APPLICATION OF MULTI-CRITERIA DECISION MAKING PROCESS TO DETERMINE CRITICAL SUCCESS FACTORS FOR PROCUREMENT OF CAPITAL PROJECTS UNDER PUBLIC-PRIVATE PARTNERSHIPS

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ABSTRACT

Investigation about project success has attracted the interest of many researches and practitioners. Determining the critical success factors for procurement of capital projects is a contemporary phenomenon. This paper presents the outcome of an investigation into the critical success factors in Public-Private-Partnerships (P-P-P) for procurement of capital projects using the multi-criteria decision making process. Drawing from the results of responses to a survey of 705 experts involved in P-P-P projects worldwide, the paper presents the critical success factors (CSF) from a list of 47 factors, identified as contributing to the successful delivery of capital projects. The study revealed that owner satisfaction with the delivered project, adherence to schedules/budget/quality/ safety/environmental controls, and appropriate funding mechanisms were predictable factors while lack of legal encumbrances, clearly defined project mission and adequate planning and control techniques were less commonly expected factors.

Key Words: Analytic Hierarchy Process, Critical Success Factors, Multi-Criteria Decision Making, Infrastructure, Public-Private Partnerships
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1. Introduction

Despite well-known research results, volumes of words written about procurement of capital projects using the Public-Private-Partnerships (P-P-P) model, and decades of individual and collective experience managing P-P-P projects, results continue to disappoint stakeholders. In the past, research has focused only on success factors for the procurement of projects, and best practices in dealing with success in project development. A wide array of research methods have been used to determine the critical success factors of project success. Some of these factors are the realization of case studies (e.g. Sumner, 1999), group interviews (e.g. Khandewal and Miller, 1992), structured interviews (Rockart and Van Bullen, 1986), as well as analysis of relevant literature (e.g. Esteves and Pastor, 2000). According to Shah and Siddiqui, (2002) the most frequently used method to identify success factors is the realization of a questionnaire. Although the number of studies examining the relevance of CSF in regard to the individual phases of the project lifecycle has increased, most studies still remain limited to the sole identification of these CSF and do not address their individual degree of relevance at all.

Two different approaches can be found from comprehensive studies addressing both identification and the relevance. The approach implemented by Pinto and Prescott (1988), for instance, is based upon the same set of CSF at all times, while examining their individual degree of criticality along the different project phases. In contrast, other studies have chosen to define different sets of CSF for each project phase. Although differently executed, both concepts generally tend to refer to the same set of CSF. Presently, a pragmatic study is required to identify critical success factors for procurement of projects by incorporating a comprehensive approach. The multi-criteria decision making process (MCDM) has been found to be significant in decision making when an extensive number of factors are involved. The MCDM as a methodology provides a precise language regarding the components of the problem and the relationship between these components. One such method of the MCDM is the Analytic Hierarchy Process (AHP) developed by Professor Thomas Saaty in the 1970s. This paper presents the outcome of an investigation into the CSF in P-P-P for procurement of capital projects using multi-criteria decision making process. The subject of CSF was selected for detailed research because it represents areas or functions where events and actions occur to ensure successful competitive performance for an organization.

2. Background

Since the end of World War II, economic development has become a key policy concern worldwide. Changes in the social economic structure over the past several decades have led to radical responses toward the economic development policies of many governments. Policy officials at different levels of government have discovered that greater economic development and sustainability might be reached if a more active approach toward attracting investment is made. Rather than passively waiting for business interests to seize on new incentives in the tax code, public officials proactively court businesses in an attempt to secure contractual agreements. This policy has come to be known as the Public-Private Partnership, abbreviated variously as; P-P-P, 3Ps, P^3, P3. P-P-P assumes that the public and private sectors can cooperate and create new value and benefit for all concerned parties. Whereas the traditional approach is to procure separate project roles for the public and private sectors, P-P-Ps combine the forces of public and private sectors to create added value for projects. Proponents of P-P-P claim that the public and private sectors benefit immensely under the P-P-P approach (Pinto & Slevin, 1987).

The successful procurement of capital projects is very important to many developers because large sums of investment capital are expended annually on developmental projects. Enough information is required by developers to be able to determine the right procedures required to make the best procurement processes. The capital projects industry (i.e. the industry that executes the planning, engineering, procurement, construction and operation of predominantly large-scale buildings, plants, facilities and infrastructure) greatly lags behind other sectors in exploiting technological advances (FIATECH, 2006). The capital project industry is faced with huge disparities in business practices and application of technology. It is evident from looking at different companies in this industry and across their supply chain that many different tools and technologies are used (FIATECH, 2006). Known emerging procurement strategies such as Public Finance Initiative (PFI) and Public-Private Partnership (PPP) are being used, but they are not a panacea (Confederation of British Industry, 1996). A search for proper strategies

which can contribute to successful procurement and implementation of capital projects (Confederation of British Industry, 1996; Private Finance Panel, 1996) is required. Public-Private Partnerships (P-P-P) are increasingly being adopted as a procurement strategy for delivery of capital (and other privatized) projects all over the world. Several factors have been mentioned as making contributions to the success or failure of capital projects in terms of their objectives. This research explores the critical factors that can contribute to successful procurement and implementation of capital projects by developing, administering and analyzing results of a P-P-P survey. The findings can influence policy development toward P-P-Ps, and the way in which those involved go about developing Public-Private Partnerships.

Identifying contributing factors to successful procurement of capital projects is one of the many management practices that facilitate corporate success. Attempts to study problems related to P-P-P procurement have discovered issues such as high cost in tendering, complex negotiation, cost restraints on innovation, and differing or conflicting objectives among the project stakeholders. Despite this, many P-P-P projects are regarded as successful. Many studies have developed differing lists of success factors (SF) for P-P-P projects, and similarities occur among them (Hardcastle, Edwards, Akintoye & Li, 2004). Less information exists about the relative importance of CSF associated with P-P-P projects in many nations. Different types of public-private partnerships are being practiced in worldwide infrastructure development with diverse results and a variety of problems are being encountered. This study sought to identify the critical factors that can successfully facilitate procurement of capital projects under the P-P-P projects. By identifying the CSF the study thus seeks to contribute to the knowledge base in the construction industry by strengthening the theoretical understanding of methodologies used for procurement and development of P-P-P projects and analyzing the processes using relevant theories. Second, the study provides a new methodology that enables a rigorous examination of capital projects under P-P-P concepts. Third, the study provides evidence as to whether P-P-P projects deliver Value- For-Money for the client and profit for organizations by way of improvements in economic efficiency reached. Fourth, the study identifies the forces in the P-P-P development process that either encourage or discourage implementing capital projects. Fifth, it helps to develop potential solutions to the problematic issues identified in the procurement of P-P-P projects, and clarifies the future research agenda on P-P-P. In addition, the research findings can help a wide range of individuals, from people concerned with the state of the public services to those involved in public spending whose duties include the delivery of Capital Projects. As P-P-P type of procurement is rapidly gaining popularity around the world, the findings can be of value in countries that are still experimenting with this procurement processes.

3. Critical Success Factors

The term, critical success factors (CSF), was first used in the context of information systems and project management by Rockart (1982). His definition states, "those few key areas of activity in which favorable results are absolutely necessary for a particular manager to reach his or her own goals...those limited number of areas where 'things must go right'" (Rockart, 1982, p.2). Since then, some publications have cited the CSF methodology in research and the definitions, following that of Rockart. Boynton and Zmund (1984) define critical success factors as "those few things that must go well to

ensure success for a manager or an organization" (p. 17). Sanvido, Parfitt, Grobler, Guvenis and Coyle (1992) also define critical success factors as "those factors predicting success on projects and events or circumstances that require the special attention of managers" (p. 99). Tiong, Khim-Teck, Yeo and McCarthy (1992) identify CSF as "those characteristics...that when properly sustained and managed have a significant impact upon winning...those things that must be given special and continued attention and must go well to increase the...chances of success" (p. 220). According to A. J. Smith and C. Walker (1994) CSFs are "those factors in which success is necessary in order that each of the major project participants in a...project has the maximum chance of achieving the goals" (p. 247). Lim and Mohamed (1999) wrote that CSFs are "those [things] needed to produce the desired deliverables for the customer" (p. 244). CSF measure end results. Ghosh, Liang, Meng and Chan (2001) see CSF as key success factors which are critical for excellent performance of the company, rather than just survival. Of interest is the pattern formed by each of the above definitions. Three clear sections to each definition become apparent. For example, in Rockart's quote the three sections of the definition are, "those few key areas", "favorable results are absolutely necessary", and "to reach his or her own goals".

Using this method to segregate and analyze the identified definitions, a new definition of Critical Success Factors related to P-P-P projects is proposed. CSF are those few factors which, when judiciously applied to a P-P-P scenario, can lead to, and/or actively contribute to, a profitable conclusion for one or more of the parties involved" (Owen 1997, p. 55). This definition is used throughout this paper to describe Critical Success Factors.

4. Methodology

The multi-criteria decision method (MCDM) was leveraged for the study because of its significance in decision making when an extensive number of factors are involved. MCDM as a methodology has a precise language regarding the components of the problem and the relationship between them. One such method of the MCDM is the Analytic Hierarchy Process (AHP) developed by Professor Thomas Saaty in 1970. Since its development, the AHP has been successfully applied to solve a wide range of multi-criteria decision making problems. Some areas where AHP has been applied are: location analysis (Min, 1994), resource allocation (E.W.L. Cheng & Li, 2001; Ramanathan & Ganesh, 1995), outsourcing (Udo, 2000), and evaluation (C.H. Cheng, 1997; Chin, Chui, & Tummala, 1999; Davis & Williams, 1994; Liang, 2003), and AHP application review (Vaidya, O., S., & Kumar, S, 2006).

The AHP involves four steps:

1. Constructing a decision hierarchy by breaking down the decision problem into a hierarchy of inter-related elements
2. Performing pair-wise comparisons of the inter-related elements
3. Estimating the weights of the decision elements by using the Eigen -value method
4. Aggregating the relative weights of the decision elements to provide a set of ratings for the decision alternatives (Canada, Sullivan, and White, 1996)

Three major principles of analytic thought associated with AHP are the construction of hierarchy, establishment of priorities and logical consistency (Saaty, 1990).

One of the software packages available that incorporates the ideas and methodology of the AHP is Expert Choice (EC). It is "designed for the analysis, synthesis, and justification of complex decisions and evaluations" and can be used in either individual or group situations (Quick Start Guide and Tutorials, 2001, p. 6). All necessary steps involved in the AHP are captured in the EC software. The AHP and EC software engage decision makers in structuring a decision into smaller parts, proceeding from the goal to objectives to sub-objectives down to the alternative courses of action. Decision makers then make simple pair-wise comparison judgments throughout the hierarchy to arrive at priorities for the alternatives. The decision problem may involve social, political, technical, and economic factors. The AHP helps people cope with the intuitive, the rational and the irrational, and with risk and uncertainty in complex settings. It can be used to predict likely outcomes, plan projected and desired futures, facilitate group decision making, exercise control over changes in the decision making system, allocate resources, select alternatives, do cost/benefit comparisons, evaluate employees and allocate wage increases.

Expert Choice is intuitive, graphically based and structured in a user-friendly fashion so as to be valuable for conceptual and analytical thinkers, novices and category experts. Because the criteria are presented in a hierarchical structure, decision makers are able to drill down to their level of expertise, and apply judgments to the objectives deemed important to achieving their goals. At the end of the process, decision makers are fully aware of how and why the decision was made and have results that are easy to communicate and are actionable.

For this study, seven hundred and five participants were enlisted from around the world and invited to participate in a survey. These participants included 267 from Canada, 175 from US, 82 from UK, 48 from Australia, 47 from the Middle East, 33 from Hong Kong, 18 from Africa, 18 from New Zealand, 10 from China, and 7 from Germany. The 705 experts were comprised of owners, project managers, consultants/contractors, financiers, and operators for procurement of capital projects. Using these experts, a model based on the Analytical Hierarchy Process was developed to investigate the CSF. The hierarchical model developed was used for detailed analysis of the findings, using software based on the Analytical Hierarchy Process (AHP). The analysis helped to point out the CSF considered by each project participant in the construction industry. Agreement between different project participants has been calculated using Spearman's and Kendall's technique.

A pair-wise comparison was performed on 47 success factors derived from existing literature to determine the CSF. Out of the 705 experts that were recruited world-wide, 140 agreed to participate in the survey. Ninety-three participants responded to the survey invitation producing a response rate of 70.0%. Since this is an exploratory study, the researcher gathered data only from experts in the construction industry who were involved in capital projects procurement and who have experience with Public-Private Partnerships. This is called judgment sampling, a type of purposive sampling. According

to Cooper and Schindler (2003), "judgment sampling occurs when a researcher selects sample members to conform to some criterion" (p. 201).

According to Cooper and Schindler (2006), research questions are the choices that best state the purpose of the research study. A number of questions were posed for this research with the main research question being, "what are the CSF for procurement of capital projects using Public-Private Partnership arrangements?" More specific questions such as those enumerated below were asked in light of the issues raised in order to provide the information needed to make decisions:

1. What are the Critical Success Factors for delivering P-P-P projects?
2. How can Critical Success Factors which are particular to the successful realization and delivery of P-P-P projects be identified?

The following investigative questions were formulated in order to reach a satisfactory conclusion about the research question:

1. What are the factors that contribute to the successful delivery of P-P-P projects?
2. How can critical issues be identified to provide successful delivery of projects under the P- P-P projects?
3. How can the factors that contribute to the successful delivery of P-P-P projects be assessed?
4. What factors contribute to the failure of the P-P-P projects?
5. What factors have been applied to the delivery of P-P-P projects and have contributed profitably to one or more of the parties involved?
6. How can the transfer of risk be reduced to the private sector in P-P-P project delivery?
7. How can Value-For-Money be provided to the taxpayer for the contributions made in P-P-P project delivery?
8. What scheme can be applied to ensure the successful delivery of projects under the P-P-P arrangement?

In addition to the questions indicated above, the following hypotheses were tested;

H_o: The owners, project managers, consultants/contractors, financiers and operators are mutually independent in the ranking of major portion of the success factors.

H_1: The owners, project managers, consultants/contractors, financiers and operators are not mutually independent in the ranking of major portion of the success factors.

A literature review shows earlier studies focused on the CSF for different project objectives. For example, Asif (2003), concluded after a pair-wise comparison and analysis that adequate planning, and control technique, owner satisfaction with the delivered project and clearly defined project mission, and objective and scope are the most important CSF. Similar conclusions have been identified in the literature survey; however Asif (2003) proposed that further research be carried out for specific project delivery such as Public-Private Partnership and Project Finance Initiatives to provide a

better understanding of the developing construction environment and the ability to consistently achieve outstanding project outcomes. In other research, factor analysis was used to identify factor groupings that can be used to represent relationships among sets of many inter-related variables (Kleinbaum, Kupper, & Muller, 1988; Norusis, 1992). Saaty and Vargas (1991) identify two philosophical foundations for grouping success-related factors under separate sub-hierarchies. First, factors of similar nature should logically be grouped into one cluster to facilitate pair-wise comparison during the survey. Second, it is known that an individual cannot simultaneously compare more than 7± 2 elements with satisfactory consistency, and hence hierarchical decomposition is desirable (Saaty & Vargas, 1991). Hierarchical decomposition uses a simple but powerful notation by first dividing the system into top-level subsystems. Next, every top-level sub-system is divided into second-level sub-systems, and the sub-systems are identified with a hierarchical numbering. The technique has been applied in listing success factors in this study to explore the groupings that might exist among the success factors. Morledge and Owen (1998) used six principal factors to group success factors for the investigations on CSF in public finance initiatives and the principal factors groupings have been adapted for this study. Based on the criterion above, the 47 factors identified in the literature review were grouped into six categories: project participants, effective procurement, project implementation/characteristics, government guarantee, favorable economic conditions and available financial market.

A questionnaire developed from the research questions indicated above was then sent to participants requesting that they identify, from a list, those factors which they agreed were critical in procurement of P-P-P projects. Yin defines the case study research method as an empirical inquiry that investigates a contemporary phenomenon within its real-life context when the boundaries between phenomenon and context are not clearly evident and in which multiple sources of evidence are used (Yin, 1984, p. 23). A case study of a typically procured Public-Private Partnership capital project was used as the basis of the research. The Sea-to-Sky road project linking Vancouver to Whistler in the Province of British Columbia, Canada, was used for this study. The $600-million capital project involved upgrading the highway to increase its safety, reliability and capacity for the 2010 Winter Olympic Games. The research methodology constructively distributed into various phases of the research program is shown in Figure 1.

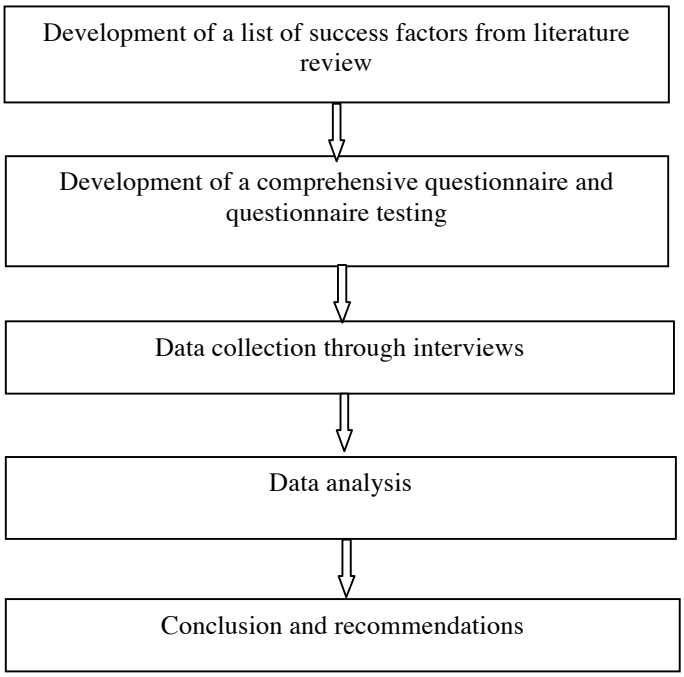


Figure 1 Methodology flowchart

To comply with the requirement of the EC software, the success factors identified for this study were decomposed into a hierarchy as shown in Figure 2 with four levels of hierarchy. At the top (level 1) of the hierarchy is the goal or overall objective of the research i.e. success factors. Level 2 of the hierarchy shows the principal factor groupings of the success factors. The major factors are at the third level of the hierarchy followed by the success related factors or the alternatives at the bottom or last (level 4) of the hierarchy. The model as developed in Expert Choice (EC) software is a multi-objective decision support tool based on the Analytical Hierarchy Process (AHP), a powerful and comprehensive methodology designed to facilitate sound decision making by using both empirical data as well as subjective judgments of the decision-maker (www.expertchoice.com).

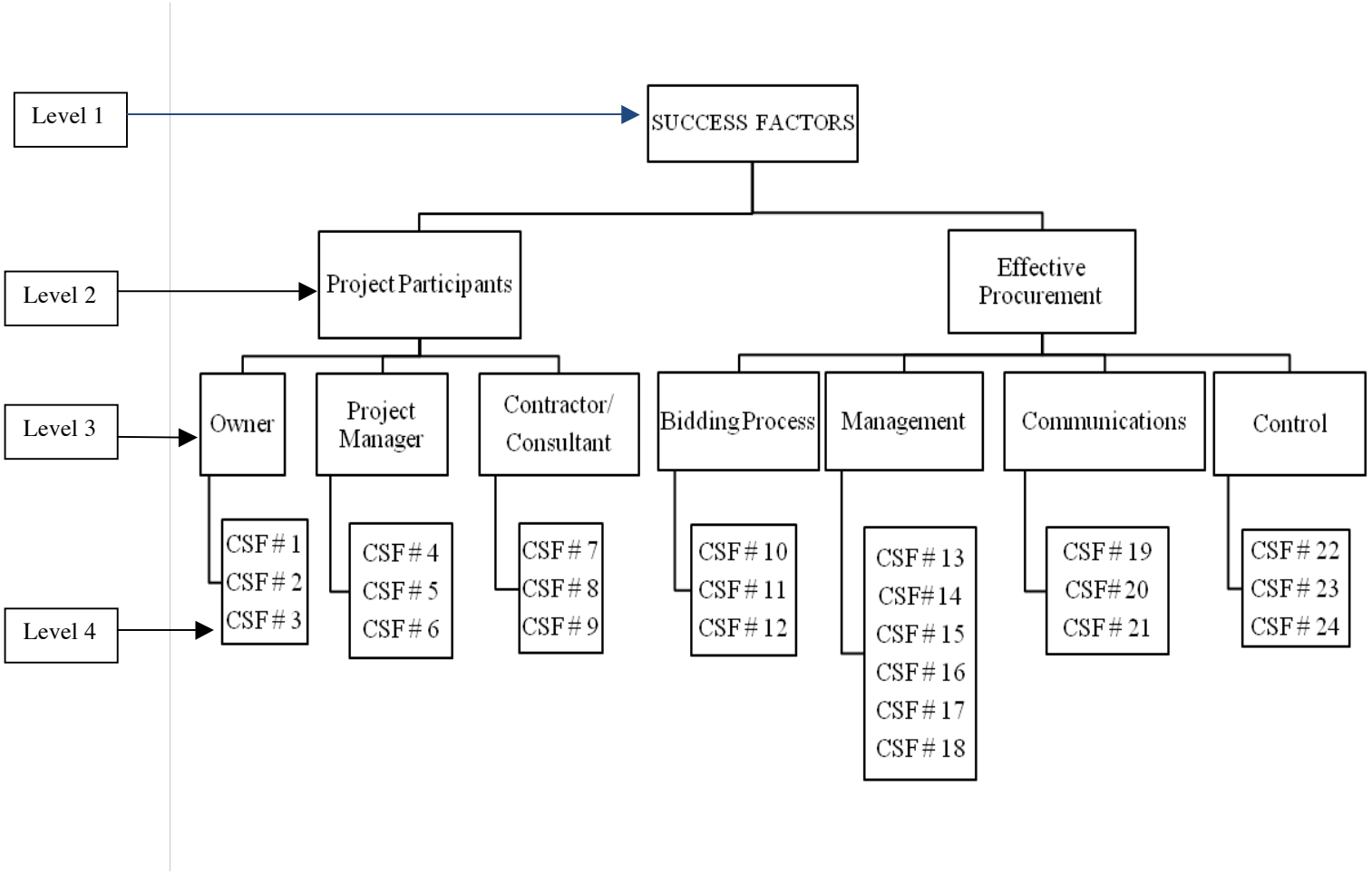


Figure 2 Hierarchy of success factors (CSF # 1 to CSF # 24)

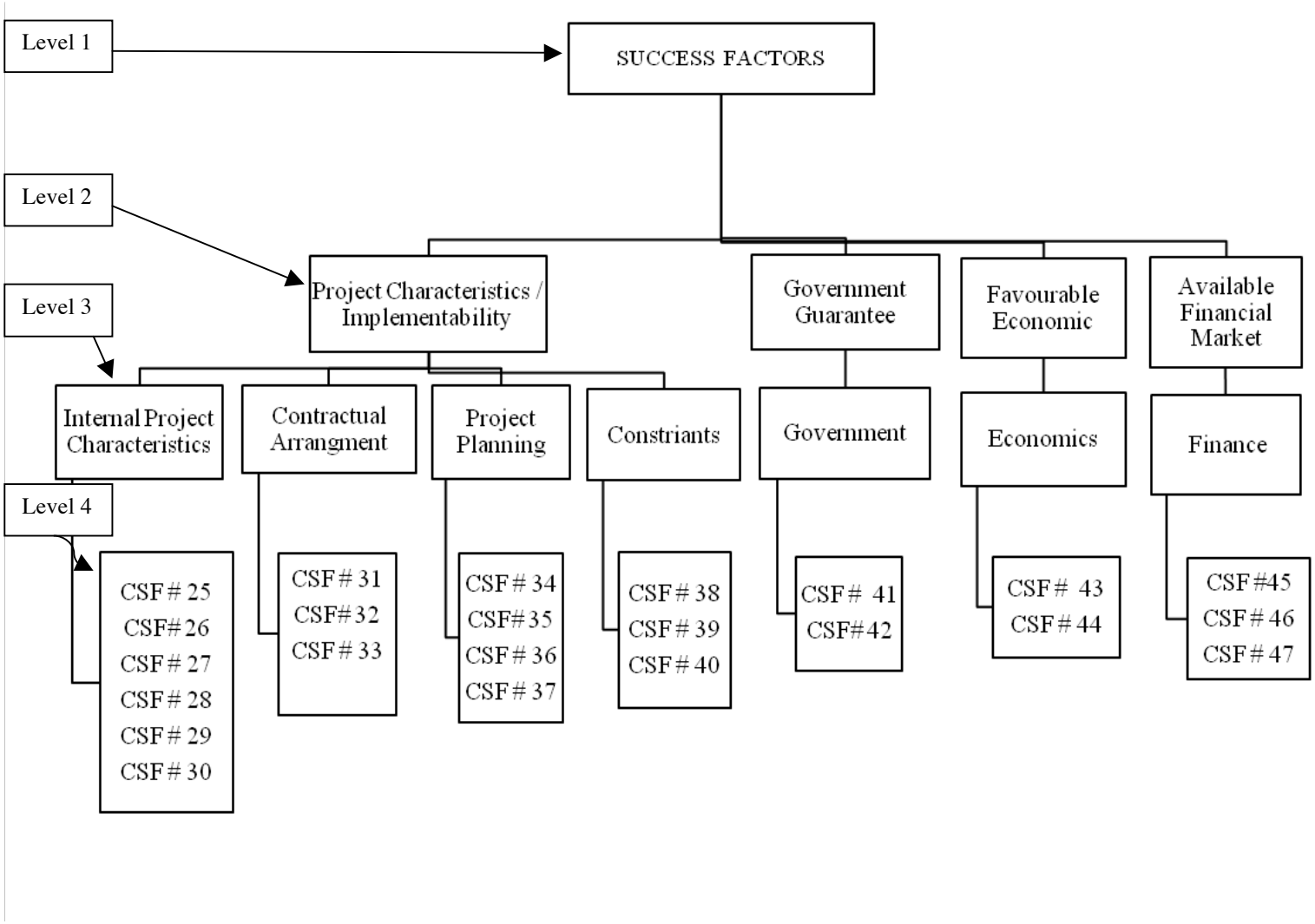


Figure 2 (cont'd) Hierarchy of Success Factors (CSF # 25 to CSF # 47)

5. Data collection, analysis and results

Survey data were collected from September 01, 2009 to November 20, 2009. The data were collected through interviews and were separated by the major factors and screened for different project participants.

The target population was experts in the construction industry who were involved in procurement of capital projects using the Public-Private Partnership arrangement. At least twenty (20) experts from each of the identified groups (owners, project managers, consultants/ contractors, financiers and operators) were recruited world-wide in the survey process.

The Analytical Hierarchy Process (AHP) was used for detailed analysis of the data in the Expect Choice Theory software. The analysis helped to point out the critical CSF considered by each project participant for the construction industry. Agreement between different project participants was calculated using Spearman's and Kendall's technique. In order to provide a definite measure of the primary objectives for the research, it was necessary to collect the data by conducting surveys. Semi-structured interviews and electronic self-administered questionnaires were used. Personal semi-structured interviews have the advantage of being more formal than "unstructured" interviews and yet are more flexible than structured interviews. They are constructed using specific topics and both open and closed-ended questions. The purpose of conducting the semi-structured interviews was to "scope" the experience of the target groups for capital project P-P-P procurement in order to ascertain the relative issues involved. The topic areas for the semi-structured interviews were sent to the interviewees after they had initially been contacted by email to confirm their interest and willingness to be involved in the research. Due to the disparate geographic locations of participants and the limited time available for this study, it was difficult to conduct face-to-face interviews with the experts. Consequently, a "tele-interview" was held as required and the responses were coded and recorded on a blank copy of the topic document by the interviewer.

An introductory note explaining the objectives of the research and a question about their interest in participating in the research was sent to the selected groups through email. Meetings were arranged with 5 members of project group of the Sea-to-Sky project who showed interest in the study. The face-to-face method of qualitative study was explored with the Sea-to-Sky project as a case study. A case study yields deep narrow results (Fellows & Liu, 1997). The case study project in question served to test the validity of the CSF identified from the related literature, and the established framework as a sound foundation applicable to P-P-P project. Yin (1984) notes that the single case study method is appropriately applied where the case in question represents an extreme or unique case or if the situation has not previously been selected as the most appropriate means for the research reported in this paper. Evidence was collected for the case study through the review of project documents from the Centric Project web site and an informal three-stage semi-structured interview process with the participants. Brief definitions of the factors were developed and taken to all the interviews to help the experts better understand the meaning of the factors. The interviewer also used the contributions of the participants in refining the definitions of the success factors.

The factors considered for the research are, the major factors at the third level of the hierarchy followed by the success related factors or the alternatives at the bottom or last (level 4) of the hierarchy. Figure 3 shows the hierarchy model in Expert Choice 11.5 software.

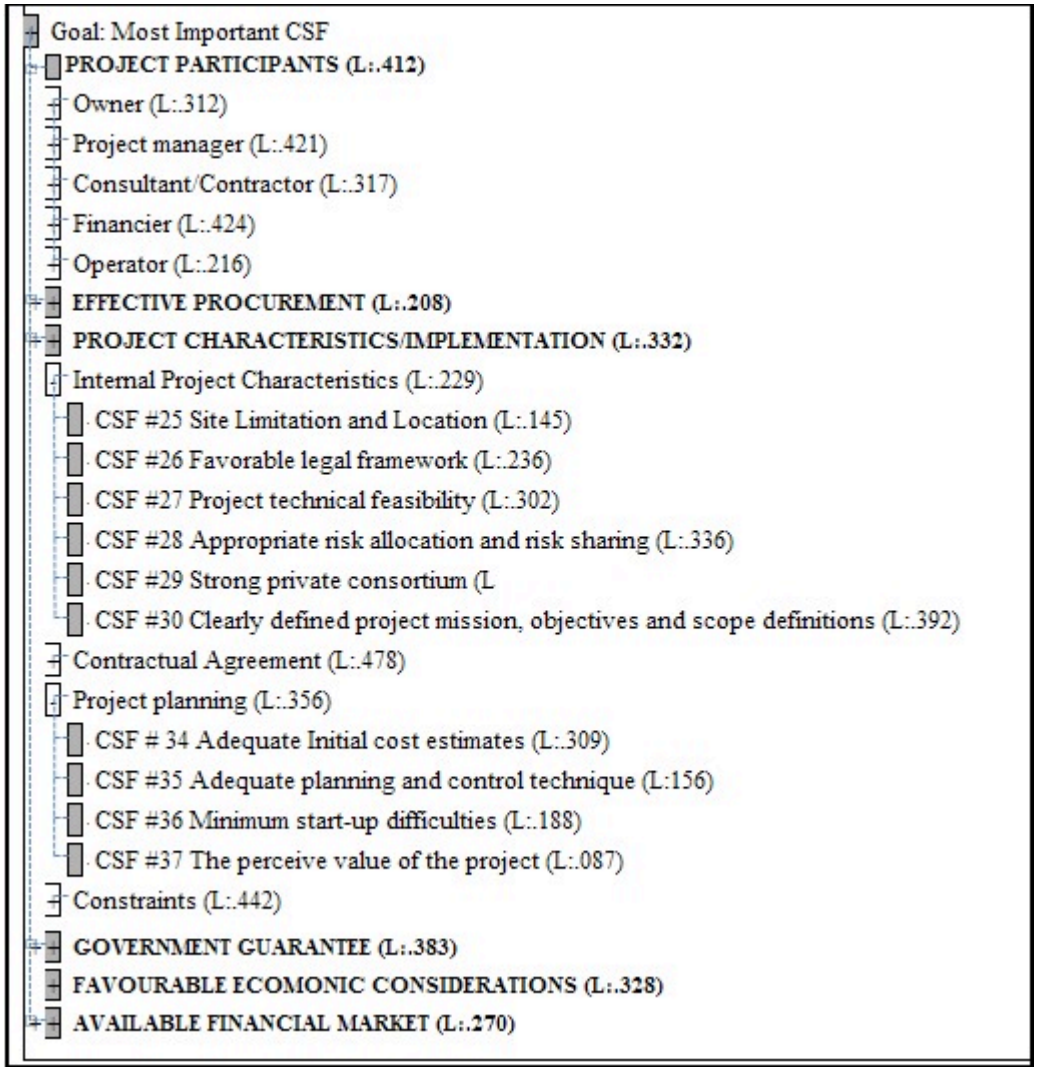
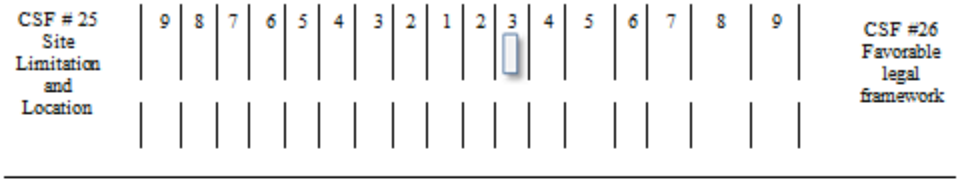


Figure 3 Hierarchy model developed in Expert Choice, 11.5 Software

Figure 4 shows an example of the pair-wise comparison data grid in which factors for project characteristics are being compared for the cost objective. Weights were assigned for the pair-wise comparison from the 1-9 scale scale and varied from 1 to 5. In the questionnaire at the top of Figure 4 judgments marked in the top row indicated the row element for the pair in the matrix was dominant, judgments marked in the bottom row indicated the column element was dominant and the inverse would have been entered in the matrix.



Compare the relative importance with respect to:
Project Characteristics /Implementation /Internal Project Characteristics

	CSF#25	CSF#26	CSF#27	CSF#28	CSF#29	CSF#30
CSF #25 Site Limitation and Location	1	3	2	4	5	3
CSF #26 Favorable legal framework		1	3	2	2	3
CSF #27 Project technical feasibility			1	2	3	4
CSF #28 Appropriate risk allocation and risk sharing				1	3	3
CSF #29 Strong private consortium					1	2
CSF #30 Clearly defined project mission, objectives and scope definitions						1

Figure 4 Example of pair-wise comparison data grid built in Expert Choice 11.5 Software

The results from EC for all the participants are shown in Figure 5 for the major factors. Combined results of all the participants show that the project participant's role is of great importance for the construction industry. Project characteristics/implementation is followed by effective procurement and available financial market. These are followed by government guarantee and favorable economic considerations.

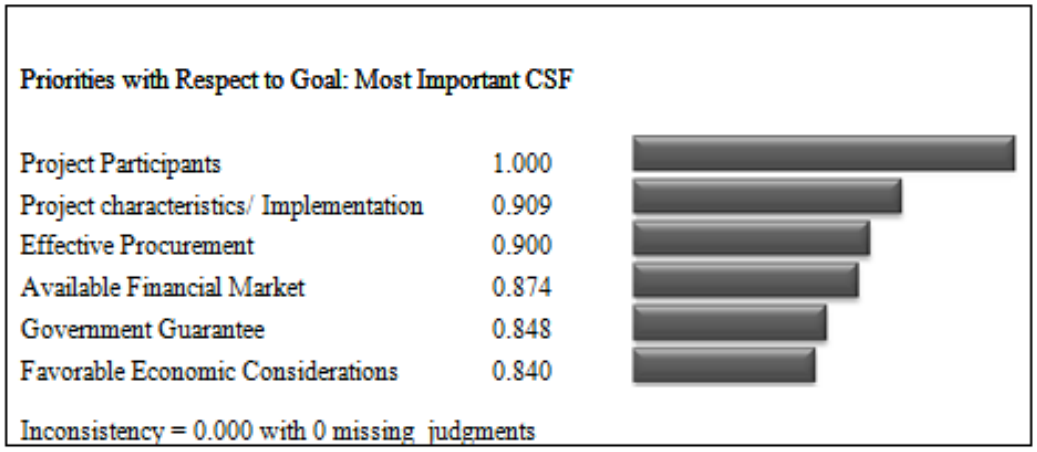


Figure 5 Priorities with respect to goal: most important CSF

5.1 Validity and reliability of study

Although perfect consistency is hard to achieve especially when considering multiple conflicting criteria, Analytical Hierarchy Process provided a mechanism for measuring the consistency of the decision made and allowed for revisions of the decision to reach an acceptable level of consistency. In the AHP a measure of consistency of judgment is derived by means of Consistency Ratio (CR). If the value of the ratio is 0.1 or less, the decision is "good". If the value exceeds 0.1, the judgment may somehow be random and should be revised (Saaty, 1990). Calculating the CR starts with multiplying each entry of the pair-wise comparison matrix by the relative priority (the average) corresponding to the column, and then totaling the row entries. Next, the row totals are divided by the corresponding entry from the priority vector. The average of those entries is the Eigen-value λmax.

Consistency Index (CI) was measured using the formula: $CI = (\lambda max - n)\ (n-1)$, where n is the number of elements (factors) being compared in the matrix. The CI was then divided by its random index (RI) to get the consistency ratio, which indicated a measure of how much variation is allowed. Spearman Correlation (rs) was primarily used to assess the correlation of the factors. Spearman R is the regular Pearson product-moment correlation coefficient (Pearson r); that is in terms of the proportion of variability accounted for, except that Spearman R is computed from ranks. Spearman correlation coefficient can range from -1.00 to + 1.00. On the lower side, -1.0 represents a perfect negative correlation, +1.00 represent a perfect positive correlation and 0.00 represents a lack of correlation. The Spearman correlation was used to find and compare how well any two participants agree while ignoring the third participant completely. The Spearman correlation was calculated by the following formula (Thondike, 1978):

$rs = 1 - 6\ \Sigma d^2 / (n^3 - n)$, where:

rs = The Spearman correlation
d = the difference between ranking for each group of judges
n = number of factors to be ranked

To assess the degree of association or agreement among sets of rankings, the Kendall coefficient of concordance was measured. The Kendell coefficient of concordance (τ) is a measure of degree of association or agreement among sets of rankings. Range of the coefficient of concordance is from zero to one. One indicates a perfect agreement and zero indicates no agreement.

To calculate the Kendell coefficient, the data was first arranged into a 'k x n' matrix. Each row (n) represents ranks assigned by a particular judge (k) to (n) factors or aspects of a concept or problem. Kendell coefficient was calculated using the following formula (Thondike, 1978):

$$\tau = \frac{\sum_{i=1}^{k} (R_i - R)^2}{n\left(n^2 - 1\right)/12} \qquad (1)$$

R_i = Average of the ranks assigned by an individual
R = Average of the ranks assigned to the nth variable factor (sum of R_1 / n)
K = Number of judgments
n = the number of aspect of a problem or factor being ranked - in this study, 47.
$n (n^2 - 1) / 12$ = the maximum possible squared deviations; i.e. the numerator which occurs if a perfect agreement among k set ranks and the average ranking are 1, 2, 3,……n.

5.2 Level of agreement between all participants recruited for the survey

In order to assess the level of agreement between participants for the study, hypotheses were designed. Hypothetical testing relating to the level of agreement present between all the project participants i.e. Owners, Project Manager, Consultants/Contractor, Financier and Operators groups were performed.

Using Kendall coefficient of concordance (τ) depends upon the sample size (n). For values of n greater than 10, standard error of (τ) is calculated using the following equation:

$$Sr = \sqrt{\frac{2(2n+5)}{9n(n-1)}} \qquad (2)$$

A test of statistical significance is calculated using the following equation:

$$Z = \frac{\tau}{Sr} \qquad (3)$$

Calculations are presented in the Table 1 for (Ri – R), which were used to calculate Kendall's coefficient of concordance.

Table 1
Level of agreement between all participants

Kendall"s data Correlation		Ranking By					Mean Ri		
Success Factor		Owner	Project Manager	Consultant/ Contractors	Financier	Operator		Ri-R	$(Ri-R)^2$
CSF # 1	Owner Enthusiasm	6	7	11	6	7	7.4	0.77	0.5929
CSF # 2	Owner commitment to establishing budget and schedules	6	9	4	6	9	6.8	0.17	0.0289
CSF # 3	Owner satisfaction with the delivered project	9	13	12	9	13	11.2	4.57	20.8849
CSF # 4	Project Manager"s competency and authority	8	10	11	8	10	9.4	2.77	7.6729
CSF # 5	Project Manager"s commitment to establish budget and schedule	6	8	2	6	8	6	-0.63	0.3969
CSF # 6	Nature of the projects managers authority	9	4	21	9	4	9.4	2.77	7.6729
CSF # 7	Capability of Contractor/Consultant"s key persons to establish Budget and Schedule	8	8	16	8	8	9.6	2.97	8.8209
CSF # 8	Contractor/Consultants team commitment to budget and schedule	6	7	2	6	7	5.6	-1.03	1.0609
CSF # 9	Experience of Contractor/Consultant"s team in P-P-P	10	9	16	10	9	10.8	4.17	17.3889
CSF # 10	Transparency in procurement process	5	14	10	5	14	9.6	2.97	8.8209
CSF # 11	Competitive procurement process	4	7	3	4	7	5	-1.63	2.6569
CSF # 12	Thorough and realistic assessment of the cost and benefits	10	10	19	10	10	11.8	5.17	26.7289
CSF # 13	Absence of bureaucracy	6	3	10	6	3	5.6	-1.03	1.0609
CSF # 14	Meeting design goals	4	3	1	4	3	3	-3.63	13.1769
CSF # 15	Efficient pre-contract activities	9	4	14	9	4	8	1.37	1.8769
CSF # 16	Satisfactory budget management (Profit and Loss)	6	5	13	6	5	7	0.37	0.1369
CSF # 17	Proper design Construction Interface management	11	2	15	11	2	8.2	1.57	2.4649
CSF # 18	Effective communication throughout the project	8	7	14	8	7	8.8	2.17	4.7089
CSF # 19	Effective communication throughout the project	10	6	12	10	6	8.8	2.17	4.7089
CSF # 20	Proper coordination between project professionals	3	3	5	3	3	3.4	-3.23	10.4329
CSF # 21	Monitoring and feedback of project activities	7	4	17	7	4	7.8	1.17	1.3689
CSF # 22	Regular construction control meetings	4	6	10	4	6	6	-0.63	0.3969

CSF # 23	Design and control meetings	1	5	3	1	5	3	-3.63	13.1769
CSF # 24	Adherence to Schedules, Budget, Quality, Safety and Environmental Controls	11	4	18	11	4	9.6	2.97	8.8209
CSF # 25	Site limitation and location	6	2	11	6	2	5.4	-1.23	1.5129
CSF # 26	Favorable legal framework	2	4	3	2	4	3	-3.63	13.1769
CSF # 27	Project technical feasibility	6	4	18	6	4	7.6	0.97	0.9409
CSF # 28	Appropriate risk allocation and risk sharing	9	5	19	9	5	9.4	2.77	7.6729
CSF # 29	Strong private consortium	12	4	11	12	4	8.6	1.97	3.8809
CSF # 30	Clearly defined project mission, objective and scope definitions	9	6	15	9	6	9	2.37	5.6169
CSF # 31	Adequacy of plans and specifications	6	8	5	6	8	6.6	-0.03	0.0009
CSF # 32	Formal dispute resolution process	2	3	4	2	3	2.8	-3.83	14.6689
CSF # 33	Contractual motivation/incentives	4	5	21	4	5	7.8	1.17	1.3689
CSF # 34	Accurate initial cost estimates	9	5	12	9	5	8	1.37	1.8769
CSF # 35	Adequate planning and control techniques	2	6	0	2	6	3.2	-3.43	11.7649
CSF # 36	Minimal start-up difficulties	3	4	17	3	4	6.2	-0.43	0.1849
CSF # 37	The perceive value of the project	6	6	14	6	6	7.6	0.97	0.9409
CSF # 38	Lack of legal encumbrances	9	3	17	9	3	8.2	1.57	2.4649
CSF # 39	Minimized number of Public/government agencies involved	2	3	0	2	3	2	-4.63	21.4369
CSF # 40	Constraints imposed by end-users	3	2	20	3	2	6	-0.63	0.3969
CSF # 41	Government Involvement in providing a guarantee	8	5	10	8	5	7.2	0.57	0.3249
CSF # 42	Multi-benefit objective	5	3	1	5	3	3.4	-3.23	10.4329
CSF # 43	Stable macroeconomic conditions	4	3	13	4	3	5.4	-1.23	1.5129
CSF # 44	Sound economic policy	5	3	15	5	3	6.2	-0.43	0.1849
CSF # 45	Availability of a suitable and adequate financial market	7	5	15	7	5	7.8	1.17	1.3689
CSF # 46	Appropriate funding mechanisms	8	8	15	8	8	9.4	2.77	7.6729
CSF # 47	Confidence in project funding agencies	12	6	9	12	6	9	2.37	5.6169
Total ∑								331.6	280.078
Mean R								6.63	

Hypotheses: Hypotheses are as follows:

H_o: The owners, project managers, consultants/contractors, financiers and operators are mutually independent in the ranking of major portion of the success factors.

H_1: The owners, project managers, consultants/contractors, financiers and operators are not mutually independent in the ranking of major portion of the success factors.

Test statistic:. The test statistics were calculated using Equation 1. And Values of (Ri-R) are obtained from Table 1. The sum (Ri-R) is 331.6, the summation of $(Ri-R)^2$ is 280.078, and the mean of R is 6.63. With the value obtained, the Test statistics was calculated as follows:

$$\tau = \frac{\sum_{i=1}^{k}(280.0783)}{47\left(47^2-1\right)/12} \qquad (4)$$

$$\tau = 0.032$$

Decision rule: Significance statistic was calculated using Equations 2 and 3 as follows:

$$Sr = \sqrt{\frac{2(2x47+5)}{9x47(47-1)}} \qquad (5)$$

$$Sr = 0.1$$
$$Z = 0.032 / 0.1$$
$$Z = 0.32$$

To accept H_o, the test statistic should be less than the significance statistic; otherwise the null hypothesis is rejected. The null hypothesis is accepted since $0.1 < 0.32$. At a significance level (α) of 0.05 or 95% confidence interval, it can be deduced that owners, project managers, consultants/contractors, financiers and operators do not agree on the rankings of a major portion of the success factors. One reason for this is that each group is working towards their own interest in the procurement of Public-Private Partnership projects.

6. Conclusions, Implications and Recommendations

The main purpose of the study was to determine the critical success factors that could be used to successfully procure capital projects under P-P-P based on accumulated knowledge and judgment of experts including owners, project managers, consultants/ contractors, financiers and operators. The research helped in achieving the following objectives:

1. Investigate the CSF, and delineate into factor groupings for analysis purposes
2. Investigate the CSF according to different project participants (each participant provided a set of most important CSF based on their objectives)

The findings are clearly supported by the outcome of the hypothesis testing which was conducted using the project participants on all the identified success factors." The top ten factors that were considered the CSF are listed as follows:

1. Owner satisfaction with the delivered project
2. Clearly defined project mission, objective and scope definitions
3. Adequacy of plans and specifications
4. Lack of legal encumbrances
5. Appropriate funding mechanisms
6. Adequate planning and control techniques
7. Experience of Contractor/Consultant's team in P-P-P
8. Adherence to schedules, budget, quality, safety and environmental controls
9. Project Manager's commitment to establish budget and schedule
10. Effective communication throughout the project

The factors are listed in order of importance based on the analysis of the survey response in Expert Choice software. The top five on the list may be considered the most critical success factors. The critical success factors which are particular to the successful realization and delivery of P-P-P project based on the responses are as follows:

1. Perceived need identified with a well-defined purpose and objective
2. Early identification and selection of a viable project by the consortium is critical for project delivery
3. Adequate and accurate risk assessment by all parties involved, with the responsibility of managing each risk placed with the party most able to control them
4. Detailed guidelines based on past experience to explain the risk accepted by each party is critical for project delivery
5. Good communication between all team members through established links is a critical factor in P-P-P
6. Setting of objectives by all parties, and an agreement made before a contract is signed is a critical success factor for P-P-P project
7. Detailed guidelines based on past experience to explain the risk accepted by each party is a critical success factor
8. An unerring commitment from public sector management and civil servants with an appreciation for the private sector
9. A multi-disciplinary team with an experienced, skilled leader
10. Client with sufficient financial strength and ability to pay for all services being provided for the duration of the contract

From a practical and professional standpoint, these findings should influence policy development towards P-P-Ps and the manner in which partners go about the development of P-P-P projects. Since the utmost factor is owner satisfaction with the delivered project, this has important implications for the development of P-P-P at the conceptual stage.

Parameters that are of ultimate concern to the owner must be given the greatest attention. As long as the utmost factor is linked with the perceived need identified and there is a well-defined purpose and objective for the project, the project is likely to be successful. The study involved experts in the construction industry belonging to five major groups, namely owners, project managers, consultants/contractors, financiers and operators, with at least ten years' experience in the construction industry. One of the issues that emerged was that the greatest proportion of participants was from the consultant/contractor category followed closely by the financiers. Some of the issues that emerged from the findings relate specifically to the structuring of the financing and legislation for the procurement of P-P-P. As a result, construction management organizations can use those CSF to evaluate whether or not they should embark on development of capital projects.

This research study has focused on the procurement of capital projects for Public-Private Partnerships in general. Further research can be carried out on different projects with specific delivery systems, e.g. success factors for design-built, Built Operate Transfer, construction management, design-management, and research and development projects. By collecting data from different project delivery systems, researchers may unearth factors that are unique to the specific project delivery. The factor groupings used for the study include project participants, effective procurements, project implementation/characteristic, government guarantee, favorable economic conditions and available financial markets. In future investigations it might be possible to use different project objectives grouping the factors into project objectives including cost, time and quality. The methodological approach to this research was the Analytical Hierarchy Process based on the multi-critical decision method. Other multivariate techniques like regression can be used in further research using only the top few factors to gain further insight into critical success factors for procurement of capital projects.

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