteristics of this particular project	❑	❑	❑	❑	❑	❑	❑

4. ABOUT THE PROJECT PROCEDURE

1. What procurement system did the project adopt?
   - ❑ Sequential traditional system
   - ❑ Accelerated traditional system
   - ❑ Competitive design & build
   - ❑ Enhanced design & build
   - ❑ Novation
   - ❑ Management contracting
   - ❑ Guarantee maximum price
   - ❑ Do not know
   - ❑ Other *(Please specify)*: ____________

2. What type of tendering method was used?
   ❑ Open tendering ❑ Selective tendering ❑ Negotiation tendering
   ❑ Other *(Please specify)*: ______________________

3. What other management skill(s) was used?
   ❑ Partnering ❑ Value Management/Engineering
   ❑ Other *(Please specify)*: ______________________

5. ABOUT THE PROJECT ENVIRONMENT AND TECHNOLOGY

Please rate the following statements that contributed to the perception on the level of complexity of this project to construct.	Strongly complex	Complex	Slightly complex	Neutral	Slightly simple	Simple	Strongly simple
1. Physical environment	❑	❑	❑	❑	❑	❑	❑
2. Prevailing economic environment	❑	❑	❑	❑	❑	❑	❑
3. Social-political environment	❑	❑	❑	❑	❑	❑	❑
4. Level of technology advanced	❑	❑	❑	❑	❑	❑	❑
5. Overall environment	❑	❑	❑	❑	❑	❑	❑

7. ABOUT THE CLIENT

7.1 Client objectives

Please rate the following statements that best describe your opinion of the client's emphasis on project objectives, where:	Strongly low	Low	Slightly low	Average	Slightly high	High	Strongly high
1. Low construction cost	❑	❑	❑	❑	❑	❑	❑
2. Quick construction time	❑	❑	❑	❑	❑	❑	❑
3. High quality of construction	❑	❑	❑	❑	❑	❑	❑

7.2 Client competency measures

Please rate the following statements that best describe your opinion on the competency of client.	Strongly weak	Weak	Slightly weak	Average	Slightly strong	Strong	Strongly strong
1. Ability to effectively brief the design team	❑	❑	❑	❑	❑	❑	❑
2. Ability to quickly make authoritative decisions	❑	❑	❑	❑	❑	❑	❑
3. Ability to effectively define the roles of the participating organizations	❑	❑	❑	❑	❑	❑	❑
4. Ability to contribute ideas to the design process	❑	❑	❑	❑	❑	❑	❑
5. Ability to contribute ideas to the construction process	❑	❑	❑	❑	❑	❑	❑

8. ABOUT THE PROJECT TEAM LEADERS

In this section, the project team leaders involve the client's representative, design team leader and construction team leader. **Please rate their effectiveness in terms of their technical skills, managerial skills, commitment on project, support by parent company, provision of resources and working relationship.**

8.1 Client's representative

Please rate the following statements that best describe your opinion on the competency of client's representative.	Strongly weak	Weak	Slightly weak	Average	Slightly strong	Strong	Strongly strong
1. Technical skills	❑	❑	❑	❑	❑	❑	❑
2. Management Skills (planning, organization, coordinating, motivating and controlling)	❑	❑	❑	❑	❑	❑	❑
3. Experience and capabilities	❑	❑	❑	❑	❑	❑	❑
4. Early and continued involvement in the project	❑	❑	❑	❑	❑	❑	❑
5. Adaptability to changes in the project plan	❑	❑	❑	❑	❑	❑	❑
6. Support by parent company	❑	❑	❑	❑	❑	❑	❑

8.2 Design team leader

Please rate the following statements that best describe your opinion on the competency of design team leader.	Strongly weak	Weak	Slightly weak	Average	Slightly strong	Strong	Strongly strong
1. Technical skills	❑	❑	❑	❑	❑	❑	❑
2. Management Skills (planning, organization, coordinating, motivating and controlling)	❑	❑	❑	❑	❑	❑	❑
3. Experience and capabilities	❑	❑	❑	❑	❑	❑	❑
4. Early and continued involvement in the project	❑	❑	❑	❑	❑	❑	❑
5. Adaptability to changes in the project plan	❑	❑	❑	❑	❑	❑	❑
6. Support by parent company	❑	❑	❑	❑	❑	❑	❑

8.3 Construction team leader

Please rate the following statements that best describe your opinion on the competency of construction team leader.	Strongly weak	Weak	Slightly weak	Average	Slightly strong	Strong	Strongly strong
1. Technical skills	❑	❑	❑	❑	❑	❑	❑
2. Management Skills (planning, organization, coordinating, motivating and controlling)	❑	❑	❑	❑	❑	❑	❑
3. Experience and capabilities	❑	❑	❑	❑	❑	❑	❑
4. Early and continued involvement in the project	❑	❑	❑	❑	❑	❑	❑
5. Adaptability to changes in the project plan	❑	❑	❑	❑	❑	❑	❑
6. Support by parent company	❑	❑	❑	❑	❑	❑	❑

9. ABOUT THE MANAGEMENT ACTIONS

Please rate the following statements that best describe your opinion of the effectiveness of managerial actions taken by the project team.	Strongly ineffective	Ineffective	Slightly ineffective	Neutral	Slightly effective	Effective	Strongly effective
1. Communication system for the project	❑	❑	❑	❑	❑	❑	❑
2. Control mechanism, such as monitoring and updating plans	❑	❑	❑	❑	❑	❑	❑
3. Feedback capabilities	❑	❑	❑	❑	❑	❑	❑
4. Up-front planning efforts	❑	❑	❑	❑	❑	❑	❑
5. Developing an appropriate organizational structure	❑	❑	❑	❑	❑	❑	❑
6. Implementing an effective quality assurance program	❑	❑	❑	❑	❑	❑	❑
7. Implementing an effective safety program	❑	❑	❑	❑	❑	❑	❑
8. Development of a good reporting system	❑	❑	❑	❑	❑	❑	❑
9. Development of standard procedures	❑	❑	❑	❑	❑	❑	❑

10. ABOUT THE PROJECT PERFORMANCE

Please indicate the performance of this health-care project.

1. Time performance:
❑ On schedule
❑ Ahead schedule by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%
❑ Behind schedule by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%

2. Cost performance:
❑ On budget
❑ Underrun budget by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%
❑ Overrun budget by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%

3. Disputes occurrence
❑ Indifferent to an average project
❑ Above an average project by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%
❑ Below an average project by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%

4. Claims occurrence
❑ Indifferent to an average project
❑ Above an average project by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%
❑ Below an average project by: ❑ below 1% ❑ 1% to 5% ❑ 6% to 10% ❑ more than 10%

5. Overall performance (client):
❑ very unsuccessful ❑ unsuccessful ❑ average ❑ successful ❑ very successful

11. LEVEL OF SATISFACTION (PROJECT LEVEL)

Please indicate the level of your satisfaction on the performance of this completed health-care project	Strongly dissatisfied	Dissatisfied	Slightly dissatisfied	Neutral	Slightly satisfied	Satisfied	Strongly satisfied
1. Time	❑	❑	❑	❑	❑	❑	❑
2. Cost	❑	❑	❑	❑	❑	❑	❑
3. Quality of design	❑	❑	❑	❑	❑	❑	❑
4. Quality of workmanship	❑	❑	❑	❑	❑	❑	❑
5. Safety record	❑	❑	❑	❑	❑	❑	❑
6. Overall performance	❑	❑	❑	❑	❑	❑	❑
7. Achieving functionality	❑	❑	❑	❑	❑	❑	❑
8. Achieving environmental friendliness	❑	❑	❑	❑	❑	❑	❑

12. PERSONAL VIEWS ON SUCCESS CRITERIA

Please rate the following criteria that you consider them for measuring success in a health-care project.	Strongly Disagree	Disagree	Slightly Disagree	Neutral	Slightly Agree	Agree	Strongly Agree
1. Project is completed on time	❑	❑	❑	❑	❑	❑	❑
2. Project is completed on budget	❑	❑	❑	❑	❑	❑	❑
3. Project is completed on required quality standard	❑	❑	❑	❑	❑	❑	❑
4. Project is basically achieved its purpose/function	❑	❑	❑	❑	❑	❑	❑
5. Project is completed with a low accident rate	❑	❑	❑	❑	❑	❑	❑
6. Project is completed with environmental friendliness	❑	❑	❑	❑	❑	❑	❑
7. Performance of project is satisfied by client	❑	❑	❑	❑	❑	❑	❑
8. Performance of project is satisfied by various participants	❑	❑	❑	❑	❑	❑	❑
9. Performance of project is satisfied by various end-users	❑	❑	❑	❑	❑	❑	❑
10. Project is achieved with expectations of various end-users	❑	❑	❑	❑	❑	❑	❑
11. Project is profitable	❑	❑	❑	❑	❑	❑	❑
12. Project can create further/long-term gains	❑	❑	❑	❑	❑	❑	❑

End

Thank you for your contribution

Return Slip (Optional)

Those who wish to receive a summary of the research findings, please enter the details below:

Name:
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