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Evaluation of Project Critical Success Factors for Key Construction Players and Objectives

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ABSTRACT

Critical Success Factors (CSFs) are used to support and evaluate the success of a strategic and tactical approach in project implementation in order to increase the probability of success. This system is used by executors in project delivery to achieve improved performance capabilities with limited resources. The present paper aims to identify the impact of CSFs amongst the main elements involved in construction industry of projects in Iran (Owner, Contractor, and Consultant). Therefore, 41 CSFs-related indices based on present research conditions in Iran were selected and classified into five major categories: (1) Financial, (2) Interactive Processes, (3) Human Resources, (4) Contractual Arrangements, and (5) Project Characteristics. To analyze the CSFs of project, the required data were collected by questionnaire based on randomized sampling method by project managers, chief executive officers, and experts of construction industry of Owners, Contractors, and Consultant who have working experience in major projects in Iran. The results indicated that indices related to human resources group from the point of view of Owners and Contractors as well as the indices related to financial and project participants from the point of view of Consultant are the main success priorities in projects. Moreover, the indices of "adequacy of plans and specifications" and "Project manager competency" were chosen indices common in previous and present studies. The results of this study will provide the project managers with practical solutions in order to benefit the findings as guidelines for CSFs formation according to Construction projects in Iran.

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1. INTRODUCTION

The volume of construction activities is one of the main indices of development in a country. Thousands of billions of assets are annually spent directly or indirectly by state and private organizations of different countries for civil activities and infrastructure installations.

A construction project is a set of different events, expected or unexpected, which occur during the project life cycle and continues its life under the shadow of environmental changes. However, there are certain factors which bear double importance in the success of failure of a project. These factors are defined as critical success factors (CSFs). The CSFs are defined as "a set of environmental factors which affect the project's outputs. These factors may speed up or slow down the implementation procedure of a project, so project leads to its success or failure. However, these factors are not regarded as the basis of project evaluation [1].

According to PMBOK Standard (Project Management Body of Knowledge), a project is an exclusive effort to offer a range of products (output) within the limit of predetermined Time, Cost and Quality [2]. The projects are a set of activities which should be conducted within clear scope boundaries, specified time deadlines, approved cost, and quality service description. The exclusion of each of these 4 factors could lead to unsuccessful and uneconomic project. It is reasonable to assume that general CSFs ranking will be different in terms of involvement of different project participants and so it is intended as research hypothesis. The establishment of CSFs for project targets (Scope, Cost, Time, and Quality) enables the industrial actors to gain a better understanding of project success.

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On the other hand, lack of sufficient and comprehensive knowledge of CSFs makes the procedure of controlling, monitoring and performance of projects more difficult. So, the recognition of factors which affect the success or failure of projects, depending on the type of projects by project manager and project key personnel could provide them appropriate framework for the assessment of project outputs. Besides, the recognition of success factors could facilitate the proper management of resource allocation during the project lifetime [3]. The identified CSFs and key indices of performance could be developed to help the examination, evaluation and improved performance of project management as well. This controlling process authorizes the companies to adopt the most appropriate methods compared to others to support the continuous improvement and survival in competition [4].

2. RESEARCH BACKGROUND

2. 1. Critical Success Factors (CSFS) of Project The success of project for the individuals involved is defined as achievement of certain predetermined goals of project such as time, cost, performance, quality and safety. But, we should not forget that users and general public do not have such predetermined goals about project. So, everyone's expectations and perceptions of success or failure of the project will be different [1]. In other words, the project's success depends on correct scheduling of goals, achievement of true financial planning and controlling to reach a desirable quality. According to the researcher's interest in investigation of success topic, other similar researches were done in this field. Those studies can be found in similar articles [5-9]. Several studies conducted on specific aspects of construction projects include project partnership, impact of management and human resources on construction efficiency, success of the construction process by traditional method, type of construction contract methods, and contract disputes. There has been studies on project success management rather than studies on success of the whole project [10]. Regardless of theoretical and empirical studies, the success factors may also be identified by examining the real project [11].The application of neural network approach which implements the artificial intelligence program and simulates how the brain functions or remembers it, has led to the recognition of 67 success-related factors based on a professional survey focused on project purposes according to Table 1 [12]. A model to determine the contractor`s claims of construction projects has been studied by Gholhaki et al. [13].

2. 2. Consolidated Framework of CSFS for Construction Projects According to the traditional projects, the potentially conflicting interests among stakeholders can also influence the success of an eco-city. The government and International cooperation are also important participants in an eco-city, which can facilitate the exchange of information and technical expertise on environment policy and innovation [14, 15]. Moreover, for identifying CSFs of eco-city and analyze the inter-relationship among them, Liu et al. opined that ‘Clear definition and targets’, ‘conflicting interests among stakeholders’, ‘residents’ behavior and awareness of environment protection and energy conservation’ and ‘management in operation stage of eco-city’ were the most important CSFs for eco-city development in China [16].

TABLE 1. 67 success-related factors by project aspect based on study by Chua et al. [12]

Project aspect	Success-related factor
Project characteristics	(1) political risks; (2) economic risks; (3) impact on public; (4) technical approval authorities; (5) adequacy of funding; (6) site limitation and location; (7) constructability; (8) pioneering status; (9) project size
Contractual arrangements	(10) realistic obligations/clear objectives; (11) risk identification and allocation; (12) adequacy of plans and specifications; (13) formal dispute resolution process; (14) motivation/incentives
Projects Participants	(15) project manager competency; (16) project manager authority; (17) Project manager commitment and involvement; (18) capability of owner key personnel; (19) competency of owner proposed team; (20) owner team turnover rate; (21) owner top management support; (22) owner track record; (23) owner level of service; (24) capability of contractor key personnel; (25) competency of contractor proposed team; (26) contractor team turnover rate; (27) contractor top management support; (28) contractor track record; (29) contractor level of service; (30) capability of consultant key personnel; (31) competency of consultant proposed team; (32) consultant team turnover rate; (33) consultant top management support; (34) consultant track record; (35) consultant level of service; (36) capability subcontractor key personnel; (37) competency of subcontractor proposed team; (38) subcontractor team turnover rate; (39) subcontractor top management support; (40) subcontractor track record; (41) subcontractor level of service; (42) capability of supplier key personnel; (43) competency of supplier proposed team; (44) supplier team turnover rate; (45) supplier top management support; (46) supplier track record; (47) supplier level of service
Interactive Processes	(48) formal design communication; (49) informal design communication; (50) formal construction communication; (51) informal construction communication; (52) functional plans; (53) design complete at construction start; (54) constructability program; (55) level of modularization; (56) level of automation; (57) level of skill required; (58) report updates; (59) budget updates; (60) schedule updates; (61) design control meetings; (62) construction control meetings; (63) site inspections; (64) work organization chart; (65) common goal; (66) motivational factor; (67) relationships

Many developing countries face challenges to establish CSFs for public housing projects. Seven CSFs for PHPs in Nigeria was explained by Mukhtar et al. [17]. These factors were: (1) institutional framework for public housing, (2) availability of competent personnel, (3) effective project management, (4) good maintenance management practice, (5) appropriate design and good location, (6) effective housing finance system and (7) adequate political support. Also, the promotion of Green Buildings (GB) became a global trend and the CSFs of GB investigated. Shen et al. [18] presented the importance of 16 CSFs of green building industry in Thailand. Using factor analysis, these CSFs of green building can be grouped into five categories, namely competence of project participants, integration of GB project team, technical and management innovation, external environment, and project characteristics. The results indicated that: 1) enhancing both competence of individual participants and integration of a project team are critical in fulfilling tasks of green building; 2) favorable global and local economic conditions can create new demand and supply of green buildings, and economic environment can greatly impact on the green building industry. Yang et al. created a list of CSFs for China's build-operate-transfer (BOT) projects to help the government and project companies to achieve success of BOT projects [19].

This assessment shows that ten top factors in ranking analysis could play a useful role in the phases of preparing, bidding, constructing, operating and transferring BOT projects, which may be helpful for project companies and the government when making decisions. Sanvido et al. [20] implemented a research to determine the CSFs for construction projects using data by owner, architects, engineers and contractors interviews. Ahmed and Kangari [21] studied the factors recognized as important factors in contracting organizations by owner. Chan and Kumaraswamy [22] studied the prolongation factors of construction time in Hong Kong.

Iyer and Jha [23] conducted a research on CSFs affecting the cost performance in India projects. They reported the coordination among project participants as the most important CSF for cost performance. Another research by Pakseresht and Asgari identified and ranked the most important factors of success in construction projects of Pars Garma Co. by distributing questionnaires among 58 people including employees, managers and technical experts [24]. In the same year, a study was implemented by Adinyira et al. to identify the critical success factors in public housing projects in Ghana using the experiences of 13 experts in this area [25]. The success of the project based on the localizing the criteria redefined by Ghazi Moradi et al. [26]. The result determined the degree of importance of each criterion for the stakeholders. Contractor has the highest priority among other stakeholders for the criterion of completing the project base on the approved budget or the criterion of the monomial changes in the range of the project is more important for the contractor than other stakeholders.

Kog and Loh [27] conducted a study to recognize the CSFs from the points of view of different experts including civil and construction engineers, mechanical and electronical engineers, architectures and supervision organizations. After collecting the expertise discretion of 27 specialists of building industry and on the basis of Analytic Hierarchy Process (AHP), 10 superior CSFs were identified. Hong and Lim conducted a study to recognize the CSFs in construction projects of Singapore by distributing the questionnaires containing 32 CSFs between 12 experts holding at least 10 years of working experience as Owners, Contractors and Consultants [28].

Another study was conducted by Yong and Mustaffa [29] to recognize the success factors in Malaysia. In this research, 46 CSFs in Malaysia were studied by 48 experts including Contractors, Consultants and Developers. It also defined the project human resources, commitments and communications of executive members, management and controlling the executive procedure as CSFs. It is reasonable that general ranking of CSFs based on construction projects approaches differs amongst countries. Therefore, through recognition of CSFs for project purposes in previous studies, the recognition and computation of CSFs in construction projects in Iran were determined as the main goal in this study. This enables us to (1): avoid project failure, (2): identify promising projects and track them, and (3): identify problematic areas of projects to undergo the necessary corrective measures.

According to the traditional projects, the potentially conflicting interests among stakeholders can also influence the success of an eco-city. The government and International cooperation also brings important participants in an eco-city, which can facilitate the exchange of information and technical expertise on environment policy and innovation [14, 15]. Moreover, for identifying CSFs of eco-city and analyze the inter-relationship among them, Liu et al. [16] opined that 'Clear definition and targets', 'conflicting interests among stakeholders', 'residents' behavior and awareness of environment protection and energy conservation' and 'management in operation stage of eco-city' were the most important CSFs for eco-city development in China.

3. RESEARCH OBJECTIVE AND METHODOLOGY

The present paper is a practical (in terms of purpose) and descriptive survey (in terms of method). The selected factors related to success are basically extracted according to comprehensive research on identifying key factors of success in a project conducted by Chua et al in 1999 [12]. These selected factors were used not only in later studies but also in this case. 41 factors influencing project success in Iran were selected in 5 categories as presented in Table 2. These initial factors were resulted according to conditions governing the implementation of the project in Iran and the elimination of contradictions and differences in social, cultural and political conditions, and based on the gathering of comments through semi-structured interviews with experts and experts in the construction industry in the development of Iran.

Due to the sensitivity and importance of results, questionnaires were distributed among elected individuals with experience, expertise and knowledge in the management of construction projects. In general, the statistical populations are experts and leading managers of state, custodians of implementation and investment of country's projects including owner, professional consulting engineers and first and second rate contractors of construction projects of the country. Since the accuracy of ranking factors depends on the accuracy of input data, information of the construction was received from the experts as shown in Table 3. Among the total of ???? distributed questionnaires, 175 questionnaires were collected. Then, the data were examined and the invalid questionnaires were omitted. Finally, 137 questionnaires were analyzed. 35.8% of sample population had working experience as Owner, 32.8% as Contractor and 31.4% as Consultant (Figure 1). According to Figure 2, almost 65% of people have working experience of more than 15 years and 90% more than 10 years. Due to the importance of expertise in selection of CSFs of Construction projects in Iran, Figure 2 demonstrates that the collection of data required by experienced managers and executors agents in projects.

Validity is the most important feature of every test which shows the extent to which the test measures what it was designed for. In this study the reliability and validity were measured by Cronbach's alpha. According to the definition of Cronbach's alpha, we reach to the conclusion that 1: as the positive correlation between questions increases, the Cronbach's alpha will also increase and vice versa 2: as the variance of questions mean increases, the Cronbach's alpha will decrease 3: the increase in number of questions whether positive or negative, depending on the correlation between questions, will affect the level of Cronbach's alpha 4: increased sample size reduces the mean questions variance and increases the Cronbach's alpha. The value of Cronbach's alpha is calculated as 0.875 which signifies that the research questionnaire possesses desirable reliability.

4. DATA ANALYSIS AND RESULT DESCRIPTION

The qualitative research variables and the significance level lower than 0.05 obtained from Kolmogorov-Smirnov test indicate that the test is significant and the data are not normal. So, the Nonparametric Test was applied for data analysis.

The Chi-Square test was also used to examine the correlation between the variables. The primary premise of this test is that there is no significant relationship between the variables.

TABLE 2. 41 Selected success-related factors considered in the study

Project aspect	Success-related factor
Financial (8 Factors)	(1) adequacy of funding; (2) economic risks; (3) owner team turnover rate; (4) contractor team turnover rate; (5) consultant team turnover rate; (6) owner top management support; (7) contractor top management support; (8) consultant top management support
Interactive Processes (10 Factors)	(9) design complete at construction start; (10) constructability program; (11) report updates; (12) budget updates; (13) schedule updates; (14) design control meetings; (15) construction control meetings; (16) site inspections; (17) relationships; (18) common goal
Human Resource (8 Factors)	(19) project manager competency; (20) project manager authority; (21) project manager commitment and involvement; (22) capability of owner key personnel; (23) capability of contractor key personnel; (24) competency of contractor proposed team; (25) capability of consultant key personnel; (26) competency of consultant proposed team
Contractual Arrangements (5 Factors)	(27) realistic obligations/clear objectives; (28) motivation/incentives; (29) risk identification and allocation; (30) formal dispute resolution process; (31) adequacy of plans and specifications
Project Characteristics (10 Factors)	(32) impact on public; (33) constructability; (34) project size; (35) site limitation and location; (36) owner track record; (37) owner level of service;(38) contractor track record; (39) contractor level of service; (40) consultant track record; (41) consultant level of service;

TABLE 3. A Sample of the questionnaire

Name: …… **Corporation Name: ……**

Education Level: ……

Experience in project implementation: above 15 years□ between 10 and 15years □ between 5 and 10 years □ Under 5 years □

In which project organization have you worked? Owners (Client) □ Contractor □ Consultant □

The extent to which the success of the project depends on your experience

Item	Factors evaluated	Very low	Low	Average	High	Very high
Financial	adequacy of funding					
	economic risks					
	owner team turnover rate					
	contractor team turnover rate					
	consultant team turnover rate					
Interactive Processes	owner top management support					
	contractor top management support					
	consultant top management support					
	design complete at construction start					
	constructability program					
	report updates					
	budget updates					
	schedule updates					
	design control meetings					
	construction control meetings					
	site inspections					
	relationships					
	common goal					
Human Resources	project manager competency					
	project manager authority					
	project manager commitment and involvement					
	capability of owner key personnel					
	capability of contractor key personnel					
	competency of contractor proposed team					
	capability of consultant key personnel					
	competency of consultant proposed team					
Contractual Arrangements	realistic obligations/clear objectives					
	motivation/incentives					
	risk identification and allocation					
	formal dispute resolution process					
Project Characteristics	adequacy of plans and specifications					
	impact on public					
	constructability					
	project size					
	site limitation and location					
	owner track record					
	owner level of service					
	contractor track record					
	contractor level of service					
	consultant track record					
	consultant level of service;					

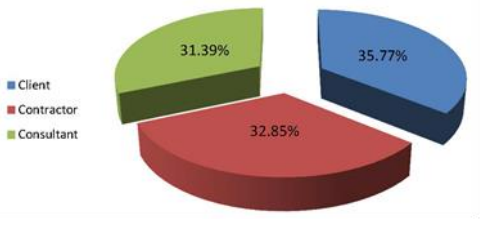

Figure 1. Distribution of participants' working experience in projects

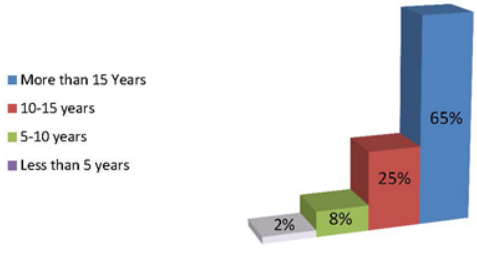

Figure 2. Distribution of respondents' executive background

With regard to Chi-square value and the significance level lower than α=0.05 (probability level of 95%), we come to the conclusion that there is a significant relation between criteria ranking.

The following sections show the results of analysis for criteria ranking based on average ranking of Friedman test for all data. The value calculated by Friedman test shows the criteria ranking in related group. The

Friedman test is the non-parametric alternative to the one-way ANOVA with repeated measures. It is used to test for differences between groups when the dependent variable being measured is ordinal. It can also be used for continuous data that has violated the assumptions necessary to run the one-way ANOVA with repeated measures. The bigger scores signify the higher ranking in related group.

4. 1. CSFs of Projects Related to Financial Aspect The present study evaluated 8 factors affecting the project success in financial aspect. The results of Table 4 demonstrate the Friedman Test scores amongst statistical populations. Table 5 also demonstrates the ranking of financial factors in entire population and separately by Owners, Contractors and Consultants.

Examination of Financial factors ranking shows that "adequacy of funding" was selected as the CSF and avocation by Contractors and Consultants. "Owner top management support" which has been selected the first CSF from the point of view of Owners is regarded as the second critical success factor amongst entire statistical population.

4. 2. CSFs of Projects Related to Interactive Processes Aspect The interactive processes in this study include 10 factors as the second part of project success. As shown in Tables 6 and 7, which respectively demonstrate the factors scores and ranking amongst different groups, the "relationships", "budget updates", and "construction control meetings" were evaluated as the most important indices in this section. Amongst the interactive processes factors, the Owners, Contractors and Consultants selected "relationships" as the critical success factor.

4. 3. CSFS of Projects Related to Human Resource Aspect Tables 8 and 9 represent the analysis of human resource-related factors in present study. As shown in Table 8, which demonstrates the factors ranking of this group, the selection of priorities related to success factors in diverse groups possess identical rankings, approximately. According to Table 8, the "capability of contractor key personnel" and "project manager competency" and regarded as critical success factor amongst these groups.

TABLE 4. Points gained by financial-related factors

Row	Factor	Friedman Test	Standard deviation	Score	Average
1	adequacy of funding	5.62	0.744	605	4.42
2	economic risks	4.87	0.737	569	4.15
3	owner team turnover rate	5.36	0.707	587	4.28
4	contractor team turnover rate	4.71	0.780	553	4.04
5	consultant team turnover rate	1.54	0.915	335	2.45
6	owner top management support	5.36	0.622	594	4.34
7	contractor top management support	4.93	0.769	570	4.16
8	consultant top management support	3.61	0.966	493	3.60

TABLE 5. Raking of Financial-related factors for all population and each project player

Success-related factor	All	Owner		Contractor		Consultant	
	Ranking	Friedman Test	Ranking	Friedman Test	Ranking	Friedman Test	Ranking
adequacy of funding	**1**	5.09	**4**	5.92	**1**	5.90	**1**
owner top management support	**2**	5.42	**1**	5.41	**3**	5.26	**3**
owner team turnover rate	**3**	5.32	**2**	5.44	**2**	5.31	**2**
contractor top management support	**4**	4.93	**6**	5.13	**4**	4.72	**5**
economic risks	**5**	5.09	**5**	4.99	**5**	4.50	**6**
contractor team turnover rate	**6**	5.10	**3**	4.14	**6**	4.85	**4**
consultant top management support	**7**	3.64	**7**	3.53	**7**	3.66	**7**
consultant team turnover rate	**8**	1.41	**8**	1.42	**8**	1.80	**8**

TABLE 6. Points gained by Interactive Processes-related factors

Row	Factor	Friedman Test	Standard deviation	Score	Average
1	design complete at construction start	5.81	0.710	562	4.10
2	constructability program	5.81	0.658	565	4.12
3	report updates	4.06	0.776	504	3.68
4	budget updates	6.01	0.794	572	4.18
5	schedule updates	5.29	0.776	548	4.00
6	design control meetings	5.46	0.689	555	4.05
7	construction control meetings	5.84	0.688	567	4.14
8	site inspections	4.89	0.734	533	3.89
9	relationships	7.07	0.695	608	4.44
10	common goal	4.76	0.810	525	3.83

TABLE 7. Raking of Interactive Processes-related factors for all population and each project player

Success-related factor	All		Owner		Contractor		Consultant	
	Ranking	Friedman Test	Ranking	Friedman Test	Ranking	Friedman Test	Ranking	
relationships	**1**	6.65	**1**	7.56	**1**	7.02	**1**	
budget updates	**2**	5.22	**8**	6.07	**2**	6.84	**2**	
construction control meetings	**3**	6.21	**2**	5.68	**3**	5.59	**5**	
design complete at construction start	**4**	5.74	**3**	5.59	**4**	6.10	**4**	
constructability program	**5**	5.62	**4**	5.57	**5**	6.27	**3**	
design control meetings	**6**	5.47	**6**	5.48	**6**	5.44	**6**	
schedule updates	**7**	5.62	**5**	4.87	**8**	5.36	**7**	
site inspections	**8**	5.37	**7**	4.54	**9**	4.72	**8**	
common goal	**9**	4.83	**9**	5.17	**7**	4.26	**9**	
report updates	**10**	4.26	**10**	4.49	**10**	3.40	**10**	

TABLE 8. Points gained by Human Resource-related factors

Row	Factor	Friedman Test	Standard deviation	Score	Average
1	project manager competency	5.19	0.632	600	4.38
2	project manager authority	4.32	0.670	568	4.15
3	project manager commitment and involvement	3.46	0.815	529	3.86
4	capability of owner key personnel	3.68	0.765	540	3.94
5	capability of contractor key personnel	5.85	0.587	630	4.60
6	competency of contractor proposed team	5.13	0.623	602	4.39
7	capability of consultant key personnel	4.29	0.748	564	4.12
8	competency of consultant proposed team	4.08	0.789	555	4.05

TABLE 9. Raking of Human Resource-related factors for all population and each project player

Success-related factor	All		Owner		Contractor		Consultant	
	Ranking	Friedman Test	Ranking	Friedman Test	Ranking	Friedman Test	Ranking	
capability of contractor key personnel	**1**	5.62	**1**	5.92	**1**	6.03	**1**	
project manager competency	**2**	5.58	**2**	5.00	**3**	4.95	**2**	
competency of contractor proposed team	**3**	5.18	**3**	5.51	**2**	4.67	**4**	
project manager authority	**4**	4.33	**4**	4.17	**5**	4.47	**5**	
capability of consultant key personnel	**5**	3.85	**6**	4.21	**4**	4.87	**3**	
competency of consultant proposed team	**6**	4.00	**5**	3.86	**6**	4.42	**6**	
capability of owner key personnel	**7**	3.84	**7**	3.70	**7**	3.47	**7**	
project manager commitment and involvement	**8**	3.60	**8**	3.63	**8**	3.12	**8**	

4. 4. CSFS of Projects Related to Contractual Arrangements The fourth part includes the analysis of contractual arrangements -related factors of success in projects which is conducted by five factors. Table 10 demonstrates scores of all factors using Friedman Test. Table 11 also represents the ranking of these factors amongst the statistical population and each project player.

Similar to Human Resource group, the priorities factors is this group also possess almost identical ranking. "Realistic obligations/clear objectives" and "risk identification and allocation" were selected as two superior and critical success factors in this research.

4. 5. CSFS of Projects Related to Project Characteristics Aspect 10 factors related to Project characteristics were studied and evaluated in this part. Table 12 shows the indices scores and Table 12 also demonstrates the factors ranking in this group amongst total population and from each project player. According to Table 13, "contractor track record", and "contractor level of service" were selected as two critical success factors by all groups.

5. DISCUSSION

To evaluate the CSFs of projects conducted in Iran compared to previous studies, the level of affectivity of 10 selected factors among 41 factors were calculated. Table 14 demonstrates ranking of these factors from the points of view of the total population and each project player.

TABLE 10. Points gained by Contractual Arrangements-related factors

Row	Factor	Friedman Test	Standard deviation	Score	Average
1	realistic obligations/clear objectives	4.00	.568	623	4.55
2	motivation/incentives	2.45	.723	511	3.73
3	risk identification and allocation	2.91	.757	546	3.99
4	formal dispute resolution process	2.75	.856	530	3.87
5	adequacy of plans and specifications	2.90	.727	544	3.97

TABLE 11. Raking of Contractual Arrangements-related factors for all population and each project player

Success-related factor	All		Owner		Contractor		Consultant	
	Ranking	Friedman Test	Ranking	Friedman Test	Ranking	Friedman Test	Ranking
realistic obligations/clear objectives	**1**	3.87	**1**	4.03	**1**	4.12	**1**
risk identification and allocation	**2**	2.84	**3**	2.86	**3**	3.03	**2**
adequacy of plans and specifications	**3**	3.21	**2**	2.91	**2**	2.52	**5**
formal dispute resolution process	**4**	2.62	**4**	2.84	**4**	2.80	**3**
motivation/incentives	**5**	2.46	**5**	2.36	**5**	2.52	**4**

TABLE 12. Points gained by Project Characteristics-related factors

Row	Factor	Friedman Test	Standard deviation	Score	Average
1	impact on public	4.13	.884	483	3.53
2	constructability	4.54	.778	503	3.67
3	project size	3.99	.916	478	3.49
4	site limitation and location	4.06	.840	486	3.55
5	owner track record	5.60	.775	542	3.96
6	owner level of service	6.09	.658	565	4.12
7	contractor track record	6.95	.625	596	4.35
8	contractor level of service	7.54	.676	613	4.47
9	consultant track record	6.50	.784	575	4.20
10	consultant level of service	5.58	.717	548	4.00

TABLE 13. Raking of Project Characteristics-related factors for all population and each project player

Success-related factor	All	Owner		Contractor		Consultant	
	Ranking	Friedman Test	Ranking	Friedman Test	Ranking	Friedman Test	Ranking
contractor track record	**1**	7.58	**1**	7.80	**1**	7.22	**1**
contractor level of service	**2**	6.60	**2**	7.28	**2**	7.01	**2**
consultant track record	**3**	6.45	**3**	6.08	**4**	7.00	**3**
owner level of service	**4**	6.15	**4**	6.09	**3**	6.03	**4**
owner track record	**5**	5.50	**6**	5.31	**5**	6.02	**5**
consultant level of service	**6**	5.67	**5**	5.28	**6**	5.80	**6**
constructability	**7**	4.47	**7**	4.53	**8**	4.63	**7**
impact on public	**8**	4.02	**10**	4.64	**7**	3.72	**10**
site limitation and location	**9**	4.43	**8**	3.93	**10**	3.78	**9**
project size	**10**	4.12	**9**	4.06	**9**	3.78	**8**

TABLE 14. Raking of 10 top critical success factors for all population and each project

Success Factor	All	Owner	Contractor	Consultant
capability of contractor key personnel	**1**	**1**	**1**	**1**
realistic obligations/clear objectives	**2**	**4**	**2**	**2**
contractor track record	**3**	**2**	**3**	**5**
relationships	**4**	**6**	**4**	**4**
competency of contractor proposed team	**5**	**5**	**5**	**13**
adequacy of funding	**6**	**14**	**6**	**3**
project manager competency	**7**	**3**	**8**	**11**
contractor level of service	**8**	**9**	**7**	**10**
owner top management support	**9**	**7**	**10**	**7**
owner team turnover rate	**10**	**10**	**9**	**6**

Comparison of the results of present study with the results of similar studies conducted by Ashley et al. [30], Chue et al. [12], Kog and Loh [27] and Hawng and Lim [28] in Singapore showed that the indices of "realistic obligations/clear objectives" and "project manager competency" were the selected common in 10 critical success factors in previous studies by the experts of different countries [12, 19, 27-29]. Another comparison between critical success factors of present study in Iran with CSFs in implementation of constructional projects in Malaysia conducted by Yong and Mustaffa showed that the five critical success factors of "adequacy of funding" , "project manager competency", "owner top management support", "capability of contractor key personnel" and "competency of contractor proposed team" amongst the 10 top critical success factors of Malaysia are consistent with ranking calculated in this research. The consistency could be due to developing situation in two countries and commonalities in projects locations between the two countries. Table 15 shows the CSFs identified in present and previous studies. According to the findings of this study, the two factors affecting the project success in Iran are similar to the conditions governing the success of the projects of other countries. This subscription the selection of key factors influencing project success has reached 50% (5 out of 10 selected agents) according to the nature of the progressive development between Iran and Malaysia.

With regard to the importance of each aspect in development of construction projects in Iran, several superior factors amongst 10 top critical factors associated to each "Financial, Interactive Processes, Human Resource, Contractual Arrangements, and Project Characteristics" were studied. Table 16 shows that the results of this study were separately identified according to respondent aspect. As shown in Table 16, under the new conditions, the execution of construction projects in Iran, most of the factors among dozens of critical success factors of projects are the categories of financial and human resources which signifies the importance of human resource related indices similar to important financial issues.

TABLE 15. Comparison of CSFs in different studies

CSFs	This study	Hawng and Lim [28]	Yong and Mustaffa [29]	Kog and Loh [27]	Chue et al. [12]	Ashley et al. [30]
political risks			*		*	
adequacy of funding;	*	*				
site limitation and location				*		
constructability			*	*	*	
realistic obligations/clear objectives	*		*	*	*	*
risk identification and allocation			*			*
adequacy of plans and specifications		*	*	*	*	
motivation/incentives			*	*	*	
project manager competency	*	*		*	*	*
project manager commitment and involvement				*	*	*
owner team turnover rate	*					
owner top management support	*	*				
owner level of service						
capability of contractor key personnel	*	*				
competency of contractor proposed team	*	*				
contractor track record	*					
contractor level of service	*					
capability of consultant key personnel		*				
schedule updates			*			
design control meetings			*			
construction control meetings			*		*	
site inspections		*	*		*	
relationships	*					

TABLE 16. Categories of 10 top critical factors amongst the main aspect

Success Factor	All Population	Owner	Contractor	Consultant
Financial	**3**	**2**	**3**	**3**
Interactive Processes	**1**	**2**	**1**	**2**
Human Resource	**3**	**3**	**3**	**1**
Contractual Arrangements	**1**	**1**	**1**	**1**
Project Characteristics	**2**	**2**	**2**	**3**

On the other hand, the present study shows that major success factors related to human resources amongst CSFs belong to owners and contractors` group, while the number of CSFs in project characteristics group is more important for the Consultants of a project. One probable explanation for such difference in point of view is that construction of a project is based on the efforts and workshop involvement of individuals of people, owner's agents and contractors at implementation phase of project. As a result, these physical interactions and interactive mechanisms could lead to selection of competent priorities and capabilities of executive agents in these groups. On the contrary, these activities, which are conducted by Consultants in order to design and create new ideas for implementation of a project, practicing the different ideas of architect engineers and solving the administrative problems at construction time, require more efficiency of results prepared by Consultants and preparation of services for project users. They are the serious avocations of Consultants for the success of a project.

The analysis also showed that the role of owners in project success is increasing. The project achievements are the results of direct involvement of owners and owner in management and delivery of project. The owner and employers make critical decisions and provide positive management. The current procedure to reduce the exclusive performance of organization, owner and owner in planning, engineering and constructional operations is quite different from the traditional management in the past. The presence of different agents and factors makes it necessary for owners to be involved in process of success [30].

6. CONCLUSION

The present paper was conducted to identify the CSFs from the aspects of different agents and factors of project. For reaching these purposes, 41 success factors were identified and selected based on the previous studies and semi-structure interviews with experts in construction industry in Iran. These factors were classified into five categories 1- Financial, 2- Interactive Processes, 3- Human Resource, 4- Contractual Arrangements, and 5- Project Characteristics .

Then, for ranking and measurement of selected factors from the points of view of owners, contractors and consultants, the related questionnaires were distributed amongst the managers and experts of construction projects in Iran. The results showed that human resource related factors are important CSFs from the point of view of owners and contractors, while the project characteristics related factors are the most important factors from the point of view of consultants. Therefore, it is seen that for owners and contractors, the competent human resource is a really vital aspect for success of project. These two different perspectives of ranking are quite different due to the different roles of these groups in projects and dominant insight in construction atmosphere and project implementation amongst owners, contractors, and consultants in Iran. This environment caused the manifestation of different experience and dissimilar judges about definition of CSFs.

It is evident that construction environment in Iran, unlike traditional methods, has been influenced by a pattern which changes its focus towards the selection of capable and competent human resources. The success of construction projects depends on a combination of factors related to human resources, project management and interactive processes at the time of project implementation. The participants, depending on these factors, have different benefits in a project. But as a general rule, they should be in agreement with project purpose and certain key elements which lead to project success. Unlike disagreement in general ranking of CSFs in previous studies, the critical success factor of "realistic obligations/clear objectives" and "project manager competency" were regarded as common critical success factors amongst these researches. The results also indicated that due to developing situation of Iran and Malaysia, half of the 10 top CSFs of projects in previous studies were common in these two countries .

The present study could offer practical uses for project leaders. They could apply these uses as guidelines to form CSFs according to the order and specification of the customers for their projects. They could also compare the CSFs identified in this study with real CSFs of previous studies.

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Evaluation of Project Critical Success Factors for Key Construction Players and Objectives

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چکیده

شناسایی عوامل کلیدی موفقیت در یک پروژه، رویکردی استراتژیک و تاکتیکی جهت بالابردن احتمال موفقیت در زمان اجرای آن است. این سیستم در تحویل پروژه‌ها و برای بهبود عملکرد توانمندی‌ها در کنار منابع محدود، مورد استفاده مجریان قرار گرفته است. این مقاله به شناسایی میزان تاثیر عوامل کلیدی موفقیت در بین ارکان اصلی دخیل در صنعت ساخت پروژه‌های کلان عمرانی در کشور ایران می پردازد. برای دست‌یابی به این هدف، ابتدا ۴۱ عامل از عوامل مهم موفقیت براساس شرایط ساخت پروژه‌های عمرانی کشور ایران در پنج دسته ۱- مالی، ۲- فرآیندهای تعاملی، ۳- نیروی انسانی، ۴- تنظیمات قراردادی و ۵- خصوصیات ماهیتی پروژه انتخاب شدند و از طریق پرسشنامه به شیوه نمونه‌گیری تصادفی از بین مدیران پروژه و مدیران ارشد اجرایی کارفرمایان، پیمانکاران و مشاوران و خبرگان صنعت ساخت، که دارای سابقه کاری در اجرای پروژه‌های بزرگ در کشور ایران بوده اند، اطلاعات لازم برای شناسایی عوامل کلیدی موفقیت پروژه، جمع آوری گردید. نتایج حاصل از این بررسی که بر روی قراردادهای ساخت به شیوه سه عاملی صورت گرفته، نشان می‌دهد که عوامل مرتبط با نیروی انسانی از نظر کارفرمایان و پیمانکاران و عوامل مرتبط با خصوصیات ماهیتی پروژه و مالی از نظر گروه مشاوران به عنوان اولویت‌های اصلی در بین عوامل موفقیت پروژه‌ها می باشند. همچنین، "درج تعهدات واقع گرایانه و شرح خدمات و اهداف مشخص در قرارداد" و "صلاحیت حرفه‌ای مدیر پروژه کارفرما" به عنوان عوامل کلیدی منتخب در بین پژوهش‌های گذشته و این تحقیق شناسایی شده است. نتایج این بررسی می‌تواند به عنوان راهنمایی برای لحاظ کردن و در نظر گرفتن عوامل کلیدی موفقیت در زمان اجرای پروژه و افزایش سطح تحقق موفقیت پروژه مطابق شرایط کشور ایران، مورد استفاده رهبران و مدیران پروژه قرار گیرد.

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