COMPETITIVENESS ASSESSMENT MODEL FOR CONSTRUCTION COMPANIES

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ABSTRACT

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The Construction industry is facing an enormous number of challenges due to continuous advancements in construction technologies and techniques. Consequently construction management theories have to confront critical newly issues concerning market globalization and construction innovations. The key factor to address these challenges is to improve the competitive abilities of the competing construction firms.

Literature reports that existing competitive practices for construction companies do not fully address the recent industry problems or consider the available technologies and challenges. Therefore, this research proposes a competitive assessment model with a wide range of essential factors and attributes that covers broad aspects of the present competitive market.

Four new pillars (4P) for competitiveness assessment are proposed for construction firms: (1) Organization Performance, (2) Project Performance, (3) Environment and Client, and (4) Innovation and Development. These pillars have the potential to assist construction firms manage not only short term strategic plans but also long term ones. Based on the 4P concept, 21 factors and 80 criteria are defined and incorporated in the proposed company competitiveness assessment model. A questionnaire survey is conducted in the Canadian and

Vietnamese market in order to collect 2 main sets of information. The first set includes pair wise comparison feedback regarding the relative importance of each factor, while the other set collects utility scores concerning their impacts. Based on the collected data, the AHP technique is used to calculate the factors' relative weight. In addition, the utility functions are developed in order to build the competitiveness assessment model using multi-attribute utility theory (MAUT).

The developed MAUT model is tested via three case studies in which the results show that the model has a potential to demonstrate a detailed performance analysis pertaining to the competitive ability of any given construction firm.

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CHAPTER 1. INTRODUCTION

1.1 Overview

Management and competitiveness are considered the most important factors in every construction organization. In the last two decades, a lot of technological advancements have improved the performance of construction industry and various benefits have been recorded concerning the reduction of time and cost of construction projects. However, construction management processes have adapted slowly to these advancements and few progresses have been recorded.

The concept of globalization amplifies the opportunity for many construction companies to be established, to grow, and to innovate. It is often found that through globalization, construction companies are allowed to acquire assets worldwide, such as; capital, labor, and technology. In particular, a construction firm in Vietnam could use their resources in international bodies, such as American banking network, and to be engaged in new projects worldwide. This is of course, possible if funds and resources, such as highly innovative technicians and labor, can be partnered through foreign affiliations. Hence, it is best understood that firms, which have better resources, have the advantage to compete in the market and acquire more benefits.

More specifically, the concept of globalization also allows for a more competitive and fiercer market due to the variety of firms and innovative advantages. For

example, Chinese contractors, who have cheap laborers and good management skills, can use globalization to become competitive in foreign markets such as Canada. Similarly, in the Asian market Vietnamese companies face competitors from Korea, Japan, China, as well as France in which all hold strong capital, high technology as well as management skills for complex projects.

For a construction firm to survive in the above market environment, it is necessary to improve the firm's competitive abilities. Rethinking and re-measuring competitiveness of construction companies is an effective method to help them improve their competitive nature and ability.

1.2 Problem Statement and Research Objectives

Construction management and the competitiveness of construction companies face many problems. When the surrounding environment change, only construction organizations and personnel who adapt well to such changes can develop and sustain profits. Literature shows that current competitiveness assessment models do not fully address the present challenges that face construction organizations. Thus, current competitiveness performance models cannot provide the industry with accurate and concrete analysis concerning company's competitiveness performance. Therefore, the main problem that is addressed in this research is the lack of competitiveness assessment model(s) considering a variety of critical issues that face construction companies.

For that reason, the main objective of this research is to develop an assessment model for the competitiveness of construction companies. The sub objectives can be summarized as follows:

- Identify and study the Key Competitive Factors (KCFs) and Key Competitive Criteria (KCC) that affect the competitiveness performance of construction companies.
- Develop a competitiveness performance model and index for construction companies.

1.3 Research Methodology

The proposed methodology to fulfill the predefined objectives follows these steps:

Literature Review

Based on published literature, a brief study is performed concerning competitive theories, strategy management, performance, and assessment of competitiveness for construction companies and industry. Previous work regarding competitiveness assessment models in construction companies are analyzed where their limitations and benefits are discussed.

Integration of 4P Concepts and Competitiveness Principles

Four Pillars (4P) for the construction industry are proposed in order to address the challenges and limitation found in literature. These 4 pillars are divided into 21 Key Competitive Factors (KCFs) and 80 Key Competitive Criteria

(KCC). In addition, the challenges facing the construction industry are briefly tackled and how the concept of 4P can address them.

Data Collection

A questionnaire survey containing the four pillars, the KCFs and KCCs is sent to construction experts throughout Canada and Vietnam. The survey collects information concerning relative weights of the predefined factors as well as their utility values. Also the survey gathers experts' feedback concerning competitive scores so as to be used in case studies' implementation and validation purposes.

Developing the Competitiveness Index Model

Based on the collected data, the Analytic Hierarchy Process (AHP) technique is used to calculate the factors' relative weight. The utility functions and values are also generated for criteria of hard-data. The criteria's score have been generated by surveying, historical data, and utility functions. Thus, the overall competitiveness index can be generated mathematically by multiplying the decomposed weight of each attribute with the score of each sub-factor followed by a summation of results of each criterion within the whole incorporated factors.

1.4 Thesis Organization

As previously stated, the main objective of this research is to propose a competitiveness assessment model that can address the present challenges in the construction industry. Accordingly, the thesis is organized to achieve this objective.

The literature review is compiled and organized in Chapter 2, including an overview of competitive theories, competitiveness in construction industries and assessment models to calculate competitive performance. Advantages and limitations of current models are reported and discussed.

Chapter 3 gives an overview of the research methodology followed in this research where each step in developing the model is described.

Chapter 4 introduces four new pillars that will serve as the conceptual base for the proposed model. Advantages and benefits of implementing such 4 pillars are also reported. Based on these pillars, factors and attributes incorporated in the model will be defined and categorized.

Chapter 5 describes the data collection process. The collected data will be used to generate 2 main set of information to run the model. The first set is the factors' relative weight and the second is used to generate the utility functions of their corresponding factors.

Chapter 6 explains in detail the development and implementation process of the competitiveness assessment model. The proposed MAUT model is based on the weights of the factors and their corresponding utility values. As a proof of concept, three case studies are demonstrated and analyses of their results are reported. The validation of the model is also discussed in this chapter.

Chapter 7 presents the conclusions and recommendations. It includes the limitations of the developed model and its application, research contributions and enhancements for future work.

CHAPTER 2. LITERATURE REVIEW

2.1 Introduction to Competitiveness

The business environment has become more complex where changes occurring continuously and companies' competitiveness arises quickly. New technologies, markets, and skills of labor have made many construction companies compete among each other to maintain a leading position in the industry. How to succeed and survive nowadays is the big question. Construction organizations also face similar challenges. Their management strategies have to be modified continuously in order to adapt to market changes. Traditional construction management methods that focus mainly on each project is not up to the challenge in today's market. Measuring, checking and improving competitive ability is one of the best methods for construction organizations in the present time. Increasing profit and maintaining success nowadays depends on competitiveness (Flanagan, 2005).

With the increasing demands of new technologies, globalization, construction complexity and customer demands, the traditional construction management method that concentrates on projects and on-site activities cannot fully respond to the density of construction management today. This is due to the limited number of factors and aspects considered in traditional construction management methodologies. To improve the competitive ability of a construction company, many factors concerning adding value to the construction process

must be considered, including productivity, organizational resources, clients, industry and international factors (Flanagan, 2005).

Definition of Competitiveness

Porter (2008) reported that "competitiveness remains a concept that is not well understood, despite widespread acceptance of its importance". The word "Competitiveness" originated from the Latin word, "competer", which means involvement in a business rivalry for markets (Ajitabh, 2004). Longman's Advanced American Dictionary (2000) defines competitiveness as "the ability of a company or a product to compete with others and desire to be more successful than other people". Similar to the previous definition the Oxford Dictionary of Economics (2002) defines competitiveness as "the ability to compete in markets for goods or services...this is based on a combination of price and quality. With equal quality and an established reputation, suppliers are competitive only if their prices are as low as those of rivals".

Competitiveness can be interpreted as the ability of a firm to cope with structural changes (Beck, 1990). Buckley et al. (1988) claims that competitiveness is synonymous with a firm's long-run profit performance and its ability to compensate its employees and provide superior returns to its owners. In addition to that, the term competitiveness can be defined as "the degree to which a firm can, under free and fair market conditions, produce goods and services that meet the test of international markets while simultaneously maintaining or expanding the real incomes of its employees and owners" (Ivancevich *et al.*, 1997).

The committee of the House of Lords on Overseas Trade (UK) reported in 1985 that a competitive firm is defined as one that can produce products and services of superior quality and can have lower costs than its domestic and international competitors. In that report, competitiveness is synonymous with a firm's long-run profit performance and its ability to compensate its employees and provide superior returns to its owners.(IMD,2004)

Moreover, other researchers defined competitiveness as something that includes both efficiency; reaching goals at the lowest possible cost; and effectiveness that aims to achieve the right goals. It is this choice of industrial goals which is crucial; therefore competitiveness includes both the ends and the means towards those ends (Buckkley *et al.,* 1988). According to the Competitive Advisor Group, competitiveness includes elements of productivity, efficiency and profitability. But it is not an end in itself or a target. It is a powerful mean to achieve rising living standards and increasing social welfare and a tool for achieving targets. Globally, by increasing productivity and efficiency in the context of international specialization, competitiveness provides the basis for rising peoples' earning in a non-inflation way (IMD,2004).

The World Competitiveness yearbook has selected in 2003 a set of 14 definitions of competitiveness, such as the definition from the Department of Enterprise, Trade and Employment (UK). This Department defines competitive advantage at firm level as the ability to consistently and profitably deliver products and services which customers are willing to purchase in preference to those of competitors (IMD, 2004).

For the purpose of this research, construction company competitiveness will be defined as the ability of a company to achieve the products, services, values, experiences, and management that satisfy the requirements better than other competitors to achieve with long-term benefits and goals.

Benefits of Competitiveness Theories

Construction companies use competitive theories to achieve competitive advantage, strategy management, and production development. Using the Five Forces of Porter's theory (Porter, 1980), construction companies can analyze environmental aspects to develop strategy plans for Construction Company. Using three generic strategies: overall cost leadership, differentiation, and focus, a firm can gain and sustain competitiveness. Using Resource Based Review (RBV) and Core Competency, companies develop resources like personnel and finance. Construction industry has the highest employment number and the largest value of all of the Vietnamese and the Canadian industries (constructionforecasts, 2010, thitruongxaydung, 2010). The construction industry directly employs more than 750,000 employees which is more than 5% of all jobs in Canada. Their benefits depend totally on competitive ability. With the increase of competitor from other countries in the world, Construction companies in Vietnam and Canada should emphasis more on competitive ability, thus implementations of competitiveness theories must be enhanced.

Level of Competitiveness

Literature reports several level of competitiveness. The national level is considered the highest one where communities such as The World Economic

Forum (WEF) and International Institute of Management Development (IMD) publish reports yearly to measure the competitiveness of nations. These reports provided definitions of competitiveness in a nation level, identified competitive indicators, surveyed and calculated competitiveness index for different countries, and they ranked the competitiveness of nations based on their competitiveness index (WEF, 2009; IDM, 2004, 2009). Industry level is another level were detailed analysis for individual industries can be studied. A study was conducted to measure competitiveness performance in construction industries like Australia, Finland, Sweden, the UK and the USA (Franagan *et al.,* 2005). Literature also reports implementations of competitive theories in a detailed level such as firm and project levels. Firm or organization level focuses mainly on individual company's competitiveness. Competitiveness research at firm level developed competitive strategy that helps achieve and sustain competitiveness (Porter, 1985), and analyze forms' resources that sustain competitiveness (Barney, 1991; Hamel, 1994). Competitiveness research at project level or products focus on competitiveness of each project such as bidding strategy for project (Friedman, 1956) and studied factors that affects competitiveness in project (Shen and Tan, 2005).

2.2 Overview of Competitive Theories

There are several theories concerning firm's competitiveness. The following section will briefly study different theories.

Porter's Competitive Theory

One of the most noted competitive theories is Porter's theory about competitiveness (Flanagan, 2007). Based on his articles, starting from oldest titled "How Competitive Forces Shape Strategy" till his recent theory about the nation's competitiveness, Porter has introduced frameworks for systematically examining competitive strategies, activities and their connection to competitive advantage and competitive abilities. In summary Porter's competitive theories focus on: forces driving industry competition, three generic competitive strategies, the value chain and the diamond model (Porter, 1980, 1985, 2008).

In the theory of forces driving industry competition, Porter reports that competitive environment is the main force that affects a firm's competitiveness. The five forces are: the threat of new entrants; the threat of substitute products or services; buyers; suppliers; and the rivalry among existing firms (Porter, 1980). Figure 2.1 shows these forces and displays the relationship between them.

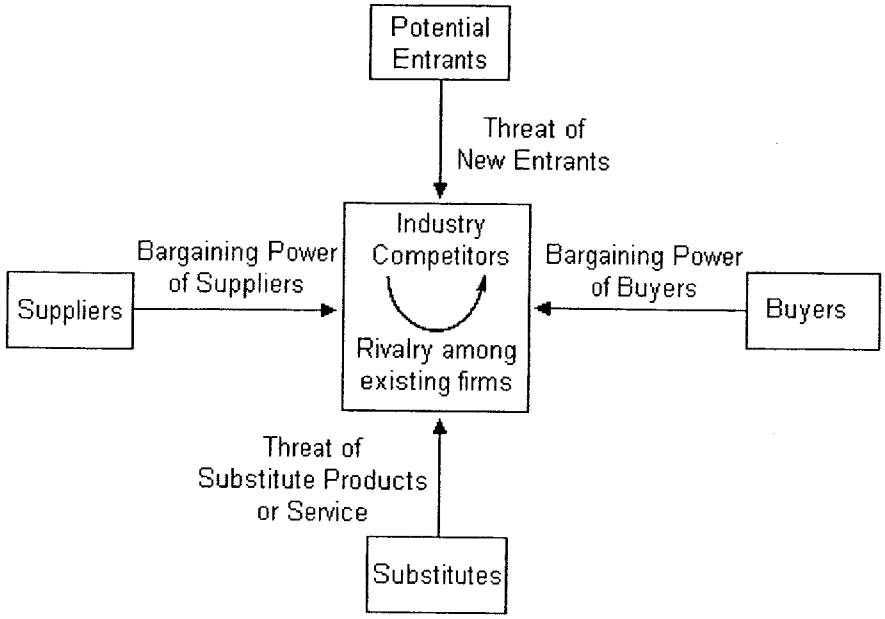

Figure 2-1: Forces Driving Industry Competition (Porter, 1980)

The power of each force is different from industry to industry, from country to country, and from time to time. For example, the threat of new entrants in the airplane industry is weak because it requires high technology programs and skilled technician workers. On the other hand the same threat in the bicycle industry is strong, because it does not require high technology techniques, skilled technician workers...etc.

Porter thinks that the industry structure has a strong influence in determining the competitive rules of the market as well as the strategies' potentially available to the firm. Porter argues that there are five forces that determine the competitive strength and thus its profitability (Porter, 1980). In other words, these forces influence the firm's ability to serve its clients and to make a profit. A change in

any of the forces usually requires a firm to re-assess the marketplace. Companies, throughout their strategies can control the five forces (Porter, 1985).

Concerning the three generic competitive strategies, Porter suggests that a firm may earn high rates of return even though industry structure is unfavorable. Cost leadership, differentiation, and focus aspects are three generic strategies for a firm to achieve about-average performance in an industry (Porter, 1980). The focus strategy has two deviations: cost focus and differentiation focus as shown in Figure 2-2.

		COMPETITIVE ADVANTAGE	
		Lower Cost	Differentiation
COMPETITIVE SCOPE	Broad Target	**1.Cost Leadership**	**2.Differentiation**
	Narrow Target	**3A. Cost Focus**	**3B. Differentiation Focus**

Figure 2-2: Three Generic Competitive Strategies (Porter, 1980)

Concerning cost leadership, the firm sets out to become the low-cost producer in its industry. A low-cost producer must find, discover and exploit all sources of cost advantage. While in a differentiation strategy, a firm strives to be unique in its industry in a specific way that it is widely appreciated by buyers (Porter, 1980).

On the other hand the focus strategy is quite different from the others because it relies on the choice of a narrow competitive scope within an industry. In cost focus, a firm seeks a cost advantage in its target segment, while in differentiation focus a firm seeks differentiation in its target segment. Achieving both cost leadership and differentiation are usually inconsistent, because differentiation is usually costly (Porter, 1980).

A particular firm can decide on any option among generic strategies; the benefits of a focus strategy cannot be gained if a firm is simultaneously serving a broad range of segments (cost leadership and differentiation). However, a construction company can be competitive while stuck in the middle (Kale, 2002).

The third focus of Porter's competitive theory studies the value chain. A firm has many activities, such as designing, producing, marketing, delivering, and supporting its product. Each activity can have a cost leadership and differentiation strategy. According to Porter, the value chain is a systematic way of examining all activities. The matter of how a firm performs and observes these activities interaction is necessary for analyzing the sources of competitive advantage (Porter, 1985). The value chain displays total value and consists of value activities and margin as shown in Figure 2-3.

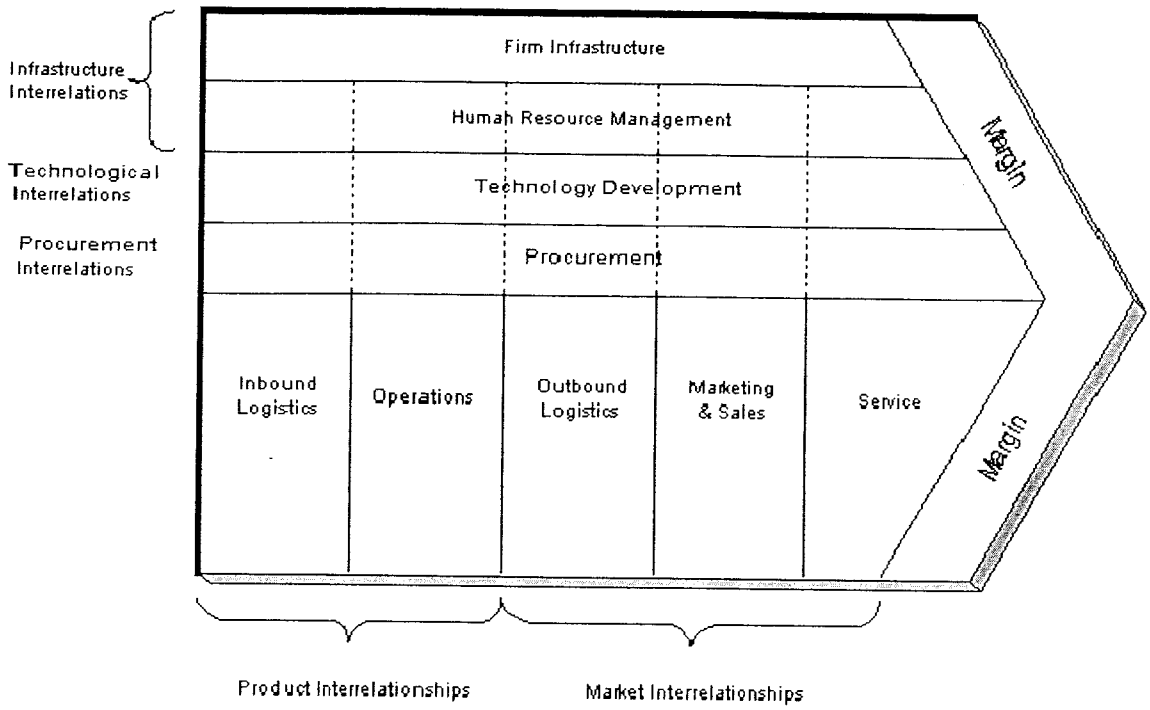

Figure 2-3: The Generic Value Chain (Porter, 1985)

As per the previous figure, primary activities have five main generic categories that are involved in competing in any industry: inbound logistics, operations, outbound logistics, marketing and sales, and service. Each of the categories may be critical to competitive advantage depending on the industry. While the support activities involved in competing in any industry can be divided into four generic categories: firm infrastructure, human resource management, technology, development, and procurement. Each category can be isolated into a number of distinct value activities that are specific to a given industry. Moreover, each category of primary and support activities has three activity types: direct, indirect, and quality assurance. For a particular industry, a firm should define its value chain. Value chain analysis views the organization as a sequential process of

value-creating activities. This approach is helpful for understanding the building blocks of competitive advantage (Porter, 1985).

The last focus point of Porter's competitive theory is the diamond model. This model aims to answer questions regarding why are certain companies based in certain nations able to consistently innovate or why do they ruthlessly make improvements. Moreover, this model seeks the advantages for an increasingly sophisticated source of competitive ability. The diamond model has four attributes has shown in Figure 2-4: factor conditions, demand conditions, related and supporting industries and firm strategy, structure, and rivalry (Porter, 2008).

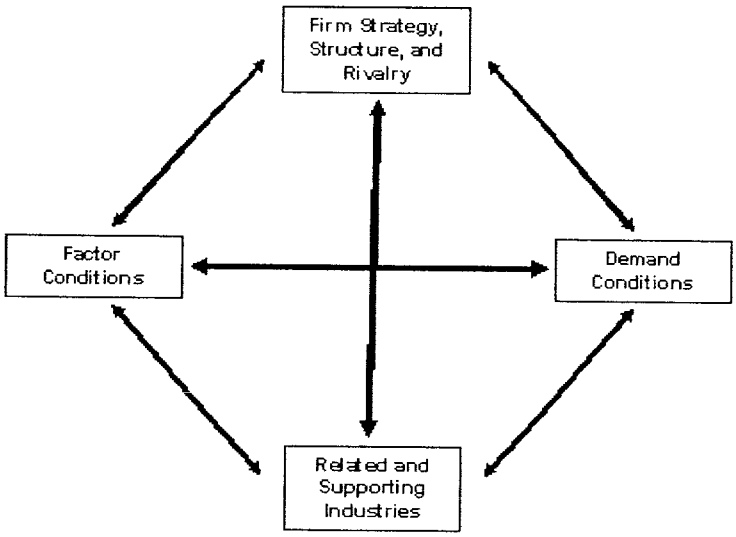

Figure 2-4: Porter's diamond framework (Porter, 2008)

Diamond framework determinants create the national environment in which companies are created and learn how to compete. Ofori (1994) used the

diamond framework to make a long-term strategy for Singapore's construction industry, thereby demonstrating that point that the model can help improve strategic planning in construction. Oz (2001) used the diamond framework for the Turkish construction industry to find competitive advantages.

Competitiveness Based On Strategic Management Approach

Strategic management is defined as a management approach that consists of analysis, decisions and actions an organization undertakes in order to create and sustain competitive advantage. Such a management has four key attributes (Dess *et al.*, 2008). It directs the organization toward overall goals and objectives as well as includes multiple stakeholders in decision making. Also it needs to incorporate short-term and long-term perspectives while recognizing trade-offs between efficiency and effectiveness. (Dess, 2008).

A firm can use strategic management to undergo its competitive advantage. Although there are many strategic management theories, the present research will focus on the following key points with strategic management for firm competitiveness:

- Key success factors (KSFs) and critical success factors (CSFs)
- SWOT analysis
- Core competencies
- Balanced Scorecard of Kaplan & Norton

KSFs define the key factors that make a firm successful. These factors apply to the entire industry, not to a specific company. Researchers have defined KSFs as variables that can effect significantly the competitive positions of all companies within an industry or strategic group. Typically, these factors are determined by the economical and technological characteristics of particular industries and the competitive power on which firms have to build their strategies upon. Moreover, these factors usually are related to strategic variables, product qualities, and organizational capabilities that are combined together to add more value for the customers.

CSFs are a business supporter term for parts which are necessary for an organization or project to achieve its mission. They are the critical factors or activities required for ensuring the success of a business. CSFs were investigated and modeled in construction organizations based on a survey of several construction organizations across Canada, Egypt, and other countries (Elwakil *et al.,* 2009). To identify critical success factors for construction organization, several studies were implemented. Abraham (2000) adopted the approach of Pollais and Friez (1993) for combining the latest strategic management theory; the seven guiding principles of strategic management for civil engineering (Chinowsky and Meredith, 2000), with the latest critical success factors methodology theory for IT organization (Rochart *et al.,* 1996). Abraham (2000) added a third dimension and incorporated information from the organizations with the two knowledge domains. Mazri surveyed some

construction companies in Malaysia, and then proposed a ranking scale for factors that influence the success of construction organizations (Mazri, 2005)

Another key point of strategic management for competitiveness is the SWOT analysis. It is a strategic planning method used to evaluate the Strengths, Weaknesses, Opportunities, and Threats (SWOT) concerning a project or a firm. SWOT analysis provides a frameworks for analyzing those four elements of a company's internal and external environment (Dess, 2008).The key factors in each area will allow a company to take advantage of opportunities or will make a company susceptible to environmental threats. SWOT analysis factors can be divided into two main factors as shown in Table 2-1:

- Internal factors: The internal strengths and weaknesses to an organization.
- External factors: The opportunities and threats presented by the external environment to the organization.

Table 2-1: SWOT Analysis

	Helpful	Harmful
Internal origin	**Strengths**	**Weaknesses**
External origin	**Opportunities**	**Threats**

Some limitations of SWOT can be summarized as follows: SWOT's focus on the external environment is too narrow, it gives a one-shot view of a moving target and it overemphasizes a single dimension of strategy (Dess, 2008). In the

construction industry, SWOT was used to analyze case studies related to consulting firms in ShenZhen, China and Vietnam. The results of these studies revealed that the Chinese consulting firms are lagging behind foreign firm in: design and technical capability, experience in international projects, general and project management ability, and financial capacity. Vietnamese AEC firms are lagging behind foreign firms in: financial capacity, experience in complex projects, knowledge in advanced design and construction technology, and management ability (Ling, 2009).

'Core competencies' is another key point in competitiveness based on strategic management approach where it define activities the company performs especially when compared to competitors. It has three key criteria: It offers consumer benefits, is difficult for competitors to imitate and it can be widely leveraged for many products and markets. Core competencies are the collective learning in organizations, and involve the coordination of diverse production skills and integrate multiple streams of technologies. It is a communication, an involvement, and a deep commitment tool for working across organizational boundaries (Prahalad, 1990).

Presented in 1992 in Harvard Business Review, the Balanced Scorecard (BCS) has become one of the most useful methods of measuring and driving performance as well as analyzing a firm's competitiveness. According to Kaplan and Norton, "The Balanced Scorecard provides managers with the instrumentation they need to navigate to future competitive success" (Kaplan, 1996). The Balanced Scorecard as presented in Figure 2-5 allows managers to

analyze their business from four important perspectives: customer, internal, innovative and learning, and financial perspectives (Kaplan, 1992).

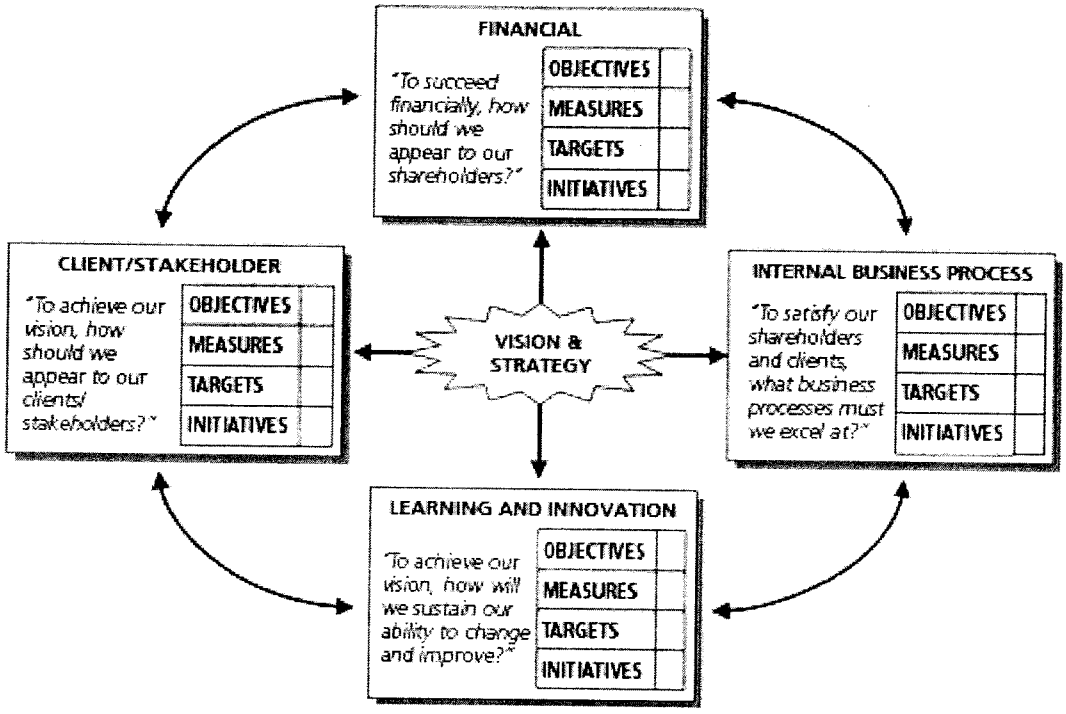

Figure 2-5: Balanced Scorecard (Kaplan and Norton, 1992)

By spotlighting not only financial outcomes but also operational, marketing and developmental inputs, the Balanced Scorecard offers a more comprehensive view of a business, which in turn helps organizations act in their best long-term interests (Kaplan, 1996). In practice, early Scorecards achieved this balance by encouraging managers to select measures from three categories: customer, internal business processes and learning and growth. Since the introduction of original model, Balanced Scorecards have become a rich field of theory, research and consulting practice. Implementing balanced scorecards usually contains four processes:

- Translating the vision into operational goals;
- Communicating the vision and linking it to individual performance;
- Business planning and index setting;
- Feedback and learning, and adjusting the strategy accordingly.

Companies implement Balanced Scorecards to: drive strategy execution, clarify strategy and make strategy operational, Identify and align strategic initiatives, link budget with strategy, align the organization with strategy and to conduct periodic strategic performance reviews to learn about and improve strategy (Kaplan and Norton, 1992). A survey done in 1997, showed that 64 percent of the companies questioned were measuring performance from a number of perspectives in a similar way to the Balanced Scorecard (Kurtzman, 1997).

In the construction industry, this concept was used to establish a new conceptual framework for performance management in construction (Kagioglou *et al.,* 2001), to conduct performance measurement of construction firms in developing countries (Truong Van, 2008), and to measure paper performance in construction (Bassnioni, 2004).

Although BSC is an excellent tool for measuring performance management, including construction performance management, it does not take into consideration some of the main characteristics of the construction industry, such as the emphasis on project management and suppliers (Kagioglou *et al.,* 2001).

Competitiveness Based On Innovation

Organizations should create a new competitive environment based on the fact that the construction industry is always affected by continuous change and competitiveness. Porter in the book '*Rethinking the Future*' shows that nowadays `technology and globalization aspects like capital, labor, and organization size less important than innovation and upgrade (Wibson, 1998). Similarly, Prahalad and Hamel revealed that change is the main factor in any organization's long-term existence. This process requires the organization to be capable of innovation (Wibson, 1998).

Furthermore, with the new connectivity in modern society, co-creation is more important. As an example, organizations should emphasize a horizontal approach for resource supply rather than vertical integration. Thus firms' internal focus should be on gaining entrance to resources, not necessarily owning them (Prahalad, 2008)

"In a world of ever-accelerating change, innovation is the only insurance against irrelevance." – Hamel (Wibson, 2009). Based on researches on the success of organizations like IBM (International Business Machines) and GE (General Electric Company), many scholars have shown that the main factor of their success is innovation (Wibson, 2009). All in all, Innovation can make competitiveness in the construction industry less pressing, and can lead to construction organizations gaining more benefits.

Resource-Based View (RBV)

The resource-based view (RBV) is used to decide the strategic resources obtained for a firm. The main principle of RBV is that the foundation for a competitive advantage of a firm lies primarily in the application of valuable resources at the firm's disposal. To convert a short-run competitive advantage into a sustained competitive advantage requires that these resources have to be varied in nature and cannot be imitated easily. Effectively, these resources will transform into valuable resources that are neither perfectly imitable nor substitutable without great effort. If these conditions hold, the firm's bundle of resources can assist the firm sustaining above average returns (Barney, 1991).

The RBV of a firm includes two perspectives: internal analysis of phenomena within a company and an external analysis of the industry and its competitive environment. RBV is a useful framework for gaining insights on why some competitors are more profitable than others. Also it reveals how core competencies embedded in a firm can help it develop new product and market opportunities (Barney, 1991, Grant 1991).

Each organization is a collection of unique resources and capabilities that provides the foundation for its strategy and the primary source of its returns. Differences in firms' performances across time are driven primarily by their unique resources and capabilities rather than by an industry's structural characteristics (Barney, 1991, 1995).

The key points of the theory are: identification of the firm's potential key resources, evaluation of whether these resources fulfill the Valuable, Rare, In-Imitable, Non-Substitutable (VRIN) criteria (Barney, 1991, 1995).

In contrast to Porter's five forces model , the resource-based review highlights the need for a fit between the external market context in which a company operates and its internal capabilities (Vadim Kotelnikov, 2010).

2.3 Competitiveness in Construction Industries

Momaya et al. (1998) studied the international competitiveness between the Canadian, United States (US) and Japanese construction industries. Using 95 criteria to quantify competitiveness and evaluate their framework using available statistics and industry experts' opinions, the results showed that Japan ranked the highest score and Canada the lowest score. The Canadian industry is very competitive in performance, but has distinct weaknesses in assets and processes (Momaya, 1998). Also it is lagging behind domestic and product-service dimensions of competitiveness. On the other hand, the Japanese construction industry has a high score in assets and processes and low score in performance. The US industry has a high score in assets and low scores in processes and performance. However, any construction industry is primarily localized, so evaluation of international competitiveness by comparing different countries is considered very difficult. Henricsson (2005) identified four attributes for common competitiveness measures. These attributes are found in Table 2-2.

Table 2-2: Measuring Competitiveness (Henricssion et al., 2005)

Measure	Level of abstraction	Focus
Composite indices	Nation	Potential and process
Trade related measures	Nation and industry	Performance
Profitability measures	Firm	Performance
Productivity measures	Nation, industry and firm	Performance

As per Table 2-2, a competitive construction industry must be profitable; i.e. offer satisfying returns to investors; be productive while delivering high quality with good time and cost predictability and have high client satisfaction of products and services. In addition to that, it needs to have high employee satisfaction, including aspects such as wages and health and safety, and be attractive to competent labor. Parallel with this, it has to comply with environmental regulations and codes of business ethics as well as be innovative and continuously improved and upgraded (Henricssion et al., 2005).

In the same perspective, a competitiveness hexagon has been established for the construction industry and constitutes: factor conditions, demand conditions, government, industry characteristics, firm strategy and management, human resources (Flanagan *et al.*, 2005). Flanagan states that these six areas affect a contractor's competitiveness in any market independently from nation's identity (Flanagan, 2007).

The following sections will focus the study on the Vietnamese and Canadian industries as further analysis throughout the rest of this thesis will be based on these two industries.

Vietnam is a developing country with 88.5 million people, with a Purchasing Power Parity (PPP) of $242.3 billion USD, and Gross Domestic Product (GDP) per capital of $2,800 USD. It shares 0.35% GDP of the world, a labor force of 47.4 million people, and a GDP real growth rate of 8.2% (2006), 8.5% (2007), and 6.2% (2008) (WEF & CIA, 2009). Vietnam's government invests a great deal of money in building infrastructure such as highways, North-South railways, airports, seaports, etc.

The Vietnamese construction market depends on foreign and governmental investment in industrial factories and large projects. Most of the large companies and industrial factories are based either on foreign or on government investments. Most big infrastructure projects are public based and the government and provincial authorities are the clients. This makes the industry's relationship with government and provincial authorities very important.

The superior technologies in industrial factories and projects usually depend on foreign experts (e.g. My Thuan Bridge, Long Thanh Airport, Hai Van Tunnel, Dung Quat petroleum and gas factory).

Vietnam's construction industry is now developing and expanding with a rate of development of 23% in 2007 as per the Vietnamese Construction Industry Minister. Based on big government investments for infrastructure and the development of economics, the construction industry has developed quickly in recent years.

Most construction corporations are groups of joint stock companies in which the government holds a large percentage while the private sector owns little percentage. There exists many large construction corporations, such as Song Da Construction Corporation, Truong Son Corporation, Vinaconex Corporation, Thang Long Construction Corporation, Construction Corporation No.8 (CIENCO8), Construction Corporation No.6 (CIENCO6), Construction Corporation No.5 (CIENCO5), and Construction Corporation No.4 (CIENCO4).

The SWOT analysis was implemented for the Vietnamese A/E/C Firm (Ling *et al.,* 2009); the results revealed that the Vietnamese A/E/C firms are lagging behind foreign firms in financial capacity, complex projects experience, design and construction technology, and management ability. Long (2004) investigated the problems faced by large construction projects in Vietnam and analyzed five factors that are significant for large projects: incompetent designers and contractors, poor estimation and change management, social and technological issues, site related issues and improper techniques and tools (Long *et al.,* 2004,I).

Another study surveyed 20 success factors in Vietnam and revealed 15 project success factors divided four groups: comfort, competence, commitment, and communication (Long *et al.,* 2004,II).

Canada is a highly developed country with vast land rich in natural resources and a hi-tech industrial society. It has 33,487,208 people, a GDP of $1.303 trillion (2008 est.), a GDP per capital PPP of $39,200 USD, a labor force of 18.22 million people, and a GDP real growth rate of 0.4% (CIA, 2009).

Canada has been a member of the US-Canada Free Trade Agreement (FTA) since 1989 and the North American Free Trade Agreement (NAFTA) since 1994, and also it is a member of World Trade Organization (WTO).

The Canadian construction industry provides a wide variety of services. It provides houses, skyscrapers, highways, metros, nuclear-power stations, large-scale hydroelectric power supplies, dams, petrochemical plants, and pipelines. The construction industry in Canada is the largest industry. It has the highest employment number and the largest value of all of Canada's industries. According to some statistics, the Canadian construction program was worth $104.5 billion in 1996. The construction industry directly employs more than 750,000 people which is more than 5% of all jobs in Canada. A larger number of workers are occupied in producing, transporting and merchandising construction materials and equipment (Construction forecasts, 2010).

A research has been done concerning the "International competitiveness of the Canadian construction industry: a comparison with Japan and the United States". Researchers revealed that "the Canadian construction industry faces strategic problems such as a decline in its domestic as well as international markets in the early 1990s, a limited capability for major capital projects, declining labor

productivity, high unemployment, inability to implement crucial competitive policies, and low investment for the future. This important Canadian industry is facing a long period of decline. Some countries have been successful in mitigating the impact of a slump in the domestic market by raising their share of the international market; however, Canada has not shared this success" (Momaya *et al.*, 1998).

The Canadian industry has a strong competitiveness in performance, but it is weak in assets and processes. The industry lacks trusting relationships among stakeholders, and has poor technological and industrial infrastructure, weaknesses in implementation and a lack of synergy (Momaya, 1998).

"Its strengths in performance may not be sustained if the neglect of vital processes and underinvestment in assets are not addressed. These processes include human resources development, project delivery, integrated production, technology development, and building cooperative network linkages with related and supporting industries. The Canadian industry is also lagging behind on domestic and product–service dimensions of competitiveness. Its average annual percent productivity increase in the period 1981–1989 was just 0.5 compared with 5.4 for mining and 2.6 for manufacturing industries" (Momaya *et al.*, 1998).

Characteristics of Canada's Construction Company

Canada has many construction companies, some of which are in the top 20 construction companies in the world, such as SNC-Lavalin. Many of the US's construction companies invest in Canada; for example, Bechtel Construction

Company, the number one contractor in the US, has an office in Montreal, Canada. Foreign investors make Canada's construction industry more competitive.

Canada's construction companies' work in a developed market and a highly technological society, so many of them have worked with new technology, building big and complex projects. They also invest in other countries in the world. SNC-Lavalin has offices in more than 36 countries on five continents and is currently working on projects in some 100 countries. In addition, SNC-Lavalin works on all sorts of different types of projects, such as infrastructure, environment, chemicals & petroleum, power, mining and metallurgy, operations and maintenance, infrastructure concession investment, industrial, project financing, etc. The Poole Construction Company Limited (PCL) family of companies has a main office in Canada, but also works in the US on many projects. PCL is one of the largest construction companies in Canada and is the seventh largest construction company in the US.

In highly developed society, Canadian construction companies can work on complex projects with advanced technology. Many construction companies have a great deal of experience and have been established for a long time; for example, SNC-Lavalin was founded in 1937, and PCL was founded in 1906.

Canadian construction companies also invest in training and education. EllisDon Corporation has EllisDon University (EllisDon Website, 2010); Aecon offers employees many important training courses to assist them in continuously

expanding and developing their skills and knowledge (Aecon Website, 2010). Most construction corporations are groups of independent companies. This structure helps companies to be more flexible in business.

2.4 Previous and Related Work

A complete competitiveness analysis must: describe what competitiveness means and how it is calculated, identify the most important factors and their relationships influencing it and how they affect the competitiveness of the subject of investigation (Lall, 2001; Hericsson, 2005).

Flanagan (2005) demonstrated that competition is becoming more complex and identified certain attributes that contribute to competitiveness analysis. These attributes are: price and value for money, process and product innovation, quality and reliability of products and customer services, speed of delivery, differentiation of products and services and technology or safety on site. It is not a wise decision to compete on all of these factors. To remain competitive, firms must continually struggle to decrease construction prices without compromising quality and safety levels.

The following sections will discuss four points concerning measuring the competitiveness in construction. These points are: Competitiveness based on competitive theories, strategic management to achieve competitive advantage and improve competitive ability, competitiveness based on synthesizing other and research about measure competiveness or performance.

Warsawski (1996) presented an orderly process for the development of a competitive strategy in a construction company. His methodological procedure for strategic planning in a construction company consists of four stages: examine the company mission, survey the company's business environment, analyze the company's main resources and develop a strategy. His competitive strategy is based on Porter's theory: *cost leadership, differentiation, and focus*. He suggested that a construction firm can attain a *cost leadership* strategy through standardization of products, training personnel, tight control, careful selection of suppliers, technological advancement and incentive programs. Also, it can achieve a *differentiation* strategy by setting higher standards or raising quality of product, having faster project completion and providing more extensive services to clients. It can conquer a *focus* strategy by focusing on certain types of projects, certain geographical areas or certain types of clients. Construction companies can achieve *growth strategies* through entry into new locations, development of international activity, entry into new types of construction projects, creation or expansion of construction material productivity capacity, participation in new types of activities and acquisition of companies with the same or complementary types of activities. In addition to that, construction companies can achieve *internal strategies* by using strategies in the development of construction capacity, marketing strategies, procurement strategies, personnel strategies, organization strategies or knowledge strategies (Warsawski, 1996).

Kale explored the US construction industry along two dimensions: scope and mode of competition. Construction firms have four main modes of competition: competing on the basis of quality of product/service, competing on the basis of product/service and process innovations, competing on the basis of time and competing on the basis of cost. Construction firms have scope of competition by adopting a narrow, broad, neutral market and product/service approach. This research reveals that construction companies can be classified on the basis of their choices regarding scope and mode of competition. Successful construction firms place varying degrees of emphasis on more than one mode of competition; due to the difficulty in differentiating their offerings, construction firms' performance is significantly related to the choices they make relating to modes of competition. Construction firms that adopt a neutral approach to the scope of competition place a strong emphasis on all modes of competition to outperform their rivals. In the same perspective, this research revealed that construction firms operate in an environment that hosts fierce competitive forces and weak institutional forces. The construction industry has low entry barriers, so the threat of a substitute service is very real and the construction firms are in a weak bargaining position with respect to their clients and suppliers. Also a construction firm can confront the fierce competitive forces hosted by the construction industry by differentiating itself from its rivals (Kale *et al.*, 2002).

Randy synthesizes strategies of Porter and Kenneth Andrews. He adapted their consistencies and inconsistencies, and Porter's five forces and value chain concepts to the construction industry. He revealed that Master's programs for

constructors should be more advanced than just focusing on the project management level. A strategic management and business policy course should be taught in the Master's curriculum by the construction faculty (Randy, 2001).

Korkmazet explored the models of competitive positioning and stability in the context of mode (cost, quality, innovation, and timing) and scope (segment, vertical, geographic, and industry) of US and Turkish construction organizations in international markets. The study revealed that construction companies are likely to follow consistent strategies in international markets while they adjust these strategies along with market demands and global tendencies. He combined mode of competition refers to construction companies by Kale (2002) (cost, quality, innovation, and timing) and some researchers about scope of competition (segment scope, vertical scope, geographic scope, industry scope). (Korkmazet *et al.,* 2008).

Strategic Management to Achieve Competitive Advantage and Ability

Chinowsky introduced a new method for competitiveness in construction organizations. In his paper, Strategic Management in Construction Organizations (Chinowsy,2001), he emphasizes the importance of organization levels in construction management. He introduced seven areas that organizations must address to compete in the face of changing customer and competitor conditions. The seven areas are: vision, mission, and goals; core competencies; knowledge resources; education; finance; markets and competition.

From the survey and analysis, Chinowsky notes that positive strategic management areas are technology and market awareness, and areas for greater emphasis are education and core competencies (Chinowsky, 2001).

Based on seven areas of Chinowsky and the latest CSFs methodology for IT organizations, Abraham (2000) revealed eleven CSFs for construction organizations. These factors are: competitive strategy; market conditions: political environment; organizational structure; technical applications; employee enhancements; process benchmarking; feedback and evaluation; inter-organizational relationships; environment factors; and management skill and relationships.

Elwakil et al. (2009) had undergone an investigation of CSFs models in construction organizations. The study surveyed many countries including Canada and Egypt. Using Artificial Neural Networks (ANNs) and Neural Network Training, the research proposed night CSFs: availability of knowledge; clear vision, mission and goals; organization structures; feedback evaluations; business experience; political conditions; research and development; employee culture environment; and competition strategy.

Another study surveyed 40 Turkish construction companies, and investigated the critical factors leading to construction company success. The study showed that business management, financial conditions and owner/manager characteristics are the most important factors to company success (Arslan and Kivrak, 2008).

Metri (2001) identified Total Quality Management (TQM) and critical success factors (CSFs) for construction firms. He confirmed ten CSFs: top management commitment; quality culture; strategic quality management; design quality management; process management; supplier quality management; education and training; empowerment and involvement; information and analysis and customer satisfaction.

Jaafari (2000) explored the potential for the application of a range of popular management concepts and techniques for powerful change and achieving competitiveness. To rise to a level of international competitiveness, a construction organization must understand, tame, and apply strategic planning and management principles to drive changes in management purposefully and optimally. He emphasized learning because construction is a technology-based business and innovation is the key to remain competitive. Construction orders are diverse and continuous innovations in the delivery and management of such orders are essential for remaining competitive. Climbing to the top rank and maintaining one's position requires learning faster than one's competitors. He also came up with CSFs: leadership, strategy and empowerment; organizational factors; training or preferable education; creativity; proactive management; IT; and performance measurement/benchmarking.

A study done at the Rice University Building Institute gives 12 strategies that drive the 21st century's most successful firms: vision; value; competitive focus; category ownership; persistent branding; marketing breakthroughs; competitive

intelligence; competitive culture; customer intimacy; high-impact people; culture of obsessive improvement; and new strategic alliances (Powell, 2008).

Competitiveness Based On Synthesis of Other Theories

Competitiveness based on synthesis of other theories tends to propose new methods. One of these methods is a PhD thesis developed by Lu for the Chinese industry. He combined Porter's competitive theory, core competency and resource-based views, and applied them to Chinese construction contractors to identify 33 critical success factors, then established the index of contractor's competitiveness for China's construction industry (Lu, 2006).

According to this study, competitiveness is a kind of powerful ability to encourage sustainable development, and should be at the heart of the model of the construction firm. Competitiveness cannot be properly analyzed without considering the different levels of analysis, such as national level, industry level, or firm level. Porter's competitive advantage and competitive strategy models, as well as the resources-based and core competence approaches, are all effective in explaining construction firms' competitiveness. Since assessing this competitiveness is an effective approach to understand the competitiveness of contractors, Lu established an index for Chinese contractor's competitiveness and posited that contractor competitiveness comes from three categories of generic sources: competitive strategy, value activities and resources. Assessing contractor competitiveness should relate the firm to a particular context in which the constructor operates (Lu, 2006). To create this competitiveness index model, he used a weighted summation method. He also established an IT support

system (the C-CACS) (Contractor Competitiveness assessment and Communication System) to calculate Index and give a sense of the competitive abilities of contractors.

One of the limitations reported for this study is that the developed index is for assessing contractors' competitiveness based on critical success factors for competitiveness of contractors only. This is inadequate because many factors are not success factors, but they greatly affect competitiveness. Moreover, his index is generated based on the Chinese construction market, which makes it very different for other markets to use. In addition, Lu's model does not provide a method for checking the index to determine if the information is correct or why it is correct. He also uses one unique type of function from that of WEF (World Economic Forum) to calculate the score for all hard-data competitive indicators as shown in equation 2-1:

$$SPV = \frac{x - x_{min}}{x_{max} - x_{min}} \text{x} 100 \qquad \text{(Equation 2-1)}$$

Where:

- SPV = value of a competitive indicator
- x = performance value of the contractor calculated.
- x_{min} = the minimal value among all the sample contractors,
- x_{max} = the maximal value among all the sample contractors.

Obviously, the value of equation 2-1 (SPV) depends on x_{min} and x_{max}. In other words, it depends on samples that used to calculate in equation 2-1. When x_{min} or x_{max} changes SPV will be changed, the score and competitiveness index that based on SPV value will be changed. Therefore, the score and competitiveness index calculated in this method cannot reflex clearly the company competitiveness ability.

Another study presents a method to assess Hong Kong contractors' competitiveness based-on fuzzy model. However, it does not give criteria to calculate an index, nor functions to calculate score (Yongtao, 2009).

Measure Competiveness or Performance

To measure company competitiveness, a model was developed in the University of Pecs to generate a competitiveness index for the construction industry as shown in Equation 2-2 (Schmuck *et al.*, 2009)

$$I_v = 0,31xK + 0,42xV + 0.349xM + 0.289xF + 0.325xS + 0.295xC \quad \text{(Equation 2-2)}$$

Where:

- K= index for research and development
- C= index for changing of target markets
- V= index for adaptation to changes
- M= index for rate of marketing budget
- S= index for participation in strategic alliances
- F= index for workforce fluctuation

Schmuck's method is used popularly in Hungary, but it does not reflect many aspects of firm competitiveness, especially construction firm competitiveness that emphasizes on time, cost, quality, etc.

Another study was developed to calculate the competitiveness index for the construction industry at China's provincial level. In this study, five first-level indicators (scale, structure, capability, performance, and relevant Industries) were used, 23 second-level indicators and 61 third-level indicators (Sha *et al.*, 2008). This study established The Competitiveness Index for the Construction Industry (CICI) to measure relative competitiveness of the construction industry at China's provincial level.

To measure the quality-based competitiveness of an organization, a study proposed nine quality factors and 57 quality sub-factors. Each sub-factor is calculated for one functional unit. The calculated index is the total of sub-index (Kumar et al., 1999).

Since 1999, the World Economic Forum (WEF) has annually published the Global Competitiveness Report (GCR). These reports are based on both qualitative and quantitative data. In 2009, WEF researchers categorized competitive factors into three main groups: basic requirements, efficiency enhancers and innovation and sophistication factors. From these three areas addition 12 main-factors and 110 criteria were proposed to calculate the index. The weight for each main group is different for the stage of development, thus it is different for each group of countries (WEF, 2009).

The International Institute for Management Development (IMD) publishes the World Competitiveness Yearbook (WCY). In 2008, researchers provided their main steps to calculate a competitiveness index, which is entitled 'Methodology in a Nutshell'. This model is used to establish competitiveness index to measure nations' competitiveness indexes (IMD, 2008).

'Key performance indicators (KPIs)' is the most popular framework used to measure performance for the UK industry (Bassioni *et al.,* 2004). In 2000, the Department of the Environment, Transport and the Regions built a KPI report for the Minister for Construction. The principle of the key performance indicators (KPIs) is to allow measurement of project and organizational performance throughout the construction industry. Using KPIs, managers can measure short-term performance only; they cannot measure long-term performance, which is very important for competitiveness (Bassioni *et al.,* 2004).

Rockwater, a global engineering and construction company, used a balanced scorecard to measure performance. Rockwater company used the table below to translate strategy objective into tangible goals and actions. The management team used its balanced scorecard to communicate the company's objectives among all project stakeholders (Kaplan, 1993).

Table 2-3: Rockwater Balanced Scorecard (Kaplan, 1993)

1. Financial Perspective	2. Customer Perspective
Return-on-Capital Employed, Cash Flow, Project Profitability, Profit Forecast Reliability, Sales Backlog.	Pricing Index, Customer Ranking Survey, Customer Satisfaction Index, Market Share.
3. Internal Processes Perspective	**4. Innovation and Learning Perspective**
Hours with Customers on New Work, Tender Success Rate, Rework, Safety Incident Index, Project Performance Index, Project Closeout Cycle.	Percentage of Revenue from New Services, Rate of Improvement Index, Staff Attitude Survey, Number of Employee Suggestions, Revenue per Employee.

Summary of Limitations

Literature covered several methods to measure competitiveness indexes concerning the construction industry. There are several limitations inherent to the available literature as briefed in the following summary.

Resource-based view (RBV) and core-competency only emphasize the company resources and internal factors that shape company competitive ability. In contrast, Porter's five forces model, focus on the company's external competitive environment. It considers the external factors as the main forces that make competitive strategy. Porter's theory does not give internal mechanism in order to convert the influence of challenging external factors into useful internal abilities (Lu, 2006), it overlooks the reputation, culture of organizations that are potential sources of sustainable competitive advantage (Lado *et al,*. 1992). For a more concrete competitive analysis results, both internal and external factors

must be considered in an integrated model (Porter, 1985). Balanced Scorecard (BSC) is a popular tool for business management, however BSC does not mention two perspectives that are very important in construction industry: project-based and supplier demand (Kagioglou *et al.,* 2001).

Schmuck's method is popularly used, but it does not reflect many aspects that are essential for a firm's construction competitiveness like time, cost, quality, supplier, etc... (Schmuck, 2009).

The competitive indicator calculated by Lu's created an index for assessing contractors' competitiveness based on critical success factors for competitiveness of contractors. This is inadequate because success factors are not included in the model, keeping in mind that they have great affect on competitiveness. Moreover, this index is created solely for the Chinese construction market, which is different from other market (such as labor's force, government controls market...). In addition, Lu's model does not provide a method for checking the index to determine if the information is correct or why it is correct. He also uses one unique type of function to calculate the score for all hard-data competitive indicators as shown in equation 2-1. Furthermore, this equation depends on contractors that are needed to calculate x_{max}, x_{min} thus it cannot reflex the competitiveness ability of contractors (Lu, 2006).

As for the model proposed to assess Hong Kong contractors' competitiveness based-on fuzzy, it does not have criteria to give the ratings and weightings of attributes. The ratings and weightings of attributes are only based on the

judgment of some experts (usually three experts) on one company's competitiveness. So the results are dependent on the judgment of limited number of experts and thus it will not reflect the performance of the whole company (Yongtao, 2009).

2.5 Multi-Criteria Decision Making

Analytic Hierarchy Process (AHP)

The Analytic Hierarchy Process (AHP) is a multi-criteria decision-making method that was developed by Thomas L. Saaty in the 1970s; it was introduced and applied for dealing with complex decisions. The AHP helps the choice makers find the decision that best suits the needs of a particular problem rather than prescribing an "exact" decision. The AHP is used as a "framework for structuring a decision problem, for representing and quantifying its elements, for relating those elements to overall goals, and for evaluating alternative solutions". AHP is based on a pair-wise comparison concept that is made using nine-point scale (from 1 to 9, following scale in table 2-4) (Saaty, 1994). The comparison takes this simple form: How important is factor 1 compared to factor 2 with respect to a user's need?

Table 2-4: Decision Aids for Pair-Wise Comparison

Relative Importance	Value*
Equal importance/quality	1
Somewhat more important/better	3
Definitely more important/better	5
Much more important/better	7
Extremely more important/better	9

To measure consistency of the input data, the consistency index is used by equation 2-3 (Saaty, 1980):

$$CI= (\lambda_{max}-n)/(n-1) \qquad \text{(Equation 2-3)}$$

Where:

CI: consistency index

λ_{max}: the largest Eigen value

n: the size of the comparison matrix

The Random Consistency Index (RI) refers to the average consistency for different order random matrices as shown in Table 2-5 (adapted from Saaty, 1994).

Table 2-5: Random consistency index (RI)

N	1	2	3	4	5	6	7	8	9	10
RI	0	0	0.58	0.9	1.12	1.24	1.32	1.41	1.45	1.49

Consistency ratio is a comparison between the consistency index and the random consistency index, as in equation 2-4:

$$CR=CI/RI \qquad \text{(Equation 2-4)}$$

Where:

CR: the consistency ratio

CI: the consistency index

RI: the random consistency index

If CR≤0.1 then the ratio has an acceptable evaluation of judgment (Saaty, 1980).

Multi-Attribute Utility Theory (MAUT)

According to the guidebook to decision-making methods in 2001, "MAUT is a quantitative comparison method used to combine dissimilar measures of costs, risks, and benefits, along with individual and stakeholder preferences, into high-level, aggregated preferences" (Baker *et al,.* 2001). MAUT is suitable for complex decisions with multiple criteria and many alternatives. MAUT can also accommodate utility functions that have an optimum utility. The basis of MAUT is the use of utility functions. Utility functions change an alternative's raw score to a utility score, between 0 and 1. Each decision criterion has a utility function formed for it. Utility functions and MAUT are used when quantitative information is known about each alternative. Utility graphs are created based on the data for each criterion. Any number of alternatives can be scored based on utility functions (Baker *et al,.* 2001).

2.6 Summary

This chapter reviewed several theories concerning competitiveness and presented the so far published research works regarding construction competitiveness, organization competitiveness, and measuring and improving competitiveness. The benefits and limitations of these theories and research are also presented. It can be summarized that Porter's theory does not give internal mechanism in order to convert the influence of challenging external factors into

useful internal abilities. Resource-based view emphasized only the company's resources and the internal factors that shape company's competitive ability. Moreover, two studies concerning competitive performances in the Chinese and Hong Kong construction industries were discussed and certain limitations were reported.

CHAPTER 3. RESEARCH METHODOLOGY

The prospective competitiveness assessment model has to take into consideration the limitations recorded from previous works and addresses the new challenges that face the construction industry. From this sense, the research methodology that addresses this concern is illustrated in Figure 3-1. The following sections explain briefly the rationale behind each phase in the proposed model.

3.1 Literature Review

A thorough literature overview is performed in order to establish a solid background concerning companies' competitiveness and the following points were studied in detail:

- Concepts, definition and importance of competitiveness.
- Three competitive theories: Porter's competitive theory, competitiveness based on strategic management approach, and the resource-based view (RBV).
- Previous work concerning competitiveness research in construction. Advantages, applications and limitations of each theory are also recorded.
- Analysis of competitiveness performances in the construction industry, drawing on examples from Vietnam, Canada, US, Japan, the UK, Sweden, and Finland.

- Assessment of competiveness performance.

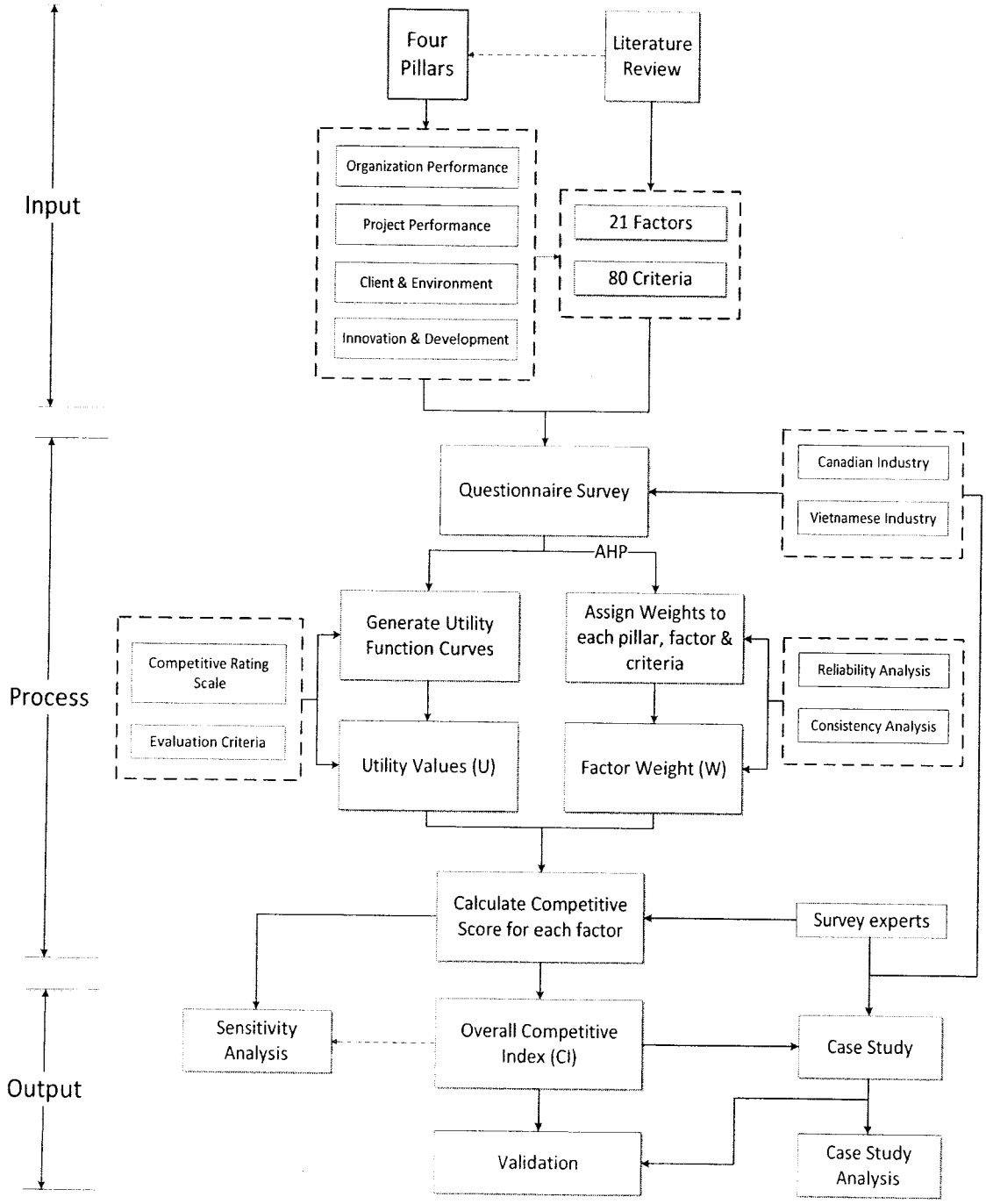

Figure 3-1: Research Methodology

3.2 Integration of Four Pillars with Construction Competitiveness Principles

This phase proposed 4 pillars (4P) to be considered when addressing competitive ability of construction companies based on the challenges faced by the construction industry. These 4 pillars are: organization performance, project performance, environment and client, innovation and development. Every construction company is impacted by 4 pillars, so 4P can be used to measure company's goals and performance, and to analyze the company's position. In current research, these 4 pillars are used to identifying key competitive factors and criteria. A pillar has some key competitive factors and a factor has some key competitive criteria.

3.3 Factors and Criteria Integrated in the Competitiveness Index (CI) Model

Based on literature review, discussion with experts in construction industry and Four Pillars (4P), current research proposed 21 key competitive factors (KCFs) and 80 key competitive criteria (KCC) which will constitute the factors incorporated in the model. KCFs and KCC reflect all vital aspects of construction company competitiveness. They include internal and external factors and performance issues of the organization and their projects.

3.4 Data Collection

The data collection phase consists of 3 parts which are required to develop and run the proposed competitiveness index model in which it is done via a questionnaire survey. In the first part, pair-wise comparison matrices were

performed between the various factors. There are three levels for comparison. Level 1 is compared between four pillars, level 2 for comparison between factors, and level 3 for comparison between criteria. Questionnaires asked experts to compare the importance between pillars, factors, criteria.

Table 3-1: Questionnaires' sample: a pair-wise comparison matrix.

▶ Level 1	Organization performance	Project performance	Environment and Client
Innovation and development			

The second part in questionnaires gathered the data needed to develop the utility functions. Experts were asked to provide the values range concerning each criterion.

Table 3-2: Questionnaires' sample: the values range to develop the utility functions.

Competitive Criterion C17: Success rate (%) of bidding over past 3 years

More than 80%	From 60% to 80%	From 30% to 60%	From 10% to 30%	Less than 10%

The last part in questionnaires collected the information needed to implement the case studies such as "Activity Ratio of company (Total assets turnover= Sales / Total assets)". The survey addressed both the Canadian and Vietnamese construction companies. However, Canadian and Vietnamese construction industries are different, current research separately uses and determines the survey in Canada and Vietnam.

3.5 Competitiveness Index Model

Based on the collected data via questionnaire survey, the AHP (Analytic Hierarchy Process) technique was used to relatively calculate the factors' weight. There are two types of criteria: criteria of hard-data and soft-data. Hard-data based on the statistics of the construction company, such as 'financial ratios' and 'number of employees with more than five years of experience', while soft-data include "leader's personality and capability" or 'the relationship with clients and owners' which are based on experts' subjective assessment. Utility functions are established only for criteria of hard-data.

The questionnaire survey also provided estimates concerning the utility-scoring functions and values. Since the objective was to obtain multi-attribute utility functions based on experts' preferences, a mean-score approach was adopted. The mean-score approach of each attribute was based on averaging scores derived from several respondents, which represented the single-attribute utility function of that attribute. Finally, the overall competitive score was generated mathematically by multiplying the decomposed weight of each attribute by the utility score of each sub-factor attribute, followed by a summation of results of each criterion within the whole incorporated factors. Because Canadian construction industry is different from Vietnamese construction industry, factor's weights and utility functions for Canadian construction companies are different from that of Vietnam.

The following equation (3.1) illustrates the proposed model:

$$I = \sum_{i=1}^{80} Wc_i * Sc_i \qquad \text{(Equation 3.1)}$$

Where:

I: competitiveness index for the construction company

Wc_i: composed weight of criterion i (i=1÷80) calculated by equation 5.1.

Sc_i: score of criterion i (i=1÷80).

Chapter 6 presents a method to calculate the scores of pillars, factors, and criteria. It also presents the graphs of these scores and their usage.

Pillar's score is calculated by equation (3.2):

$$P_k = \sum_{j=1}^{n} Wc_j * Sc_j \qquad \text{(Equation 3.2)}$$

Where:

P_k: Company competitiveness score for pillar k (k=1÷4).

n: The number of criteria that pillar k includes, mentioned in section 4.4.

Sc_j: Score/utility value of each criterion j that included in pillar k (j=1÷n).

Wc_j: Weight of criterion j that included in pillar k, (j=1÷n) calculated by equation 3.3.

$$Wc_j = WcxWf \qquad \text{(Equation 3.3)}$$

Where:

Wc: The relative weight of each criterion (see equation 5.1).

Wf: The relative weight of the factor (see equation 5.1).

Factor's score is calculated by equation:

$$F_j = \sum_{k=1}^{n} Wc_k * Sc_k \qquad \text{(Equation 3.4)}$$

Where:

F_j: Company competitiveness score for factor j (j= 1÷21).

n: The number of criteria that factor j includes, mentioned in 4.4.

Wc_k: Weight of criterion k that included in factor j, (k=1÷n). In equation 5.1, Wc_k is Wc of criterion k (it is not Wc_l).

S_{Ck}: Score/utility value of each criterion k that included in factor j (k=1÷n).

Three case studies are presented: two companies from Vietnam and one from Canada. Company's Competitiveness Indexes are calculated. The proposed model competitiveness index and experts' competitiveness index are compared, In addition, sensitivity analysis of main criteria are presented.

3.6 Summary

This chapter explained briefly the main phases of the proposed methodology. The methodology starts with a literature review, followed by a section that proposed the 4 new pillars for the construction industry. A questionnaire survey was implemented as to gather 2 main sets of information, factor's relative importance and their corresponding utility scores. The AHP (Analytic Hierarchy Process) and MAUT (multi attribute utility theory) techniques were used to develop the proposed competitiveness assessment model.

CHAPTER 4. Integration of Four Pillars Concepts with Competitive Theories

As stated earlier, the objective of this research is to develop a competitiveness assessment model that can address the present challenges in the construction companies and industries. This chapter will explain the principles of 4Pillars (4P) and how their concepts can be integrated in the construction industry as to serve competitive analysis.

4.1 New Waves of the Construction Industry

Advancements of IT technologies, communication and globalization are considered the main factors that impact the construction industry. Thus, innovation has become the main tool to gain a competitive advantage in such a continuously developing environment.

Technology and Communication Evolution

Developments in communication and management affect not only the procedures of executing projects, but also the way stakeholders think to develop such execution plans (Prahalad, 2008). In the present time, company managers can monitor exactly the CPI (cost performance index), SPI (schedule performance index), schedule, cost, etc... of each project per day through internet and mobile phone, although projects might be situated in different locations. Therefore, he/she can modify instantly the organization plans based on daily updated information. Likewise, employees can be kept up to date with information on the organization through the internet and cell phones. Since they

have a clear and open communication with both company's decisions and clients directly, employees can have more exact and quick resolutions to new problems that arise. The role of staff in decision making is now more important in the organization.

Clients and owners are informed and networked in an active and global environment. The client can communicate directly with a project's stakeholders and he/she can witness and participate in the project decisions. With the possibility of such choices regarding contractors, designers, materials and suppliers, the client's task has become more sophisticated and more responsibilities are addressed to him (Prahalad, 2008).

Knowledge and information exploding

Knowledge exploding causes the workplace to evolve from a skill-based environment to a knowledge-based one. Workers and staff should study new construction knowledge continuously. New technologies correspond to a new market, new tools, new automated works and new types of projects. All of these developments require that workers and staff should continuously develop knowledge bases. The structure and policy of organizations should also be adapted to suite new technology, new knowledge and new environments. Employees can now be aware of the vision and strategy of the organization as well as the detailed problems of their projects. Thus, they can share the vision, mission, goals and strategies of their respective organizations (Chinowsky, 2000).

Market Advancements and Globalization

Globalization methodologies affect the construction industry in many ways. It can facilitate a market's expansion from a local market to an international one. A single company can have projects in different countries; for example, SNC-Lavalin recently had projects in Venezuela, Algeria, China and Dubai. As a consequence of this expansion, construction organization faces new competitors from different countries. For example in the US industry, there are many contractors from Korea, China, India, and Japan. During the period from 1992 to 2002, approximately 180 million people moved from their native countries to seek jobs. As a result, production of single product can engage human, natural and capital resources from several countries (Shurchuluu, 2002).

Chinowsky (2000) revealed the area of emerging markets and competition. Traditionally, construction industry markets are divided into three main classifications: heavy, industrial, commercial, or residential markets. Based on this classification, construction organizations focus their efforts on narrowly defined competitive markets.

With the increase in demand to increase profit margins and market boundaries, the construction organization should consider long-term benefits, integration between projects and the advanced competitive strategy (Chinowsky, 2000). In addition, the success of the company is less dependent on attractiveness of its industry or country's environment, and more reliant on firm-specific factors that decide its competitive advantage (Hawawini *et al.*, 2004). Companies need to

expand their thinking beyond national borders when it comes to competition, capabilities, and customers (Wethyavivorn *et al.*, 2009).

Environment and Market Change

With the development of new construction process method such as Built Operate Transfer (BOT), design-build and design-build-finance-operate, construction organizations have to innovate and develop new business strategies continuously. Developments like pre-fabrication materials in the construction industry make the supplier environment more important and thus challengeable.

The sources of value are rapidly shifting from final products to personalized experiences. Thus the market dependency is changing from a single firm to a network of suppliers. Similarly, the decision making philosophy is changing from firms' deciding individually what consumers can have to creating value with the active involvement of consumers (Prahalad, 2008).

Innovation as a Vital Competitive Advantage

"In a world of ever-accelerating change, innovation is the only insurance against irrelevance." Hamel, (Wibson, 2009).

A key success factor for an organization to maintain a competitive aspect is the constant seek for opportunities for growth and performance improvement. As stated previously in Chapter 2, "Most famous business gurus claim that innovation is the main force in this century" (Porter, 1985). Porter shows that technology and globalization make traditional sources such as capital, labor, and size of organization less important, in contrast to factors like innovation and

business upgrade. In the same perspective, change is considered the main key to any organization's long-term existence (Prahalad and Hammer, 1994). Competing for future projects means creating new sources and new benefits continuously. This process requires that organizations need to be capable of innovation and have to focus more at external organization impacts. Thus, organizations should create a new competitive environment based on the rule of change and competitive advantage in a 'now' situation.

4.2 The Proposed Four Pillars for Construction Management

The traditional triangle model of project management (time, cost, quality) has recorded limitations concerning addressing present developments. It does not take into consideration the impact of technological changes, market changes and improvement and innovation factors. In order to address the previous stated challenges in the present construction market, four new pillars are proposed in this regard to address these challenges (Figure 4-1): organization performance, project performance, environment and client, innovation and development.

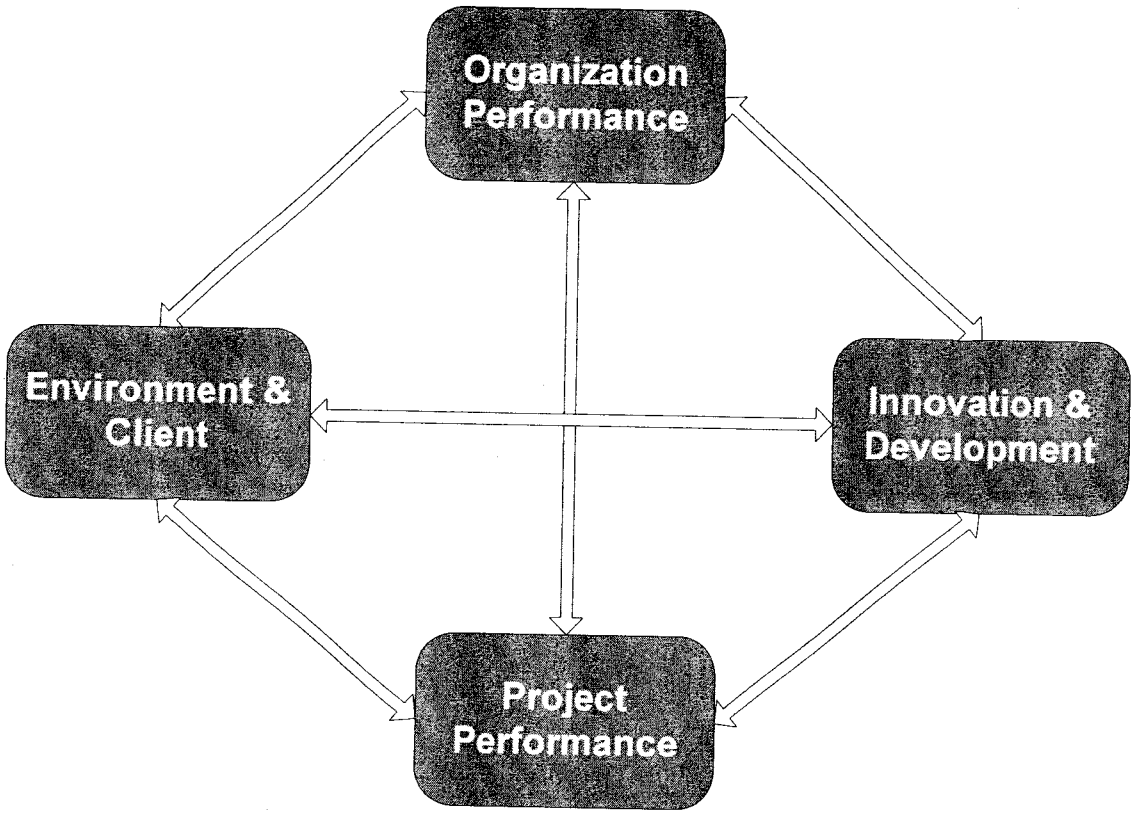

Figure 4-1: The Proposed Four Pillars in Managing Construction Companies

Organization and Project Performance

New communication technologies such as internet and cellular phones connect project to project and people to people. Construction managers should deal with projects as being one part of the construction organization that includes many projects and departments and not only as an isolated phase. Standards of the World Trade Organization (WTO) minimized the entry barriers into markets, thereby increasing competition (Ngowi *et al.*, 2005). In order to secure long-term competitiveness in such a situation, managers of construction firms must shift their focus from a project level to an organizational strategic level, simultaneously

aligning all project goals along with the firm's general strategy (Wethyavivorn *et al.*, 2009).

The project-oriented management tendency may be partly due to project demands such as time, cost and quality issues. Thus, concerning long-term objectives, less management attention will be addressed to other critical managements' issues (Abraham, 2000). With the increase of competition in both quality and quantity, construction organizations should emphasize more on long-term plans, strategies, and benefits. Thus, construction management should put a greater emphasis on organization performance.

Due to the increase in market's competition, construction organizations have to combine several projects together in order to increase their profit. In addition, labor skill and experts availability has to be given a high priority as to establish a feasible competitive strategy. Advancements in construction knowledge and technology require additional education, cooperation, and strategy management at a company level. Thus a new challenge faces construction managements that have to shift from project performance-based to organization performance and project performance ones.

Client and Environment

With the increased number of competitive contractors, the client has more options concerning contractor selection. This aspect force contractors to increase their quality standards, lower their bidding cost and shorten their delivery deadlines. Advancements in communication technologies assist the client to

track and monitor the product's production and apply instant modification when needed. Thus client's contribution to construction management will be more effective.

With the increase of technology and communication, construction companies use suppliers and sub-contractors more. From products to serve the project site, pre-products, to use sub-contractors to supply new technology, construction companies depend more on environment (or environment is more important for construction management).

Gibson (2009) said that "What organizations need to understand is that, at the macro level, productivity - which of course is central to profitable economic growth - has always been determined by two elements. On one side, it is determined by the efficiency with which companies use their inputs - how much labor and capital it takes to produce their goods and services. On the other side, productivity is determined by the value that customers place on the outputs. For most of the industrial era, the predominant focus was on efficiency as opposed to value. Yet when we look at the companies that are creating most of the new wealth today, we find that they are not doing it by seeking out the last few percentage points of efficiency from their business processes. They are doing it by creating things that bring incredible new value to customers".

Innovation and Development

As stated earlier Porter recognized innovation as one of the key issues in sustained competitive advantage (Porter, 1985). Innovation is defined as a

successful introduction of a new method to a market field. In other words it is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services (Luecke and Katz, 2003). "Companies cannot grow through cost reduction and reengineering alone; innovation is an essential element in providing aggressive top-line growth to increasing bottom-line results" (Davila *et al.,* 2006). There have been an important breakthrough in the means and methods of construction, including modularization, prefabrication, information technology, and construction automation. Value added by innovation and technology must be qualitatively and quantitatively assessed when measuring construction productivity (Flanagan, 2005).

The customer's needs in the industry have a greater emphasis on speed of delivery and value-based services. From this sense, they have to emphasize more on service and delivery achievements (Yisa *et al.,* 1996; Jaafari, 2000, Wethyavivorn, 2009). This shift, combined with the development of new technology, new markets, and new construction procurement methods, make implementation of innovative ideas a must.

In a world of global market, companies cannot rely totally on their own research; they should instead buy or license processes or inventions (e.g. patents) from other sources. Employees, suppliers, customers, competitors, and researchers must adapt to acquire the advancements in construction innovation instead of relying of managements' levels. As a result, financial plans will be spread across a variety of functions including marketing, product design, information systems, manufacturing systems and quality assurance (Prahalad, 2008).

If the environment changes quickly and the competition is fierce, a construction organization should innovate and develop more since Innovation is a key element for long-term plans, long-term goals, and long-term strategies. With the development of technology and market changes, construction organizations should adapt to environments. Thus innovation and development are considered a vital role of construction organizations in the present time. From this perspective, Table 4-4-1 summarizes the main recorded changes that affected the construction industry.

Table 4-4-1: Environment's Effect on Construction (adapted from Flanagan, 2005)

Traditional Market	Futuristic Market
Driven by price	Driven by value
Productivity improvement	Continuous improvement, benchmarking
Design led	Design and production integration
Using technology where necessary	Embracing technology to improve performance and productivity
Measuring site productivity using labor output	Measuring competitiveness that embeds productivity

4.3 Advantages of Four Pillars (4P) Implementations

The Four Pillars (4P) model, illustrated in Figure 4-1, demonstrates four conceptual aspects that have a potential to address some of the new challenges that face the construction management performance.

The 4P connects project and organization performances, internal and external factors (i.e. client and environment), shorter (i.e. project performance) and long-term plans (i.e. strategy of organization performance), present and future actions (i.e. innovation and development). This section will highlight

prospective advantages of implementing 4P concepts in the construction industry.

4P and Construction Management

The complexity of managing an organization today requires that managers be able to view performance or activity in several areas simultaneously (Kaplan, 1992). It minimizes the gap between the strategy of an organization to the process and executional works of a project.

Based on the fact that strategic management and competition are areas that construction organizations should extremely emphasize (Chinowsky, 2001, 2002), 4P model helps construction organizations to enhance their strategic management and competitive ability. 4P allows construction organizations to plan their strategies not only for short-term periods but also long-term phases. In other words, it translates strategy into actions by integrating internal factors like organization performance, project performance and external factors environment and client.

4P and Activities' Performance Assessment

Based on 4P concepts, the user can identify the goals, key performance indicators, and critical success factors for each pillar of a construction organization. This is illustrated in Tables 4-4-2; 4-4-3 and 4-4-4 were users can measure the performance of the construction firm. They also can use the Four Pillars to define key competitive factors, where the competitiveness of the organization can be measured.

Table 4-4-2 : Four Pillars Goals

Pillars	Goals	Measures
Environment & Client	-.....	-.....
Organization Performance	-.....	-.....
Project Performance	-.....	-.....
Innovation &Development	-.....	-.....

Table 4-4-3: Four Pillars Critical Factors

Pillars	Critical Factors	Measures
Environment & Client	-.....	-.....
Organization Performance	-.....	-.....
Project Performance	-.....	-.....
Innovation &Development	-.....	-.....

Table 4-4-4: Four Pillars Key Performance Indicators

Pillars	Key Performance Indicators	Measures
Environment & Client	-.....	-.....
Organization Performance	-.....	-.....
Project Performance	-.....	-.....
Innovation & Development	-.....	-.....

Converting the Vision into Operational Goals

Four pillars allow managers to set up new management processes that can contribute to linking long-term and short-term actions as well as projects and organization action. As per Table 4-4-2, 4P can support a detailed explanation of an organization's vision concerning future goals were the entire staff can

understand such goals. Thus, a more reliable integration can be achieved between the organization's vision and strategy. Traditionally, construction firms follow predefined standards as to monitor and assess their activities' performance. Taking into consideration the challenges encountered by modern technologies, an organization can face difficulties addressing tasks like controlling, operating, and managing. The Four Pillars model, however, can support the organization with a detailed strategic management system that supports continuous competitive demands.

Using 4P models can encourage managers to select a limited number of critical factors within each pillar; thus assisting managers to improve their performance which are based on detailed strategic vision. From a measurement point of view, 4P can be used to convert a business unit's strategy into a linked set of measures that define the long-term strategic objectives.

Communicating the Organization's Vision

Based on the Four Pillars, users can build both a project framework and personal framework that help communicate the corporate and unit objectives to project stakeholders. Also a thorough understanding of the strategies, visions, and goals proposed by the organization thus enabling shared ideas, visions, and feedback. 4P allows managers to communicate their strategies throughout all levels of an organization and continuously update them with departmental and individual objectives.

Organization Planning

The Four Pillars model allows companies to integrate their projects plans with their organization plans. Construction organizations have to optimize the project's activities and specifications as to achieve maximum levels concerning time, cost, quality, energy, and resources. Managers usually face situations that lead to frequent dissatisfaction with the programs used to manage these project constraints. Four Pillars measurement techniques as illustrated in Table 4-4-2 have the potential to lay the foundation for allocating resources and setting priorities in a more concrete way.

Four Pillars and Construction Firm's Plan

The main challenges in a competitive strategy plan are connecting functions and actions, and strategy is the product of group works of leaders and main staff (Porter, 2008). SWOT analysis usually considers external factors when analyzing opportunities, threat, and internal factors when analyzing Strengths and Weakness. Each field in the Table 4-4-5 (SWOT-Pillars) may address questions like: 'What are the project strengths?' or 'What opportunities are achieved when applying such innovation &development plan?'. SWOT Pillars considers all of the company's strengths, weaknesses, opportunities, and threats concerning project performance in comparison to the traditional SWOT matrix developed by Humphrey in 1960s. SWOT Pillars can address prospective innovation & development.

Table 4-4-5: Four Pillars and SWOT

	Strengths	Weaknesses	Opportunities	Threats
Organization performance	Organization performance *strengths*	Organization performance *weaknesses*	Organization performance *opportunities*	Organization performance *threats*
Project performance	Project performance *strengths*	Project performance *weaknesses*	Project performance *opportunities*	Project performance *threats*
Environment & client	Environment &client *strengths*	Environment & Client *weaknesses*	Environment & client *opportunitie*	Environment &client *threats*
Innovation & development	Innovation & development *strengths*	Innovation & development *weaknesses*	Innovation & development *opportunities*	Innovation & development *threats*

Four Pillars can be used to develop strategy maps whereby all team leaders and project personnel can clearly understand the strategy of the organization. Such maps help managers in developing better and clearer strategies in order to reduce prospective management conflicts.

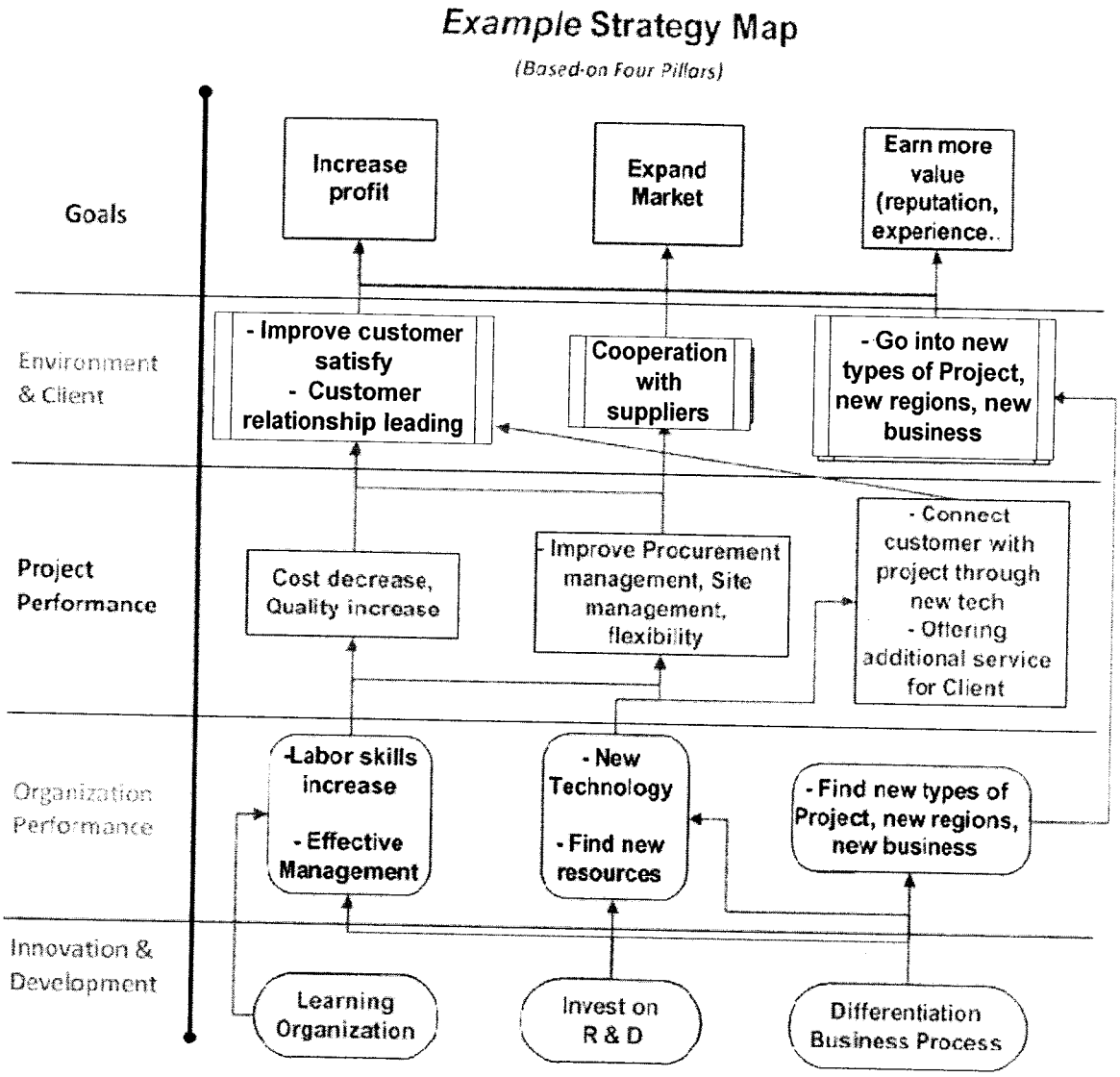

Figure 4-2: 4P Strategy Map for Company 512 (Vietnam)

As illustrated in Figure 4-2, the goals of Company 512 are to improve profit, expand market, and earn more value. In order to achieve these, current research takes in its considerations the opinion of company 512's manager to develop a 4P strategy map. The map helps directors and managers to gain a clear vision on their goals and process. The map also helps all company's staff to clearly understand the company's' goals and missions. As a result, it encourages the

company develop easily and smoothly. The first company used "Learning organization", "Invest on R&D", and "Differentiation Business process" as a main tools to achieve 'innovation and development'. "Invest on R&D" aids the company in finding new resources such as the use Sika to fasten the production of concrete. As for 'project performance', this can be achieved by increasing the profit and decreasing the waste. Concerning 'Environment & Client', company has to improve 'customer satisfies'.

4.4 4P Factors and Criteria Incorporated in the Model

As per the previous discussion, Four Pillars is a good potential for a framework for classifying construction competitive factors. Based on the literature review, discussions with experts in Vietnam and Canada, Key Competitive Factors (KCFs) for construction companies and Key Competitive Criteria (KCC) are proposed and classified in this section. Several KCFs and their corresponding KCCs are developed for each pillar. These factors will contribute to the main factors incorporated in the competitiveness index model.

Pillar One: Organization performance

Porter showed that human resource management is a main factor of supports activities (Porter, 1985). Most competitive theories consider personnel and their knowledge to be among important factors of a company's competitive ability (Barney, 1991). Some studies use methods of competitiveness based on human resource management. Since, employee productivity is a vital indicator of competitiveness, the higher the organization's employee productivity, the higher

the organization's competitive ability is. From this analysis, 'human and knowledge' is considered a KCF and its corresponding KCC are:

- Employee productivity
- Number of fulltime employees (%)
- Number of staff bachelor's degrees (%)
- Number of employees with more than five years experience (%)
- Organization's knowledge resources& quality of staff
- Organization's effective use of people& knowledge resources.

Financial resources are firm's primary resources (Barney, 1991). This notion includes: a firm's cash account, cash equivalent, capacity to raise equity and a firm's borrowing capacity. The profit of the company shows the effectiveness of company business. A company with higher profits, lower debts and higher income growth can be stronger in competitiveness. Therefore, finance and profit is a KCF. To evaluate a firm's performance concerning finance and profit a financial ratio analysis must be done that includes the following KCCs (Dess, 2008):

- Profit Ratio: Net profit margin= Net income / Total sales
- Activity Ratio: Total assets turnover= Sales / Total assets
- Leverage Ratio: Debt to total assets= Total debt / Total assets

- Liquidity Ratio: Quick ratio= Current Assets less inventories / Current liabilities

- Growth Ratio: Income growth= Current year's profit / Prior year's profit

Construction companies use competitive bidding to achieve the best possible value and several decision support tools for construction bidding have been developed (Moselhi et al, 1993). Recently, managers have experienced the shift from 'lowest-price-win' to 'multi-criteria selection' (Wong *et al.*, 2000). From this perspective, bidding is considered a KCF and its corresponding KCC are:

- Success rate (%) of bidding over past three years

- Effectiveness of organization's bidding strategy

- Sum of contract over past three years ($)

- Experience for bidding & availability of resources and professionals for bidding

Every firm competing in an industry has a competitive strategy, whether explicit or implicit (Porter, 2008). A company should have a clear vision, mission and goal, and strategic awareness when developing a competitive strategy. Vision, missions and goals are the starting points for all company endeavors (Chinowsky, 2001). Once a company has a strategy to follow, it can confront the challenge of implementation. Competitive strategy is proposed as a KCF and its KCC are:

- Strategy implementation
- Matching strategy to an organization's situation
- Strategic awareness & clear vision, mission and goals

A company should have clear divisions and duties for functional departments, suitable hierarchical levels and good relationships within the company. Business efficiency is demonstrated by the ratio of the money used to manage the company with respect to the profit achieved. The role of team leaders' throughout the departments is important for company competitiveness. Moreover, in a globalization market, managers should consider the company's international standing. Communication between departments, projects, staffs, and with customers and stakeholders will affect company competitive ability and business. Thus, organization structure is a KCF and its KCC are:

- Suitability of company structure
- Business efficiency
- Leader's personality and capability
- Use of international aspect (ISO)
- Organization communications

In addition to the previous mentioned competitive factors, managers should take into consideration company's resources like 'equipment availability' or 'organization culture'. These factors help the company sustain competitiveness.

The number of years in business and the value of projects completed in the past three years show the experience of the company and its past competitive ability. From this perspective, 'organization resources' is a KCF and its KCC are:

- Equipment availability (%)
- Effective use of organization's other resources
- Number of years in business
- Value of projects completed in the past three years ($)
- Organization culture

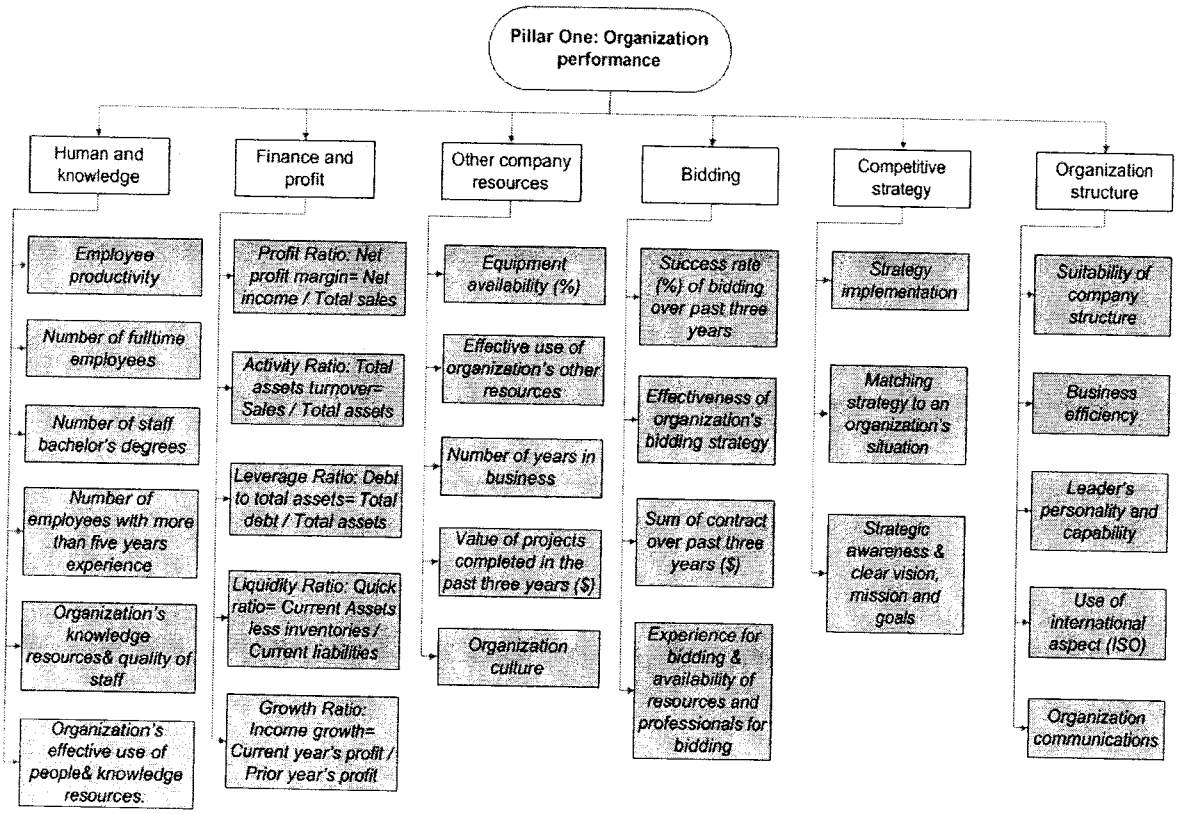

Figure 4-3: Hierarchy of KCFs and KCCs for Pillar # 1

Pillar Two: Project performance

Time, cost, and quality are so far recorded as the three main factors for project management. Literature reported numerous numbers of published papers stating the importance of these 3 factors concerning project performance. Thus, time, cost, quality are KCFs and their KCC are:

- Schedule performance index (SPI)
- Effectiveness of time management
- Construction delays
- Cost performance index CPI
- Effectiveness of cost management
- Defects (at the time of handover)
- Total quality accidents per year ($)
- Effectiveness of quality management

The construction industry has the second highest rate of injury and illness of all industries (Elwakil *et al.*, 2009), thus health and safety is considered KCF and its KCC are:

- Health and safety: Reportable accidents per 100,000 hours worked
- Health and safety: Lost time accidents per 100,000 hours worked

Moreover, criteria from construction management methodologies are also vital when studying competitiveness. The current research included the following KCC in the competitiveness index model:

- Risk management
- Site management
- Contract management
- Dispute resolving skills
- Management claims
- Logistic and supply chain management
- Environment management

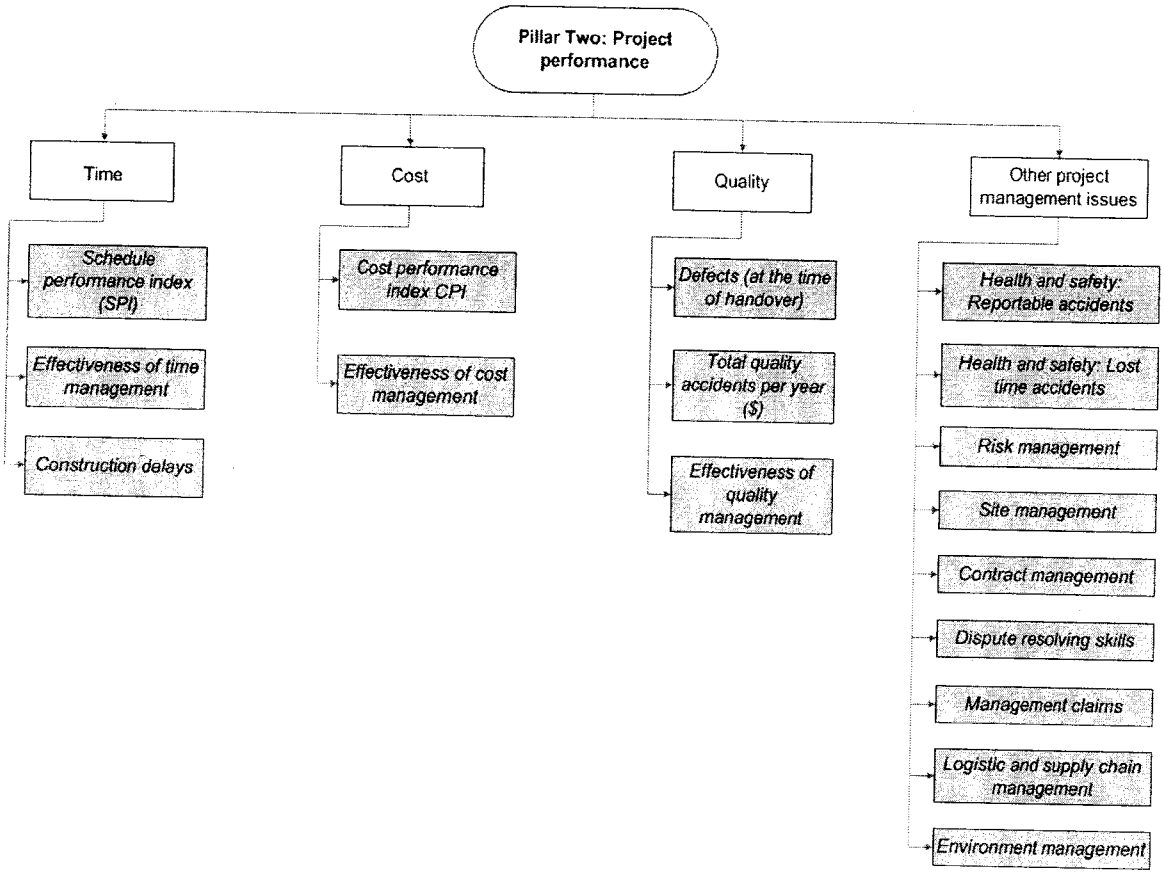

Figure 4-4: Hierarchy of KCFs and KCCs for Pillar # 2

Pillar Three: Client and Environment

Environment conditions are essential factors, so organization social and industry condition is consider KCF that should be addressed when analyzing a company's competitiveness. City laws and regulations, market conditions, supplier demands are such factors. The corresponding KCC for this factor are:

- Organization's social conditions
- Organization's construction industry conditions.

The competitions between contractors have given the client a lot of advantages as to select the most feasible bid. Parallel with this factor, advancements in

communication technologies allows the client to track and monitor the product efficiently with suppliers. Thus, client and supplier environment factor is a KCF and its KCC are:

- Client environment
- Organization's client and supplier awareness
- Supplier environment

To sustain a competitive ability, a construction company should satisfy clients' demands concerning products and services. Thus, client satisfaction is a KCF and its KCC are:

- Clients' satisfaction with (the value for money on delivered) products
- Clients' satisfaction with (the value for money on delivered) services
- Clients' satisfaction with specified criteria

In addition to that, relationships with subcontractors, suppliers, designers, consultants, government departments, and the public sector should be addressed. Relationships are considered a KCF and its KCC:

- Relationship with client or owners
- Relationship with government departments & with public
- Relationship with subcontractors or suppliers & with designers and consultants

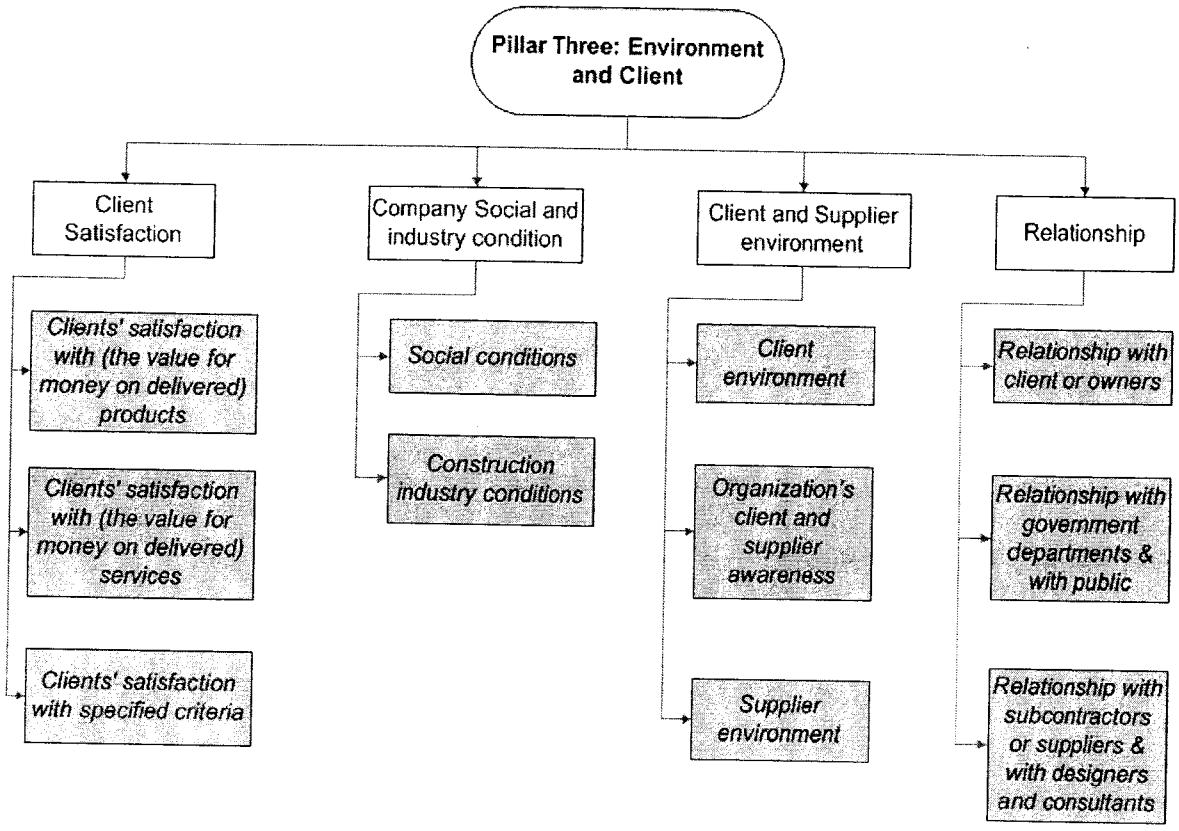

Figure 4-5: Hierarchy of KCFs and KCCs for Pillar # 3

Pillar Four: Innovation and development

When addressing a competitive strategy, a construction company should include a strategy for development, for consciousness, and for clear missions and goals. Such strategies have the potential to facilitate a company's expansion in a global market. From this perspective, strategy is a KCF and its corresponding KCC are:

- Strategy implementation
- Strategic awareness & clear vision, mission and goals

Research and development will help the organization improve its core competencies competitive ability, and create new tools to address prospective challenges. Research and development ability is a KCF and its KCC are:

- Ratio of R&D contribution per total revenue
- Investment on R&D
- Effectiveness of research and development ability

To develop and innovate, a company should invest in building up their human resources, attract labor, and carefully recruit staff. Human resource development & learning is a KCF and its KCC are:

- Employee salary
- Human resources development strategy
- Effectiveness of employee enhancements, training and education
- Money investments per one employee (for enhancements, training and education) per years
- Labor attractiveness, work conditions, wage level, employee motivation and job satisfaction

One of the most important innovations and developments this century has been the advancement of IT technology. It connects people, customers to project sites, etc. The application of IT and technologies to business has become a

fundamental criterion of competitiveness. Therefore, technological ability is considered as a KCF and its KCC are:

- IT application
- Technological innovation ability & technical application
- Investment in technological Innovation
- Ratio of technological contribution

Flexibility and adjustment ability are vital factors for competitiveness in the present time. With the increase of globalization and competition, a construction company should adjust its management as to be compatible with its environment. Therefore, adjustment of ability is a KCF and its KCC are:

- Creative ability &flexible ability of organization
- Business coverage differentiation ability (per year)
- Feedback evaluation ability

Marketing is another important factor for addressing a company's competitive ability. Since the market is exponentially advancing, the competition is higher and client's tasks are increased. From this perspective, marketing is a KCF and its KCC are:

- New orders received %
- Business coverage type of projects

- Business coverage type of regions
- Company experience in the market
- Market research, planning, and publicity
- Marketing information

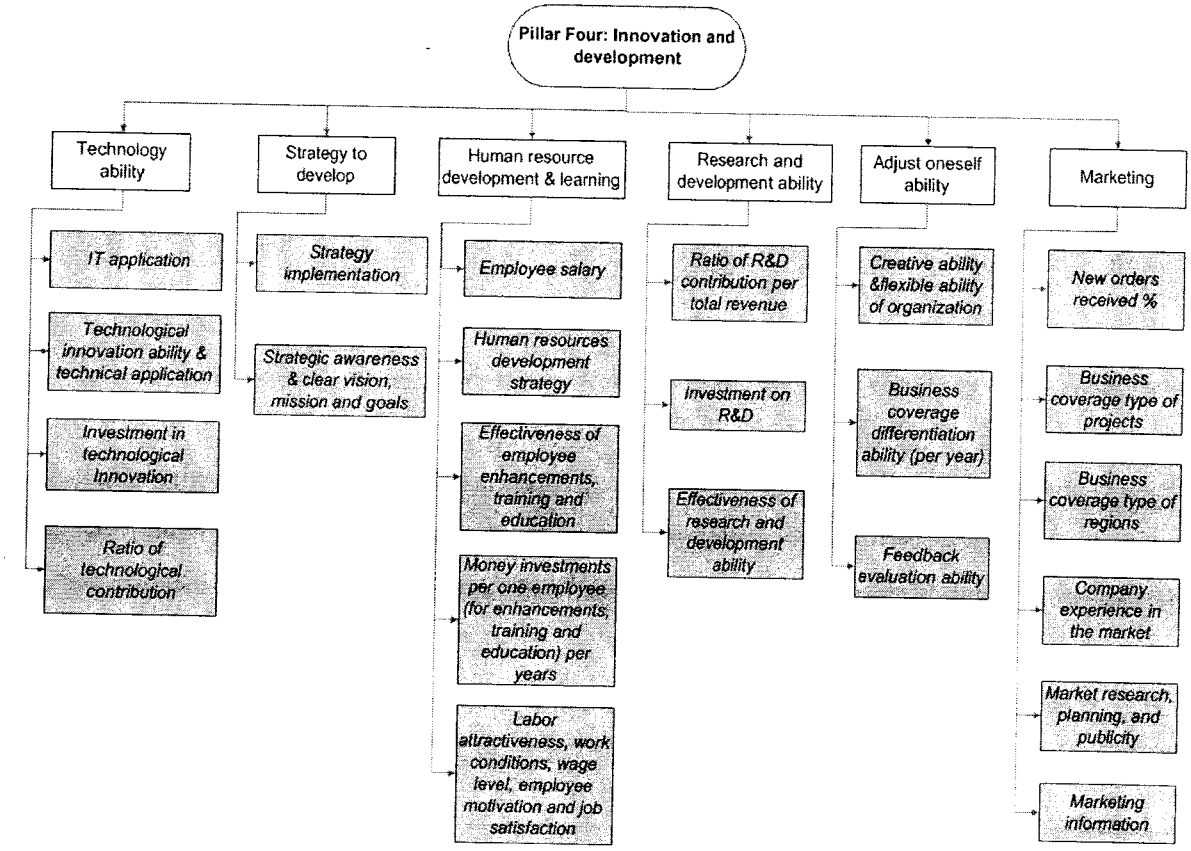

Figure 4-6: Hierarchy of KCFs and KCCs for Pillar # 4

4.5 Summary

This chapter proposed 4 pillars to be considered when addressing competitive ability of construction companies. These 4 pillars were divided into

21 Key Competitive Factors (KCFs) where 80 Key Competitive Criteria (KCC) were relatively assigned to them as illustrated in Figure 4-7. In addition, this chapter explained briefly the challenges faced by the construction industry and how the concepts of 4P can address them.

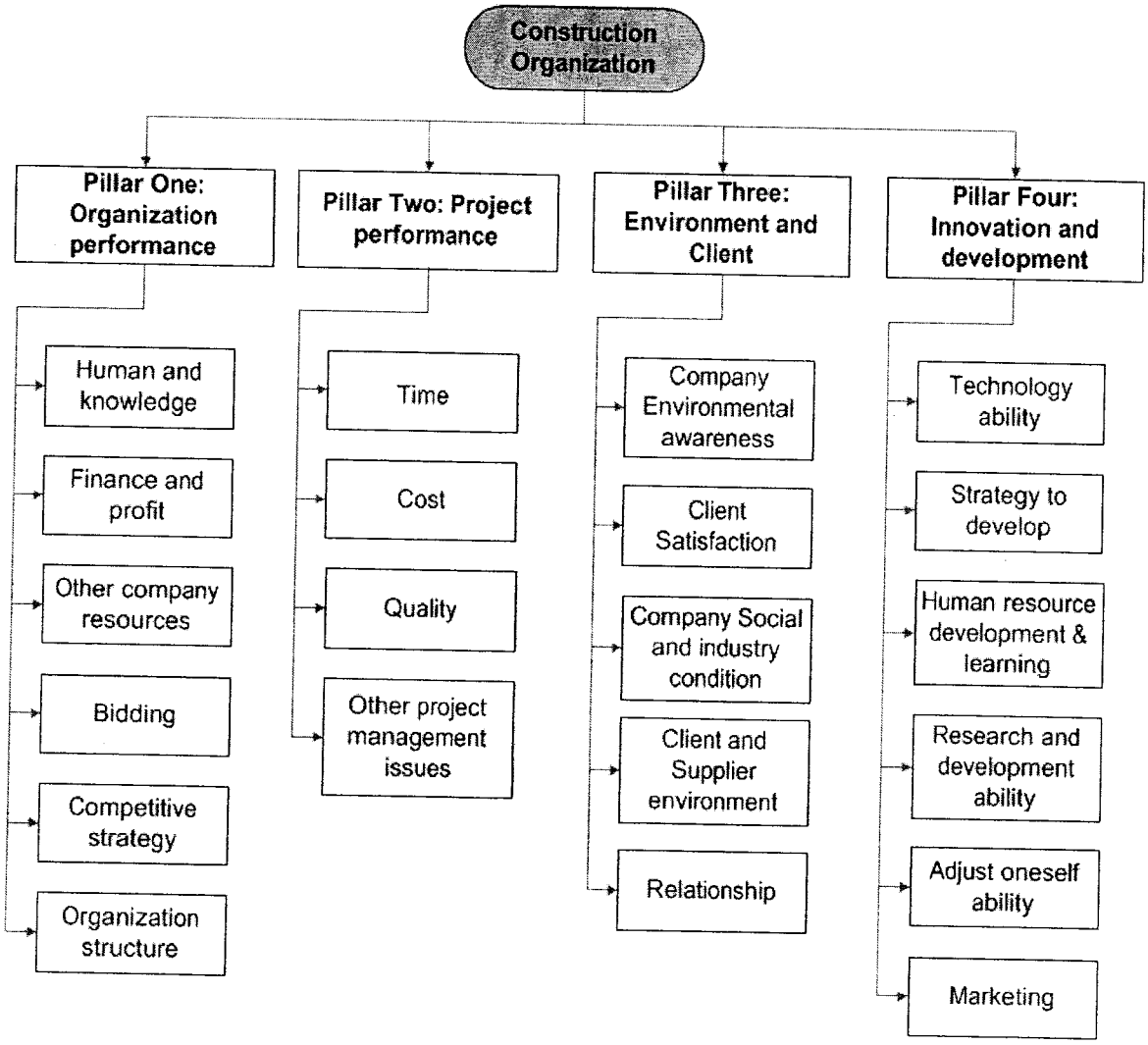

Figure 4-7: Hierarchy of pillars, KCFs, KCC

CHAPTER 5. Data collection

The data collection phase consists of 3 parts which are required to develop and run the proposed competitiveness index model. In part one, factors identified previously in section 4.4 will be relatively weighted using the AHP method. The second part gathers the data needed to develop the utility functions. In the last part, information needed for case studies implementation and validation are recorded. The survey addressed both the Canadian and the Vietnamese construction industry. This process is illustrated in Figure 5-1.

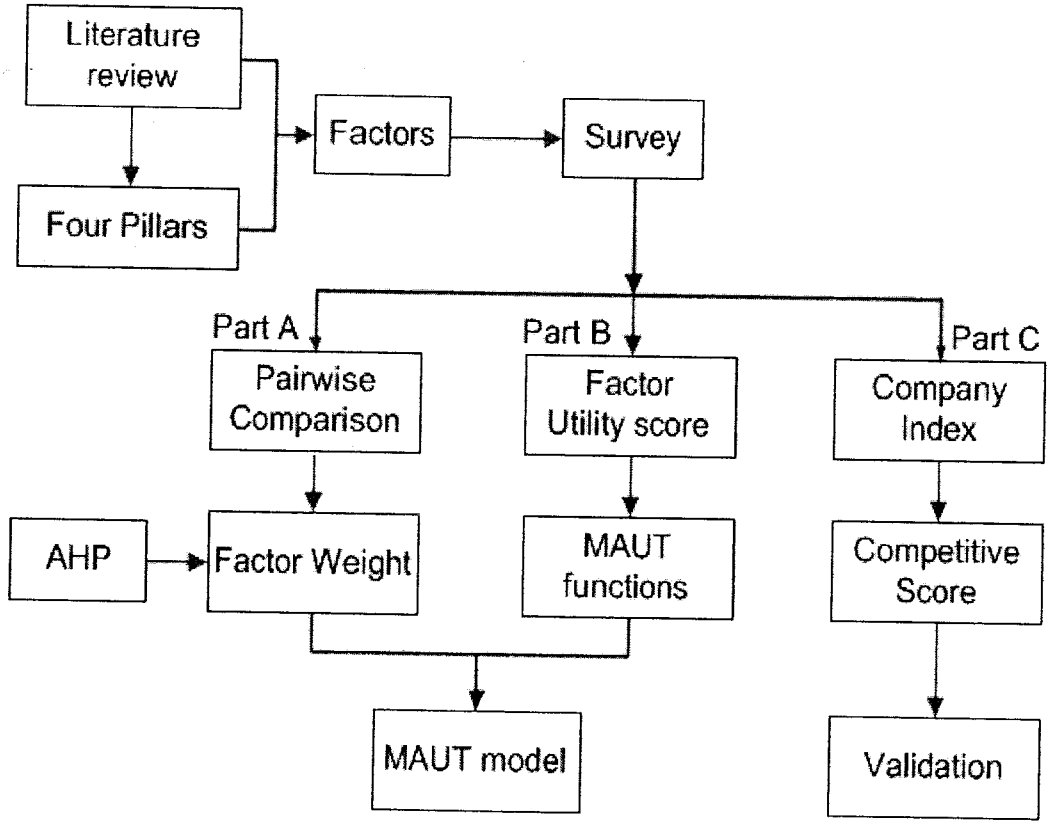

Figure 5-1: Data Collection Process

5.1 Questionnaire Survey

Questionnaire surveys are used to collect the needed information to run the model. A sample of the questionnaire is found in Appendix (A). The questionnaire consists of three parts. Part A contains questions concerning the relative importance of each of the 4 pillars, factors, and criteria by using a pair-wise comparison technique. In this part, there are three levels of questions: level 1 contains the Four Pillars, level 2 contains the 21 KCFs, and level 3 contains the 80 KCCs.

Part B consists of questions concerning the competitive scores of each of the 80 KCCs. These scores are needed to establish the attribute utility functions which will be used to establish the utility values for criteria. Since Canada's attribute utility functions are different from Vietnam's, there are two versions of this part, one for Vietnamese market and the other for Canadian market.

Part C consists of questions concerning competitive scores for a whole company. This information is needed to validate the proposed model. The validation is done by comparing the collected scores with the calculated ones using the model. Experts were asked to give his scores on the company for soft-data. The questionnaires are sent to construction companies in Vietnam and Canada. 132 questionnaires were sent to Vietnamese experts, and 72 questionnaires were sent to Canadian experts. Most responses were sent via e-mail. 26 replies were received from Vietnam which gives a percentage of received surveys equal to 19.7%. As for the Canadian industry only 11.1% of sent surveys were received which correspond to 8 replies.

Answers from Vietnam were from variety of companies, two from foreign companies that invest in Vietnam. They are M+W (head office in China) and Taisei (head office in Japan). Seven answers came from private companies, and nineteen were received from join-stock companies in which the government holds most of the stock. These construction companies work on a variety of projects: houses, dams, hospitals, bridges and roads, etc. The surveys were answered by the company's directors and managers. Replies from Canada came from companies such as SNC-Lavalin, PCL, and Graham.

5.2 Factors' Weight

The questionnaire survey asked the participants to perform a pair wise comparison for each factor found under each level. They were provided with a 9 point scale that ranges from "Equally important" to "Extremely more important". Based on 34 received responses, pair wise comparison matrix is developed for each hierarchy level based on the AHP methodology proposed by Saaty (1980). This matrix was done separately for Canadian responses and Vietnamese responses. After performing all the needed matrices, the weight of each factor is calculated by multiplying its local weight by the weight of its up-level sub-factor. The final weight of each factor is the average of weights of all the responses. This concept was done separately for both the Canadian and the Vietnamese. The weight of the criteria used to calculate competitiveness index W_{CI}:

$$Wc_I = WcxWfxWp \qquad \text{(Equation 5.1)}$$

Where:

Wc_I : Decomposed weight of criterion

Wc: The relative weight of each criterion

Wf: The relative weight of the factor that includes criterion calculated.

Wp: The relative weight of the pillar that includes criterion calculated.

5.3 Statistical Analysis of the Collected Data

The following measurements of the statistics were done to consider the collected data:

1. Reliability analysis to estimate the reliability of the tested scores.
2. Consistency ratio, which expresses the internal consistency of the judgments that have been entered to the AHP matrix calculations.

Cronbach's alpha (α) is the most widely used as a measure of reliability (Wei et al., 2007). It is an index used to estimate the reliability of a scale containing several items. Cronbach's alpha (α) is defined as:

$$\alpha = \frac{K}{(K-1)\left(1-\frac{\sum_{i=1}^{K}\sigma_{Y_i}^2}{\sigma_X^2}\right)} \quad \text{(Equation 5.2)}$$

Where K is the number of components, σ_X^2 is the variance of the observed total test scores, and $\sigma_{Y_i}^2$ is the variance of component i. (Cronbach, 1951).

The closer (α) is to 1.00, the greater the internal consistency of the items in the instrument being assessed; (α) will usually increase when the correlations between the items increase. Kaplan and Saccuzo (1993) suggested the lower acceptable limits of (α) that are 0.50 and 0.60. The reason of this analysis is to check whether the scale values achieved from the survey are reliable or not.

Attributes of Canada's data "Factor 12: Organization Social and industry condition" and "Factor 21: Marketing" showed a low reliability coefficient but within acceptable range ($0.5 < \alpha < 0.6$) and thus their results were included in the model. The result (α) values for the reliability analysis are shown in Table 5-1.

Table 5-1: Reliability Values For the Gathered Data

Main Attributes	Cronbach's Alpha		Reliability	
	Vietnam's data	Canada's data	Vietnam's data	Canada's data
Four Pillars	0.67	0.73	High	High
Pillar 1: Organization performance	0.89	0.87	High	High
Pillar 2: Project performance	0.80	0.72	High	High
Pillar 3: Environment and Client	0.87	0.88	High	High
Pillar 4: Innovation and development	0.92	0.70	High	High
Factor 1: Human and Knowledge	0.87	0.93	High	High
Factor 2: Finance and Profit	0.70	0.70	High	High
Factor 3: Other Organization resources	0.78	0.88	High	High
Factor 4: Bidding	0.73	0.80	High	High
Factor 5: Competitive strategy	0.82	0.71	High	High
Factor 6: Organization structure	0.89	0.90	High	High
Factor 7: Time	0.78	0.71	High	High
Factor 8: Cost	0.86	0.75	High	High
Factor 9: Quality	0.89	0.70	High	High
Factor 10: Other project management issues	0.81	0.88	High	High
Factor 12: Organization Social and industry condition	0.89	0.57	High	Low (within acceptable range)
Factor 13: Client and Supplier environment	0.96	0.76	High	High
Factor 14: Client Satisfaction	0.73	0.87	High	High
Factor 15: Relationship	0.73	0.83	High	High
Factor 16: Strategy to develop	0.66	0.71	High	High
Factor 17: Research and	0.84	0.93	High	High

development ability				
Factor 18: Human resource development & learning	0.89	0.86	High	High
Factor 19: Technology ability	0.72	0.75	High	High
Factor 20: Adjust oneself ability	0.80	0.80	High	High
Factor 21: Marketing	0.71	0.52	High	Low (within acceptable range)

5.4 Analysis of Data Collected from Vietnam

Data collected from construction companies in the Vietnamese and Canadian industries were analyzed. The analysis shows the importance of factors or criteria in the construction industry of Vietnam and Canada. Comparison between the two countries reveals the difference of competitiveness between a developing country like Vietnam and a developed country like Canada. Thus, it reveals which factors are vital for competitiveness improvements in Vietnam or in Canada. Construction companies could use these results to improve their competitiveness performance and to improve their implementations.

Level 1: Pillars

Based on the survey, the Vietnamese Construction Companies (VCO) emphasize "project performance" (average: 0.28) the most. The average is higher than the second most emphasized point, 'environment and client' (average: 0.268). It is also more important than 'organization performance' (average: 0.25). However, all of the four pillars are rather of close importance

(the maximum difference less than 29%). This reveals that the Four Pillars model is a good and suitable framework for construction companies.

The Vietnamese construction industry has many new projects that require new technology, knowledge, skills, and managements. If one organization is less innovative than other, it will be less competitive and less beneficial. Surveys from both Vietnam and Canada reveal that 'project performance' is more important than 'organization performance'.

Level 2: Factors

In Pillar 1 (organization performance), the 'finance & profit' average is 0.28, reflecting that Vietnamese construction companies emphasize "finance &profit" far more than the other organization resources like plant availability and organization culture. Bidding (average: 0.15) is not high because the bidding process is not clear in Vietnam, especially for public projects.

In Pillar 2 (project performance), time, cost, and quality are found to be of equal importance, with the quality factor average a bit higher (average: 0.29). These are much more important than other factors, including risk management, contract management, etc.

In Pillar 3 (client and environment), 'relationship' is very important (average: 0.30). This demonstrates the situation in Vietnam now, where firms can gain projects from having good relationships. If a firm has a good relationship with a client, the consultant can also reduce unnecessary payments. However, the survey reveals that client satisfaction is not of high importance.

In Pillar 4 (innovation & technology), 'human resource development & learning' is the most important, but not particularly high (average: 0.23). Then, 'Strategy to develop' is the second most important. "Research and development ability" is the least important, as in Vietnam, construction companies don't invest a lot on research.

Level 3: Criteria

In factor 1(human &knowledge), the criterion 'effectiveness of using human & knowledge resources' is the most important (average: 0.24), and 'employee productivity' and 'knowledge resource & quality of staff' are the second and the third most important (average: 0.229 & 0.226). 'Number of fulltime employees' is the least important. These results are similar to Canada's collected data.

In factor 2(finance &profit), the criterion 'profit ratio: net profit margin' is the most important (average: 0.28). The second is 'activity ratio: total assets turnover' (average: 0.23); this criterion is even less important in Canada.

In factor 3(other organization resources), the criterion 'effective use of organization's resources' is the most important (average: 0.31). 'Number of years in businesses is the least important. 'Organization culture' is also not important, reflecting that Vietnamese construction companies do not stress on organization culture.

In factor 4 (bidding), 'experience bidding and availability of resources and professionals for bidding' is the most important (average: 0.34).

In factor 5 (competitive strategy), 'strategic awareness & clear vision, mission and goals' is the most important (average: 0.40).

In factor 6 (organization structure), 'use of international aspect (ISO)' is the least important (average: 0.08). 'Leader's personality and capability' is the most important (average: 0.30). This is because the role of the leader is very important in Vietnam.

As for factors 7, 8 & 9 (time, cost and quality), all of them showed high importance, but 'effectiveness of management' has the highest score.

Concerning factor 10 (other project management issues), the criteria 'environment management' is the least important. Critical factors like 'health and safety' and 'risk management' had low weights. However, 'site management' and 'contract management' were reported as high important.

In factor 12 (organization's social and industry conditions), the criteria 'construction industry conditions' is a little bit more important than the 'organization social condition'.

In factor 13(client and supplier environment), 'organization's client and supplier awareness' is much more important than 'supplier environment' or 'client environment'.

In factor 15 (relationship), 'relationship with client or owners' is the most important. This is because companies can gain projects or reduce money for corruption based on good relationships with the client or owners.

In factor 17 (research and development ability), 'investment in R&D' is the least important. Most construction companies do not invest much in R&D; they prefer to subcontract companies with advanced construction expertise.

In factor 18 (human resource development & learning), the criterion "labor salary" is not of high importance.

Factors like 'Labor attractiveness, work conditions, wage levels, labor motivation and job satisfaction' and 'human resources development strategy' are important factors. In contrast, 'money invested per employee (for enhancements, training and education)' is of less importance. Thus in Vietnam companies do not invest much in training workers.

In factor 19 (technological ability), 'technological innovation ability & technical application' is important, and IT application comes second.

In factor 20 (adjust one's ability), the criterion 'creative ability & flexible ability of construction organization' is the most important and 'feedback evaluation ability' is the least important. This shows that in Vietnam construction organizations should adapt to the developing market, law, and policy, which are also changing quickly.

In factor 21 (marketing), 'company experience in the market' is the most important. 'Market research and planning' and 'marketing information' are of less important.

5.5 Analysis of Data Collected from Canada

Canada's collected data procedure is rather similar to the Vietnamese and the following section summaries the findings.

Level 1: Pillars

Based on the collected survey, Canada's Construction Companies emphasize 'environment & client' and 'project performance' more than 'innovation and development'. Out of the four pillars, 'client and environment' is the most important, the second is 'project performance', the third is 'organization performance', while the least one is 'innovation and development'. The major difference between Canada's and Vietnam's data is that Canada's results showed that the construction emphasizes more on 'environment and client' more than the Vietnamese construction industry.

Level 2: Factors

In Pillar 1 (organization performance), 'human and knowledge' is the most important and 'finance and profit 'is the second while it was shown previously that these factors are the most important in Vietnam. Factors like 'competitive strategy', 'bidding', and 'other organization resources' showed medium importance in contrast with the Vietnamese market where 'bidding' and 'competitive strategy' are of least importance.

In Pillar 2 (project performance), both countries reported similar weights concerning this factor. Also factors like 'time, cost, and quality' were shown to be

of high importance more than 'risk, health and safety, and site management'. The survey revealed that 'quality' is the most important factor.

In Pillar 3 (client and environment), 'client satisfaction' is clearly the most important, the second most important is 'relationship', and the last is 'organization environmental awareness'. The results here are different from Vietnamese market, where 'relationship' was the most important factor.

In Pillar 4 (innovation and development), 'human resource development & learning' is the most important then 'strategy to develop' is the second while 'technological ability' hold the lowest weight. This is different from Vietnam, where 'research and development ability' has the lowest importance.

Level 3: Criteria

In factor 1 (human &knowledge), the criterion 'effectiveness of using human & knowledge resources' is the most important (average: 0.25), then 'employee productivity' and 'knowledge resource & quality of staff' are the second and the third most important (average: 0.23). 'Number of fulltime employees is the least important. These results are similar to Vietnam's collected data.

In factor 2 (finance &profit), the criterion 'profit ratio: net profit margin' is the most important. The second is 'growth ratio: income growth'. The biggest difference between Canada's data and Vietnamese data is that 'activity ratio: total assets turnover' is the least important in Canada (average: 0.08), while the second most important in Vietnam (average: 0.23).

In factor 3 (other organization resources), the criteria 'effective use of organization's resources' is the most important (average: 0.42). 'Number of years in business' is the least important. 'Equipment availability' is not important. This reflects that Canadian firms can rent equipment when needed.

In factor 4 (bidding), 'Experience bidding; availability of resources and professionals for bidding' is the most important (average: 0.43).

In factor 5 (competitive strategy), 'strategic awareness & clear vision, mission and goals' is the most important.

In factor 6 (organization structure), 'use of international aspect (ISO)' is the least important. 'Leader's personality and capability' is the most important. This is similar to the Vietnamese results.

'Organization communications' is the second most important. This is different than in Vietnam.

Factors 7, 8 & 9 (time, cost and quality), reported high weights but 'effectiveness of management' is the most important.

In factor 10 (other project management issues), 'health and safety' is the most important. It is more important than 'site management', 'risk management', etc.

In factor 12 (organization social and industry condition), the criteria 'construction industry conditions' is a little bit more important than 'organization social condition'.

In factor 13 (client and supplier environment), the 'organization's client and supplier awareness' is the most important. 'Client environment' is also important, which is different than in Vietnam.

In factor 15 (relationship), 'relationship with client or owners' is the most important. This shows that contacts and cooperation between clients and owners is highly emphasized in Canada.

In factor 17 (research and development ability), similar to Vietnamese answers, 'investment in R&D' is the least important.

Concerning factor 18 (human resource development & learning), 'effectiveness of employee enhancements, training and education' are the most important. The second most important factor is 'human resources development strategy'. In contrast, 'money invested per employee (for enhancements, training and education)' is the least important.

In factor 19 (technological ability), 'IT application' is the most important and 'technological innovation ability & technical application' comes second.

In factor 20 (adjust ability), the criteria 'creative ability &flexible ability of construction organization' is the most important, just as in Vietnam's answers, while 'feedback evaluation ability' is the least important.

In factor 21 (marketing) 'company experience in the market' is the most important, and the second is 'business coverage type of projects'. 'Market research and planning' is the least important.

5.6 Comparison between Vietnamese and Canadian Data

It is clear that the importance of Pillars 1 & 2 ('Organization performance' and 'Project performance') is similar in both Vietnam and in Canada. However, Vietnamese companies emphasize Pillar 4 ('innovation and development') more than the Canadian companies. On the contrary, Canadian companies emphasis more on Pillar 3 ('environment and client') than the Vietnamese companies. A more detailed analysis is illustrated in Figure 5-2. This is because, in Vietnam, there are many new projects that require new technology, knowledge and management. Vietnam also faces a great deal of strong competition from China, Korea, and Japan—three countries strong in technological, financial, and management skills. To compete, Vietnam's companies should make 'innovation and development' a priority.

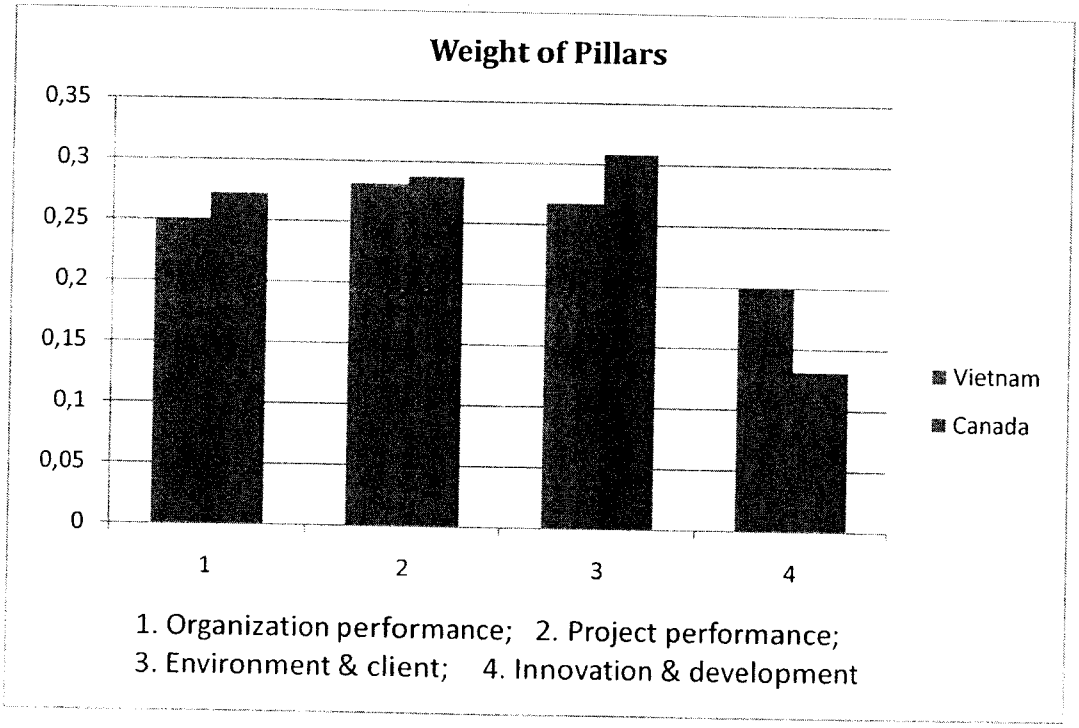

Figure 5-2: Comparison of the Pillars' Weight

Canada's companies were found to be developing in a society where suppliers and environmental aspects are important factors. In addition, Canada's clients have become stricter and more selective. Therefore, Canadian companies emphasize Pillar 3 ('environment and client') more than Vietnamese companies.

- Level 2: Factors in Pillar 1: Organization performance

As per Figure 5-3 Vietnamese companies put more efforts on 'finance and profit' and 'organization structure' than Canadian companies. This is because Vietnamese companies clearly emphasize the benefits and the leadership role. Being strong financially is a great competitive advantage in Vietnam, where the interest of banks is higher. On the contrary, Canadian companies put more emphasis on 'humans and knowledge'.

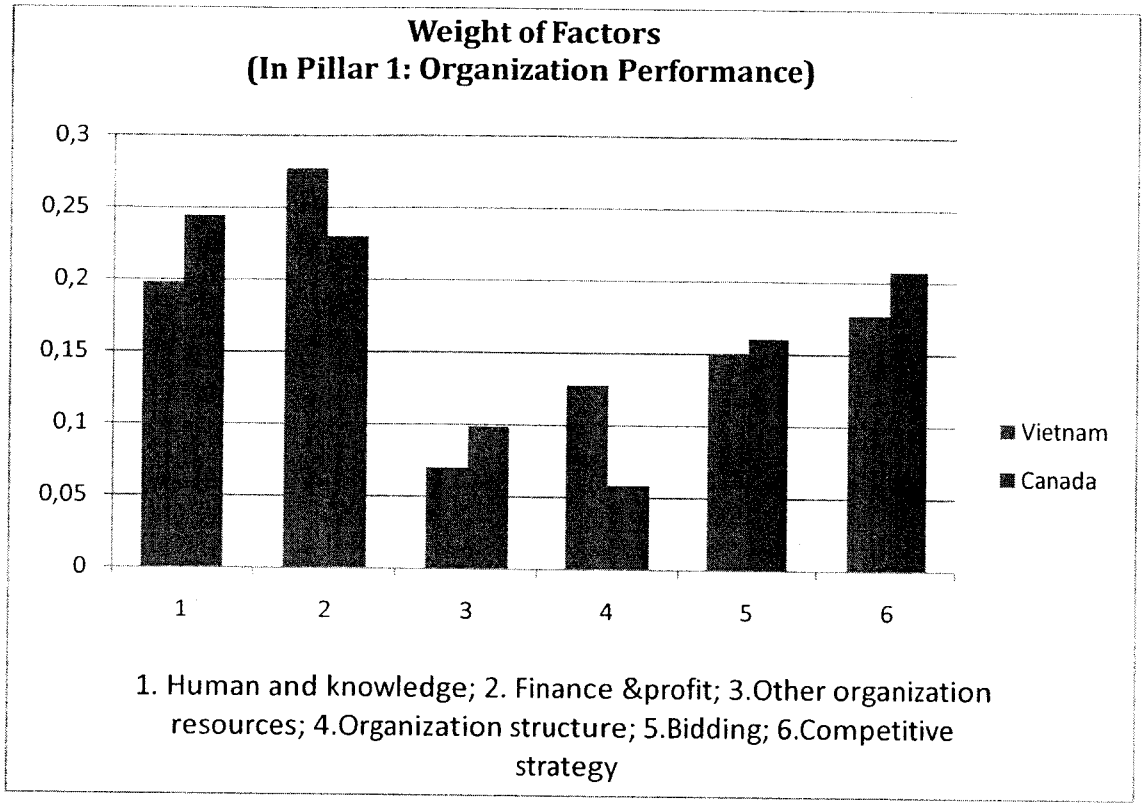

Figure 5-3: Comparison of Factors in Pillar # 1

The analysis of factors within pillar #2 reveals that Canadian companies emphasize quality aspects more than Vietnamese companies; on the other hand, companies in Vietnam put more emphasis on cost and time as shown in Figure 5-4.

As illustrated in Figure 5-5 Canada's companies emphasize more 'client satisfaction' than Vietnamese companies which concentrates on 'relationships'. This is because clients in Canada are more selective and require good quality and specific requirements. In Vietnam, relationships contribute to competitive advantage. Many companies gain bids by having good relationships with investors, and they can also improve their work situation by reducing waste.

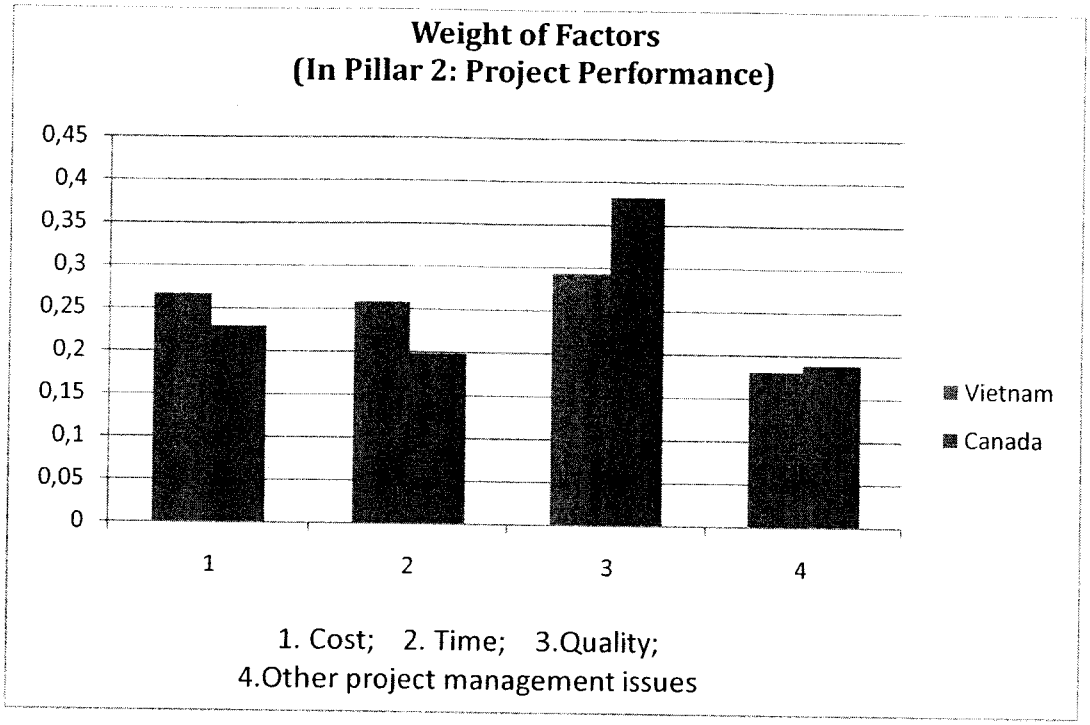

Figure 5-4: Comparison of Factors in Pillar # 2

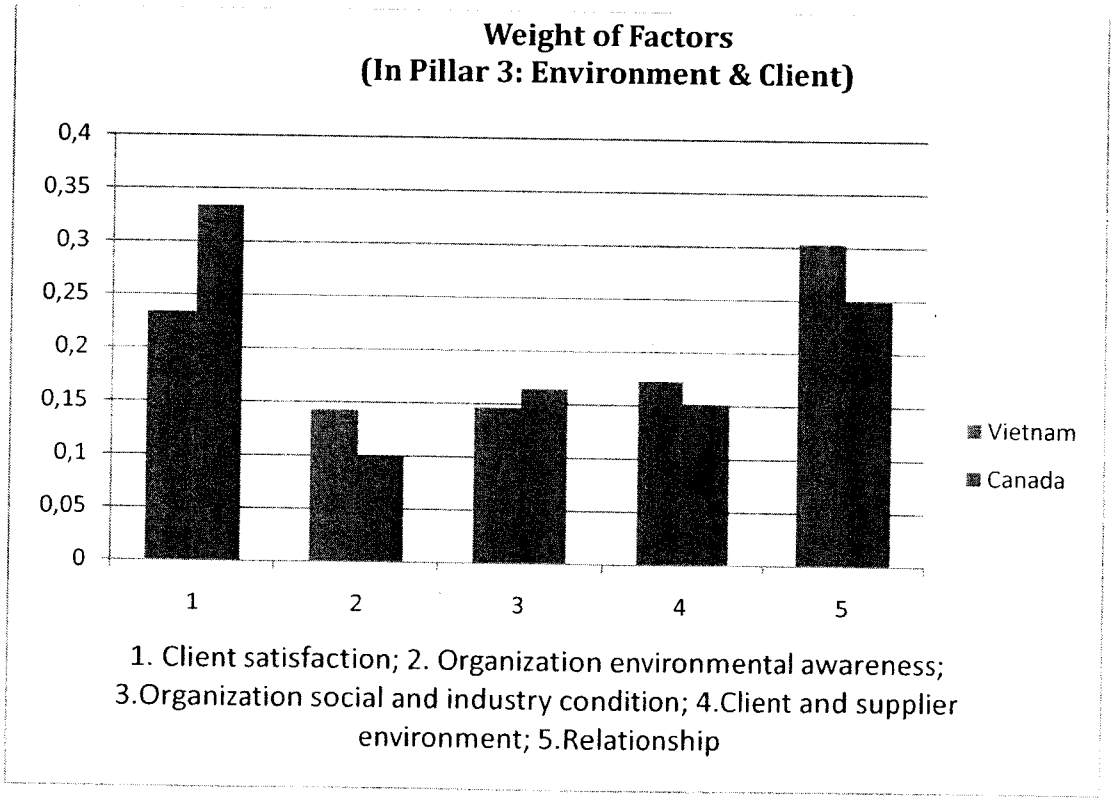

Figure 5-5: Comparison of Factors in Pillar # 3

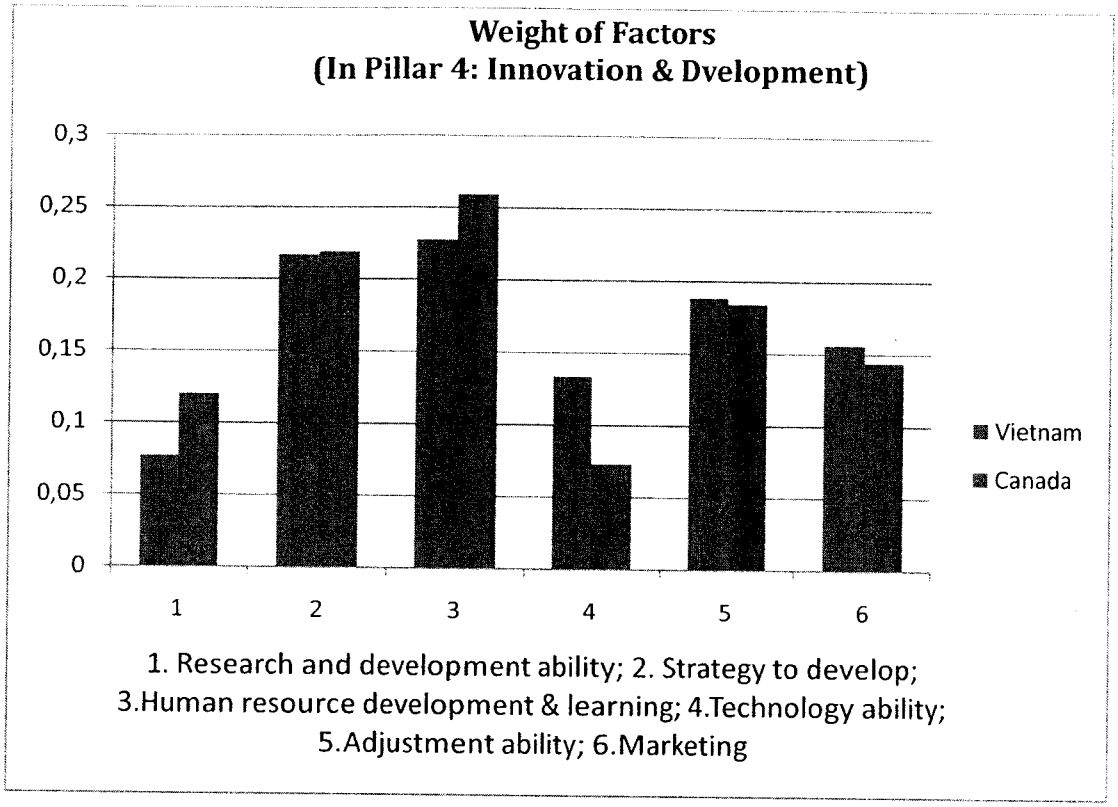

Figure 5-6: Comparison of Factors in Pillar # 4

Canadian companies emphasize 'human resource development & learning' and 'research and development ability' more than Vietnamese companies. On the contrary, Vietnam's companies put a greater effort on 'technology ability'. The results show in Figure 5-6 illustrates clearly that Canadian companies emphasize long-term plans and long-term benefits more than Vietnamese companies.

5.7 Data Collection for Case Studies

As stated earlier, the third section in the survey is intended to collect detailed statistics concerning Construction Company in Canada and Vietnam. These data are essential for two purposes. The first one is to implement the proposed model in a case study and second to validate the model by using a

comparison technique between actual competitive score and calculates ones. The two Vietnamese companies that gave full statistics are Company A and Company B. Canadian companies did not provide full statistics, as many statistics are confidential. Company's statistics were collected from websites and from experts from the corresponding companies. Detailed discussion concerning these collected data will be presented in the following chapters.

5.8 Summary

This chapter introduced the procedure used to collect the data needed to run and implement the proposed competitiveness assessment model. A questionnaire survey was sent to different construction companies in Canada and Vietnam. The survey contained 3 sections. In part one, surveyors were asked to perform a pair wise comparison concerning factors identified previously in section 4.4. The second part gathered the data needed to develop the utility functions. In the last part, information needed for case studies implementation and validation were collected. In addition to that, this chapter analyzed the factors' weight calculated using the AHP method. Also a comparison of factors' importance was performed between the Canadian and the Vietnamese construction industry.

CHAPTER 6. Model Development and Implementation

This chapter will discuss in detail the process followed to generate the competitiveness assessment model. This process consists of two parts, the first part deals with the information needed to build the model and the second part contains the utility values concerning the factors incorporated in the model. Thus, the MAUT model development process will integrate two sets of information: factor weight and factor performance impact (utility scores).

Factor weights are discussed in detail in section 5.2 (for calculating Wp, Wf, Wc, Wc_I) and this chapter will explain how these weights will help developing the MAUT model, and will explain how model implement and analyze case study. In addition to that, this chapter will explain the implementation steps followed as to calculate the competitive score of any given construction company.

There are total 80 key competitive criteria that divided two types: 43 criteria of soft-data and 37 criteria of hard-data.

Hard-data based on the statistics of the construction company, such as 'finance ratios' and 'number of employee with more than five years of experience', while soft-data such as "leader's personality and capability" or 'the relationship with clients and owners' are based on experts' subjective assessments. Part C of questionnaire survey (in appendix A) shows which criteria are measured by scores based on experts' subjective assessments, and which criteria are measured based on statistics of company.

To measure soft-data of one company, three experts were asked to provide subjective competitiveness scores for the predefined competitive criteria. For example: To calculate the score for soft-data in company A, three experts is asked to give the score for criteria "leader's personality and capability" of company A. One expert give score 7, two experts give score 5. The score of this criterion for company A is (5+5+7)/3= 5.67. Current research uses average experts' score, because experts are considered that they have the same experience and knowledge.

To measure hard-data, firstly attribute-utility-function is established for each criterion of hard-data based on interviews with company's' managers, directors and questionnaires. Secondly, use statistic of company and attribute-utility-functions, the score for each criterion is measure. These processes are clarified in section 6.1 and section 6.2.

Attribute-utility-functions are made only for criteria of hard-data. Firstly, utility scales are made based on discussion with experts (figure 6-2-a). Secondly, utility scales are surveyed to fill by experts (figure 6-2-b). From the result of survey, utility functions are established (figure 6-3 and figure 6-4).

Company's criteria scores are calculated in detail in section 6.1 and section 6.2. Competitiveness index is calculated by equation 6.1. Company's competitiveness ability is calculated for pillars' scores by equation 6.2, for factors' scores by equation 6.4. Company competitiveness ability graphs are made

based on pillars' scores, factors' scores, criteria scores. Three case studies are introduced in section 6.5.

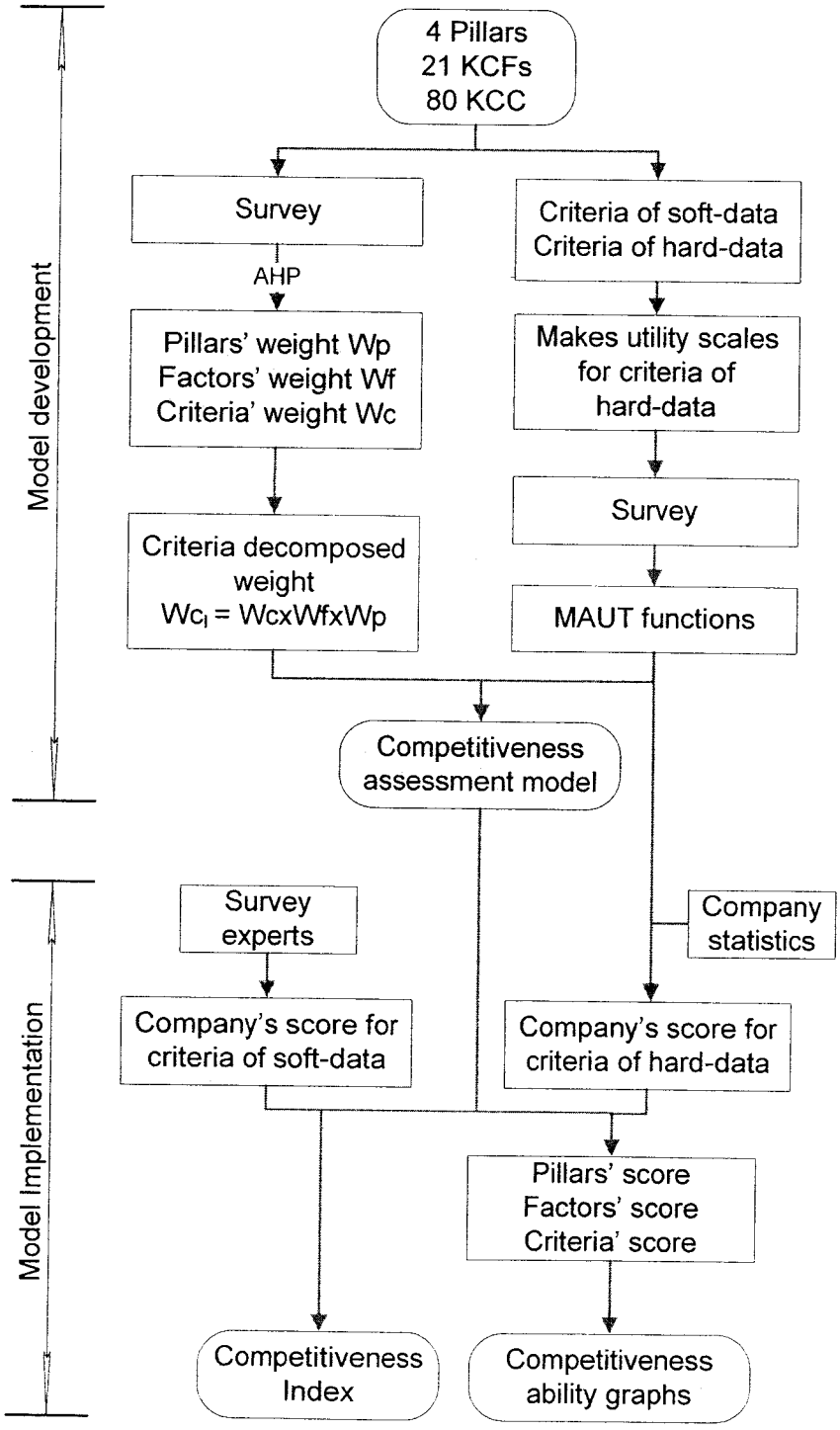

Figure 6-1: Model development and implementation

6.1 Factor Performance Impact

Although the final collected relative weights in section 5.2 are essential components in the building process of the MAUT model, they only represent the general impact of the factors and attributes on the competitiveness model. Each attribute may have different value that varies in their impact on the company's competitiveness. Therefore, to better represent this impact, specific indexes should be assigned to their corresponding attributes. From this sense, experts; throughout the distributed questionnaire; were asked to rate each attribute defined in section 4.4 using the scale shown in Table 6-1.

Table 6-1: Proposed Scale for Utility Rating

Very strong	Strong	Normal	Weak	Very Weak
9	7	5	3	1

A sample of the submitted survey is illustrated in Figure 6-2. To make utility scales, experts were asked to provide the values range concerning each criterion of hard-data (utility scales). For example: in criterion C2 (Number of fulltime employee/ Total employee), experts reported that the average value for "very strong" of a company's performance is more than 70%, while a "strong" value can be evaluated from 50% to 70%.

Respondents were asked to evaluate the impact of each attribute by assessing its different values. The respondents had provided scores for each level (attribute) of a particular sub-factor. These scores were provided on a scale from

1 to 9, where (1) means very weak impact (9) means very strong impact. An example of response is illustrated in figure 6-2-b.

Competitive Criterion C1: Employee productivity (1 million VND, value add per 1 year) =

More than 150	From 110 to 150	From 70 to 110	From 30 to 70	Less than 30

Competitive Criterion C2: Number of fulltime employee/ Total employee =

More than 70%	From 50% to 70%	From 25% to 50%	From 10% to 25%	Less than 10%

Competitive Criterion C3: Number of bachelor's staff degree/ Total employee =

More than 35%	From 25% to 35%	From 15% to 25%	From 5% to 15%	Less than 5%

Competitive Criterion C4: Number of employee more than 5 years experience/ Total employee=

More than 50%	From 30% to 50%	From 20% to 30%	From 10% to 20%	Less than 10%

Competitive Criterion C7: Profit Ratio: Net profit margin= Net income / Total sales=

More than 15%	From 9% to 15%	From 3% to 9%	From 1% to 3%	Less than 1%

Competitive Criterion C8: Activity Ratio: Total assets turnover= Sales / Total assets=

More than 140%	From 105% to 140%	From 70% to 105%	From 35% to 70%	Less than 35%

Figure 6-2-a: Survey Sample for utility scales

Competitive Criterion C1: Employee productivity (1 million VND, value add per 1 year) =

More than 150	From 110 to 150	From 70 to 110	From 30 to 70	Less than 30
8	7	4	3	1

Competitive Criterion C2: Number of full-time employee/ Total employee =

More than 70%	From 50% to 70%	From 25% to 50%	From 10% to 25%	Less than 10%
9	7	5	2	2

Competitive Criterion C3: Number of bachelor's staff degree/ Total employee =

More than 35%	From 25% to 35%	From 15% to 25%	From 5% to 15%	Less than 5%
9	9	7	5	3

Competitive Criterion C4: Number of employees more than 5 years experience/ Total employees=

More than 50%	From 30% to 50%	From 20% to 30%	From 10% to 20%	Less than 10%
8	6	5	3	1

Figure 6-2-b: Example an answer of survey for utility scales

6.2 Utility Functions Development

The distributed survey was designed to provide respective scores for the selected sub-factors which are required to estimate the utility-scoring functions. Moreover, since the main objective is to obtain multi-attribute utility functions based on experts' preferences, a mean-score approach was adopted. The mean-score approach of each attribute is based on averaging scores derived from several respondents, which represents the single-attribute utility function for that attribute.

Accordingly, in order to represent the relationship between the values of attributes and utility scores, utility functions were constructed. Scores of the different attributes obtained from the responses were used to model the utility functions. Models were fitted using mean-scores where the ability of each function to directly generate utility scores was assessed. After processing all the needed calculation, the following functions were emerged as the best functional form for converting attributes values into utility scores. In this section, only two utility functions will be explained while the remaining utility functions are found in Appendix C. These utility functions are used for every construction company in a

country. Because Canada's construction industry is different than that of Vietnam, there are two types of utility functions, one for Vietnamese construction company, and one for Canadian construction company.

From the answer of survey, mean-scores are calculated for every utility scales. One example for the mean-scores result of the experts' answers for some criteria is illustrated in figure 6-2-c. Current research uses average experts' score, because experts are considered that they have the same experience and knowledge.

. Competitive Criterion C1: Employee productivity (1 million VND, value add per 1 year) =

More than 150	From 110 to 150	From 70 to 110	From 30 to 70	Less than 30
8.72	7.43	5.36	3.14	1.27

Competitive Criterion C4: Number of employee more than 5 years experience/ Total employee=

More than 50%	From 30% to 50%	From 20% to 30%	From 10% to 20%	Less than 10%
8.77	8.08	6.09	3.91	1.86

Figure 6-2-c: Example average scores for utility scales

Based on the mean-scores of utility scales above, the utility functions are established as illustrated in figure 6-3 and figure 6-4.

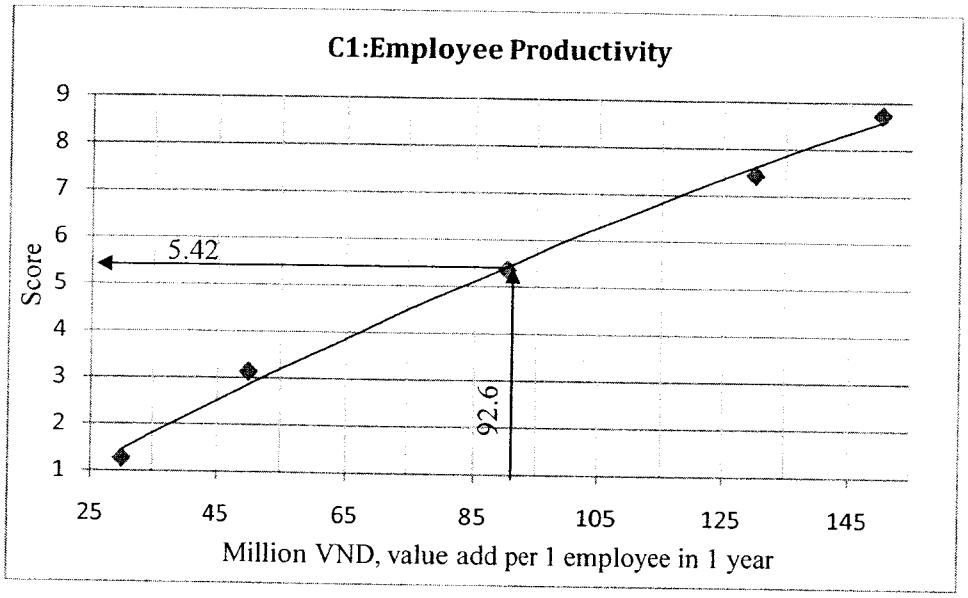

Figure 6-3: Utility Function for 'Employee Productivity'

Figure illustrates the utility function of competitiveness criterion 'Employee Productivity'. For example Company A has an employee productivity of 92.6 million VND value add per one employee per year. Thus, based on the graph in figure 6-3, it has a score of 5.42 for this competitive criterion.

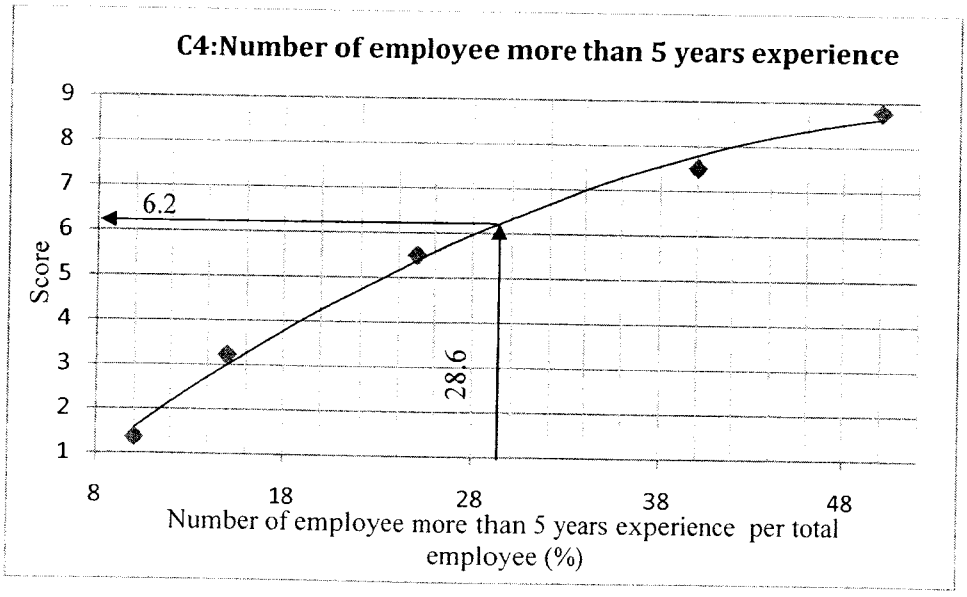

Figure 6-4: Utility Function for Number of 'Employee more than 5 years experience'

Figure illustrates how a company can figure out its score for criterion 'Number of employee more than 5 years' experience'. For example, the percentage value for Company B per total employee is 28.6% concerning 'Number of employee more than 5 years experience' and thus the score is 6.2 for this competitive criterion.

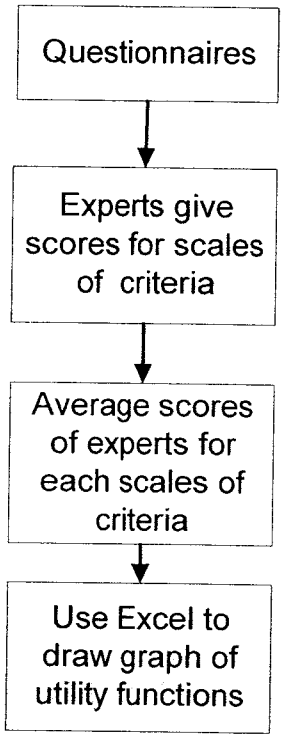

Figure 6-5: Utility Function development Process

The process to develop utility functions is illustrated in figure 6.5; firstly, questionnaires are established based on experts' ideas. Secondly, from the questionnaires survey, experts gave the scores for scales of each criterion. Thirdly, average scores of scales are calculated for each criterion. Lastly, average scores used to put in Microsoft Excel as showed in Figure 6-5. Microsoft excel draws the graph of utility functions automatically.

6.3 MAUT Model

The overall competitiveness score is generated mathematically by multiplying the decomposed weight of each attribute (Appendix B) with the utility score of each sub-factor attribute (Appendix C), followed by a summation of results of each criterion within the whole incorporated factors. The following equation illustrates the proposed model

$$I = \sum_{i=1}^{80} Wc_i * Sc_i \qquad \text{(Equation 6.1)}$$

Where:

I: Competitiveness index for the construction company

Wc_I: Weight of criterion i (i=1÷ n=80) that calculated by equation 5.1.

Sc_I: Score/utility value of each criterion i (i=1÷ n=80).

6.4 Model Implementation, Graphs and Uses

Pillar's score is calculated by equation:

$$P_k = \sum_{j=1}^{n} Wc_j * Sc_j \qquad \text{(Equation 6.2)}$$

Where:

P_k: Company competitiveness score for pillar k (k=1÷4).

n: The number of criteria that pillar k includes, mentioned in 4.4.

Sc_j: Score/utility value of each criterion j that included in pillar k (j=1÷n).

Wc_j: Weight of criterion j that included in pillar k, (j=1÷n) calculated by equation 6.3.

$$Wc_j = WcxWf \qquad \text{(Equation 6.3)}$$

Where:

Wc: The relative weight of each criterion (see equation 5.1).

Wf: The relative weight of the factor (see equation 5.1).

The graph for pillars' scores (such as Figure 6-6, Figure 6-9, Figure 6-12) is created based on score of pillars for each company. The graph shows the score of each pillar, thus it reveals pillars that company has high score or low score. In another word, it reveals company competitiveness ability strengths (corresponding to high scores) or weakness (corresponding to low scores).

Factor's score is calculated by the following equation:

$$F_j = \sum_{k=1}^{n} Wc_k * Sc_k \qquad \text{(Equation 6.4)}$$

Where:

F_j: Company competitiveness score for factor j (j= 1÷21).

n: The number of criteria that factor j includes, mentioned in 4.4.

Wc_k: Weight of criterion k that included in factor j, (k=1÷n). In equation 5.1, Wc_k is Wc of criterion k (it is not Wc_l).

Sc_k: Score/utility value of each criterion k that included in factor j (k=1÷n).

The graph for factors' scores (such as Figure 6-7, Figure 6-10, Figure 6-13) is created based on score of factors for each company. From utility functions and company statistics, scores for criteria is calculated as mention in 6.2. The graph for criteria' scores (such as Figure 6-8, Figure 6-11, Figure 6-14) is created based on score of criteria for each company. Similar the graph for pillars' scores, graphs for factors' scores and criteria' scores reveal company competitiveness ability as well as company's strengths (corresponding to high scores) and weakness (corresponding to low scores) in competitiveness.

The competitiveness index and its graphs give information about the company competitive ability. By examining the graphs, a company can analyze its weaknesses and strengths. As a result, the company can develop better business plans, improve weaknesses, and use its resources more effectively. These graphs can also be used for competitiveness benchmarking. Clients can use the provided indexes and graphs to assist in selecting the best company for a particular project. Also the government can use the model to aid in planning better economic strategies concerning construction competitiveness.

6.5 Case Study

As a prove of concept, three case studies were implemented using the proposed competitiveness model. The model has the potential to establish competitiveness index for any given Construction Company in Vietnam and Canada since the factors' weight are based on these two countries. As explained earlier, two type of information are needed to run the model statistical and subjective data. Full data were provided by two Vietnamese companies Company A and Company B. On the other hand, partial statistics were submitted by Company C, one of the highest ranked Canadian construction companies. Due to confidentiality aspects missing information concerning Company C were estimated based on interviews with company's manager. The following sections will discuss the findings for each case study.

Case Study 1: Company A

Company A was established in 1992. It is a private construction company located in Ho Chi Minh City, Vietnam. Company A has managed a wide variety of

project types, including houses, buildings, dams, bridges and roads. Although it is not a big company, Company A has had good competitive scores in business and good relationships with clients, markets, and suppliers. The needed company's information was provided by the manager and 3 experts. Two experts provided competitiveness ability score for Company A which is equal to 7 and one expert give score 5. Thus the average competitiveness index for Company A by experts is (7+7+5)/3= 6.33. By using equation 6.1, the proposed model calculates Company A competitiveness index that is 6.18.

Some graphs made, as mentioned in 6.3, to show the company competitiveness ability. Firstly, as illustrated in section 6.1 and 6.2, criteria' scores for company A are calculated based on experts survey and company A's statistics. These scores are used to draw the figure 6-8. Used equation 6.2, pillars' scores for company A are calculated, the result in table 6-2.Then they are used to draw figure 6-6. Factors' scores are calculated based on equation 6.4, then they are used to draw figure 6-7.

Figure 6-6 shows Company A competitiveness ability in level 1: Pillars. Company scored high concerning pillar 'environment and clients' (score 6.54) and low for pillar 'innovation and development' (score 5.63).

Based on figure 6-7, Company A competitiveness ability is showed in level 2: factors. Company A is strong in factors 'Organization environmental awareness' (score 7.67) and 'Client satisfaction' (score 7.37). But it is weak in 'Research and development ability' (score 4.64) and 'Marketing' (score 4.73).

Figure 6-8 shows Company A competitiveness ability in level 3: Criteria. Company A is strong in criteria 'Equipment availability' (score 9), 'Number of year in business' (score 8.25), 'Dispute resolving skill' (score 7.67), 'Cost performance Index' (score 7.5), 'Client satisfaction with product', and 'Client satisfaction with service' (score 7.67). Company A is weak in criteria 'Market research, planning, and publicity' (score 3.18), 'Schedule performance index' (score 3.8), and 'Investment on R&D' (score 3.6).

The results showed that company's resources are not used efficiently, since the score of 'Effective Use of organization's resources' is 5 and other scores of resources average were found to be more than 6.0, so the company's use of resources is not good. Moreover the analysis of these graphs showed that the company spent too much money on management (score 3.8).

Pillar	Score
Organization performance	6.21
Project performance	6.20
Environment and Client	6.54
Innovation and development	5.63

Table 6-2: Pillars' Score for Case Study #1

From the scores in Table 6-2, the graph in figure 6-6 is drawn.

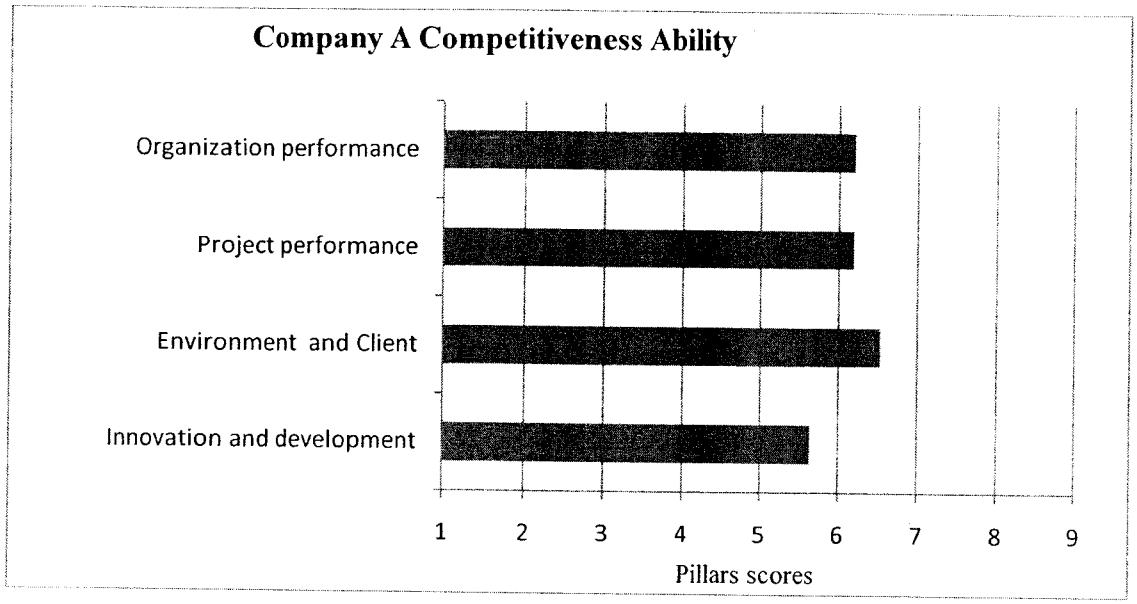

Figure 6-6: Pillars' Score for Case Study #1

Factors' scores are calculated by equation 6.4, and then the graph in figure 6-7 is drawn based on these scores. As process is illustrated in 6.4, the graph in figure 6-8 for criteria' scores are made.

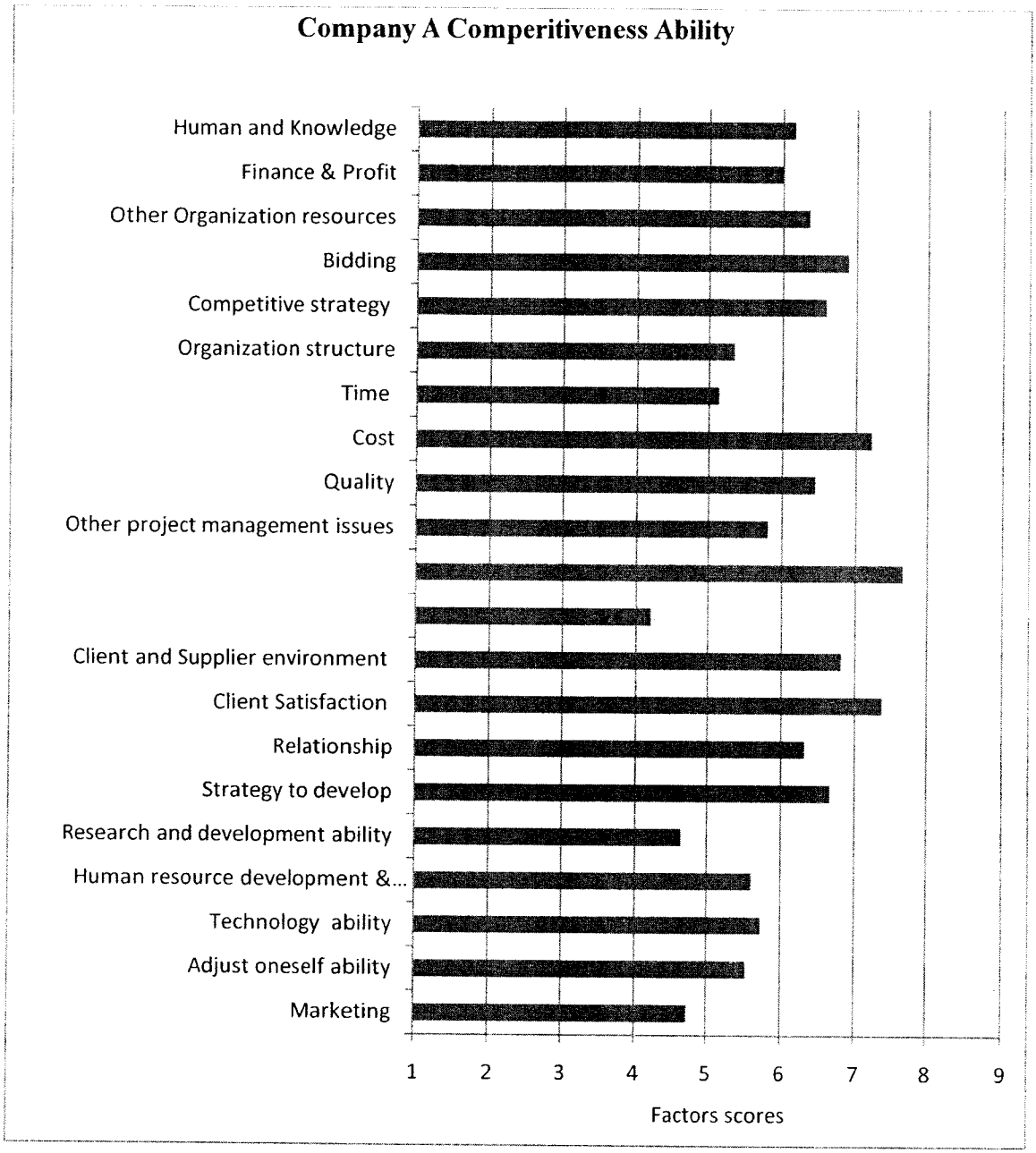

Figure 6-7: Factors' Scores for Case Study #1

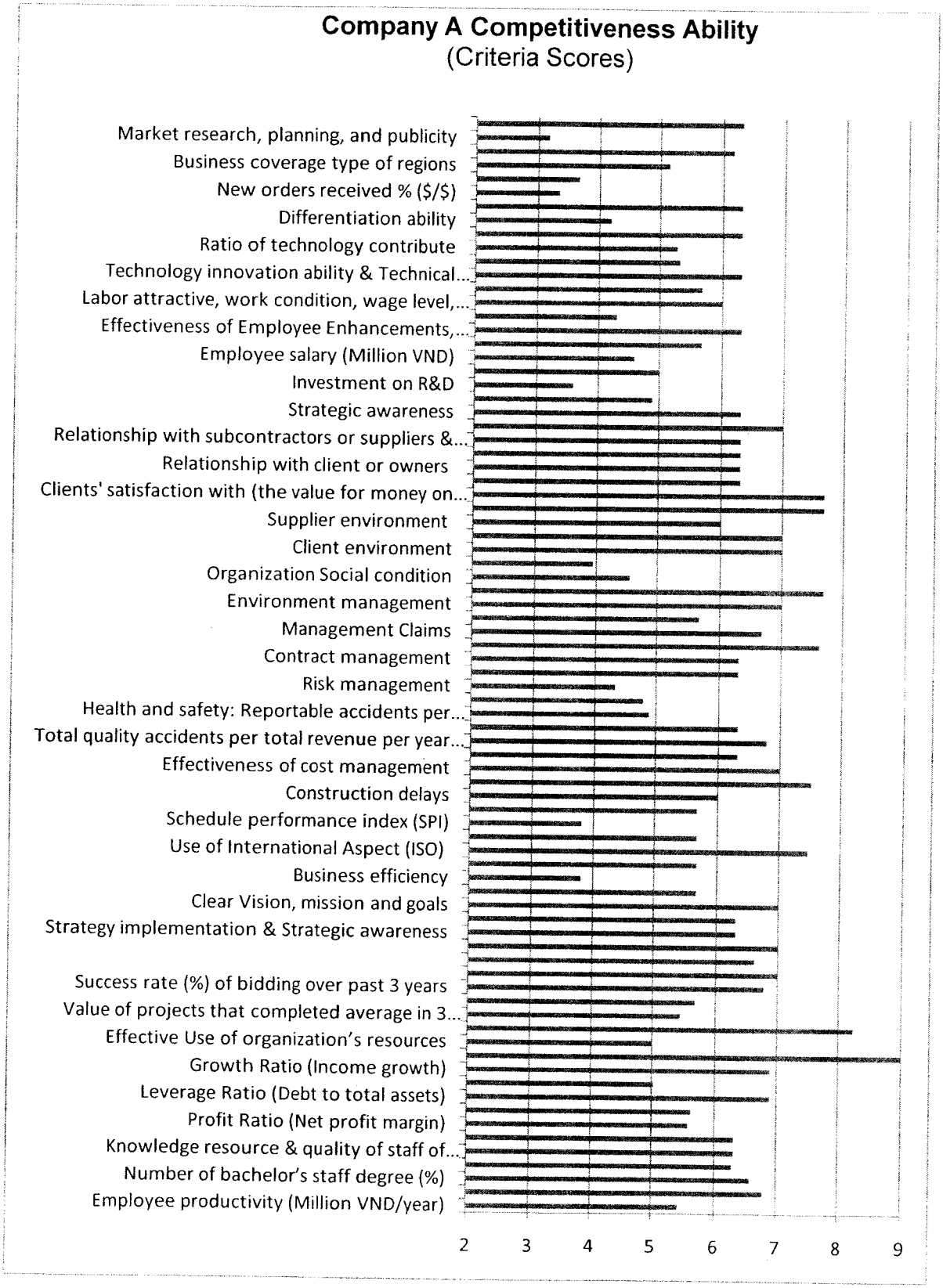

Figure 6-8: Criteria Scores for Case Study # 1

Case study 2: Company B

Company B was established in 1997. It is a private construction company located in Ho Chi Minh City, Vietnam. Its market spans within many regions of Vietnam and it deals with many types of projects: houses, bridges, dams, etc. Director of Company B, provided full company's statistics in addition to 3 experts.

The similar procedure will be used in case study 1, figures 6-9, 6-10, 6-11 are made.

In Pillars' figure, Company B is strong about 'Environment and Client' (score 6.33) and 'Project Performance' (score 5.93). It is weak about 'Innovation and development' (score 5.52).

Figure 6-10 shows Company B is strong about 'Relationship' (score 7.63), 'Bidding' (score 6.39), 'Cost' (score 6.96), 'Client and supplier environment' (score 6.57). But it is weak about 'Technology ability' (score 5.08), 'Time' (score 4.91), 'Marketing' (4.96).

Based-on figure 6-11, Company B is strong in 'Growth Ratio (Income growth)' (score 8.52), 'Success rate (%) of bidding over past 3 years' (score 7.09), 'Use of International Aspect (ISO)' (score 7.45), 'Site management' (score 7.0), and 'Relationship with government departments & with public' (score 8.33). But it is weak about 'Liquidity Ratio (Quick ratio)' (score 4.98), 'Differentiation ability' (score 4.39), 'Equipment availability' (score 3.8), 'IT application' (score 3.67).

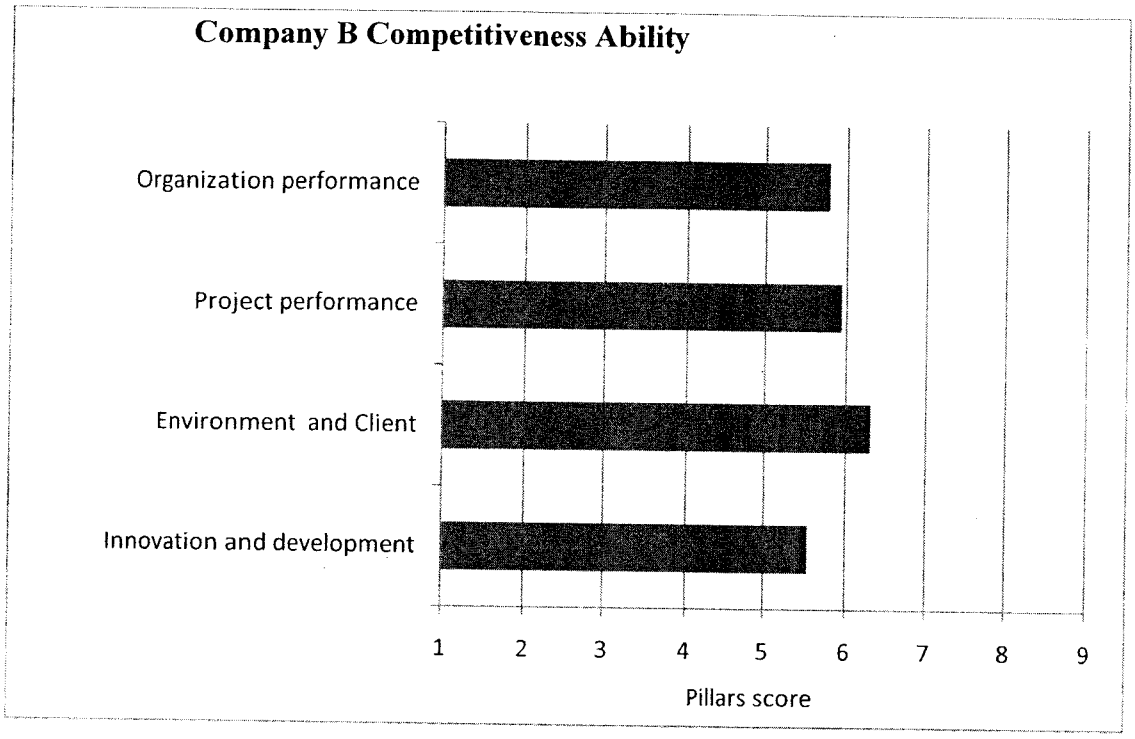

Figure 6-9: Pillars' Score for Case Study #2

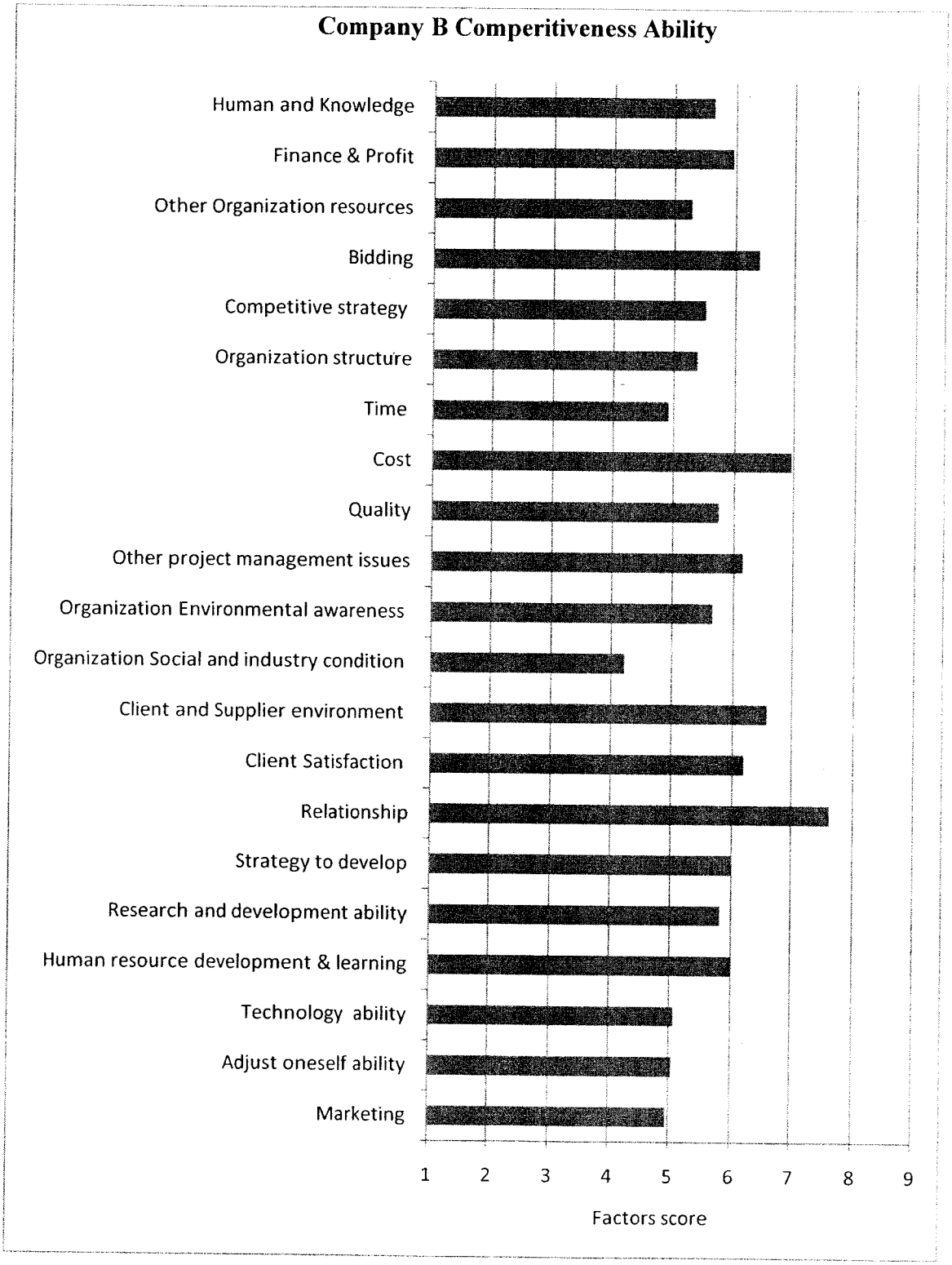

Figure 6-10: Factors' Scores for Case Study #2

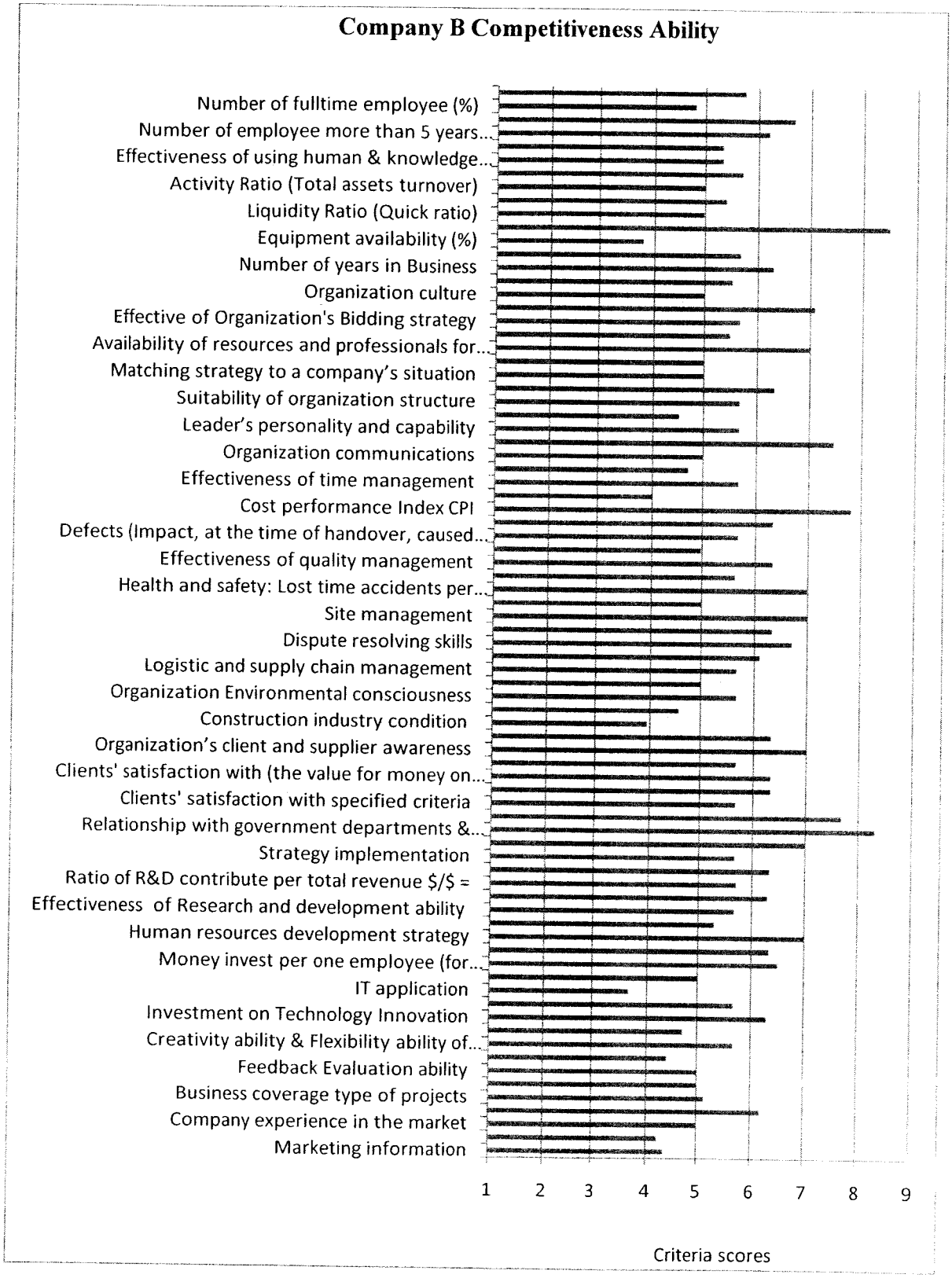

Figure 6-11: Criteria Scores for Case Study # 2

From the results presented in Figures 6.9, 6.10, 6.11, Company B showed weak responses concerning time management, market research and planning. The company is strong regarding cost management, equipment, and leadership characteristics. Three experts gave company competitiveness ability score. One expert gave a competitiveness ability score of 7 for Company B and two other experts gave a score of 5. Average competitiveness index for Company B by experts is (7+5+5)/3= 5.67. By using equation 6.1, the proposed model calculates Company B competitiveness Index that is 5.92.

Case study 3: Company C

Company C is one of the biggest construction companies in Canada. Founded in 1937, Company C has a high profile experience in the construction industry. Company C has many branches in a variety of countries throughout the world; it is skilled in different types of projects, including buildings, houses, power plants, bridges, and construction project design and consultation. Three experts from Company C completed the survey to calculate the competitiveness index.

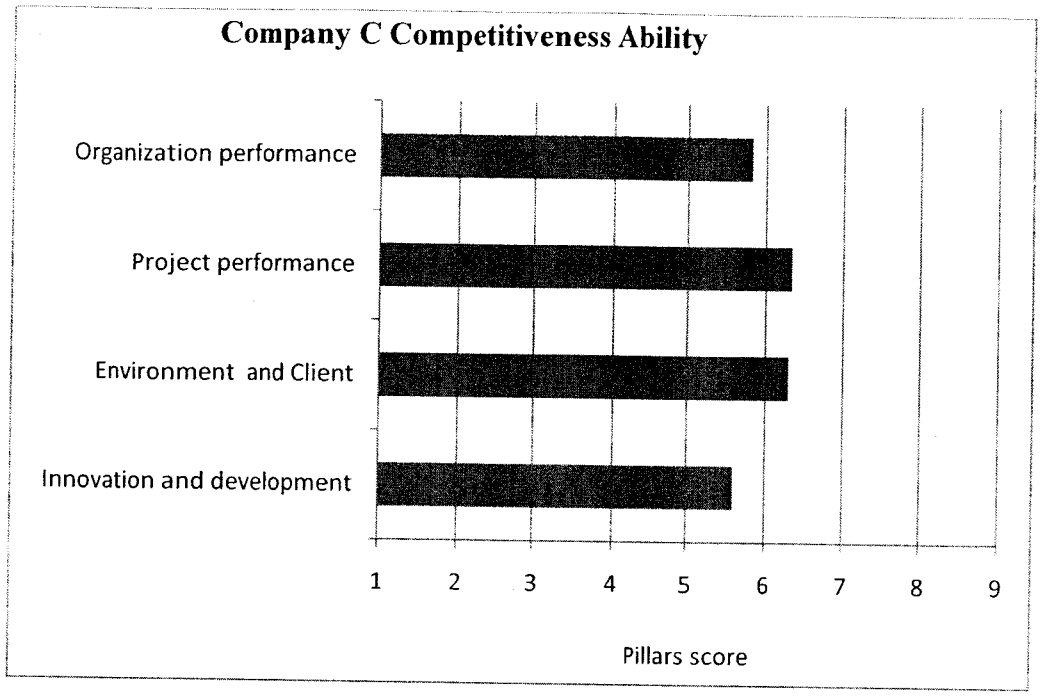

Figure 6-12: Pillars' Score for Case Study #3

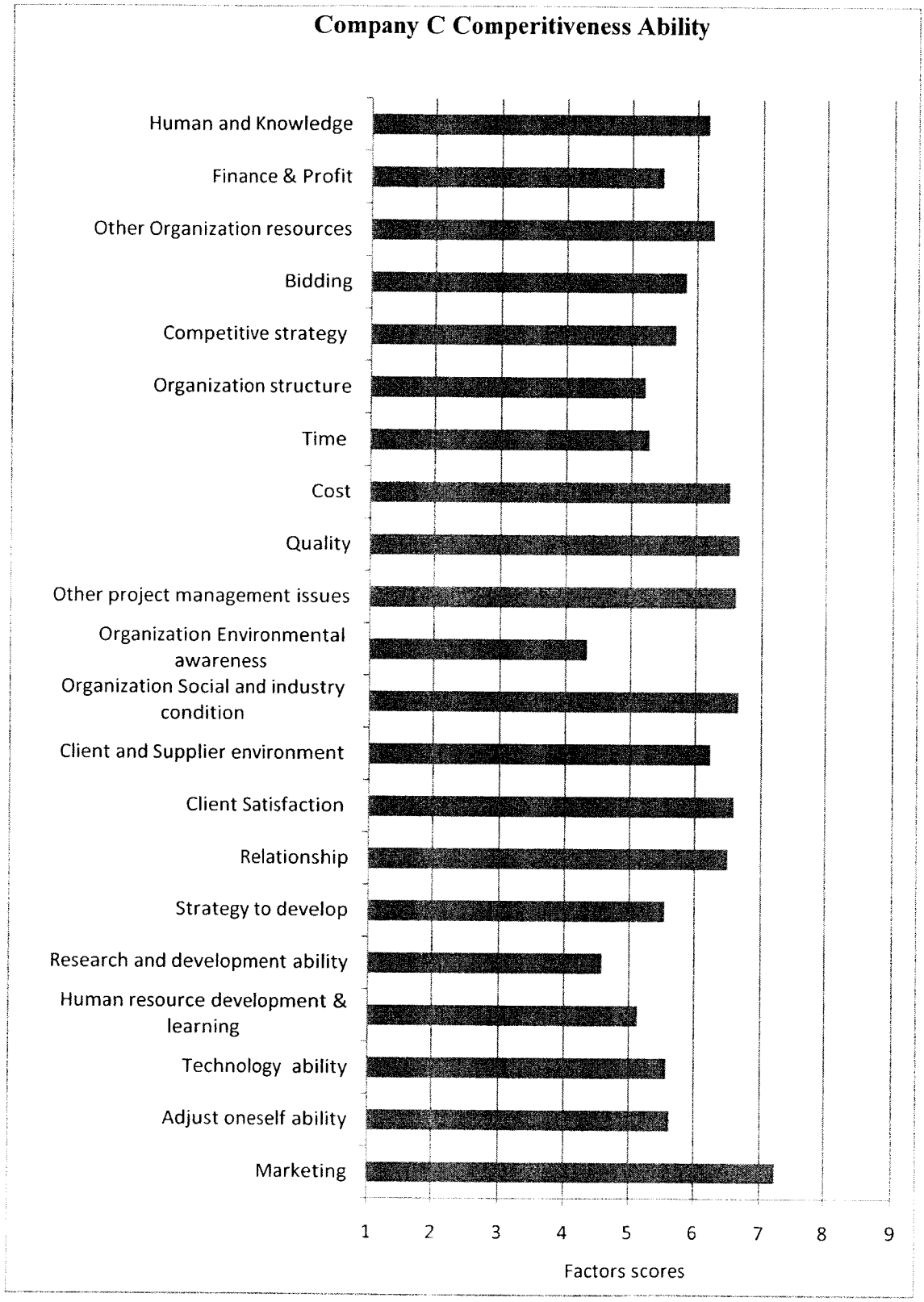

Figure 6-13: Factors' Scores for Case Study #3

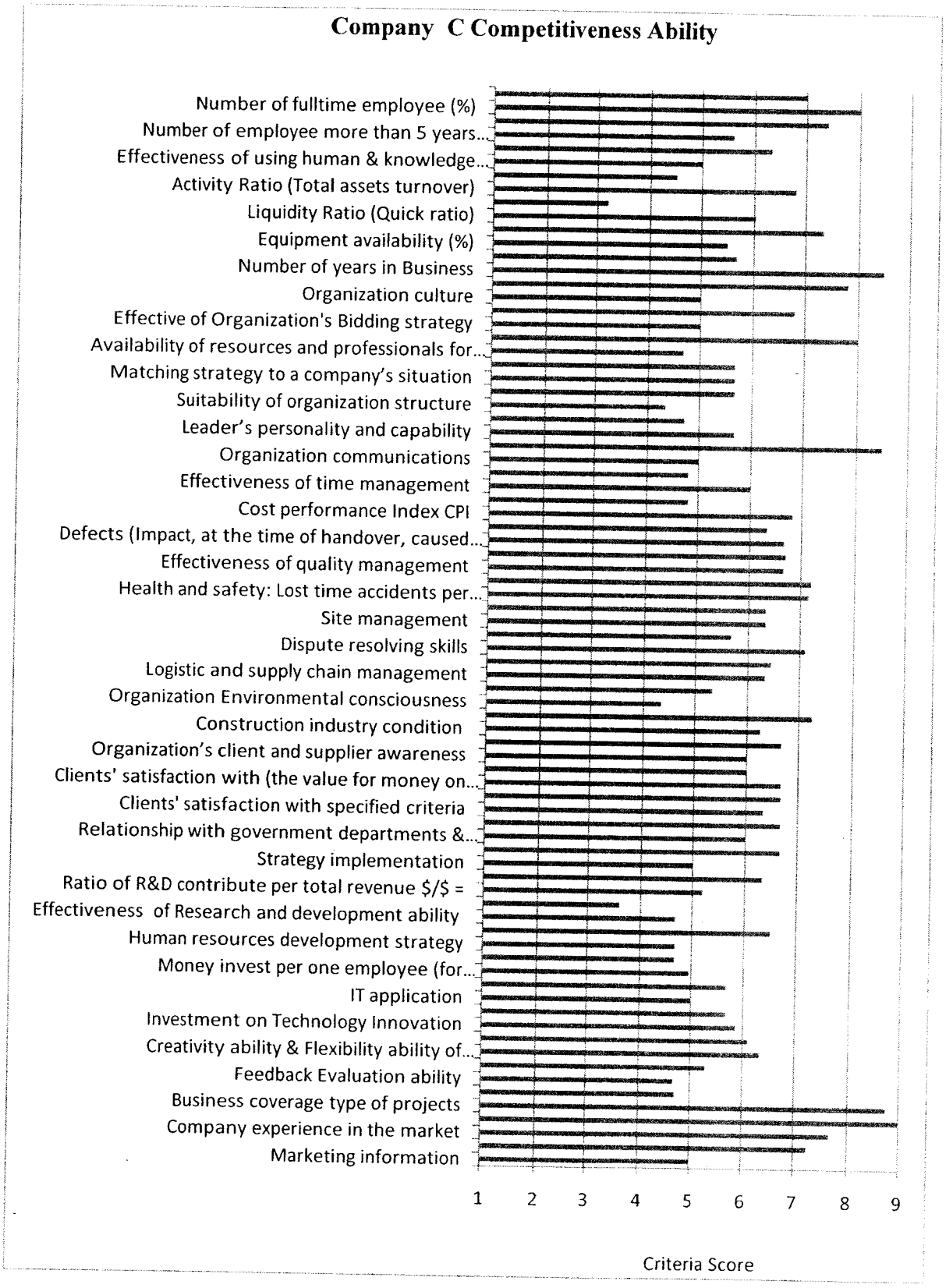

Figure 6-14: Criteria Scores for Case Study # 3

One expert gave company competitiveness ability score of 5 and other two experts gave a score of 7, thus the average competitiveness ability score by experts is (7+7+5)/3=6.33. By using equation 6.1, proposed model calculates Company C competitiveness Index that is 6.09.

The similar procedure is used in case study 1, figures 6-12, 6-13, 6-14 are made.

The above competitive graphs (Figure 6-12) showed that Company C is strong in 'Project performance' (score 6.35) and 'Environment and client' (score 6.31). However, weak scores were recorded concerning Pillars 'Innovation and development' (score 5.56), 'Organization performance' (score 5.81).

Based-on Figure 6-13, Company C is strong about 'Quality' (score 6.68), 'Marketing' (score 7.23). But it is weak about 'Research and develop ability' (score 4.59), 'Organization Environmental awareness' (score 4.33).

Based-on Figure 6-14, 'Business coverage type of projects' (score 8.75), 'Business coverage type of regions' (score 9), 'Number of years in Business' (score 8.5). Nevertheless it is weak about 'Profit Ratio (Net profit margin)' (score 4.5), 'Organization Environmental consciousness' (score 4.33).

6.6 Model Validation

The model's results were validated using comparison technique between experts' estimation (experts' competitiveness index) and calculated competitiveness index using the proposed model. Experts' competitiveness index was calculated via the survey as mention in section 6.5 through case study. For example: To calculate the experts' competitiveness index of company A, three

experts is asked to give the score for competitiveness index of company A. One expert give score 5, two experts give score 7. The experts' competitiveness index of company A is (7+5+7)/3= 6.33. Parallel with experts' competitiveness index, competitiveness index using the proposed model was calculated by equation 6.1. Figure 6-15 illustrates the difference of experts' competitiveness index and the proposed model competitiveness index. Table 6-3: shows the percentages difference of the two values.

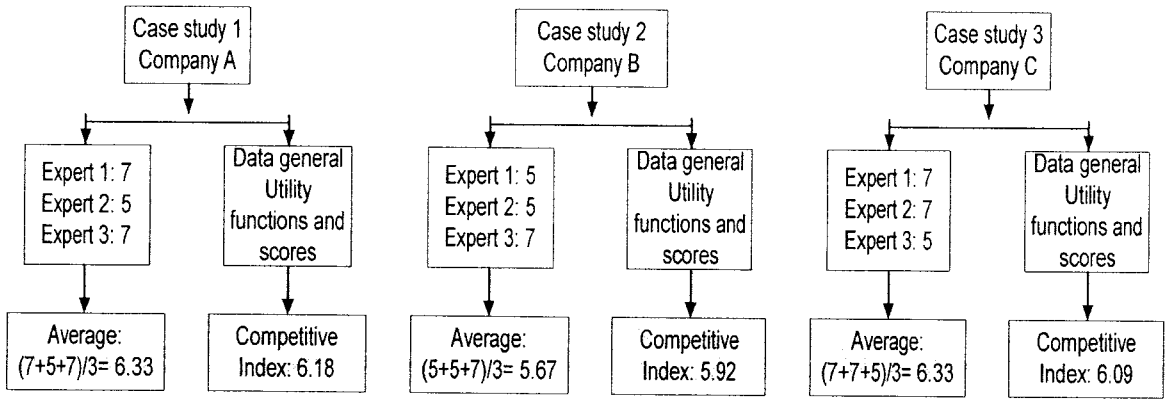

Figure 6-15: Detailed Analyses for Validation Values

Table 6-3: Comparison between experts' values and calculated values

	Case study 1	Case study 2	Case study 3
Competitiveness index based on proposed model	6.18	5.92	6.09
Competitiveness index based on experts' ideas.	6.33	5.67	6.33
Difference	2.48%	4.19%	3.99%

As per the previous difference percentage values, the proposed competitiveness assessment model has a potential to be used by the Canadian and the Vietnamese construction industry.

6.7 Sensitivity Analysis

Because the weights of factors and criteria are calculated based on experts' opinions, the sensitivity analysis was used to determine the effect of any change in the 'weight' of a criterion on the competitiveness index. The steps of performing sensitivity analysis are as follows:

1. Change the original weight of criterion "W_i" using seven percentages:

   W_i -30%; W_i -20%; W_i -10%; W_i; W_i +10%; W_i +20%; W_i +30%.

2. Determine, for each weight percentage, the difference between the original weight and the modified weight D.

3. Calculate the distributed values DV_j among the remaining criteria using Equation 6-5 as follows:

   $DV_j = D * \%age\ of\ criterion\ weight$ (Equation 6-5)

4. Calculate the modified weights of the remaining criteria using Equation 6-6 as follows:

   $W'_j = W_j + DV_j$ (Equation 6-6)

5. Use Equation 6-1 (in section 6.3) to calculate the competitiveness index based on the modified weight W'_j. However, utility values are not changed.

The analysis is done only for the 4 factor's which carry the highest weight in each pillar. Because the criteria' weights of Vietnam are different from that of Canada, therefore, two sensitivity analyses are done: (1) for Company A in Vietnam and (2) for Company C in Canada. Total 48 cases are generated and plotted as shown in Figure 6-16 and Figure 6-17.

Figure 6-16 shows that 'Effectiveness of cost management' is the most sensitive criterion in Company A in which any change in the weight of this criterion will have a strong effect on the competitiveness index. In the contrary, 'Profit Ratio' is the less sensitive criterion where the change in the competitiveness index is negligible.

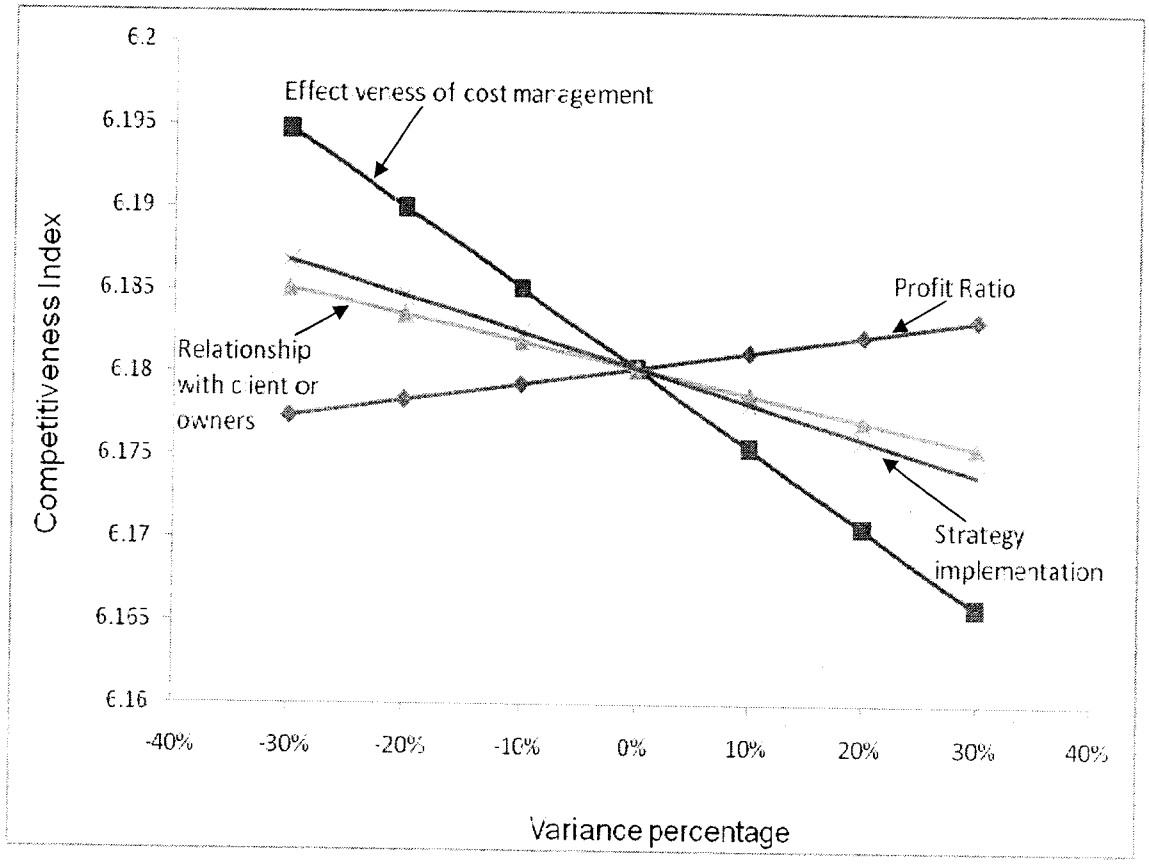

Figure 6-16: Sensitivity Analysis results for the 4 selected factors in Case 'Company A'.

Similarly, Figure 6-17 shows that 'Effectiveness of quality management' is the most sensitive criterion in Company C in which any change in the weight of this criterion will have a strong effect on the competitiveness index. In the contrary, 'Clear vision, mission, and goals' is the less sensitive criterion where the change in the competitiveness index is negligible.

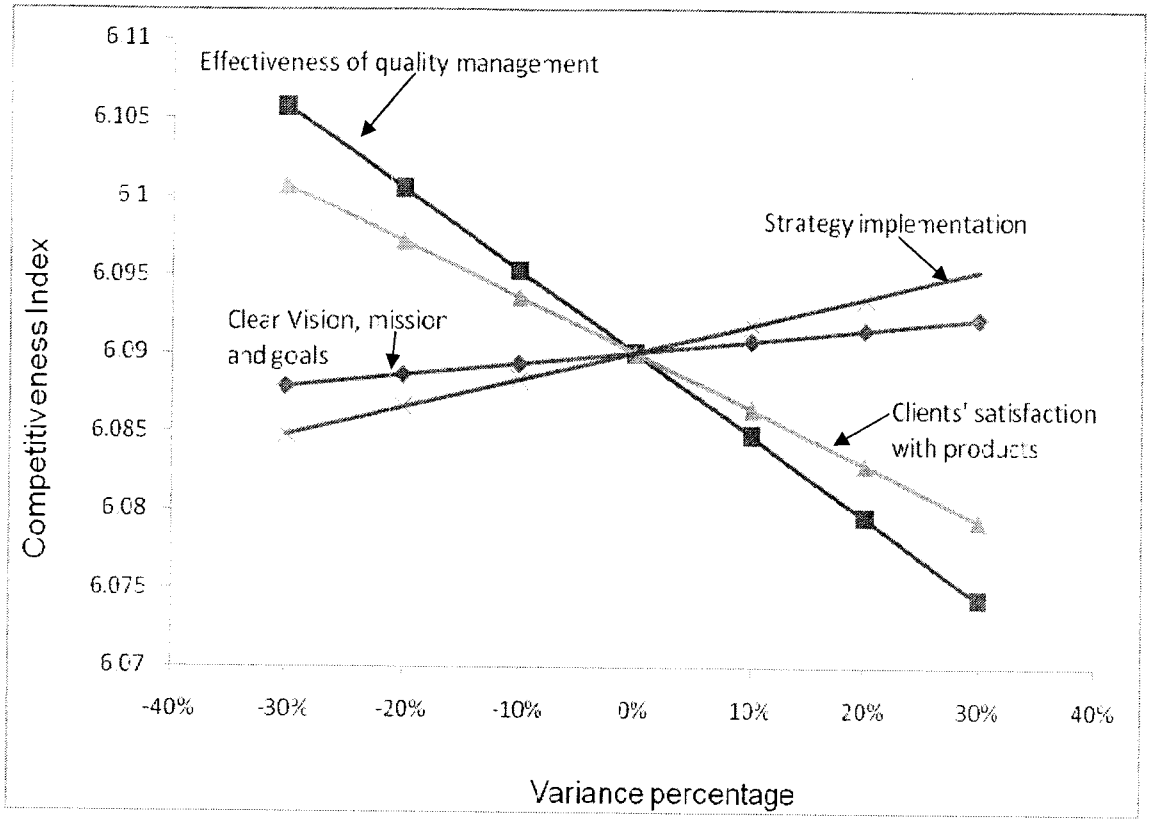

Figure 6-17: Sensitivity Analysis results for the 4 selected factors in Case 'Company C'.

6.8 Analysis of Results and Discussion

The various results generated using the proposed model, were discussed with various managers and experts from the construction industry. The main findings were that new technologies in IT and market globalization have a great influence on strategic management and organization performance. Construction organizations should highly emphasize project performance, organization performance, environment & client and innovation & development. The main benefit of using the 4P concept in competitive analysis is that detailed competitive factors can be assessed and thus analyzed easily.

Both the Vietnamese and Canadian firms revealed that the importance of factors such as relationships with customers and bidding is very critical for improving

competitiveness. In contrast, the strength of factors such as equipment and debt of finance reduces the importance for competitiveness.

Moreover, the role of organization performance is clearly important and thus long-term plan and strategy management should be emphasized. More attentions should be focused on each project to earn value. This also includes co-creation with clients and innovation. This process means that 'project performance" is highly emphasized. Factors like 'organization performance', 'environment & client' and 'innovation' are also proven to be critical aspects concerning improving company's competitiveness.

6.9 Summary

This chapter presented the development process proposed to establish the competitiveness assessment model. The model is based on two set of information: factor's weight and factor's utility values. Based on received surveys from construction companies in Canada and Vietnam factor's relative importance along with their respective utility functions were developed. An MAUT model was established to calculate the competitive scores. The second part of this chapter explained the results gathered from 3 cases studied using the new model. The validation of the results recorded small percentages of differences between real values and calculated scores.

CHAPTER 7. CONCLUSIONS AND RECOMMENDATIONS

7.1 Research Summary and Conclusions

The presented research discussed the main challenges that face competitiveness of construction companies. Due to continuous advancement in technologies, construction competitiveness theories have to adapt to these changes in a concrete manner. From this perspective, this research developed a competitiveness assessment model that takes into consideration present challenges in the market.

Factors incorporated in the model were deduced from literature reviews and interviews with experts. Based on literature findings and expert's feedback, 4 new pillars were introduced in this research as to serve as the fundamental bases for the competitiveness assessment model. The 4 pillars were: innovation and development, environment and client, project performance, and organization performance. Based on these aspects, 21 key competitive factors (KCFs) were introduced. Corresponding to these KCFs, 80 key competitive criteria were also defined.

A questionnaire survey was conducted throughout the Canadian and Vietnamese construction industry. The survey was intended to evaluate these factors in order to relatively weigh their importance. In addition to that, surveyors were asked to assign utility values to predefined competitive factors. The collected results were used to calculate the relative weights using AHP technique for every attribute and to develop utility functions for criteria of hard-data. The overall competitiveness

score is generated by multiplying the decomposed weight of each attribute with the utility score of each sub-factor attribute followed by a summation of results of each criterion within the whole incorporated factors. Three case studies were implemented using the proposed MAUT competitiveness assessment model. Two companies from Vietnam and one company from Canada provided the information needed to run and test the model. The final scores were discussed and validated with experts from the 3 addressed companies. The slight difference between the calculated scores and the company's score of the experts revels that the model has the potential to generate accurate values concerning competitiveness performance of construction companies.

The survey also revealed that all four pillars are important and rather equal in their importance to competitiveness of construction companies. Thus, the 4P is a suitable and potential management model for construction organizations worldwide.

The survey results show that the Vietnamese construction companies emphasize on 'Innovation and development' more than Canadian companies. However, the Canadian construction companies emphasize on 'Environment and Client' more than Vietnamese companies. Both of them claim that Time, Cost, Quality is very vital factors of competitiveness. They are much more important than other factors such as 'Risk Management' and 'Logistic and supply chain management'.

7.2 Research Contributions

The main contributions of this research can be summarized as follows:

- Identify and study the Key Competitive Factors (KCFs) and Key Competitive Criteria (KCC) that affect the competitiveness performance of construction companies. In comparison with previous studies done in the field of construction competitiveness, this study has introduced and classified 101 factors and criteria that addressed present challenges facing the construction industry. The developed utility functions of factors and criteria can be extremely beneficial for clients and governmental agencies that enable them to analyze construction companies' competitive performance.
- Develop a competitiveness performance model and index for construction companies. The proposed model can generate competitiveness performance scores for construction companies based on 4 new construction management pillars.

7.3 Research Limitations

There are some limitations that are inherent in the proposed research:

- The research surveys are conducted only in Vietnam and Canada. Also the attribute utility functions for Canada's company are based on the feedback of few experts.
- The KCFs, KCCs, attribute utility functions, and competitiveness index (CI) depend mainly on the environment, i.e. country's economic situation, the construction industry, etc. Thus, these

attributes must be continuously updated as to adapt to pre-mentioned environmental changes.

- Competitiveness index (CI) is only applicable to the Vietnamese and Canadian construction companies.

7.4 Recommendations and Future Work

These are some recommendations for future work that can enhance the current work:

- Future research should apply the Four Pillars to construction organizations and present some case studies, such as the application of SWOT-Pillars, strategy map based on Four Pillars, table of Four Pillars goals, etc.
- Establish a generic competitiveness index for design/build construction companies in the form of an international competitiveness index that can be used for any construction company worldwide.
- To develop a more accurate competitiveness index, future research should conduct more in-depth construction company surveys.

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APPENDIX

Appendix (A)

SAMPLE EXPERT SURVEY QUESTIONAIRE

QUESTIONAIRE SURVEY

CONSTRUCTION ORGANIZATION COMPETITIVENESS SURVEY

Your Name: _____
Your Company: _____
Your Position: _____
Your years of experience: _____

Part A: Relative Importance of Pillars, Factors, Criteria

In this section, you should give a pairwise comparison between e a variety of Competitive Factors. The comparison would simply take the form: "How important is factor 1 when compared to factor 2 for the company competitive ability"
The purpose of this survey is to calculate and analyse the Competitiveness of Construction Organization.

Table 1: Decision scale for weight rating

Importance (Weight) (For Part A)	Numerical Rating*	Importance (Weight) (For Part A)	Numerical Rating*
Extremely more important	9	Slightly less important	1/3
Very strongly more important	7	Strongly less important	1/5
Strongly more important	5	Very strongly less important	1/7
Slightly more important	3	Extremely less important	1/9
Equally important	1		

*1/2; 1/4; 1/6; 1/8; 2; 4; 6; 8 are intermediate values.

For Example, if factors to be considered in the pairwise comparison are Human and Knowledge, Finance & Profit, Company resources, Company structure, Bidding and Competitive Strategy, the comparison will be like:

▶ Level 2: Pillar1: Organization performance	Finance & Profit	Human and Knowledge	Other company resources	Bidding	Competitive Strategy
Company structure					

If you consider, example, the *Finance & Profit* is **strongly more important** over *Company structure*, you have to assign 5 below *Finance & Profit*, similar for *other columns* comparing with *Company structure* as follow:

▶ Level 2: Pillar1: Organization performance	Finance & Profit	Human and Knowledge	Other company resources	Bidding	Competitive Strategy
Company structure	5	5	1/3	1	1

One **Pillar** has some **factors**, one **factor** has some **criteria**. In example above: Pillar1, *Company performance* has **6** factors: *Human and Knowledge*, *Finance & Profit*, *Other company resources*, *Company structure*, *Bidding*, and *Competitive Strategy*. So doing comparison level 3 first is easier, then doing level 2, and last doing level 1.

From **'4 pillars'** we have **'21 factors'**. From **'21 Factors'** we have **'80 Criteria'**

a. Level 1: Compare the following Pillars with respect to the others:

▶ Level 1	Organization performance	Project performance	Environment and Client
Innovation and development			

b. Level 2: Compare the following Factors with respect to the others:

▶ Level 2: Pillar1: Organization performance	Finance & Profit	Human and Knowledge	Other company resources	Bidding	Competitive Strategy
Company structure					

▶ Level 2: Pillar 2: Project performance	Cost	Quality	Other project management issues
Time			

▶ Level 2: Pillar3: Environment and Client	Client Satisfaction	Company Social and industry condition	Client and Supplier environment	Relationship
Company Environmental awareness				

▶ Level 2: Pillar4: Innovation and development	Strategy to develop	Human resource development & learning	Research and development ability	Adjust oneself ability	Marketing
Technology ability					

c. Level 3: Compare the following Criteria with respect to the others:

▶ **Level 3: Factor: Human and Knowledge**	C4. Employee productivity	C2- Number of bachelor's staff degree (%)	C3-Number of employee more than 5 years experience (%)	C5. Knowledge resource & quality of staff of company	C6. Effectiveness of using human & knowledge resource of company
C1. Number of fulltime employee (%)					

▶ **Level 3: Factor: Finance & Profit**	Activity Ratio (Total assets turnover)	Leverage Ratio (Debt to total assets)	Profit Ratio (Net profit margin)	Growth Ratio (Income growth)
Liquidity Ratio (Quick ratio)				

▶ **Level 3: Factor: Other Company resources**	Effective of Use of company's resources	Number of years in Business	Value of projects that completed in 3 years recently ($)	Equipment availability (%)
Company culture				

▶ **Level 3: Factor: Bidding**	Success rate (%) of bidding over past 3 years	Sum of contract over past 3 years ($)	Experience bidding; Availability of resources and professionals for bidding
Effective of Company's Bidding strategy			

▶ **Level 3: Factor: Competitive strategy**	Strategy implementation	Strategic awareness & Clear Vision, mission and goals
Matching strategy to a company's situation		

▶**Level 3: Factor: Company structure**	Business efficiency	Leader's personality and capability	Suitability of company structure	Company communications
Use of International Aspect (ISO)				

▶ **Level 3: Factor: Time**	Effectiveness of time management	Schedule performance index (SPI)
Construction delays		

▶ **Level 3: Factor: Cost**	Cost performance Index CPI
Effectiveness of cost management	

▶ **Level 3: Factor: Quality**	Defects	Effectiveness of quality management
Total quality accidents per year ($)		

▶ **Level 3: Factor: Other project management issues**	Health and safety: Lost time accidents per 1000,000 hours worked	Risk mana geme nt	Site mana geme nt	Contract manage ment	Dispute resolvin g skills	Manag ement Claims	Logisti c and supply chain manag ement	Health and safety: Reportable accidents per 100,000 hours worked
Environment management								

▶ **Level 3: Factor: Company Social and industry condition**	Social condition
Construction industry condition	

▶ **Level 3: Factor: Client and Supplier environment**	Company's client and supplier awareness	Client environment
Supplier environment		

▶ **Level 3: Factor: Client Satisfaction**	Clients' satisfaction with (the value for money on delivered) services	Clients' satisfaction with (the value for money on delivered) products
Clients' satisfaction with specified criteria		

▶ **Level 3: Factor: Relationship**	Relationship with client or owners	Relationship with subcontractors or suppliers & with designers and consultants
Relationship with government departments & with public		

▶ **Level 3: Factor: Strategy to develop**	Strategy implementation
Strategic awareness & Clear Vision, mission and goals	

▶ **Level 3: Factor: Research and development ability**	Investment on R&D	Effectiveness of Research and development ability
Ratio of R&D contribute per total revenue ($/$)		

▶ **Level 3: Factor: Human resource development & learning**	Human resources development strategy	Effectiveness of Employee Enhancements, training and Education	Employee salary ($)	Labor attractive, work condition, wage level, employee motivation and job satisfaction
Money invest per one employee (for enhancements, training and education) per years ($)				

▶ **Level 3: Factor: Technology ability**	Technology innovation ability & Technical application	Investment on Technology Innovation	IT application
Ratio of technology contribute			

▶ **Level 3: Factor: Adjust oneself ability**	Business coverage Differentiation ability	Creativity ability & Flexibility ability of company
Feedback Evaluation ability		

▶ **Level 3: Factor: Marketing**	Business coverage type of projects	Business coverage type of regions	Company experience in the market	New orders received % ($/$)	Marketing information
Market research, planning & Publicity					

D: Please give other <u>Criteria</u> or <u>Factors</u> that you think that they are important, and give <u>importance level</u> of them when compare with another that the questionnaires already have.

Part B: Establish Competitive Scores

In this part, you should give your evaluation by scores for Construction Company Competitiveness. ***These scores can apply for <u>any</u> Construction Company in Vietnam, not only for your Company***.

The score is suitable in Table 2.

Table 2: Decision scale for score rating

Very strong	Strong	Normal	Weak	Very Weak
9	7	5	3	1

*2, 4, 6, 8 are intermediate values. You also can use the value 8.5; 3.2...

<u>For example</u>:

Competitive Criterion C4: Number of employee more than 5 years experience/ Total employee (%).

More50%	From 30% to 50%	From 20% to 30%	From 10% to 20%	<10%

If you think, example, **number of employee more than 5 years experience/ total employee** *more than 50%* is *<u>very strong</u>* for Competitiveness, you have to assign 9 below *more than 50%*. If you think that *from 30% to 50%* is <u>strong</u>, you have to assign 7 below *from 30% to 50%*. Similarly, we have:

Competitive Criterion C4: Number of employee more than 5 years experience/ Total employee (%).

More50%	From 30% to 50%	From 20% to 30%	From 10% to 20%	<10%
9	7	5	3	1

<u>Do similarly for others *Competitive Criteria* below:</u>

Competitive Criterion C1: Employee productivity (Million VND, value add per 1 <u>year</u>) =

More 150M	From 110M to 150M	From 70M to 110M	From 30M to 70M	<30M

Competitive Criterion C2: Number of fulltime employee/ Total employee =

More70%	From 50% to 70%	From 25% to 50%	From 10% to 25%	<10%

Competitive Criterion C3: Number of bachelor's staff degree/ Total employee =

More35%	From 25% to 35%	From 15% to 25%	From 5% to 15%	<5%

Competitive Criterion C4: Number of employee more than 5 years experience/ Total employee (%)

More50%	From 30% to 50%	From 20% to 30%	From 10% to 20%	<10%

Competitive Criterion C7: Profit Ratio: Net profit margin= Net income / Total sales=

More15%	From 9% to 15%	From 3% to 9%	From 1% to 3%	< 1%

Competitive Criterion C8: Activity Ratio: Total assets turnover= Sales / Total assets=

More140%	From 105% to 140%	From 70% to 105%	From 35% to 70%	<35%

Competitive Criterion C9: Leverage Ratio: Debt to total assets= Total debt / Total assets=

<10%	From 10% to 40%	From 40% to 80%	From 80% to 150%	More150%

Competitive Criterion C10: Liquidity Ratio: Quick ratio= Current Assets less inventories / Current liabilities=

More170%	From 112% to 170%	From 80% to 112%	From 50% to 80%	<50%

Competitive Criterion C11: Growth Ratio: Income growth= Current year's profit / Prior year's profit=

More130%	From 115% to 130%	From 100% to 115%	From 85% to 100%	<85%

Competitive Criterion C12: Company's equipment availability to do projects over past 3 years (%)

More65%	From 45% to 65%	From 25% to 45%	From 15% to 25%	<15%

Competitive Criterion C14: Number of years in Business

More than 20 years	From 10 to 20 years	From 5 to 10 years	From 2 to 5 years	Less than 2 years

Competitive Criterion C15: Value of projects that completed in 1 year (Billion VND) (per 1 employee)

More 1 B	From 0.7 to 1 B	From 0.3 to 0.7	From 0.1 to 0.3 B	<0.1 B

Competitive Criterion C17: Success rate (%) of bidding over past 3 years

More80%	From 60% to 80%	From 30% to 60%	From 10% to 30%	<10%

Competitive Criterion C19: Sum of contract over past 1 year (Million VND) (per 1 employee)

More1.2 B	From 0.8 to 1.2 B	From 0.4 to 0.8 B	From 0.15 to 0.4 B	<0.15 B

Competitive Criterion C25: Business efficiency: The money of management (VND)/ the money of sales (VND)

< 2%	From 2% to 6%	From 6% to 12%	From 12% to 20%	>20%

Competitive Criterion C27: Use of International Aspect (ISO) (or something similar)

Gained ISO9000 certification and renewed.	Gained ISO9000 certification.	Have application ISO9000 in company.	Intend to apply quality management system, But have not done.	Don't intend to apply any quality management system.

Competitive Criterion C29: Schedule performance index: SPI = Budgeted Cost of worked performance / Budgeted Cost of worked Schedule. (Calculate at the time: Budgeted Cost of worked Schedule= Budgeted Cost at Completion)

> 120%	> 115% to 120%	> 105% to 115%	> 90% to 105%	> 70% to 90%	> 40% to 70%	<40%

Competitive Criterion C31: Construction delays: Total weeks late/ Total weeks of construction (per year)

<5%	From 5% to 10%	From 10% to 20%	From 20% to 40%	>40%

Competitive Criterion C32: Cost performance Index: CPI= Budgeted Cost of worked performance/ Actual cost of worked performance. (Calculate at the time: Budgeted Cost of worked performance= Budgeted Cost at Completion. If project is completed, but Budgeted Cost of worked performance is less than Budgeted Cost at Completion, CPI calculates at the time complete the project).

>105%	>100%-105%	>90%-100%	>80%-90%	>70%-80%	>30%-70%	<30%

Competitive Criterion C35: Total quality accidents per year (VND)/*total revenue* =

Less than 0.1%	From 0.1% to 0.5%	From 0.5% to 1%	From 1% to 3%	More than 3%

Competitive Criterion C37: Health and safety: Reportable accidents per 100,000 hours worked

< 1	From 1 to 4	From 4 to 7	From 7 to 12	>12

Competitive Criterion C38: Health and safety: Lost time accidents per 100,000 hours worked=

< 15 h	From 15 h to 50 h	From 50 h to 100 h	From 100 h to 180 h	>180h

Competitive Criterion C42: Dispute resolving skills: Percentage of dispute resolving is success =

>90%	From 90% to 65%	From 65% to 40%	From 40% to 20%	<20%

Competitive Criterion C43: Claim Management: How many percent of claims are successful=

>80%	From 80% to 60%	From 60% to 40%	From 40% to 20%	<20%

Competitive Criterion C47: Social condition in Vietnam=

Competitive Criterion C48: Construction industry condition in Vietnam=

Competitive Criterion C60: Ratio of R&D contribute per total *revenue* VND/VND =

>10%	From 6% to 10%	From 3% to 6%	From 1% to 3%	<1%

Competitive Criterion C61: Investment on R&D: The money investment on R&D per *total revenue* (VND/VND) =

>2.5%	From 1.2% to 2.5%	From 0.5% to 1.2%	From 0.2% to 0.5%	<0.2%

Competitive Criterion C63: Employee salary (Million VND/month) =

>7 M	From 5.0 to 7.0 M	From 3.5 to 5.0 M	From 2.2 M to 3.5 M	<2.2 M

Competitive Criterion C66: Money invest per one employee (for enhancements, training and education) per years (Million VND) =

>3.5 M	From 2.5 to 3.5 M	From 1.5 to 2.5 M	From 0.6 M to 1.5 M	<0.6 M

Competitive Criterion C70: Money Investment on Technology Innovation per *total revenue* (VND/VND) (in 1 year)

>10%	From 6% to 10%	From 3% to 6%	From 0.5% to 3%	<0.5%

Competitive Criterion C71: Ratio of technology contribution per *total revenue* (VND/VND) (in 1 year).

>30%	From 15% to 30%	From 9% to 15%	From 3% to 9%	<3%

Competitive Criterion C73: Business coverage differentiation ability (*per year*):

a. Entry new location or regions (%) =

>60%	From 40% to 60%	From 20% to 40%	From 10% to 20%	<10%

b. Entry new types of construction projects (%) (*per year*) =

>40%	From 25% to 40%	From 10% to 25%	From 5% to 10%	<5%

Competitive Criterion C75: New orders received per *total revenue* % (VND/VND) (1 year)

>100%	From 80% to 100%	From 60% to 80%	From 40% to 60%	<40%

Competitive Criterion C76: Business coverage type of projects (Housing; Transport projects; Dam; Industry; Others) Number of types of projects:

More than 4 types	4 types	3 types	2 types	1 type

Competitive Criterion C77: Business coverage type of regions:

International + In country	International	In country	In Province

Competitive Criterion C79: Market research, planning, and publicity: Percentage of money investment per *total revenue* (VND/VND) =

> 0.7%	From 0.5% to 0.7%	From 0.25% to 0.5%	From 0.05% to 0.25%	< 0.05%

Part C: Company Competitive Scores

-In this section, you should give your company statistic or your scores about the company. Some criteria require statistic of your company, some criteria require score based-on your opinion.
-The opinion question would simply take the form: "How company's ability is". The score is suitable in Table 3.

Table 3: Decision scale for score rating

Very strong	Strong	Normal	Weak	Very Weak
9	7	5	3	1

*2, 4, 6, 8 are intermediate values. You also can use the value 8.5; 3.2...

-In the statistic questions, please give the real statistic of the company. All statistics are calculated from the statistic of over pass 3 years. If Criterion is different, we will explain it.

No	Competitive Factors	No	Competitive Criteria	Company Scores or statistic
F1	Human and Knowledge	C1	Employee productivity	Employee productivity (VND per year) =
		C2	Number of fulltime employee (%)	Number of fulltime employee/ Total employee =
		C3	Number of bachelor's staff degree (%)	Number of bachelor's staff degree/ Total employee =
		C4	Number of employee more than 5 years experience (%)	Number of employee more than 5 years experience/ Total employee =
		C5	Knowledge resource & quality of staff of company	Score=
		C6	Effectiveness of using human & knowledge resource of company	Score=
F2	Finance & Profit	C7	Profit Ratio (Net profit margin)	Net profit margin= Net income / Total sales=
		C8	Activity Ratio (Total assets turnover)	Total assets turnover= Sales / Total assets=
		C9	Leverage Ratio (Debt to total assets)	Debt to total assets= Total debt / Total assets=
		C10	Liquidity Ratio (Quick ratio)	Quick ratio= Current Assets less inventories / Current liabilities=
		C11	Growth Ratio (Income growth)	Income growth= Current year's profit / Prior year's profit=
F3	Other Company resources	C12	Equipment availability (%)	Company's Equipment availability to do projects over past 3 years (%) =
		C13	Effective use of company's resources	Score=
		C14	Number of years in Business	
		C15	Value of projects that completed in 3 years recently (VND)	
		C16	Company culture	Score=
F4	Bidding	C17	Success rate (%) of bidding over past 3 years	
		C18	Effective of Company's Bidding strategy	Score=
		C19	Sum of contract over past 3	

			years (VND)	
		C20	Experience for bidding & Availability of resources and professionals for bidding	Score=
F5	**Competitive strategy**	C21	Strategy implementation	Score=
		C22	Matching strategy to a company's situation	Score=
		C23	Strategic awareness & Clear Vision, mission and goals	Score=
F6	**Company structure**	C24	Suitability of company structure	Score=
		C25	Business efficiency	The money of management (VND)/ the money of sales (VND) =
		C26	Leader's personality and capability	Score=
		C27	Use of International Aspect (ISO)	Degree of company's system management that was accept by ISO or something else = Year: Renewed in Year:
		C28	Company communications	Score=
F7	**Time**	C29	Schedule performance index (SPI)	SPI = Budgeted Cost of worked performance / Budgeted Cost of worked Schedule=
		C30	Effectiveness of time management	Score=
		C31	Construction delays	Total weeks late/ Total weeks of construction =
F8	**Cost**	C32	Cost performance Index CPI	CPI= Budgeted Cost of worked performance/ Actual cost of worked performance=.
		C33	Effectiveness of cost management	Score=
F9	**Quality**	C34	Defects (at the time of handover)	Score=
		C35	Total quality accidents per year/net income	
		C36	Effectiveness of quality management	Score=
F10	**Other project management issues**	C37	Health and safety: Reportable accidents per 100,000 hours worked	Reportable accidents per 100,000 hours worked=
		C38	Health and safety: Lost time accidents per 100,000 hours worked=	Lost time accidents per 100,000 hours worked=
		C39	Risk management	Score=
		C40	Site management	Score=
		C41	Contract management	Score=
		C42	Dispute resolving skills	Percentage of dispute resolving is success =
		C43	Management Claims	How many percent of success rate of claims =
		C44	Logistic and supply chain management	Score=

		C45	Environment management	Score=
F11	**Company Environmental awareness**	C46	Company Environmental consciousness	Score=
F12	**Company Social and industry condition**	C47	Social condition	Give name of the society of company: Give the main market (countries of projects) of company:
		C48	Construction industry condition	Score=
F13	**Client and Supplier environment**	C49	Client environment	Score=
		C50	Company's client and supplier awareness	Score=
		C51	Supplier environment	Score=
F14	**Client Satisfaction**	C52	Clients' satisfaction with (the value for money on delivered) products	Score=
		C53	Clients' satisfaction with (the value for money on delivered) services	Score=
		C54	Clients' satisfaction with specified criteria	Score=
F15	**Relationship**	C55	Relationship with client or owners	Score=
		C56	Relationship with government departments & with public	Score=
		C57	Relationship with subcontractors or suppliers & with designers and consultants	Score=
F16	**Strategy to develop**	C58	Strategy implementation	Score=
		C59	Strategic awareness & Clear Vision, mission and goals	Score=
F17	**Research and development ability**	C60	Ratio of R&D contribute per total revenue VND/VND =	Ratio of R&D contribute per total revenue VND/VND =
		C61	Investment on R&D	The money investment on R&D per net income (VND/VND) =
		C62	Effectiveness of Research and development ability	Score=
F18	**Human resource development & learning**	C63	Employee salary (VND)	Employee salary(VND/month)=
		C64	Human resources development strategy	Score=
		C65	Effectiveness of Employee Enhancements, training and Education	Score=
		C66	Money invest per one employee (for enhancements, training and education) per years (VND)	Money invest per one employee (for enhancements, training and education) per years (VND)=

		C67	Labor attractive, work condition, wage level, employee motivation and job satisfaction	Score=
F19	**Technology ability**	C68	IT application	Score=
		C69	Technology innovation ability & Technical application	Score=
		C70	Investment on Technology Innovation	Money Investment on Technology Innovation per net income (VND/VND) =
		C71	Ratio of technology contribute	Ratio of technology contribution per total revenue (VND/VND) =
F20	**Adjust oneself ability**	C72	Creativity ability & Flexibility ability of company	Score=
		C73	Business coverage differentiation ability (per year)	Entry new location or region (%) = Entry new types of construction projects (%) =
		C74	Feedback Evaluation ability	Score=
F21	**Marketing**	C75	New orders received % (VND/VND)	New orders received % (VND/VND) =
		C76	Business coverage type of projects	Business coverage type of projects: Housing _____ Bridge, Road, transport _____ Dam _____ Industry _____ Others _____ (Please write them)
		C77	Business coverage type of regions	Business coverage type of regions: International _____ In country _____ In Province _____
		C78	Company experience in the market	Score=
		C79	Market research, planning, and publicity	Percentage of money investment per net income (VND/VND) =
		C80	Marketing information	Score=

C. Please give Score of the Company Competitiveness ability= _____ (Score is suitable table 3, from 1 to 9).

D. Some explanations

A. Criterion C5: *Knowledge resource* includes Knowledge resource on technique, market, law....

The *quality of staff* includes the quality of technical staff, the service staff....

B. C24. *Suitability of company structure* shows Clarity of divisions and responsibility of functional departments, Hierarch levels from top management to bottom, Intercompany relationship, Clearly specified property rights, Clearly specified responsibilities, Scientific management within company.

C. C28. *Company communications*: shows Company communication management, communication between departments, between projects teams, between manager and staff, between subsidiaries and projects. And company communication with stakeholders, customer, sponsor.

D. C29. *Schedule performance index (SPI)* (Average all projects over past 3 years)

Calculate at the time: Budgeted Cost of worked Schedule= Budgeted Cost at Completion.

E. C32. *Cost performance Index CPI* (Average all projects over past 3 years)

Calculate at the time: Budgeted Cost of worked performance= Budgeted Cost at Completion. If project is completed, but Budgeted Cost of worked performance is less than Budgeted Cost at Completion, CPI calculate at the time complete the project.

F. C46. *Company Environmental consciousness* shows Company consciousness about the nature environment of project; Knowledge and understand about law and social condition (market, culture, supplier....).

G. C47. *Company Social condition*: We use the conditions of societies in WEF. This indicator shows Political condition, Society labor condition, Society economical condition, social law, market condition..... of the society of your company.

H. C58. *Strategy implementation* shows Strategy to develop and innovate including implementation & Matching strategy to a company's situation. Also Including Acquisition of companies with the same or complementary types of activities.

I. C62. *Effectiveness of Research and development ability* **also** include Sustainable development and R&D.

J. C64. *Human resources development strategy* **also** includes human recruitment plan.

K. C80. *Marketing information*: also includes Capability of gathering and processing information of new projects/contracts & Availability and efficiency of product and price information of labor, materials, plants, and other resources.

Appendix (B)

The weight average of each Pillar, Factor, Criterion calculated by AHP

No	Name of Pillar, Factors, Criteria	Average (From Vietnam)	Average (From Canada)
1	Organization performance	0.25	0.27
2	Project performance	0.28	0.29
3	Environment and Client	0.27	0.31
4	Innovation and development	0.20	0.13
	Pillar 1		
F1	Human and Knowledge	0.20	0.24
F2	Finance & Profit	0.28	0.23
F3	Other Organization resources	0.07	0.10
F4	Organization structure	0.13	0.06
F5	Bidding	0.15	0.16
F6	Competitive strategy	0.18	0.21
	Pillar 2		
F7	Cost	0.27	0.23
F8	Time	0.26	0.20
F9	Quality	0.29	0.38
F10	Other project management issues	0.18	0.19
	Pillar 3		
F11	Client Satisfaction	0.23	0.33
F12	Organization Environmental awareness	0.14	0.10
F13	Organization Social and industry condition	0.15	0.16
F14	Client and Supplier environment	0.17	0.15
F15	Relationship	0.30	0.25
	Pillar 4		
F16	Research and development ability	0.08	0.12
F17	Strategy to develop	0.22	0.22
F18	Human resource development & learning	0.23	0.26
F19	Technology ability	0.13	0.07
F20	Adjust oneself ability	0.19	0.18
F21	Marketing	0.16	0.14

	Competitive Criteria	Average Vietnam	Average Canada
C1	Employee productivity	0.23	0.23
C2	Number of fulltime employee (%)	0.06	0.04
C3	Number of bachelor's staff degree (%)	0.08	0.09
C4	Number of employee more than 5 years experience (%)	0.16	0.16
C5	Knowledge resource & quality of staff of organization	0.23	0.23
C6	Effectiveness of using human & knowledge resource of organization	0.24	0.25
C7	Profit Ratio (Net profit margin)	0.28	0.30
C8	Activity Ratio (Total assets turnover)	0.23	0.08
C9	Leverage Ratio (Debt to total assets)	0.16	0.19
C10	Liquidity Ratio (Quick ratio)	0.13	0.14
C11	Growth Ratio (Income growth)	0.20	0.29
C12	Equipment availability (%)	0.17	0.14
C13	Effective of Use of organization's resources	0.31	0.42
C14	Number of years in Business	0.15	0.13
C15	Value of projects that completed in 3 years recently ($)	0.18	0.17
C16	Organization culture	0.19	0.15
C17	Success rate (%) of bidding over past 3 years	0.21	0.27
C18	Effective of Organization's Bidding strategy	0.24	0.14
C19	Sum of contract over past 3 years ($)	0.20	0.16
C20	Availability of resources and professionals for bidding	0.34	0.43
C21	Strategy implementation & Strategic awareness	0.29	0.28
C22	Matching strategy to a company's situation	0.31	0.25
C23	Clear Vision, mission and goals	0.40	0.47
C24	Suitability of organization structure	0.19	0.19
C25	Business efficiency	0.25	0.22
C26	Leader's personality and capability	0.30	0.28
C27	Use of International Aspect (ISO)	0.08	0.06
C28	Organization communications	0.18	0.24
C29	Schedule performance index (SPI)	0.33	0.37
C30	Effectiveness of time management	0.41	0.39
C31	Construction delays	0.26	0.24

C32	Cost performance Index CPI	0.43	0.40
C33	Effectiveness of cost management	0.57	0.60
C34	Defects (Impact, at the time of handover, caused by the condition of the facility with respect to defects.)	0.28	0.24
C35	Total quality accidents per year ($) =	0.29	0.26
C36	Effectiveness of quality management	0.44	0.50
C37	Health and safety: Reportable accidents per 100,000 hours worked	0.12	0.19
C38	Health and safety: Lost time accidents per 1000,000 hours worked=	0.13	0.19
C39	Risk management	0.12	0.15
C40	Site management	0.15	0.09
C41	Contract management	0.15	0.10
C42	Dispute resolving skills	0.09	0.08
C43	Management Claims	0.07	0.09
C44	Logistic and supply chain management	0.11	0.08
C45	Environment management	0.04	0.03
C46	Organization Environmental consciousness	1	1
C47	Organization Social condition	0.42	0.42
C48	Construction industry condition	0.58	0.58
C49	Client environment	0.28	0.37
C50	Organization's client and supplier awareness	0.54	0.41
C51	Supplier environment	0.18	0.22
C52	Clients' satisfaction with (the value for money on delivered) products	0.40	0.40
C53	Clients' satisfaction with (the value for money on delivered) services	0.38	0.40
C54	Clients' satisfaction with specified criteria	0.22	0.19
C55	Relationship with client or owners	0.49	0.46
C56	Relationship with government departments & with public	0.23	0.22
C57	Relationship with subcontractors or suppliers & with designers and consultants	0.28	0.33
C58	Strategy implementation	0.51	0.60
C59	Strategic awareness	0.49	0.40

C60	Ratio of R&D contribute per total revenue $/$	0.35	0.23
C61	Investment on R&D	0.23	0.18
C62	Effectiveness of Research and development ability	0.42	0.59
C63	Labor salary ($)	0.15	0.13
C64	Human resources development strategy	0.26	0.26
C65	Effectiveness of Employee Enhancements, training and Education	0.23	0.33
C66	Money invest per one employee (for enhancements, training and education) per years ($)	0.10	0.08
C67	Labor attractive, work condition, wage level, labor motivation and job satisfaction	0.27	0.20
C68	IT application	0.27	0.31
C69	Technology innovation ability & Technical application	0.32	0.33
C70	Investment on Technology Innovation	0.21	0.22
C71	Ratio of technology contribute	0.20	0.14
C72	Creativity ability & Flexibility ability of Construction Company	0.42	0.45
C73	Differentiation ability	0.37	0.32
C74	Feedback Evaluation ability	0.21	0.23
C75	New orders received % ($/$)	0.16	0.16
C76	Business coverage type of projects	0.17	0.22
C77	Business coverage type of regions	0.13	0.16
C78	Company experience in the market	0.24	0.24
C79	Market research and planning	0.15	0.09
C80	Marketing information	0.15	0.14

Appendix (C)
Attribute Utility Functions

A. Attribute Utility Functions for Vietnam Construction Company:

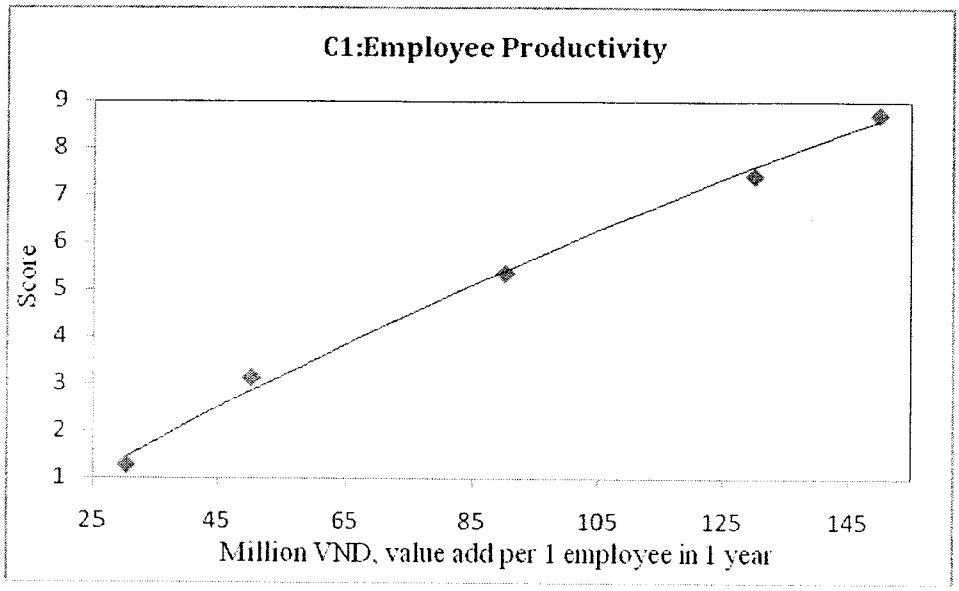

Figure F-1: Employee Productivity

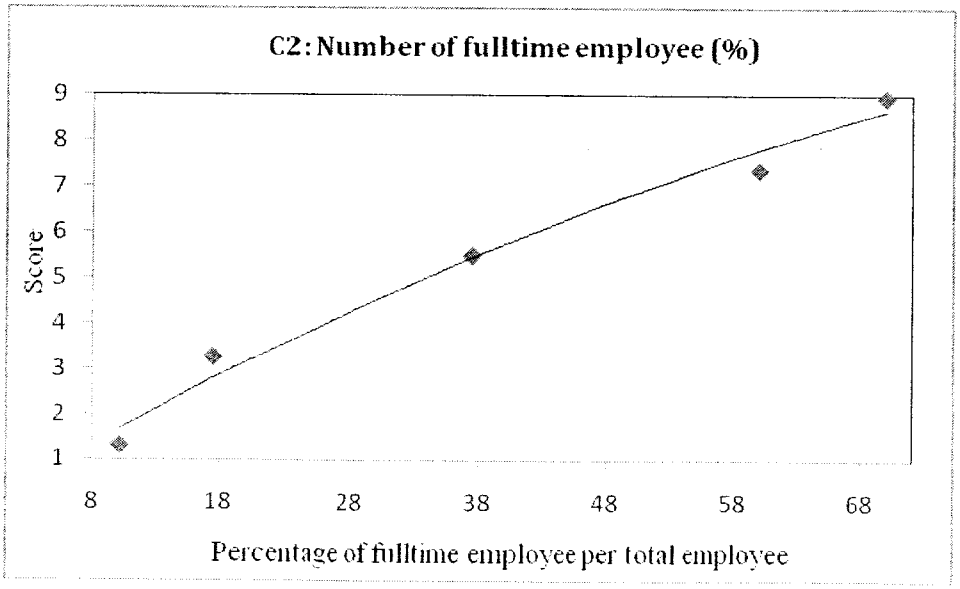

Figure F-2: Number of fulltime employee

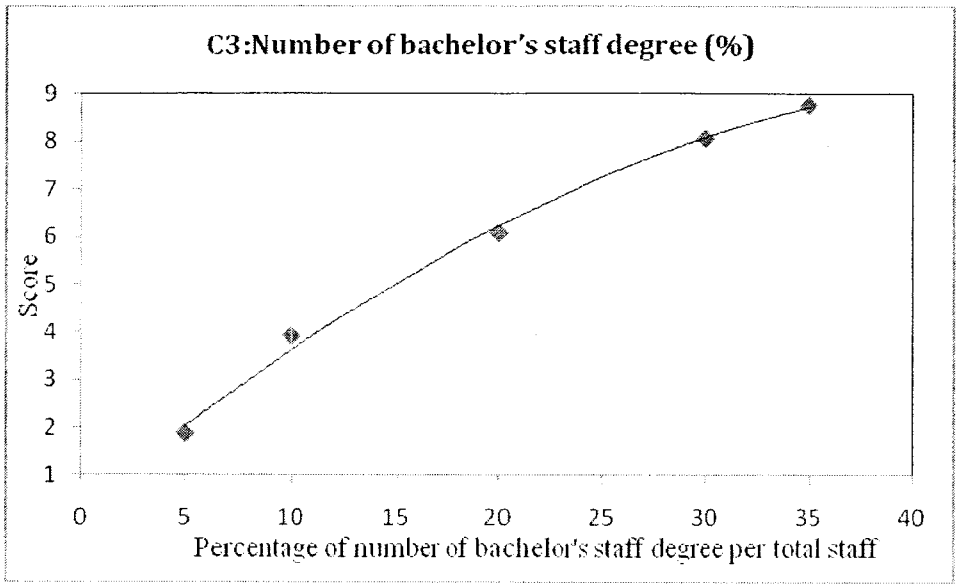

Figure F-3: Number of bachelor's staff degree

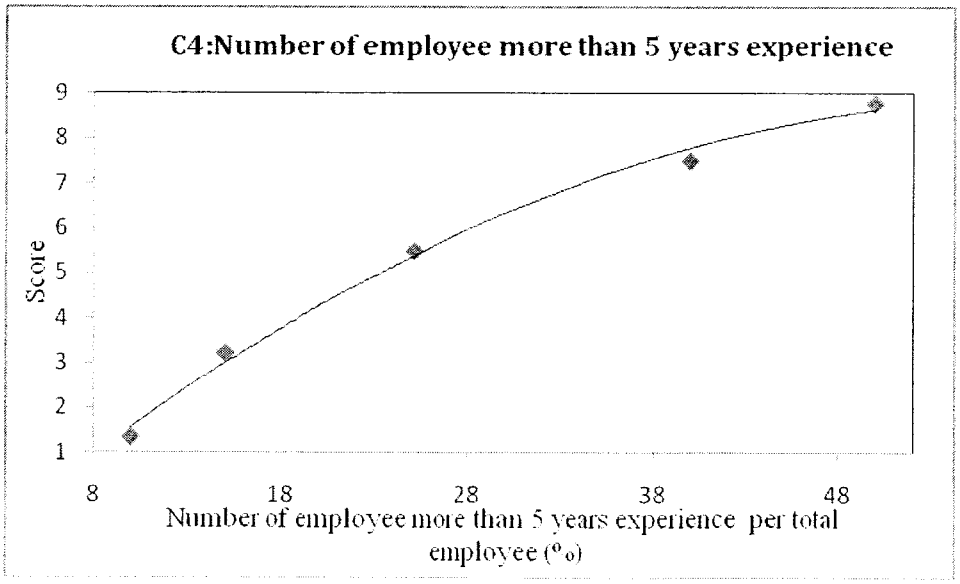

Figure F-4: Number of employee more than 5 years experience

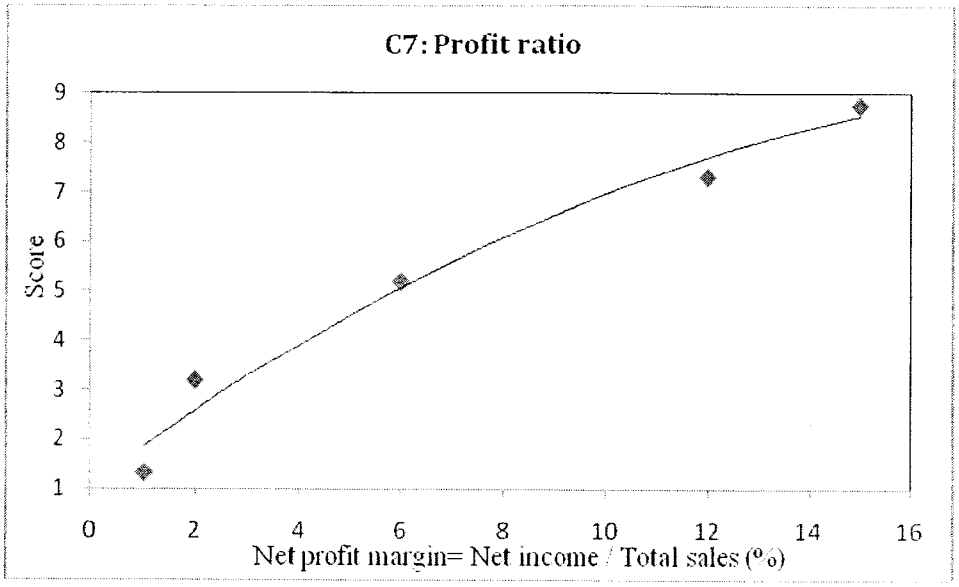

Figure F-5: Profit ratio

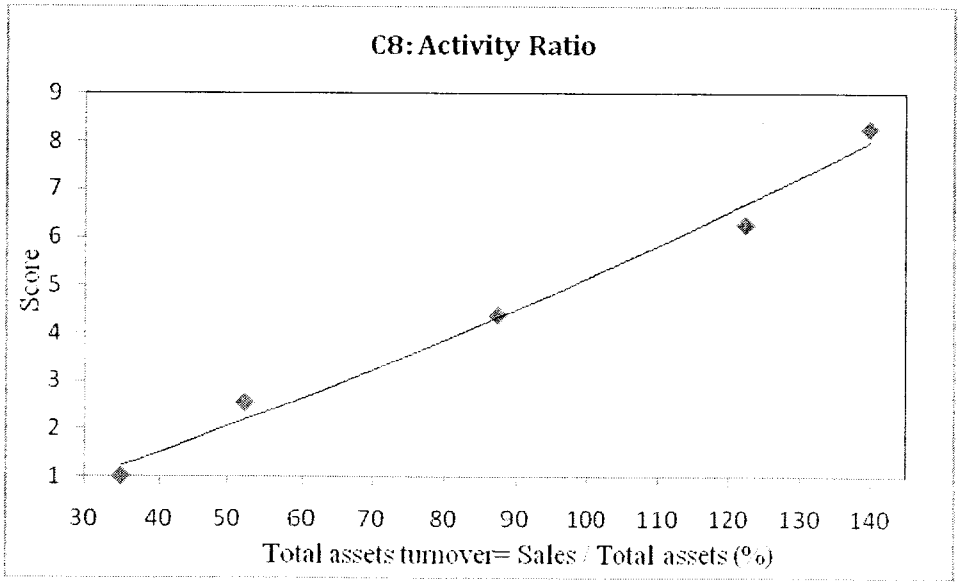

Figure F-6: Activity Ratio

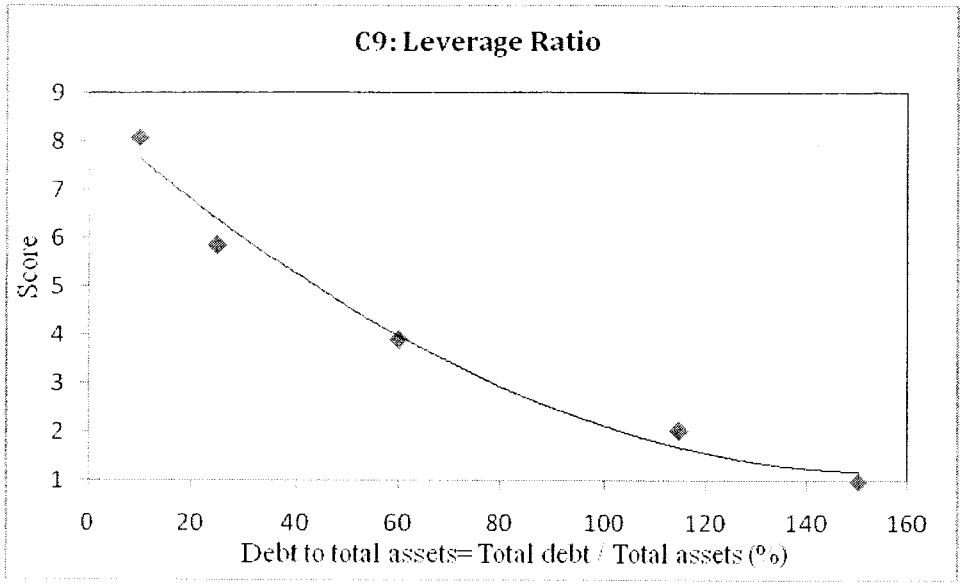

Figure F-7: Leverage Ratio

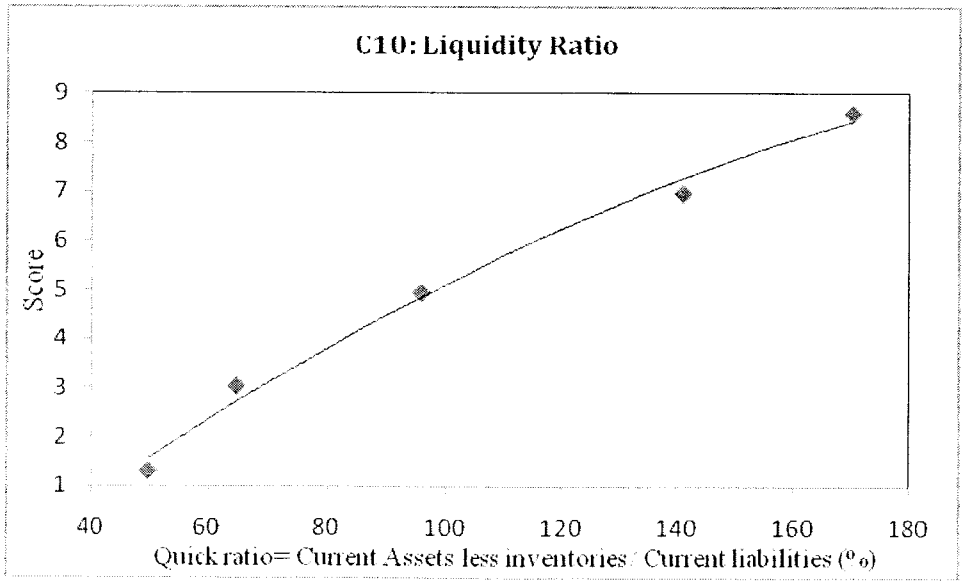

Figure F-8: Liquidity Ratio

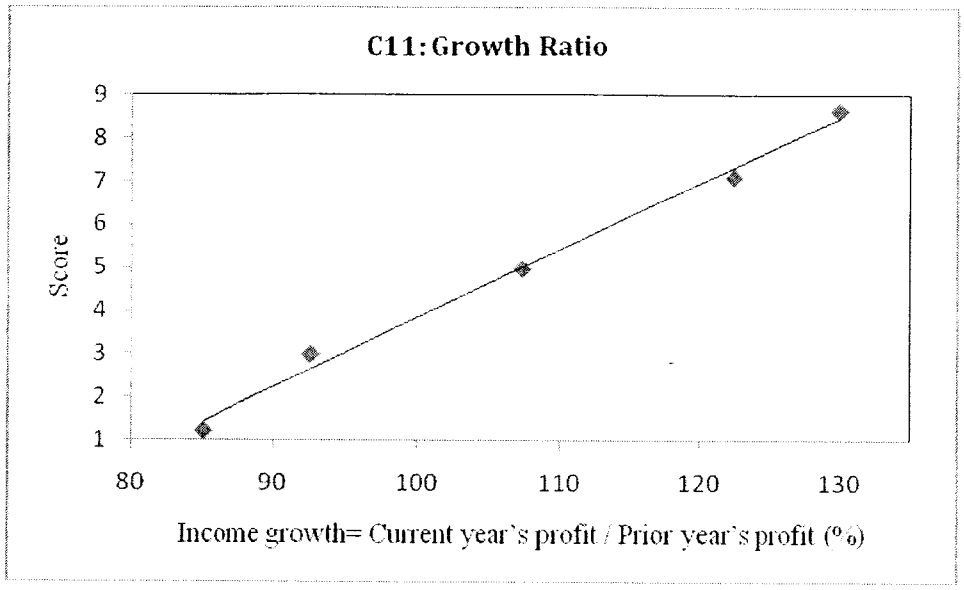

Figure F-9: Growth Ratio

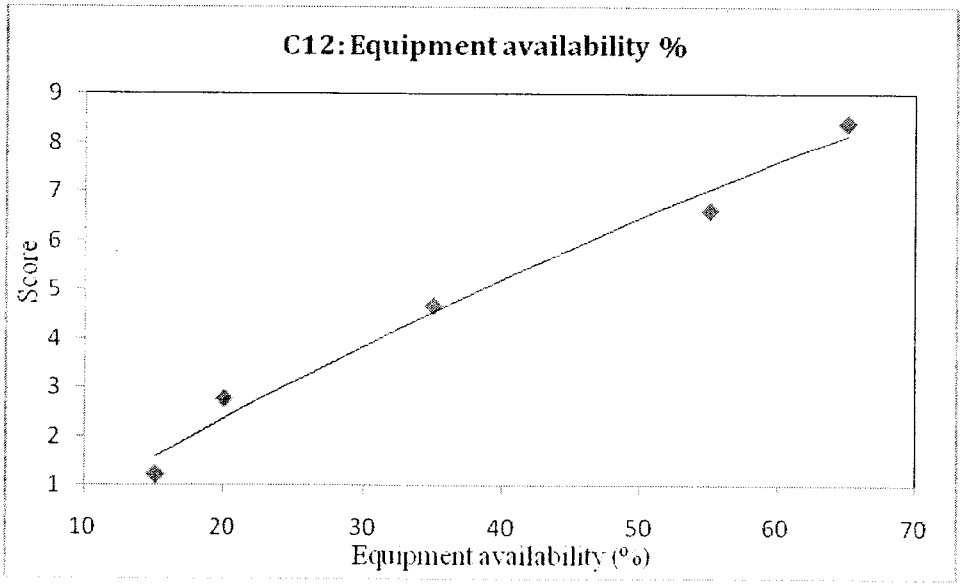

Figure F-10: Equipment availability

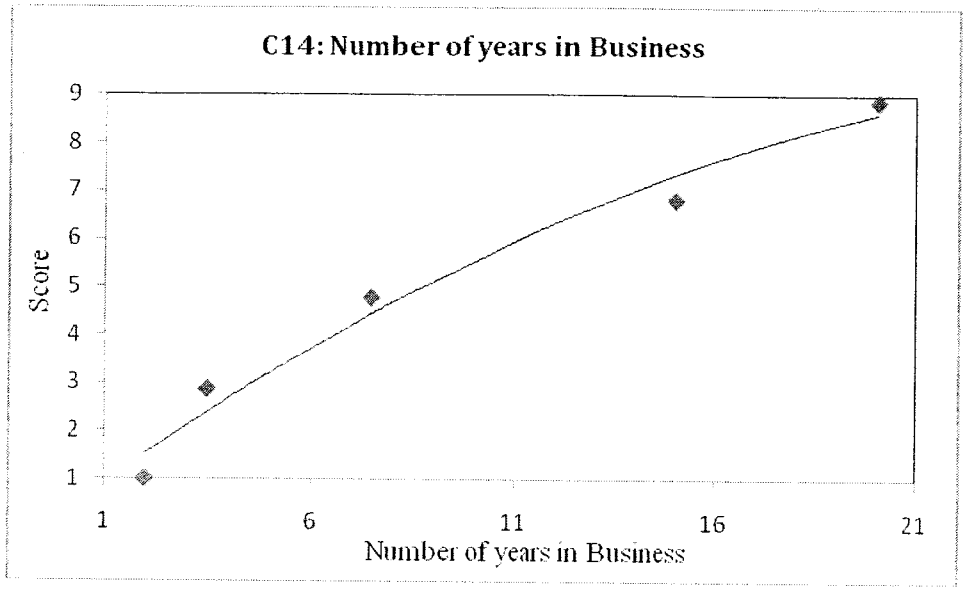

Figure F-11: Number of years in Business

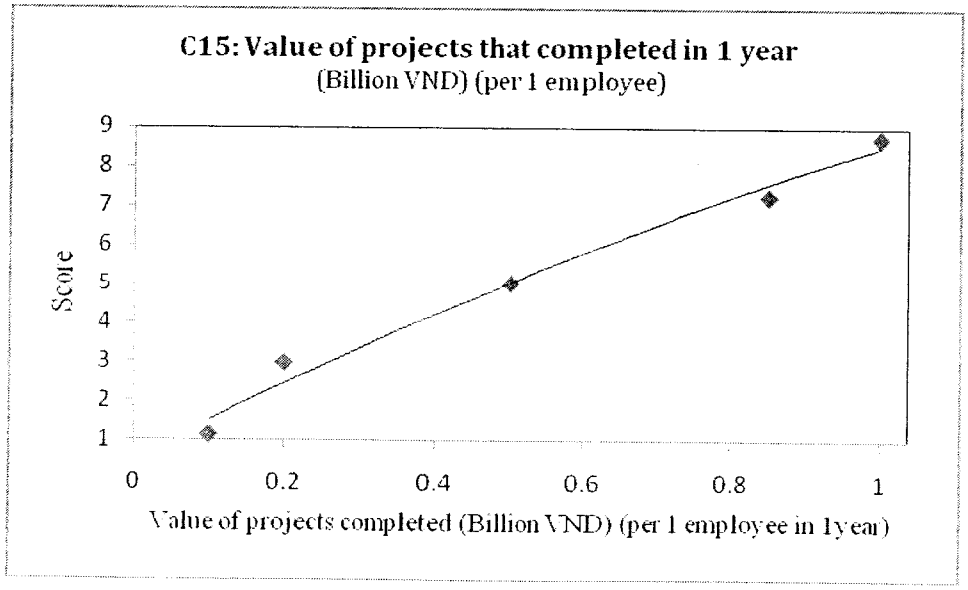

Figure F-12: Value of projects that completed in 1 year

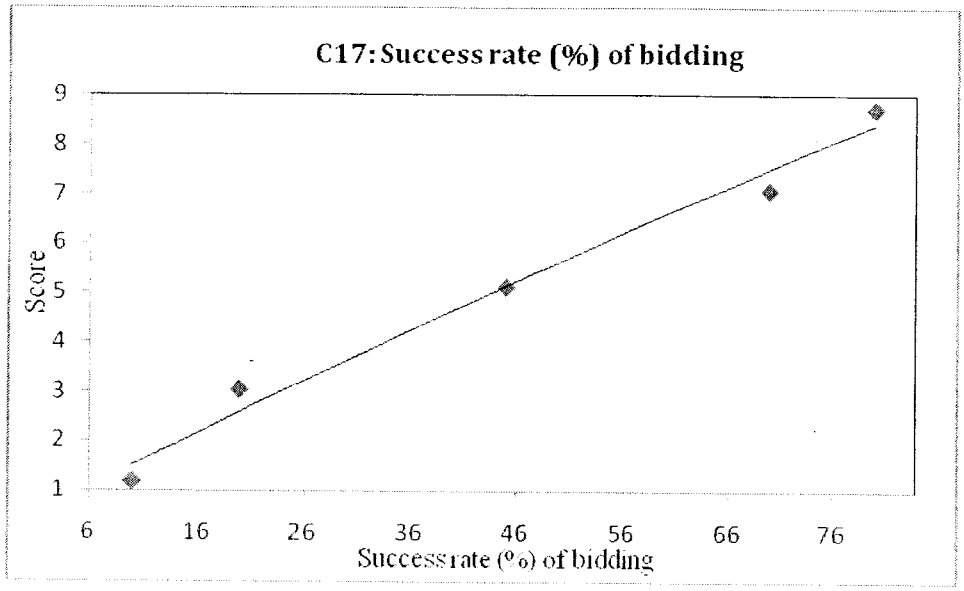

Figure F-13: Success rate (%) of bidding

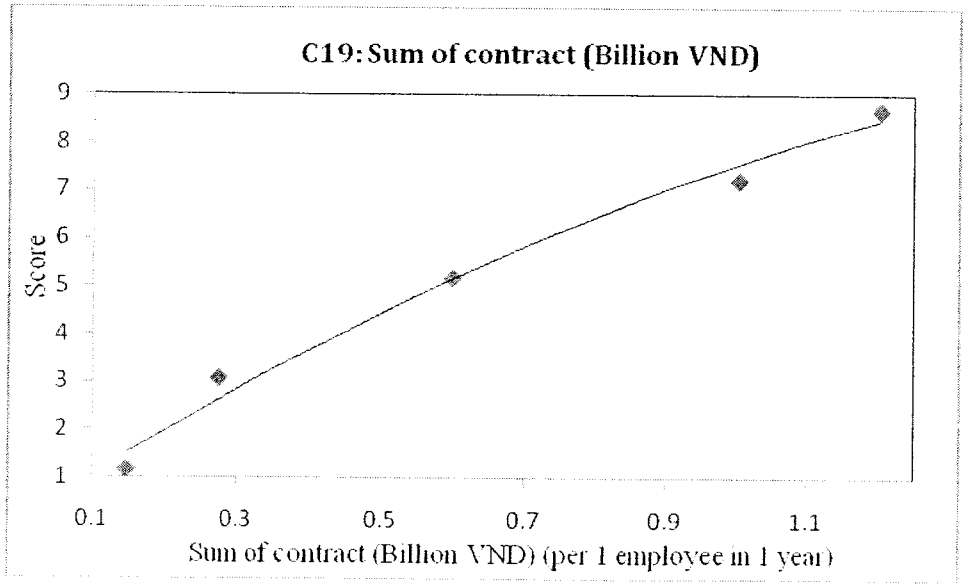

Figure F-14: Sum of contract (Billion VND)

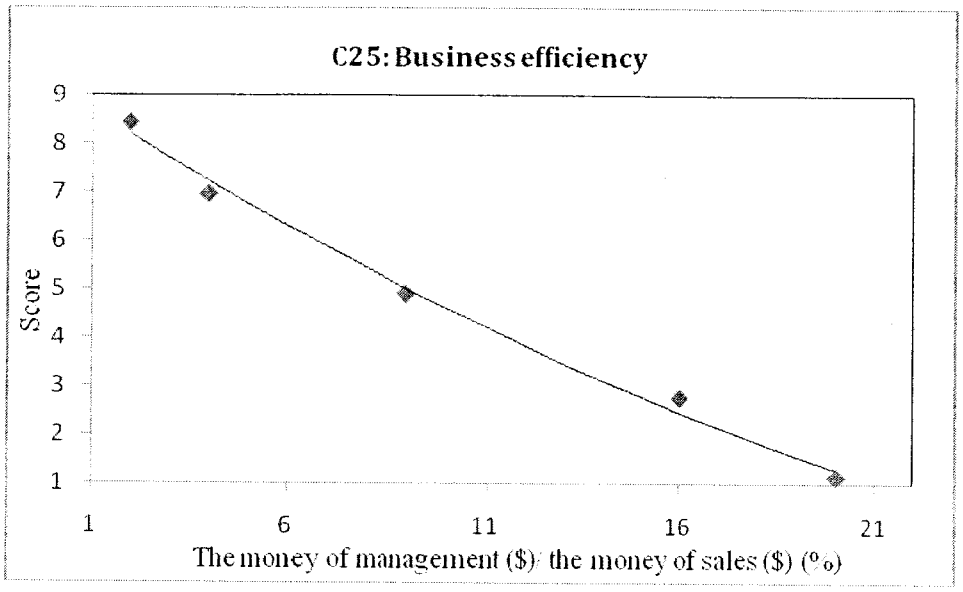

Figure F-15: Business efficiency

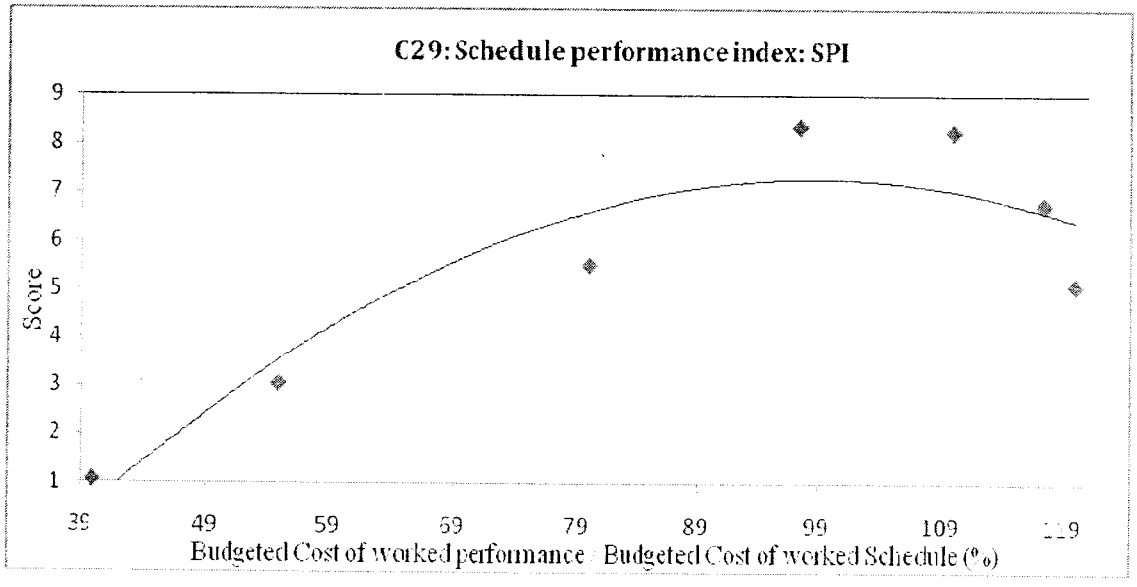

Figure F-16: Schedule performance index SPI

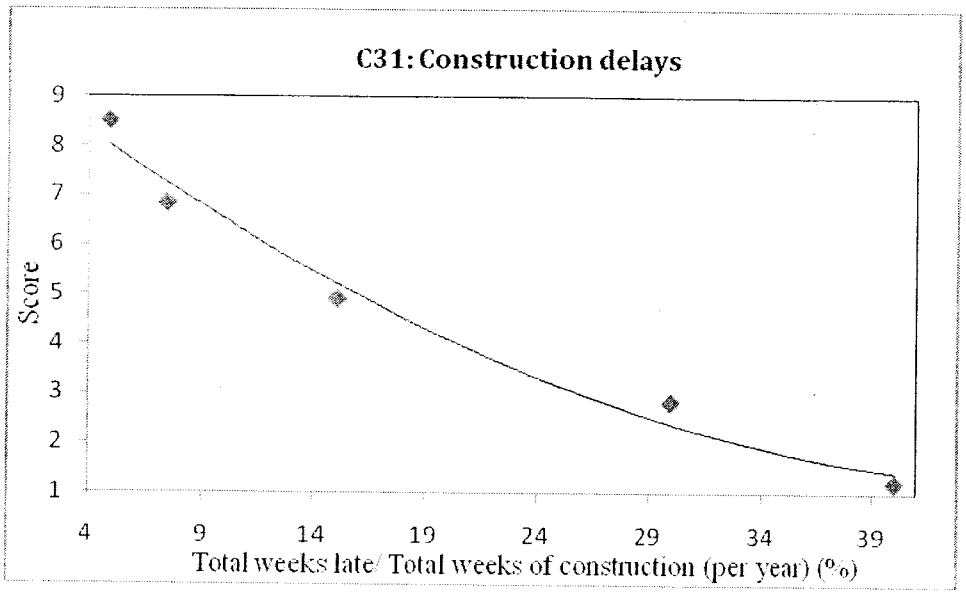

Figure F-17: Construction delays

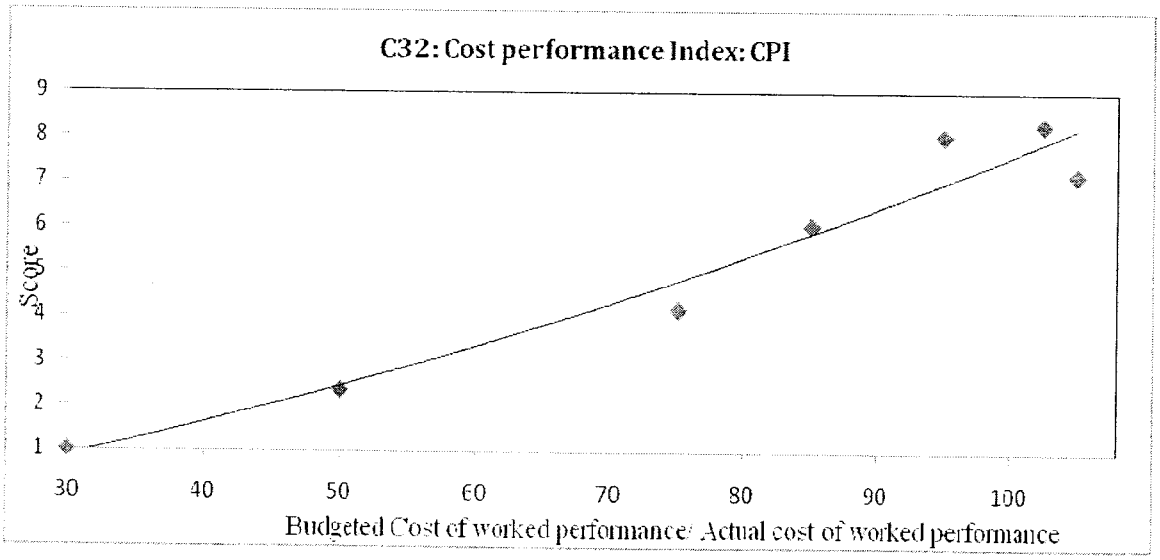

Figure F-18: Cost performance Index CPI

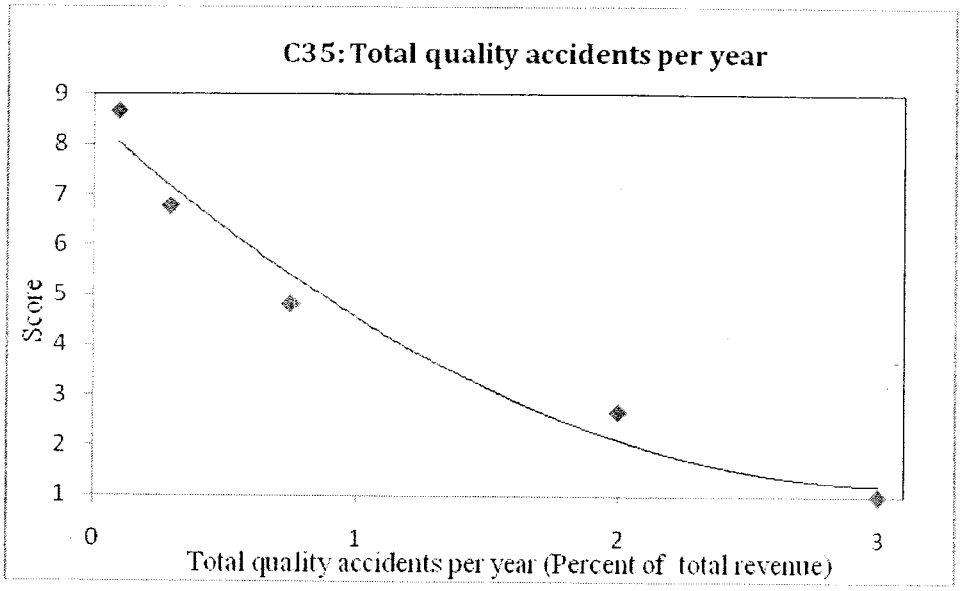

Figure F-19: Total quality accidents per year

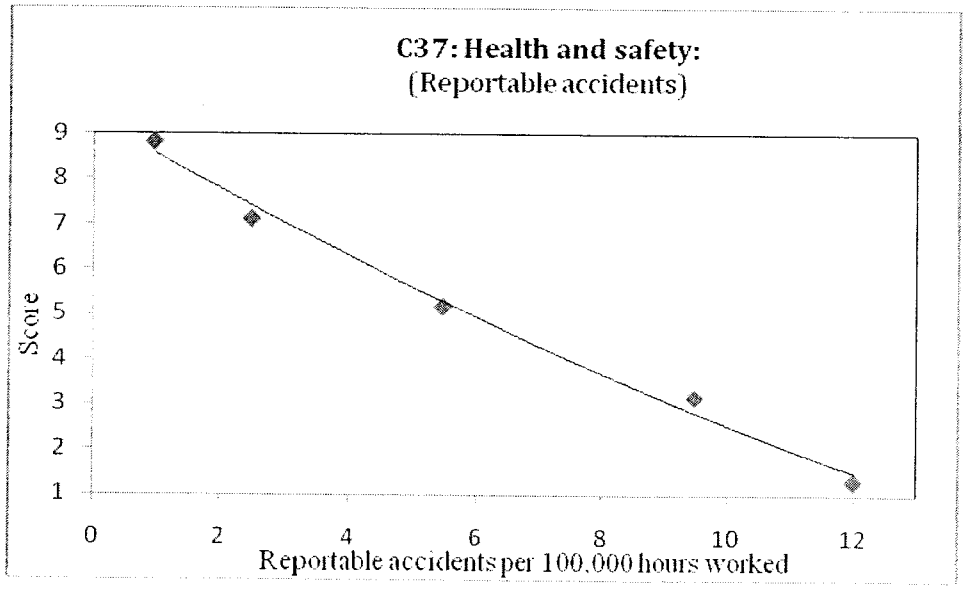

Figure F-20: Health and safety (Reportable accidents)

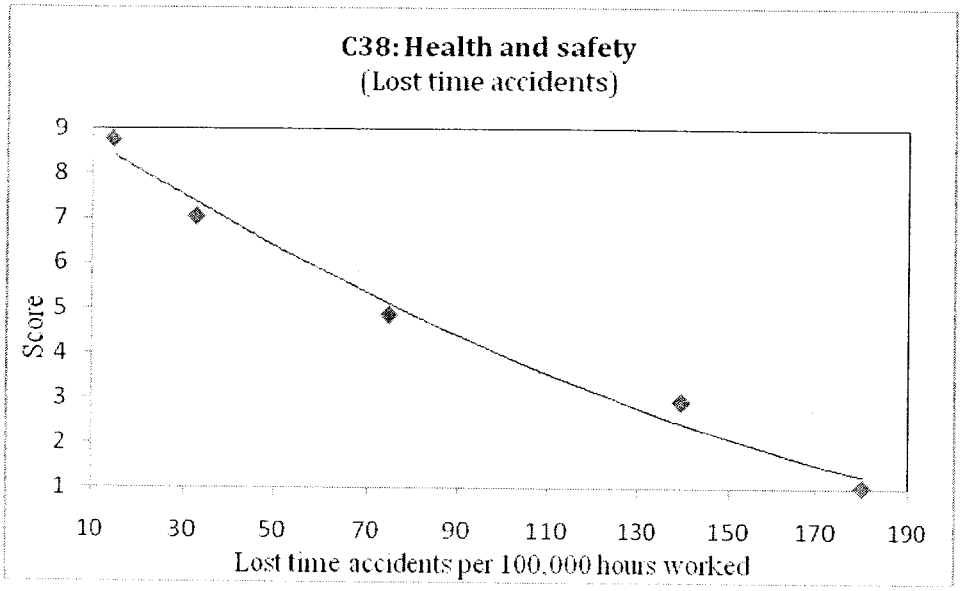

Figure F-21: Health and safety (Lost time accidents)

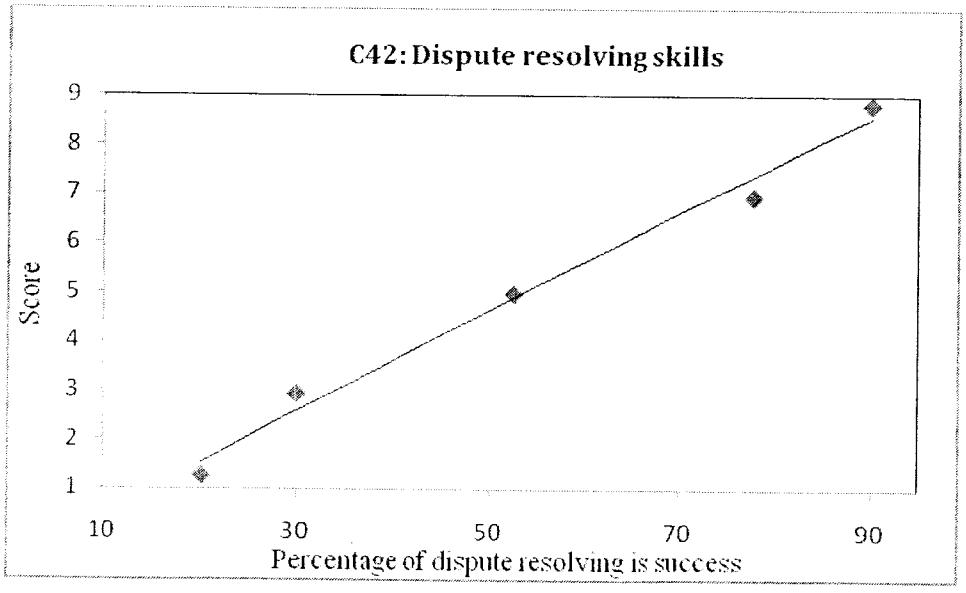

Figure F-22: Dispute resolving skills

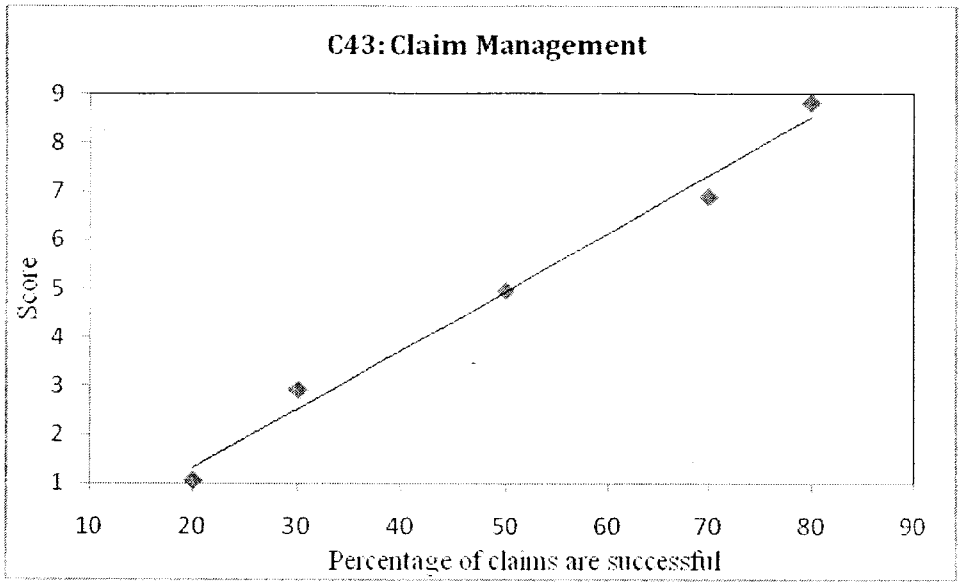

Figure F-23: Claim Management

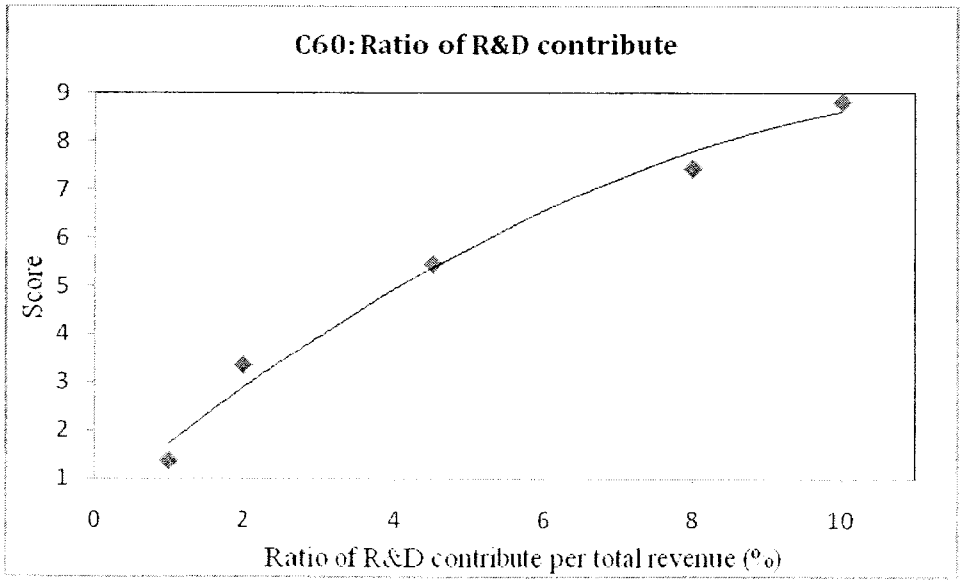

Figure F-24: Ratio of R&D contribute

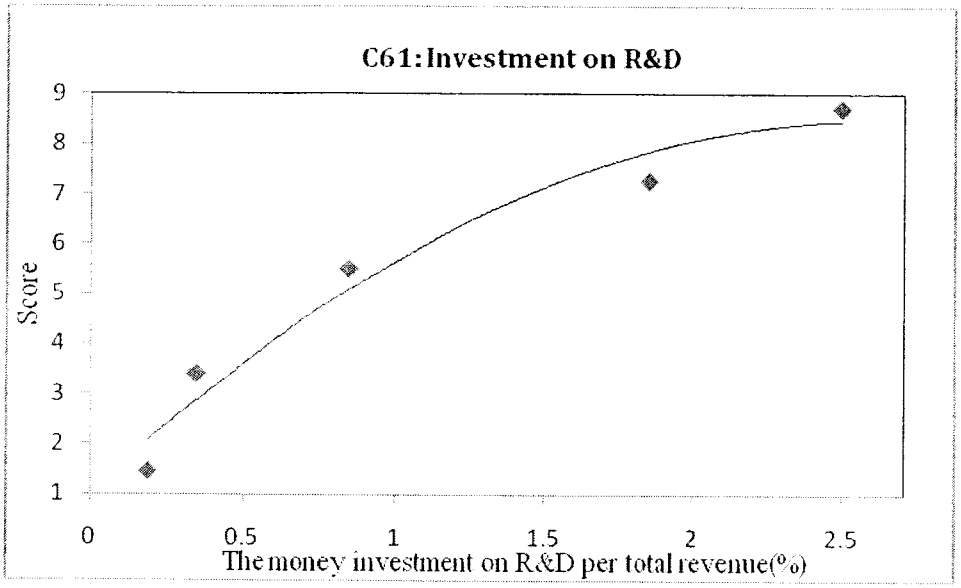

Figure F-25: Investment on R&D

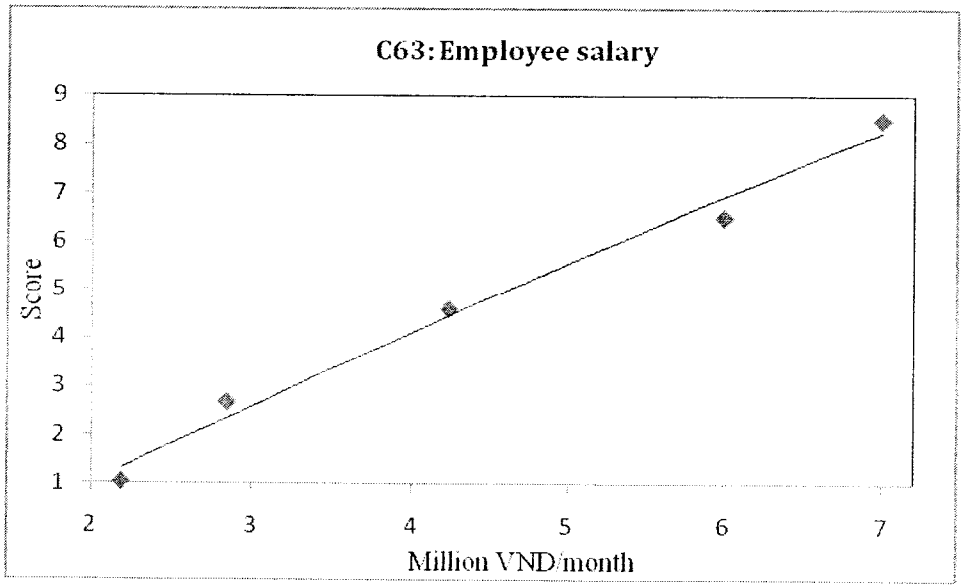

Figure F-26: Employee salary

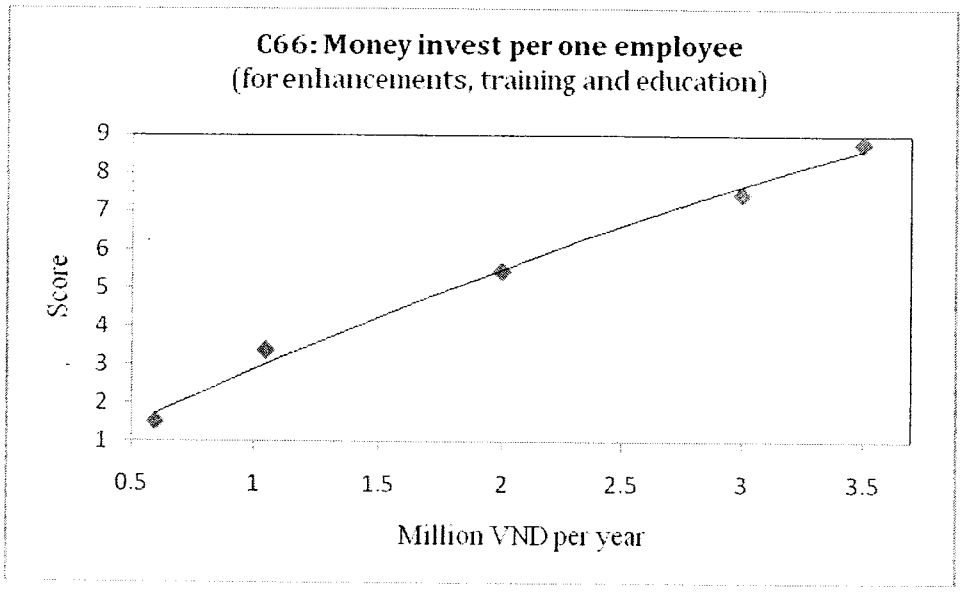

Figure F-27: Money invest per one employee (for enhancements, training and education)

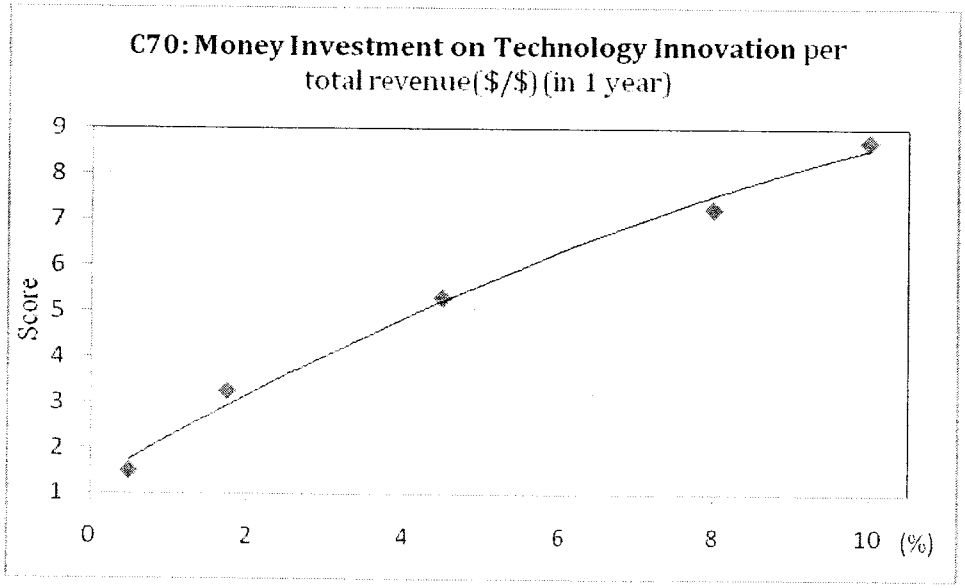

Figure F-28: Money Investment on Technology Innovation per total revenue ($/$) (in 1 year)

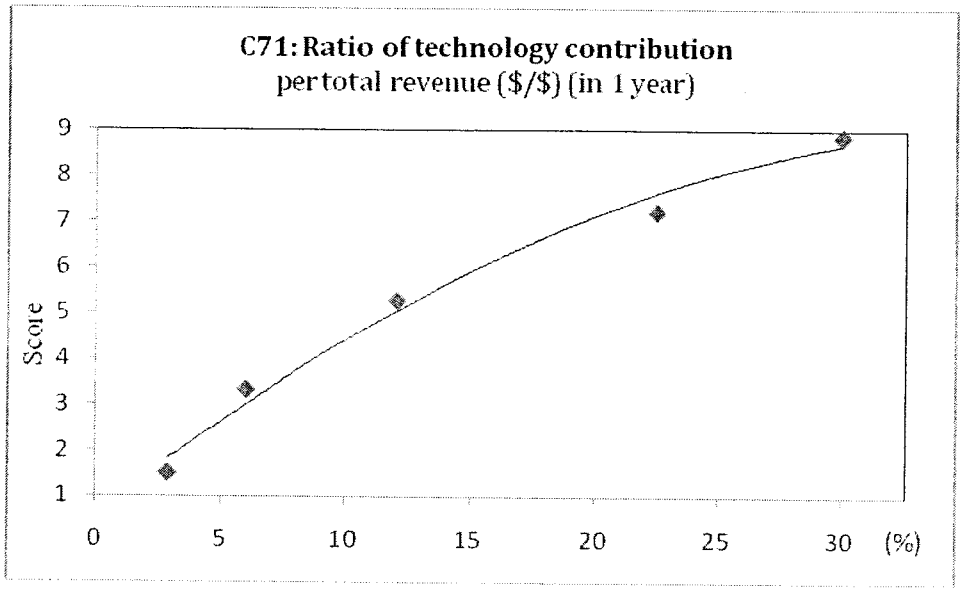

Figure F-29: Ratio of technology contribution per total revenue ($/$) (in 1 year)

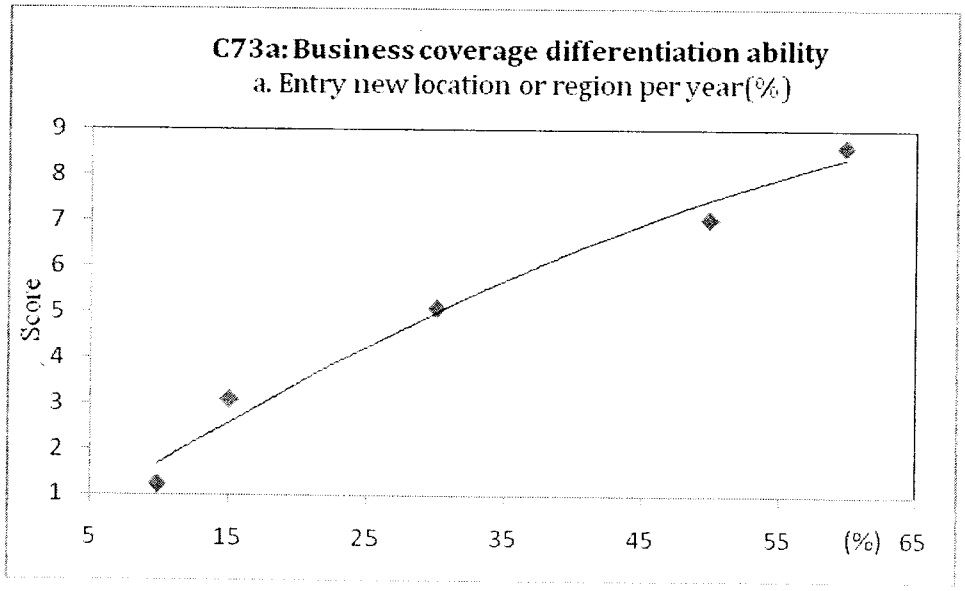

Figure F-30: Business coverage differentiation ability (Entry new location or region)

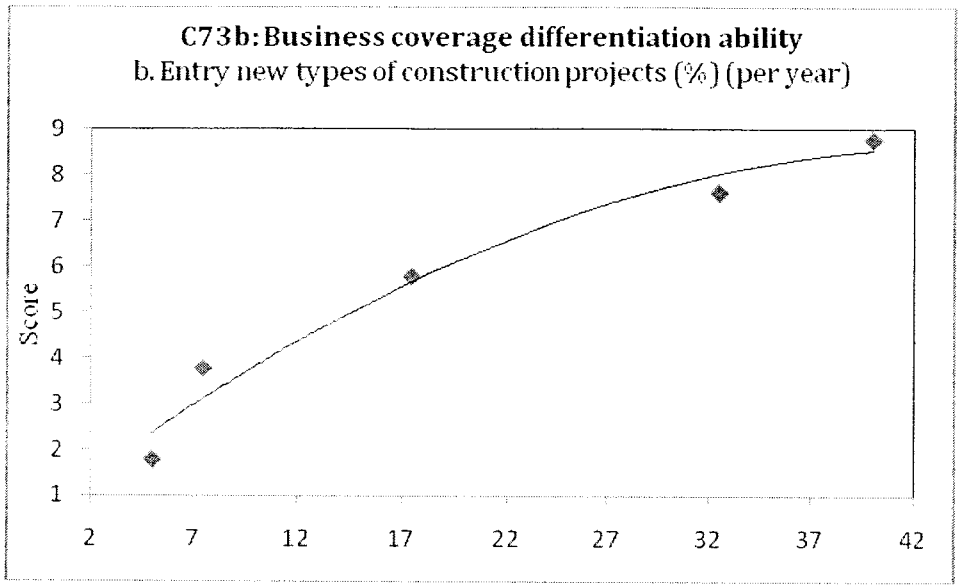

Figure F-31: Business coverage differentiation ability (Entry new types of projects)

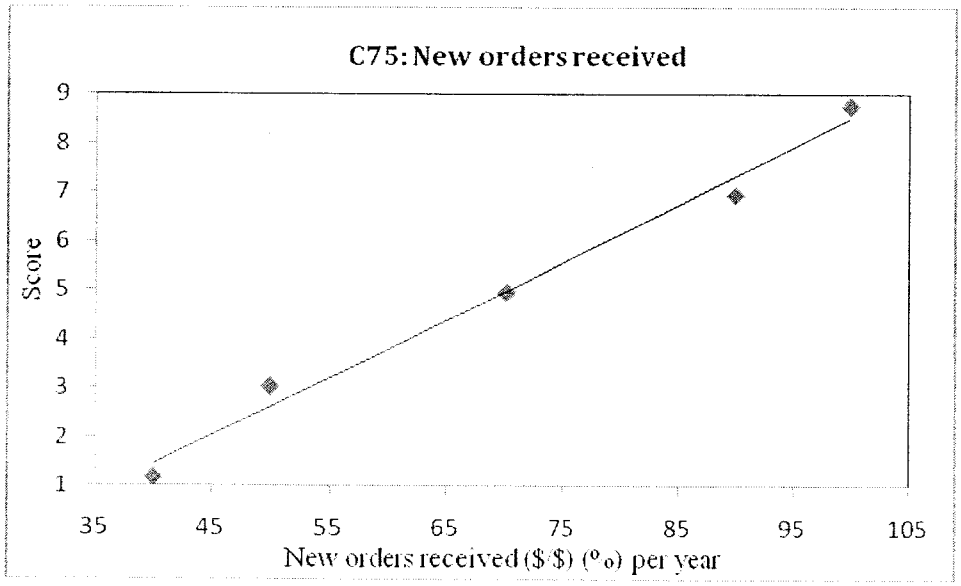

Figure F-32: New orders received

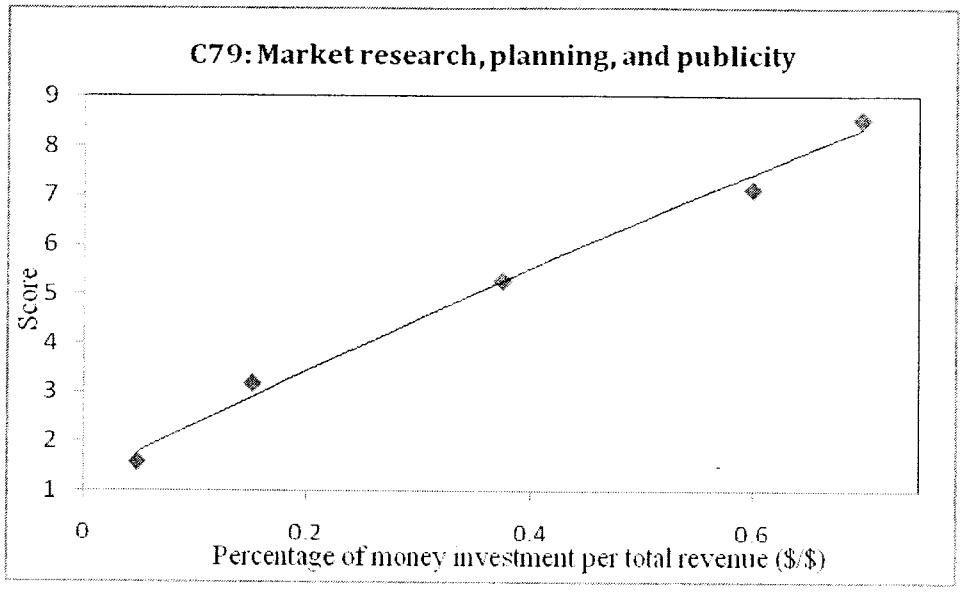

Figure F-33: Market research, planning, and publicity

B. Attribute Utility Functions for Canada's Construction Company:

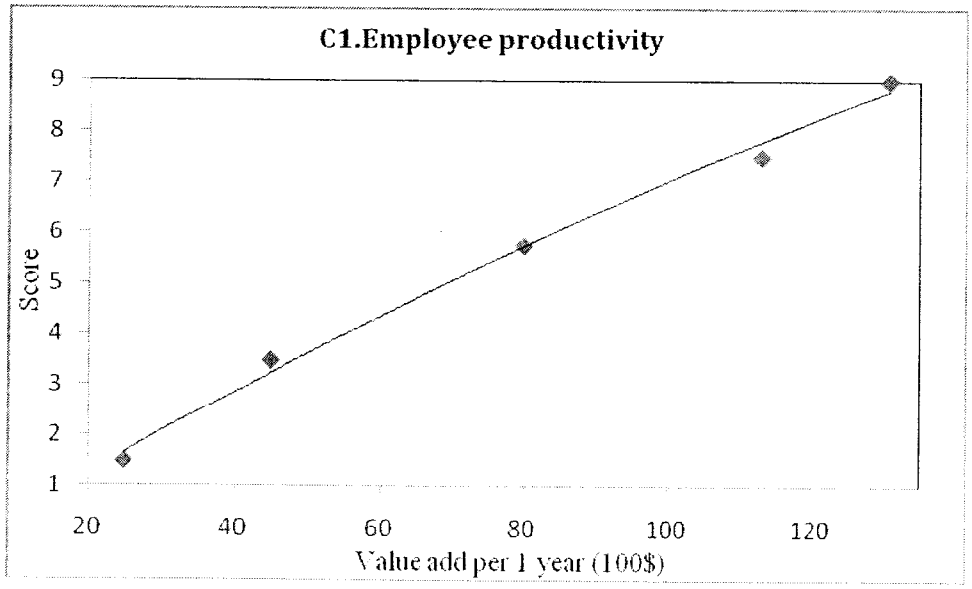

Figure F-34: Employee Productivity

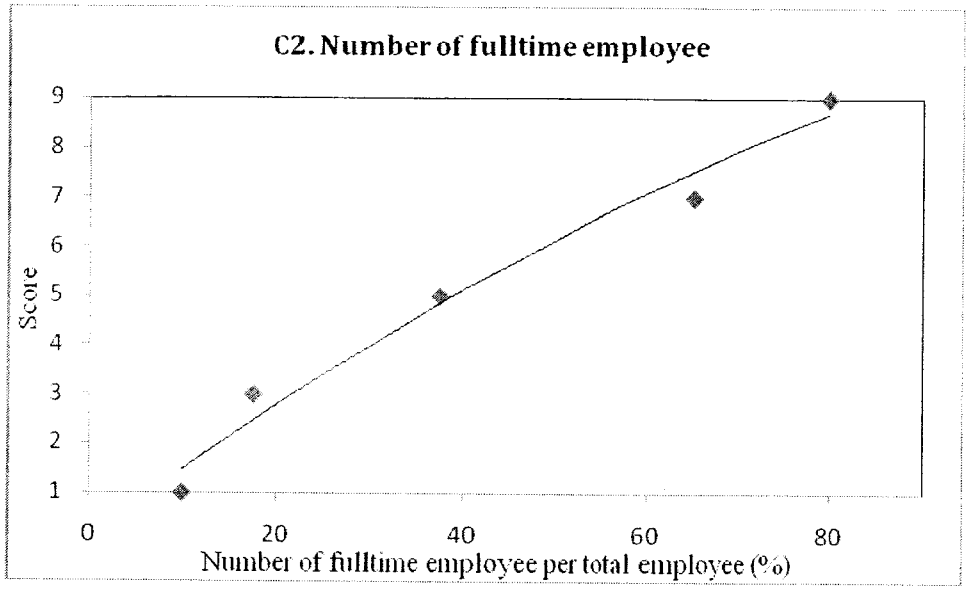

Figure F-35: Number of fulltime employee

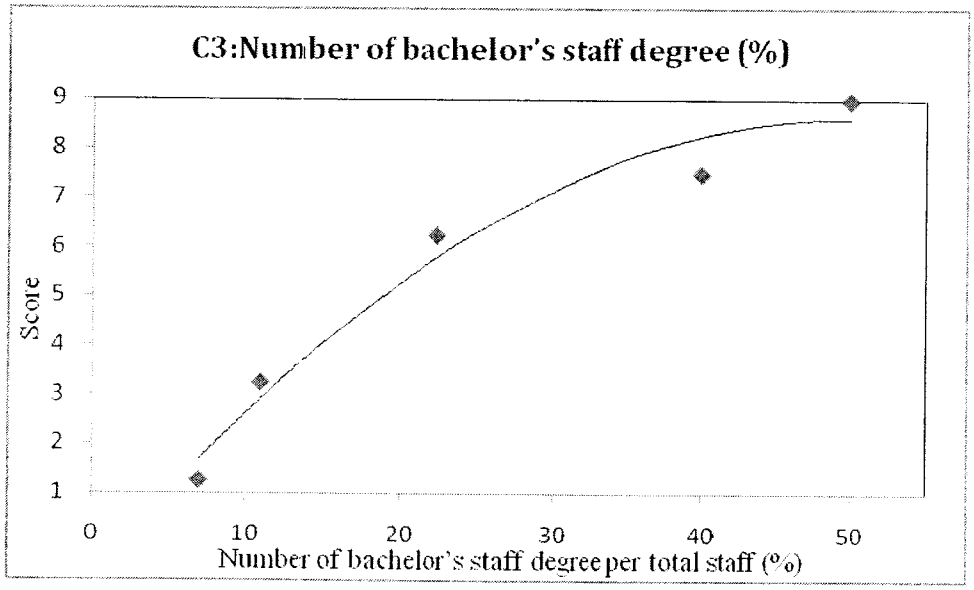

Figure F-36: Number of bachelor's staff degree

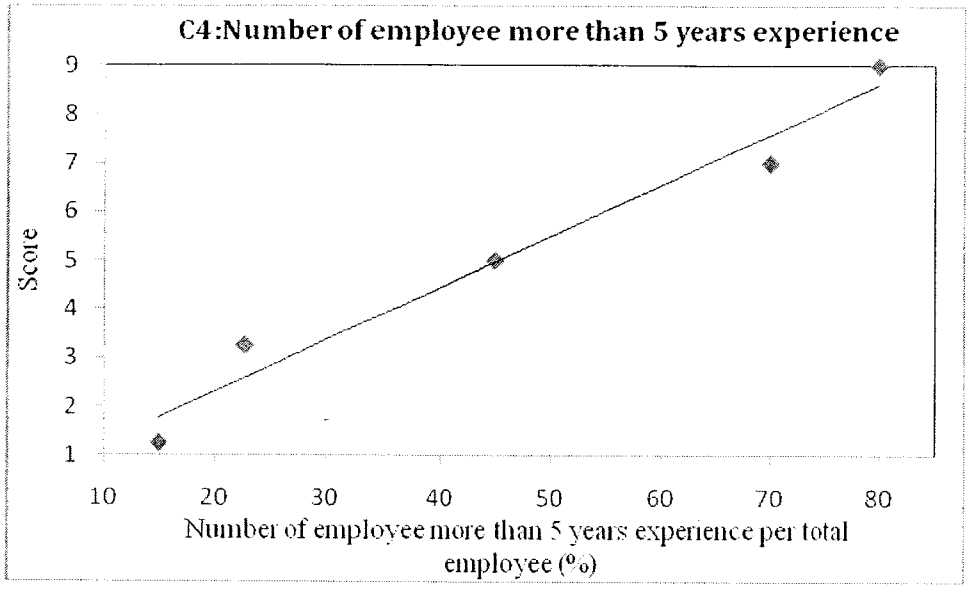

Figure F-37: Number of employee more than 5 years experience

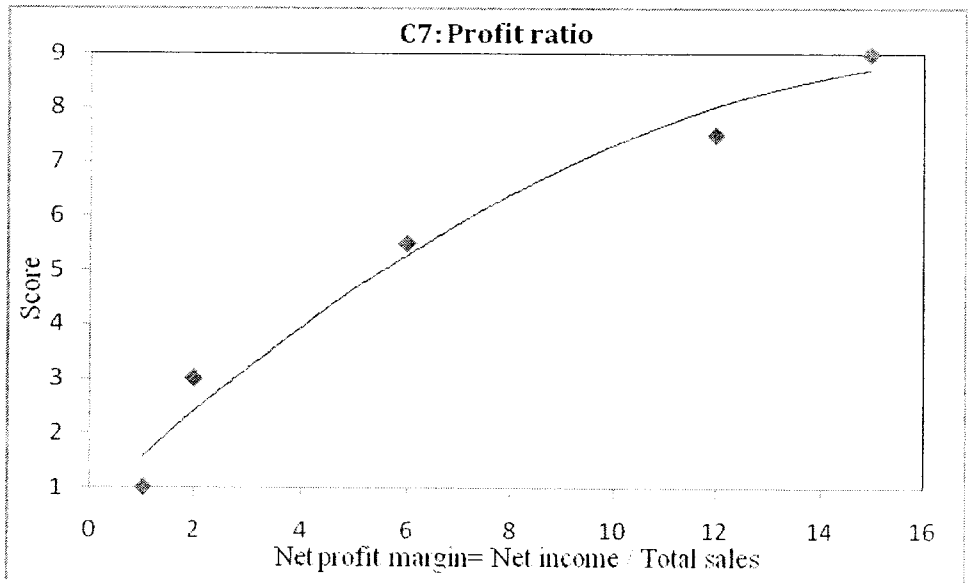

Figure F-38: Profit ratio

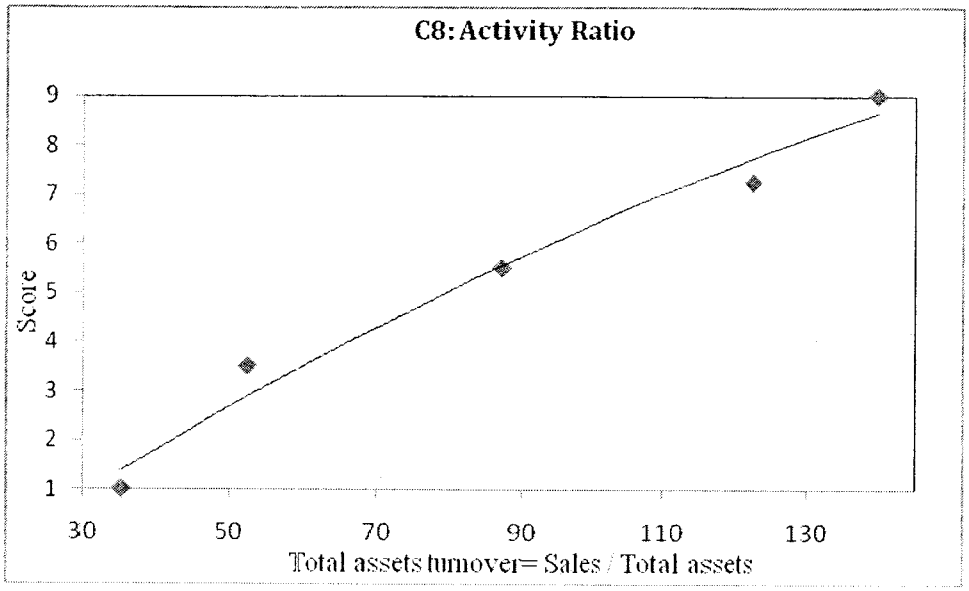

Figure F-39: Activity Ratio

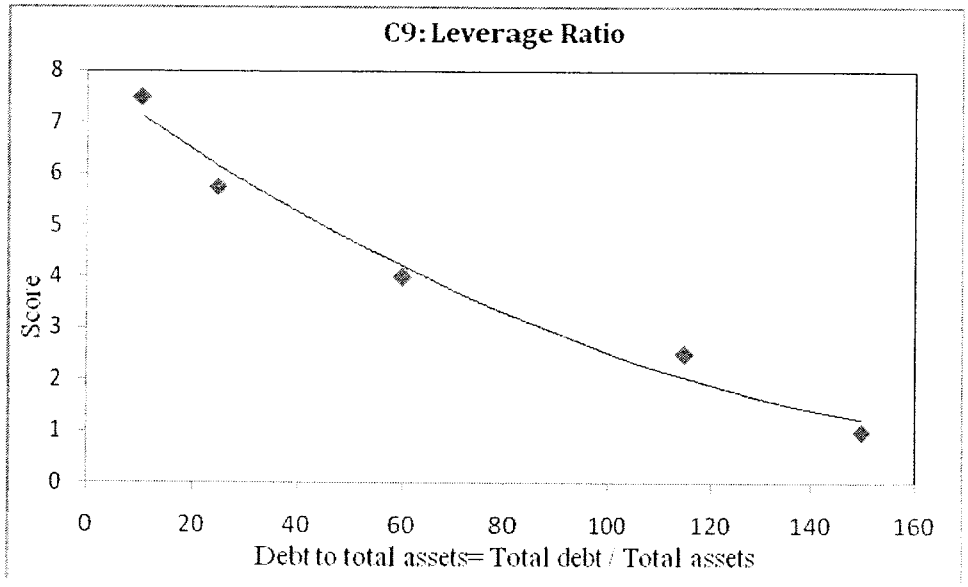

Figure F-40: Leverage Ratio

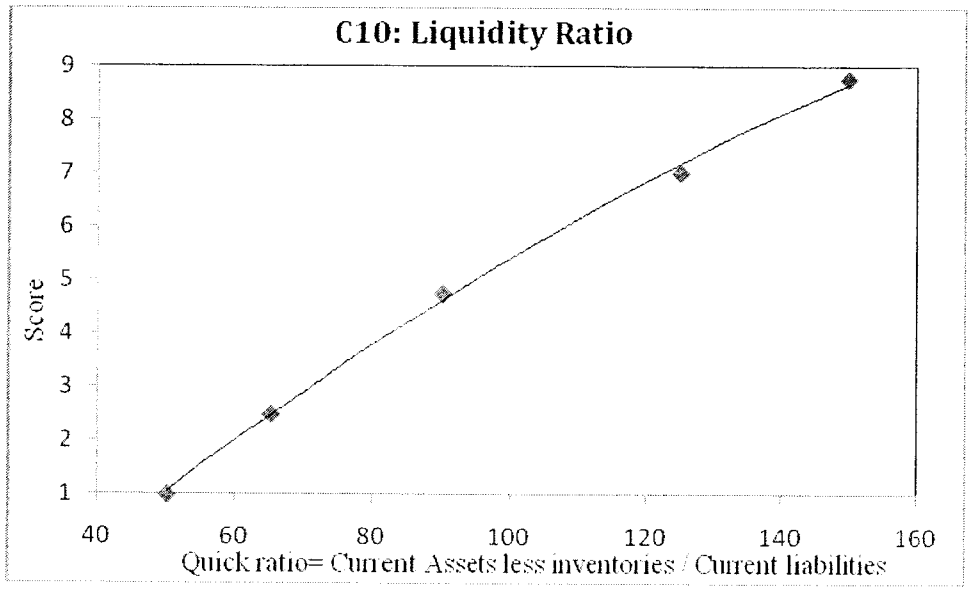

Figure F-41: Liquidity Ratio

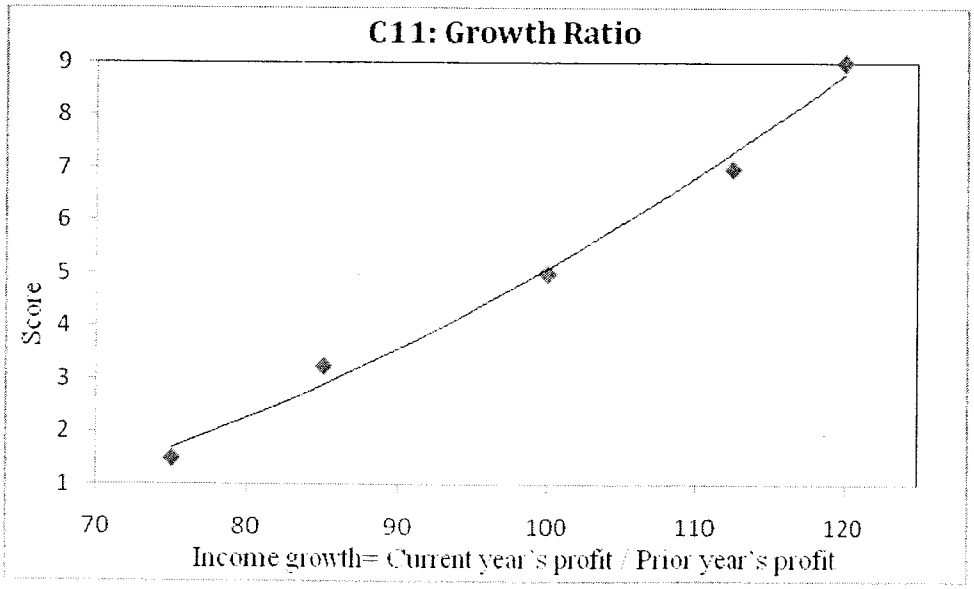

Figure F-42: Growth Ratio

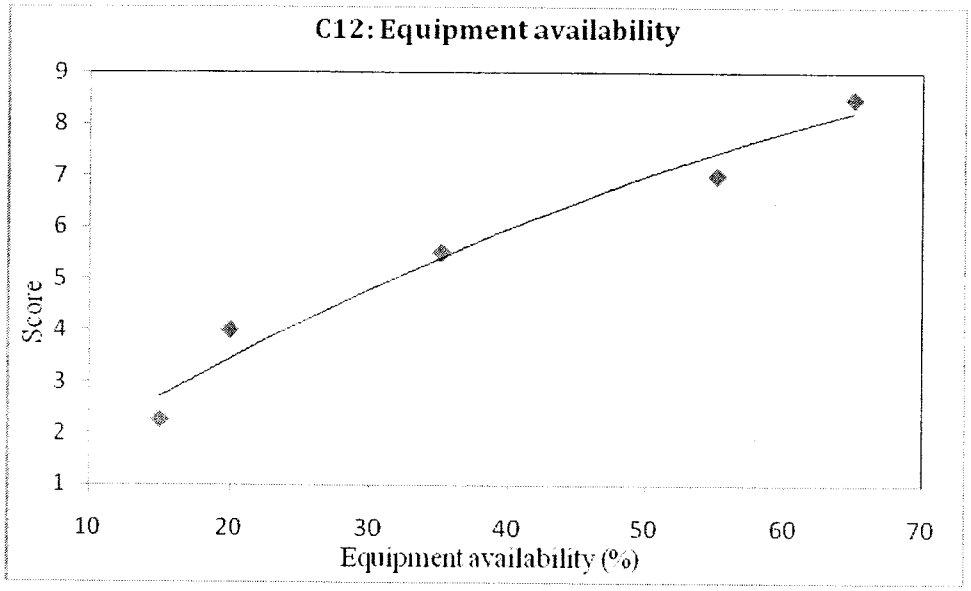

Figure F-43: Equipment availability

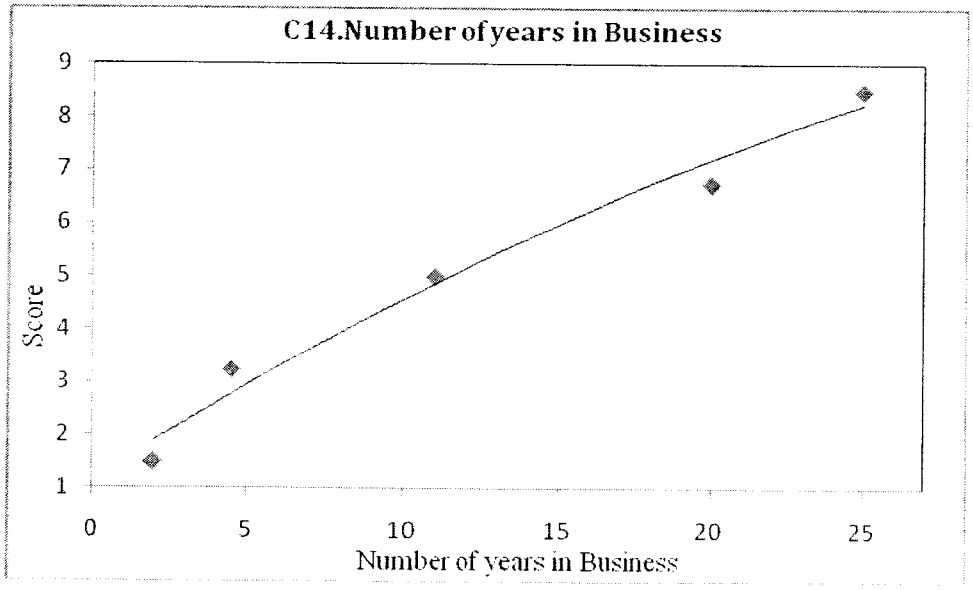

Figure F-44: Number of years in Business

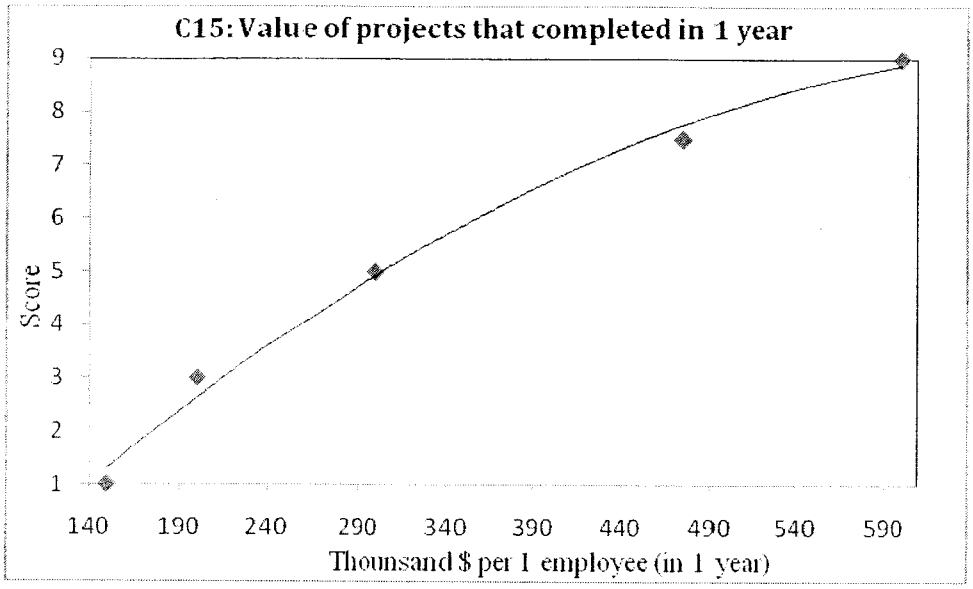

Figure F-45: Value of projects that completed in 1 year

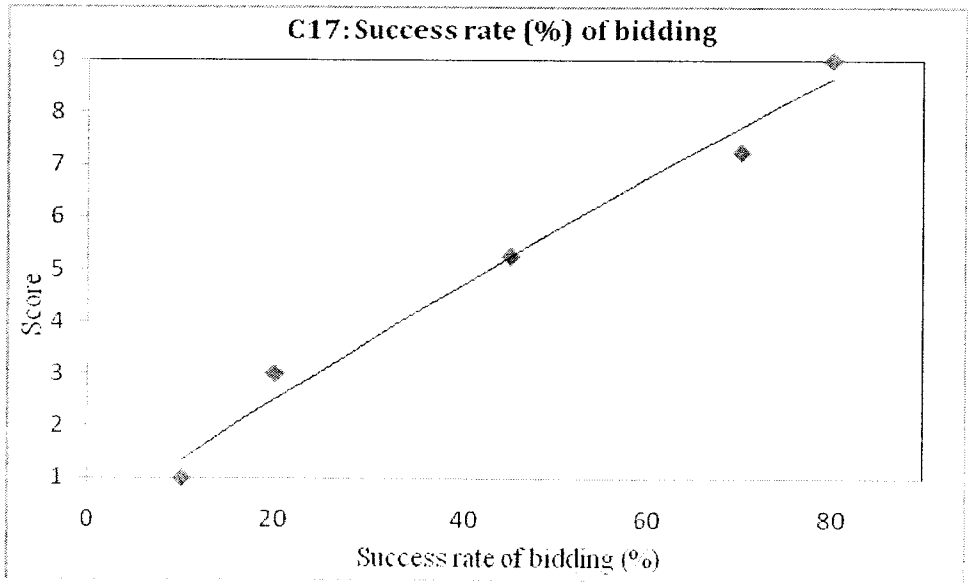

Figure F-46: Success rate (%) of bidding

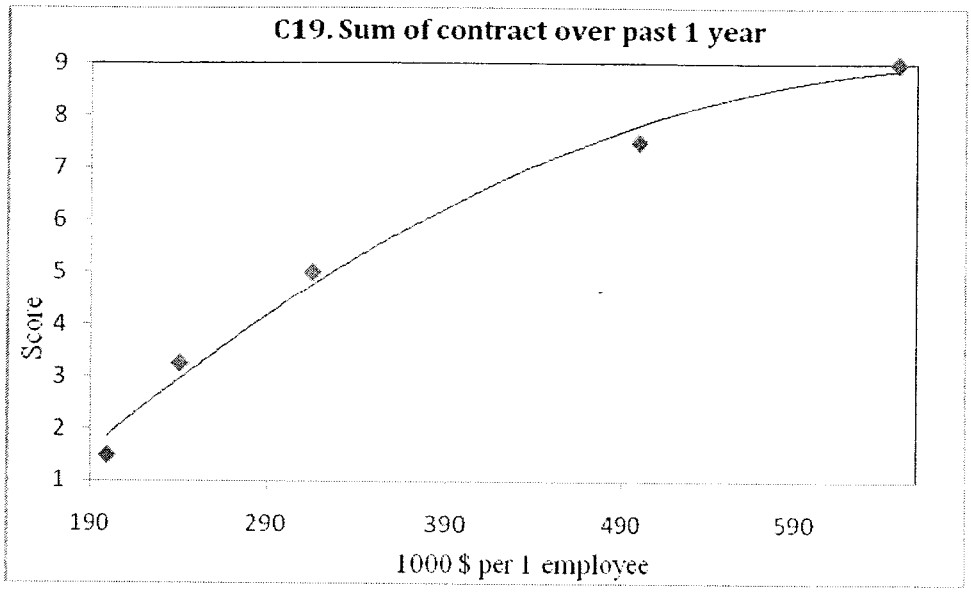

Figure F-47: Sum of contract (Billion VND)

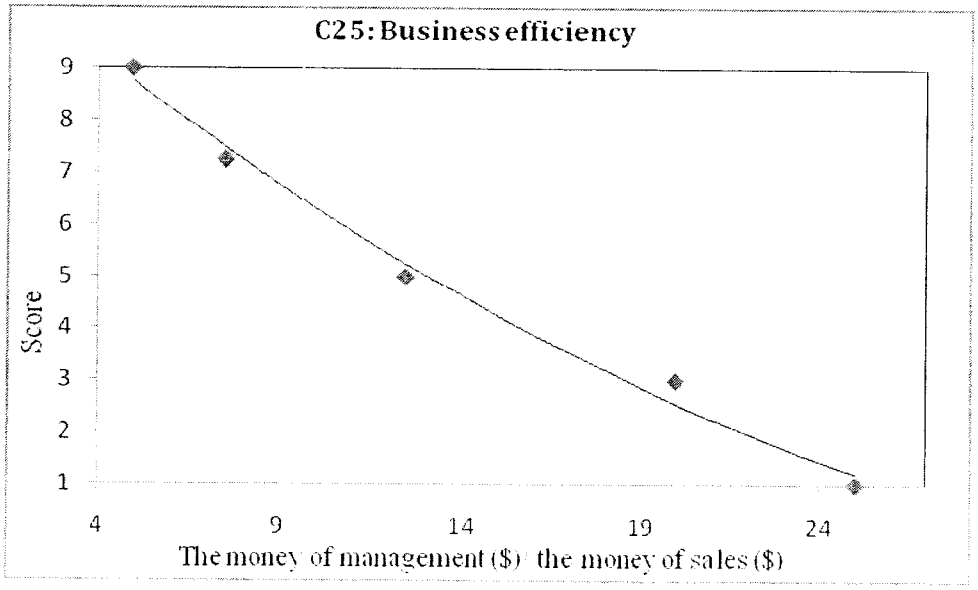

Figure F-48: Business efficiency

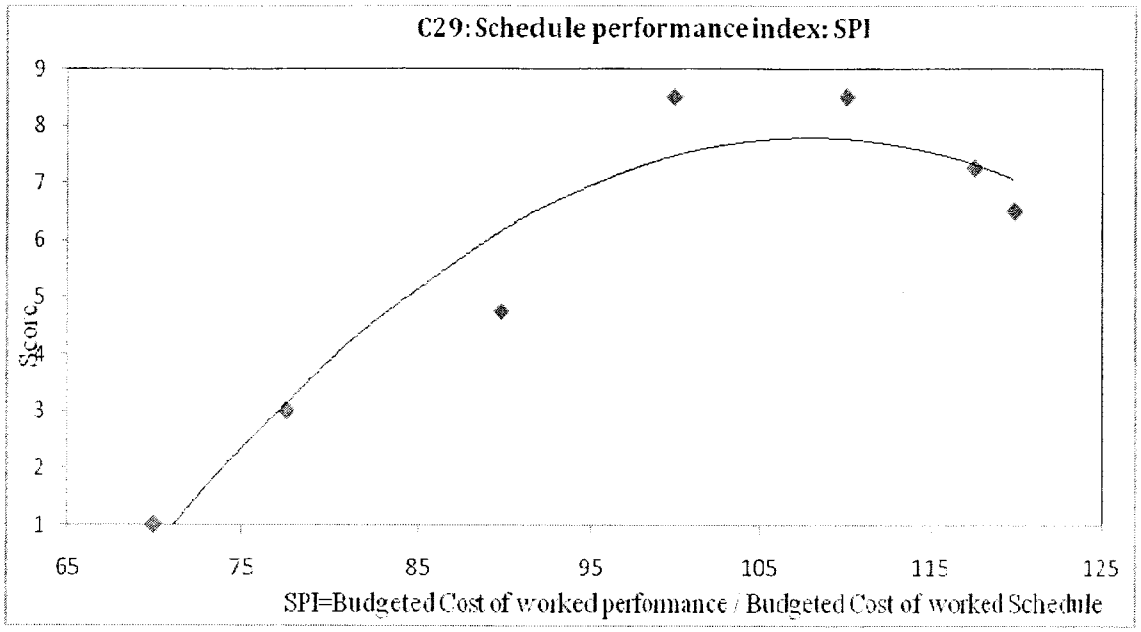

Figure F-49: Schedule performance index SPI

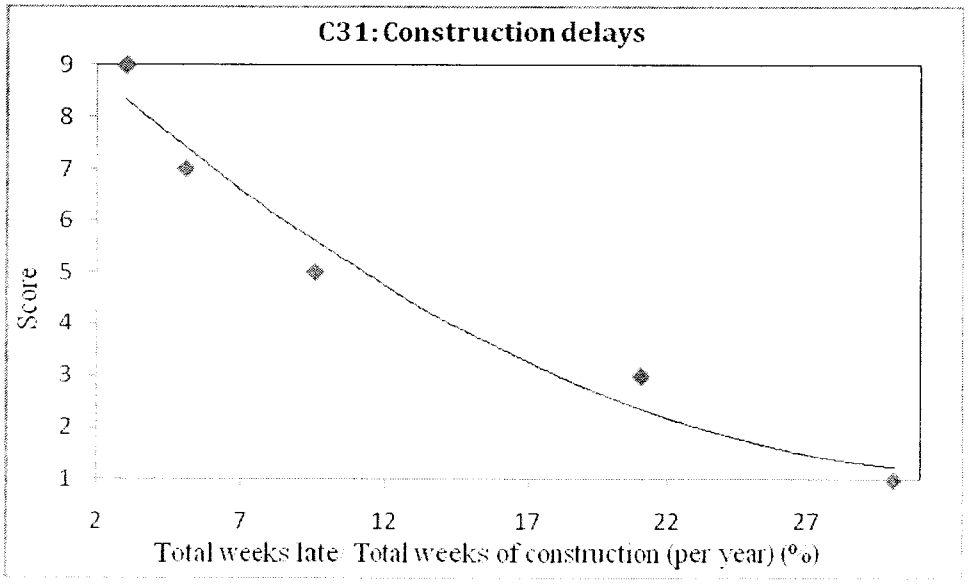

Figure F-50: Construction delays

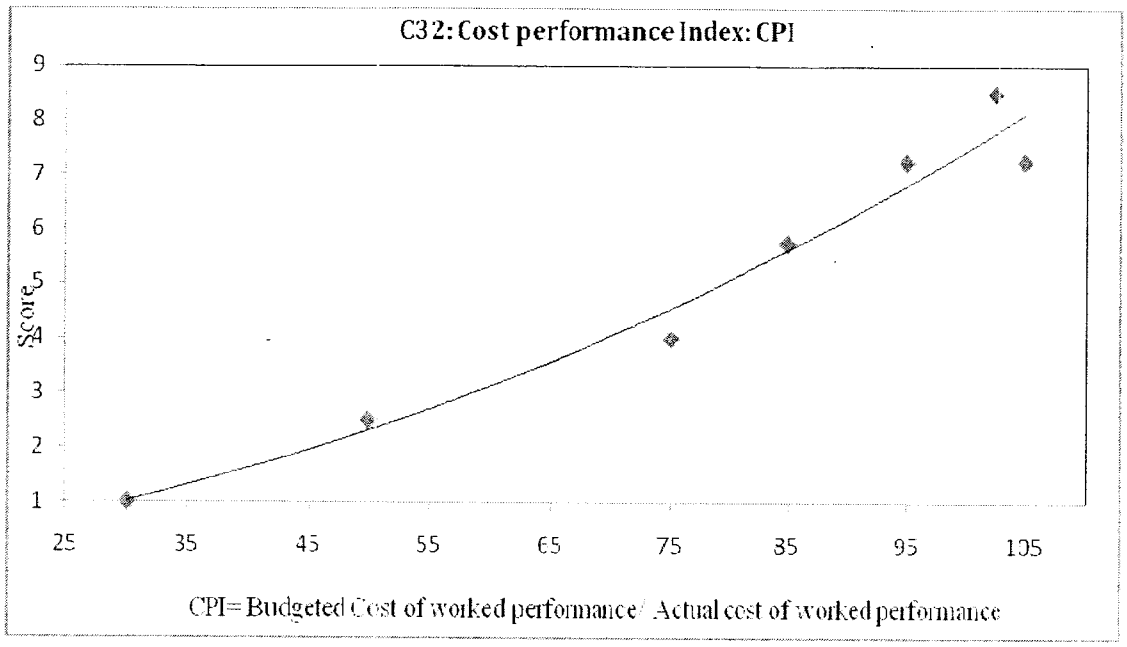

Figure F-51: Cost performance Index CPI

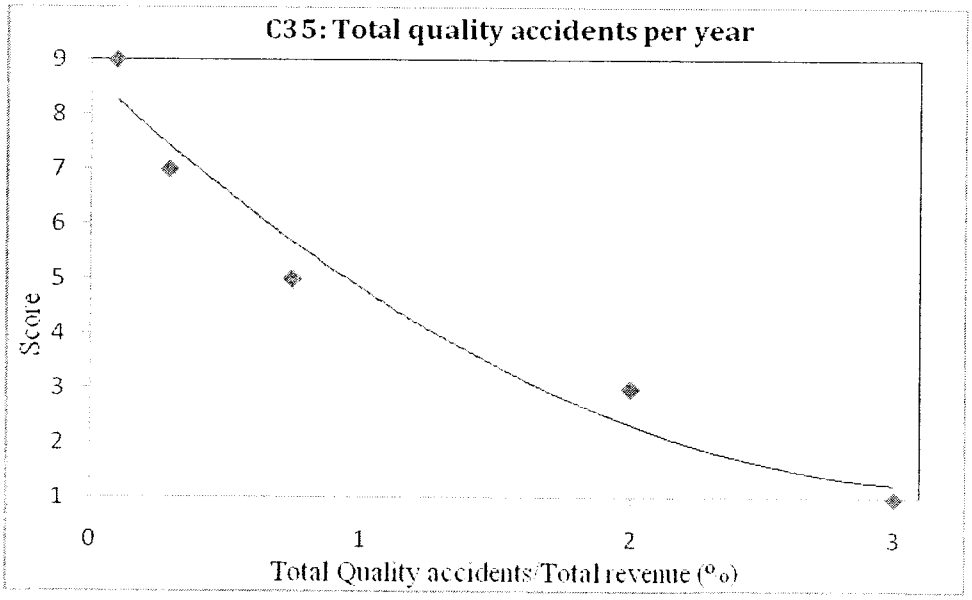

Figure F-52: Total quality accidents per year

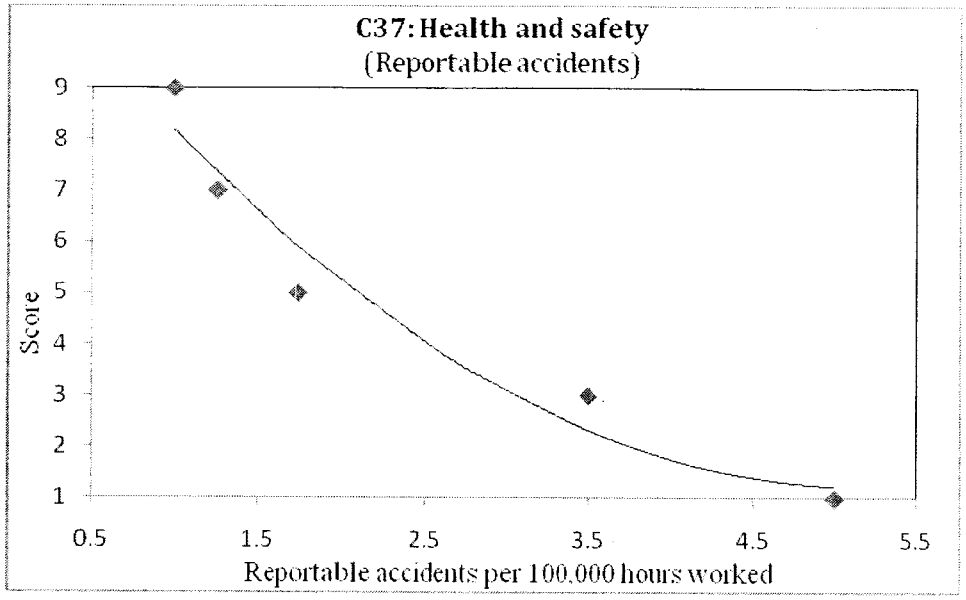

Figure F-53: Health and safety (Reportable accidents)

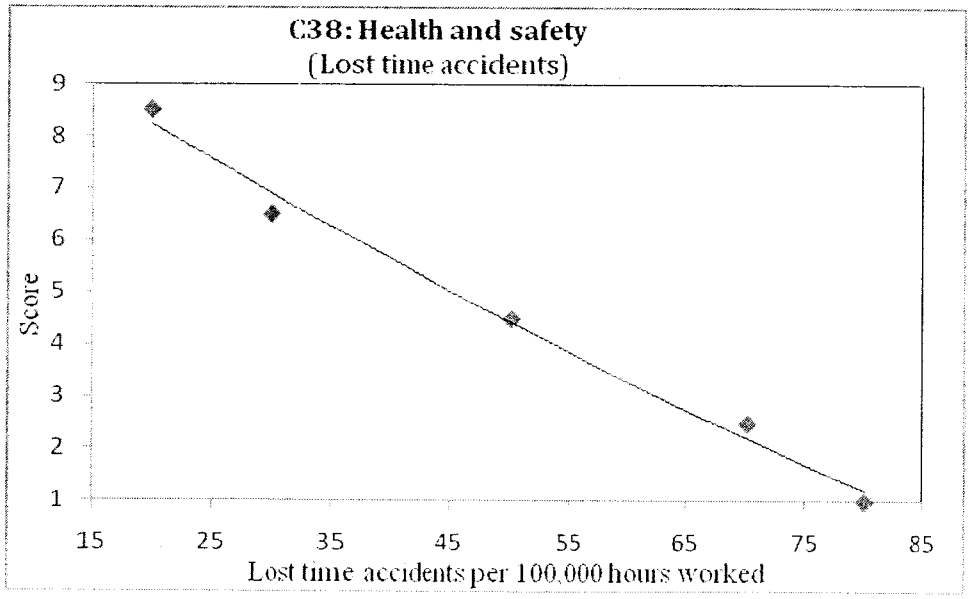

Figure F-54: Health and safety (Lost time accidents)

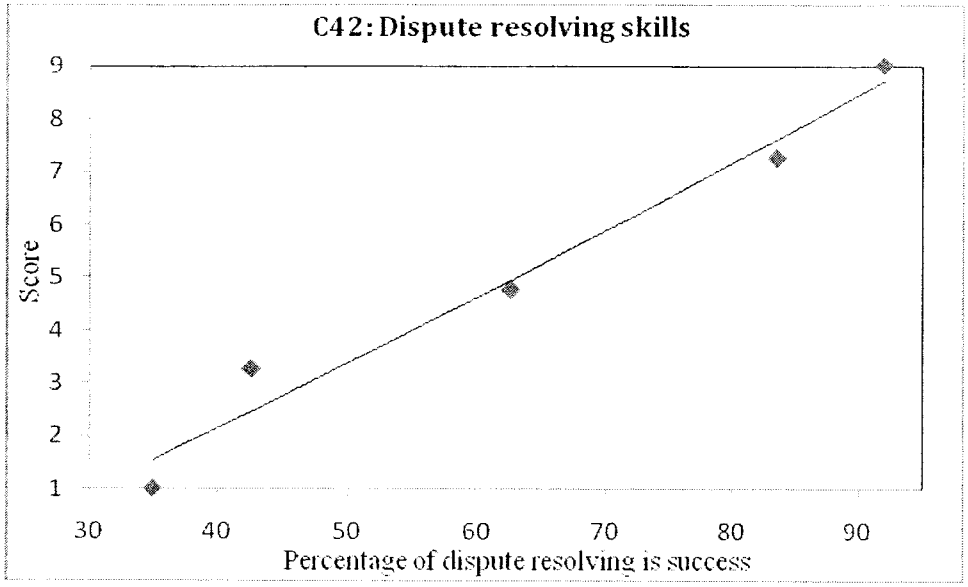

Figure F-55: Dispute resolving skills

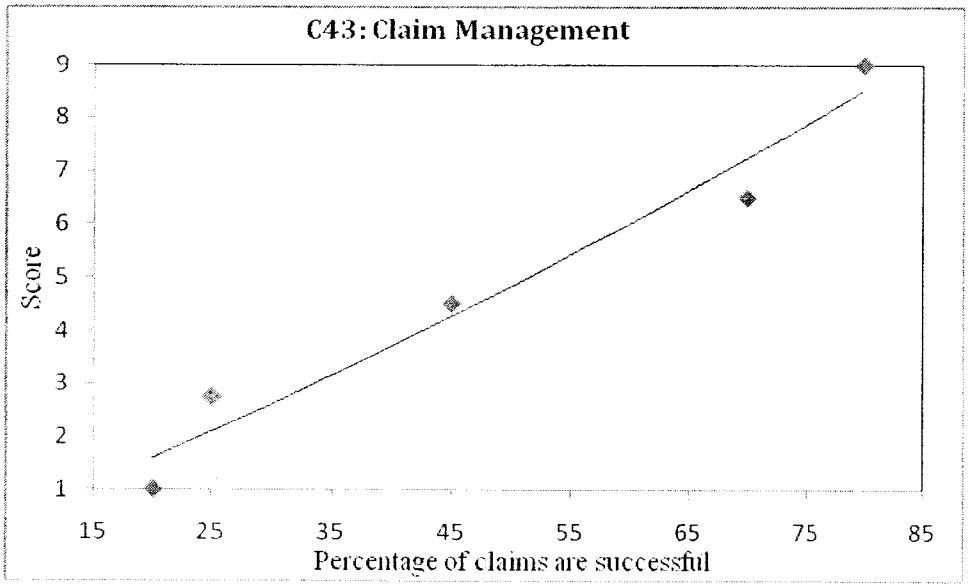

Figure F-56: Claim Management

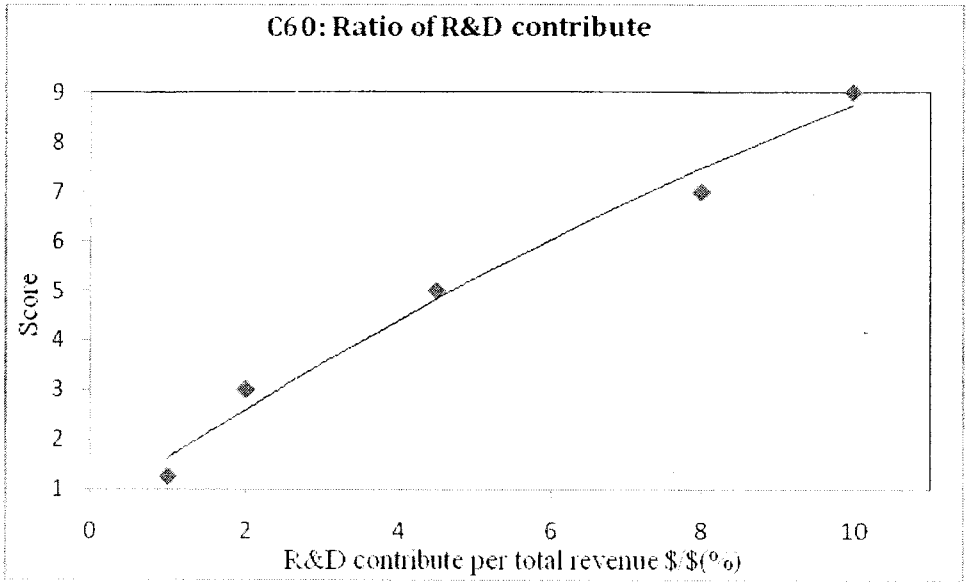

Figure F-57: Ratio of R&D contribute

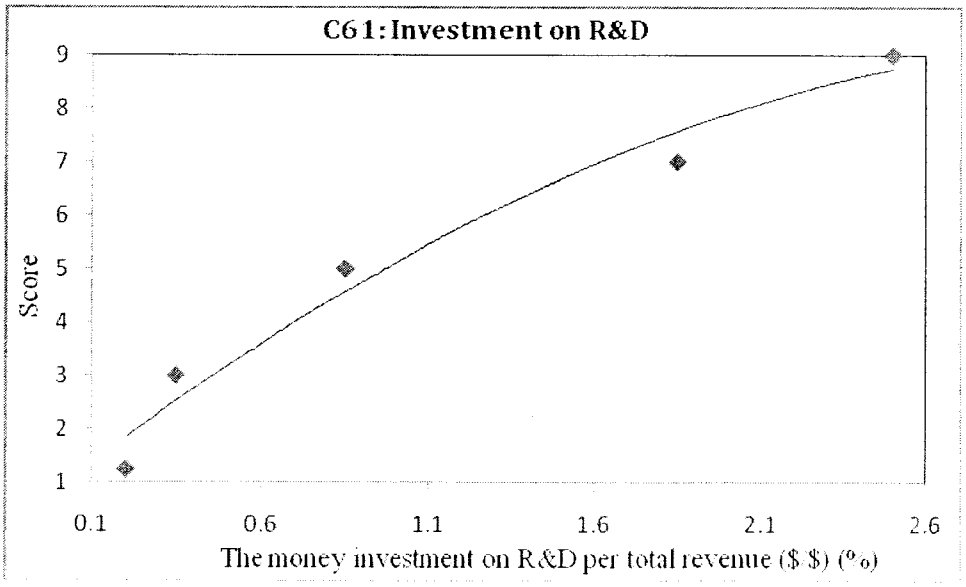

Figure F-58: Investment on R&D

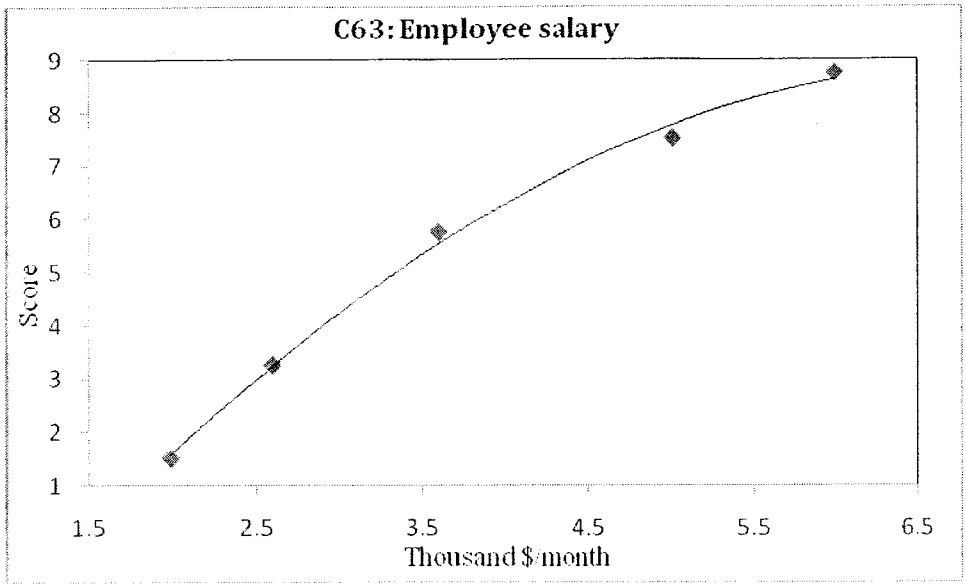

Figure F-59: Employee salary

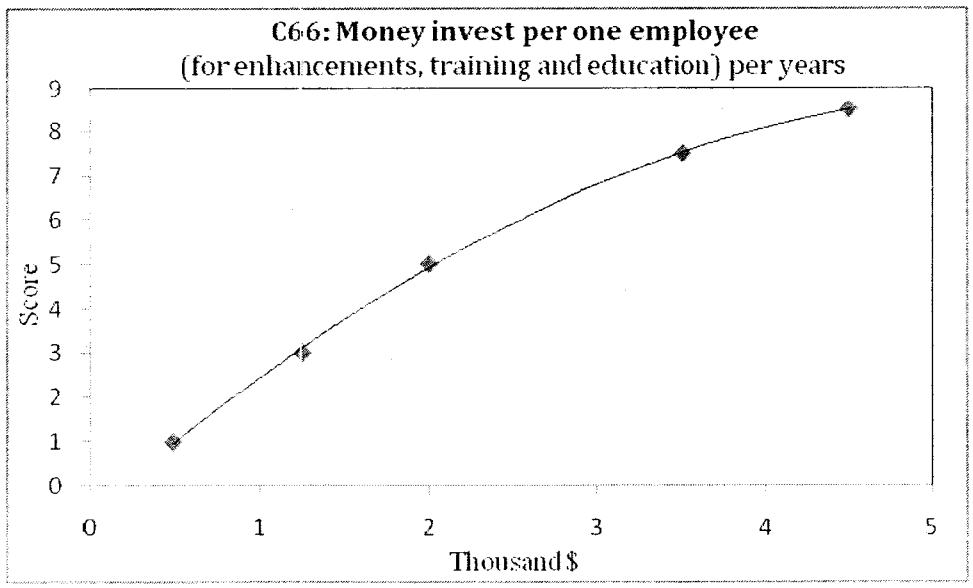

Figure F-60: Money invest per one employee (for enhancements, training and education)

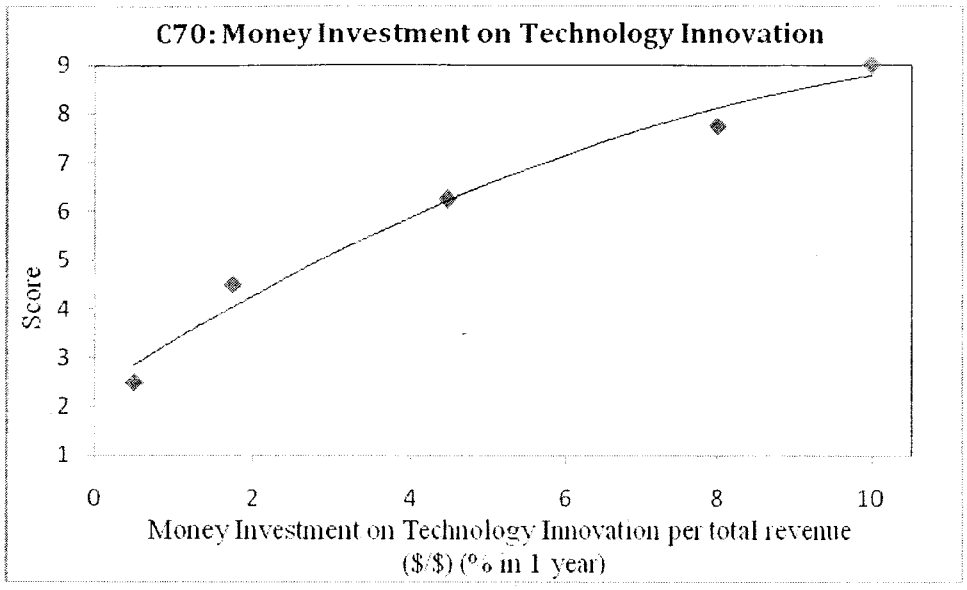

Figure F-61: Money Investment on Technology Innovation per total revenue ($/$) (in 1 year)

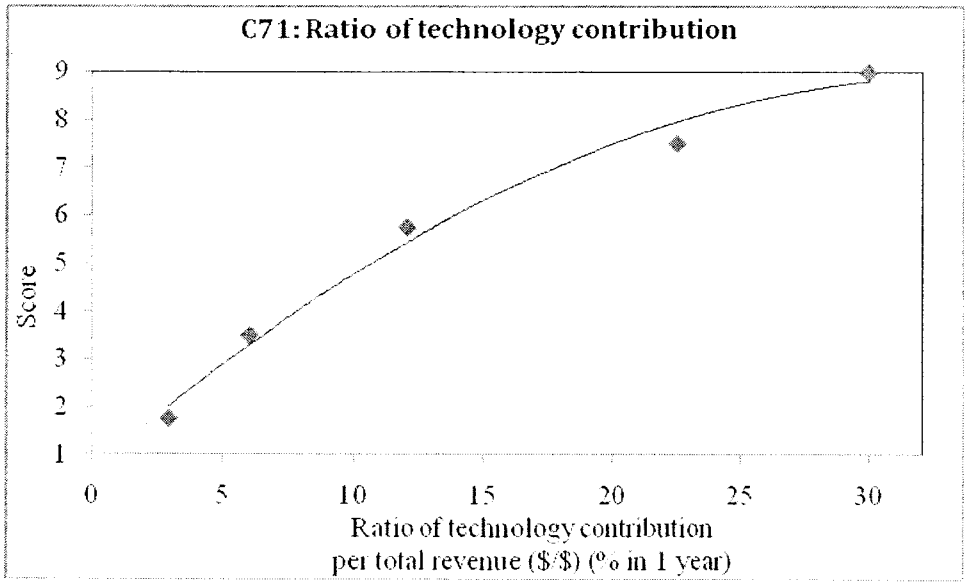

Figure F-62: Ratio of technology contribution per total revenue ($/$) (in 1 year)

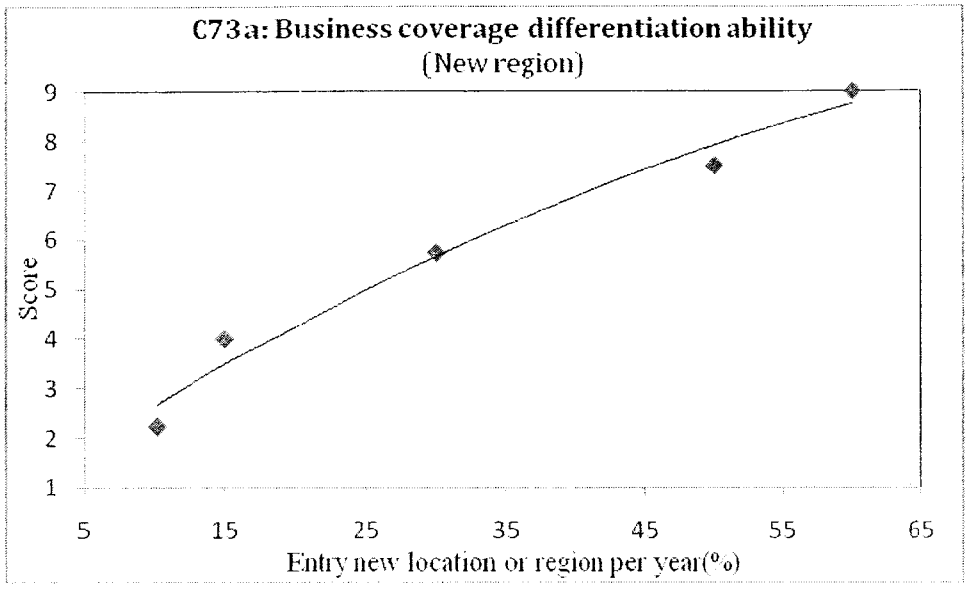

Figure F-63: Business coverage differentiation ability (entry new location or region)

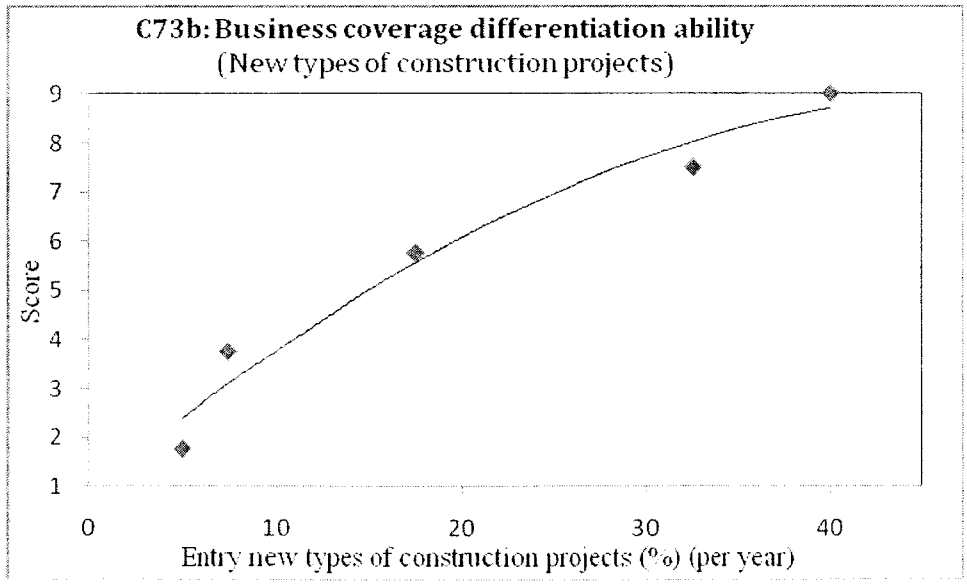

Figure F-64: Business coverage differentiation ability (Entry new types of projects)

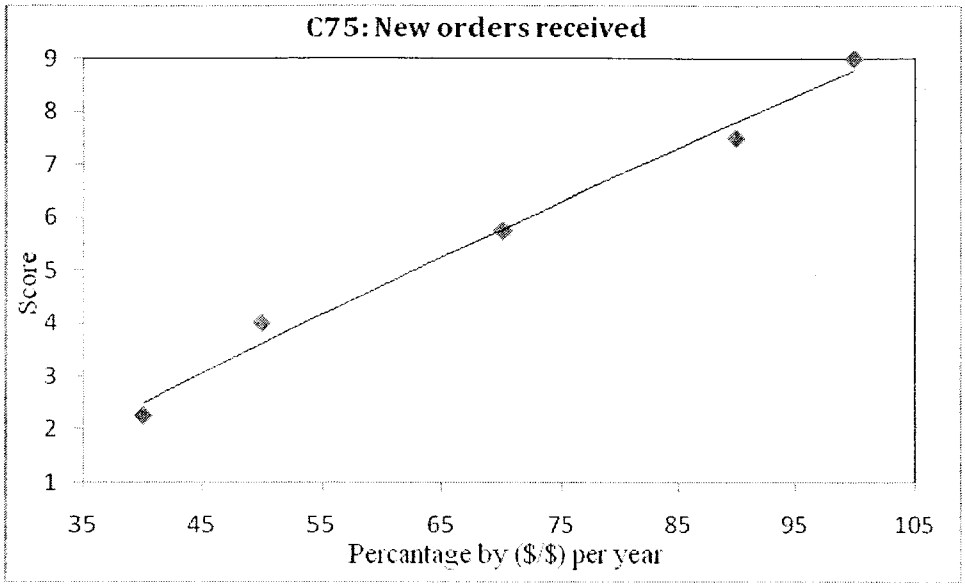

Figure F-65: New orders received

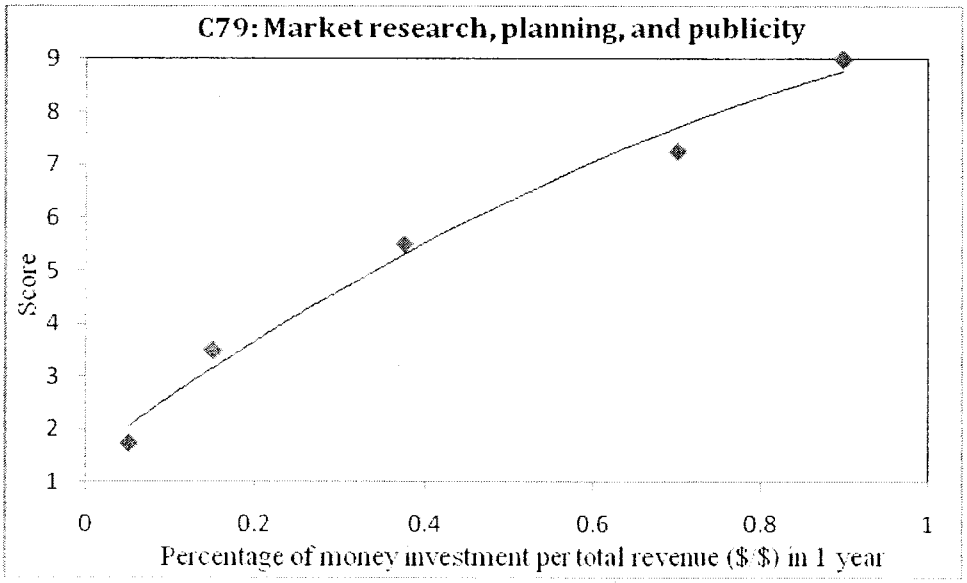

Figure F-66: Market research, planning, and publicity