Determining the Critical Success Factors in Construction Projects: AHP Approach

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Abstract
The purpose of this study is identifying and ranking the critical success factors in construction projects of Pars Garma Company. In order to identify these factors, this study was planned and performed in two stages. At the first stage to identify the critical success factors a questionnaire was made and distributed among 58 people of staff managers, project managers and technical experts of Pars Garma Company. Then data obtained from the distributed questionnaires was analyzed using Z-test and SPSS 16 software. At the second stage by omitting low-effect factors, a questionnaire was designed based on AHP method to collect the opinions of experts and distributed among 15 persons of the organizational experts. The returned questionnaires of this stage were analyzed by Expert Choice software. The research findings indicate that the critical success factors in construction projects have different priorities and weights. Also, considering the importance, the critical success factors are respectively: Technical and economic assessment of the project required resources, experience and executive records of project manager, project strategic planning and executive experiences of contractor team about the project subject.

Keywords: Critical Success Factors, Project programming, Analytical Hierarchy Process (AHP)

Introduction
Those measures which result in the organization success are called the critical success factors. \cite{7}

Of course since every organizations circumstances is unique, identifying the critical factors has been the subject of several studies. \cite{1}

So, by identifying and ranking the critical success factors, this research purpose to give a solution for the executive planning of the project of Pars Garma construction and industrial company. It is obvious that identifying and ranking the critical success factors of this supreme company, which works in various fields like construction of dam, irrigation and drainage networks, road construction, bridge construction, tunnel excavation, construction of concrete and metal heavy building, and mass construction of the residential buildings in

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cooperation with Ministry of Defense. Roads and Urban Development, Energy, Oil, Social Security Organization, Organization of Construction Engineering and Tehran Municipality, could result in achieving reliability and more desirable record and lead to this organization’s more success.

Thus, identifying the factors could not provide the organization’s success solely.

The critical success factors are indicative of the subjects which could make the organization successful; if there is deficiency or lack in these fields, the organization would fail in achieving its goals.[2]

The organizations should concentrate on the more efficient factors or so-called the critical success factors considering their restrictions.

In line with it, the main purpose of this research is recognizing the effective factors in the success of Saba Residential Tower Project and comparing it to the other projects of Pars Garma Company and also weighting and prioritizing them as the critical success factors of construction projects programming of this company.

**Literature Review**

Ronald Daniel was among the first experts who offered the critical success factors as the business guidance for the first time in 1961. In his opinion there are three to six critical factors which determine the success in all industries.

Among the next experts, Rockart contributed in the field of introducing the critical success factors more than other researchers.

In 1986 Ashley identified these seven factors as the success factors:

1. Construction activities programming
2. Design planning
3. Project manager commitment to the goals
4. Project team motivation
5. Project manager technical capabilities
6. Control systems
7. Definition of work and its field

He also identified theses six criteria as the success criteria: [3]

1. Budget performance
2. Schedule performance
3. Employer satisfaction
4. Task-orientation
5. Contractor satisfaction
6. Project manager satisfaction

It is noteworthy that the differentiation between success criteria and success factors is also important. The success criteria are the measures based on which the project success or failure is judged; while the success factors are those entered into the management systems and result in project success directly or indirectly.[5]
Then in 1987, Pinto and Slevin offered a project model and ten determining factors as below:

Project mission, scheduling, technical tasks, user consultant, user reception, feedbacks and reports, communications, fault detection, senior manager support, personnel (requirement, employment and training).

In 1996 Walid Belassi and Tukel Oya Icmeli also divided the critical success factors into four main groups in a new format: [10]

1. Project dependent factors
2. Team members and project manager dependent factors
3. Organizational structure dependent factors
4. External environment dependent factors

Studying the results proves that the project manager, management skills, team members, teamwork, their technical filed, project properties, viable environmental factors could be considered as the organization’s critical success factors; although the degree of these factors’ significance varies from one industry to another one. While in the information system of management and construction projects, project managers, management skills are the most important key factors and the environmental factors influence and conduct the construction tasks.

In an empirical survey on the relationship between project planning and project success, Dov Dvir declared that there is a certain and positive relationship between the amount of effort in determining the project’s goals, job requirements and product’s technical features on one hand and project success on the other hand and no effort should be spared in the first stage of the project to define the receivable requirements and goals, and this demand is not met without involving the customer or the final beneficiary in the processes. [6]

Adnane Belout and Clothilde Gauvereau considered the following four dimensions as the success factors in 2003:

1. Project Result
2. Customers effects
3. Commercial success and conduction and preparation for the future
4. Identifying the beneficiary groups (stockholders, managers, customers and personnel) which are significant as well as critical success factors until different people wants to see success in different ways. [4]

In 2004 Nguyen et al. identified five critical success factors among the twenty factors of projects success:

1. Competent project manager
2. Providing adequate financial resources to the end of the project
3. Competent and multidisciplinary project team
4. Commitment to the project
5. Access to resources

Muhammad Sagib et al. researched about construction projects in Pakistan and succeeded to identify 77 factors in 7 different groups and finally achieved to the prioritization of 10 critical success factors in construction projects of Pakistan. [8]

Some researches which were done in Iran to identify the critical success factors in project are as below:
1. Mehrdad Madhoushi did a research on “analysis of the factors of projects success or failure and offering a prediction model” to obtain a Ph.D. in management. In this research, a project which is completed in the framework of the determined time and budget and the function in question and meets the expectations of the manager, user or client, is defined as a successful project. 68 variables, which influence the project success/failure were defined and classified in 9 variable groups. In this research developed and updated Likert scale was used as the measurement tool. Evaluation of this tool confirmed its reliability and validity. Success prediction model was developed based on the critical and key factors and its validity was examined.

2. Rahele Nourifar did a research entitled “identifying the critical success factors of Iranian project managers- case study” in the 2nd international conference of project management which was held on March 5-6, 2006. This paper discusses the findings of case study about the experiences of active people in the field of project management in Iran. This study was in the form of questionnaire which was sent to the project managers of governmental and non-governmental organizations. Every respondent was asked to report the ways, methodologies, tools and techniques of project management and also judge the effect of these factors on achieving the desired project result. The results show people used a small number of these ways, methodologies, tools and techniques of project management and Gantt chart was been used by them widely. “on-time performance of the project”, “project completion considering the determined budget” were the criteria based on which they judge about the project success. Also, three factors of “realistic schedule” “appropriate and adequate resources and budget allocations” and “clear project objectives” were considered as three critical success factors in project.

3. Milad Ebtehaj and Hamidreza Afshari, M.A. students in Industrial Management at Tehran University, did a research entitled “evaluation of critical success factors in projects based on Belout model in MAPNA Company” in the 2nd international conference of project management held on March 5-6, 2006, which indicates that the importance of personnel factor was studied in the territory of MAPNA Company, considering the strategic importance of human resources and the necessity of identifying the role of personnel factor in the project’s success. The obtained results confirm the previous results in addition to adjust them relatively. MAPNA Company operation was also evaluated based on Belout success factors model and the cognitive differences were studied in the different levels of the organizational structure, considering the basic criteria of the model. Company operation was evaluated relatively positive in implementation and following up the basic criteria which are acceptable by the organization’s people. But, an important cognitive gap was identified in the triple structural levels and the necessity of paying attention to which, was recommended in the strategic approaches of the organization.
Research Conceptual Model

The conceptual model of this research is based on Fred R. David’s cycle of critical success factors which is shown in figure 1.

Figure 1. Cycle of Critical Success Factors

![Diagram of Critical Success Factors]

Figure 1 shows that identifying the critical success factors is needed for strategic planning; identify the factors an appropriate strategy could be planned by determining the criteria and consequently by process of studying the critical factors.

Of course based on this approach and using the previous researches and experts opinion, to identify the critical factors the hierarchical structure consists of levels of objectives, criteria and choices as below:

First Level: Objective

Identifying the critical success factors and ranking them is the objective of this research.

Second Level: Criteria

To achieve this level’s criteria, interview with project managers was done in addition to studying the principals of construction projects contracting and library resources. Finally seven criteria were selected:

1. Effective factors in project management
2. Employer related factors
3. Project logistics related factors
4. Consultant design team related factors
5. Contractor related factors
6. Project manager related factors
7. Environmental factors related to the project’s business environment
Chart 1. Decision making hierarchical structure of selecting the critical success factors in construction projects

**Third Level**
- Project Strategic planning
- Project Control Management
- On-time Decision Making Mechanism
- Executive Application of Indexes of Project Management Body Of Knowledge (PMBOK)
- Effective Implementation of Safety, Health and Environmental Standards
- Technical and Economic Assessment of the Project Required resources
- Mechanism of Forming an Experienced Technical-Legal Team at the Time of Contract
- Prioritization of Purchasing the Needed Items Considering the Project Schedule
- Clear and Precise Definition of Project Objectives by Employer
- Capability of On-Time Decision Making (Employer's Agent in Project)
- Using Experts Consultants to Design and Prepare the Project Executive Maps
- Mechanism of Financial Payment in relation to the Project Commitments & plan
- Experience of Consultant Design Team
- The amount of Graduate Studies in feasibility Stage to Decrease the Future Project Problems
- The Accuracy of Plan Analysis and Evaluation by Design Team
- Reducing the Errors and Inconsistencies of the Plans of Project's Second Phase
- Executive Experiences of Contractor Team about the Project Subject
- Mechanism of Evaluating and Confirming the Competence of the Sub Contractors Before Signing the Contract
- Mechanism of Identification and Management of Project Risks
- Mechanism of Appropriate Utilization to Increase the Efficiency of Project Machineries and Equipments
- Experience and Executive Records of Project Manager
- Ability of Coordination and Principled Agreements with Consultant and Employer's Agent in Meetings
- Ability of Analyzing the Project problems
- Authorizations in Financial Decision Makings and Cost Control Considering Project Type and Size
- Providing a Safe Working Environment for Employees
- Taking Inflation and Economic Crisis in Financial Programming and Evaluating into Consideration
- Preserving and Improving the Natural Resources and Decreasing the Environmental pollution of the Project Region

**Second Level**
- Project Management
- Logistics
- Employer
- Design Team
- Contractor
- Project manager

**First Level**
- Critical Success Factors in Project
- Environment and Business Environment
Third Level: Options
After examining the validity and reliability the Options (of the questions) related to every criterion, were also included in the questionnaire.

Methodology
This research is descriptive in terms of implementation and practical in terms of objective. The tools of gathering data are two questionnaires. The first questionnaire includes 32 questions in Likert type scale which identifies the critical success factors. The second questionnaire, which was distributed among the research experts after the first one, was in the form of AHP questionnaire and was designed for weighting the criteria and indexes related to the critical success factors.

The statistical population of this research consists of 100 people including the staff managers in the central office, project managers and technical experts in executing the company’s projects, client’s agent (employer and consultant) based in projects. The statistical population of Saba Residential Tower project consists of 35 people who are used for the critical success factors of Saba project and other projects of the company. Pars Garma Construction and Industrial Company currently have 7 active projects countrywide which human resources consists of 350 people directly and 700 people indirectly.

It is noteworthy that Cochran formula was used to calculate the appropriate and needed number. In Cochran formula:

\[ n = \frac{\left( \frac{t^2pq}{d^2} \right)}{1 + \left( \frac{t^2pq}{d^2} \right)} \]

Consequently:

\[ n = \frac{\left( \frac{(1.96)^2(0.9)(0.1)}{(0.05)^2} \right)}{1 + \left( \frac{(1.96)^2(0.9)(0.1)}{(0.05)^2} \right)} = 58 \]

Analysis of the Finding
To analyze the obtained data of the first questionnaire, the software package of SPSS16 and to extract the weights related to the second questionnaire, the Expert Choice software was used. The data of the first questionnaire was examined by “z” test in the level of 95% and the factors the mean of which was less than 3 were omitted. Then they obtained criteria of the first questionnaire regulate in the form of an AHP questionnaire and the experts’ opinions were collected and analyzed using the Expert Choice software. Table 1 shows the weights of the second level criteria of critical success factors. According this table, in the experts’ viewpoint the project’s logistics is the most important one. Project management is in the next place and paying attention to the business environment is in the last place.

It should be mentioned that the consistency rate of this model is 0.04
Table 1. The weights of the second level criteria of critical success factors

<table>
<thead>
<tr>
<th>Name of criteria</th>
<th>Weight (percentage)</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project management</td>
<td>22.3</td>
<td>2</td>
</tr>
<tr>
<td>Logistics</td>
<td>24.1</td>
<td>1</td>
</tr>
<tr>
<td>Employer</td>
<td>13.2</td>
<td>4</td>
</tr>
<tr>
<td>Consultant design team</td>
<td>6.0</td>
<td>6</td>
</tr>
<tr>
<td>Contractor</td>
<td>12.0</td>
<td>5</td>
</tr>
<tr>
<td>Project manager</td>
<td>18.9</td>
<td>3</td>
</tr>
<tr>
<td>Business environment</td>
<td>3.5</td>
<td>7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>100</strong></td>
<td></td>
</tr>
</tbody>
</table>

Consistency Rate = 0.04

The output results of the software (the weight of the third level sub criteria), which shows the prioritization of the effective factors in the success of Pars Garma Company’s construction project based on weight percentage, are presented in table 2.

Table 2. The effective factors in the success of Pars Garma Company’s construction projects

<table>
<thead>
<tr>
<th>No.</th>
<th>Critical Factors</th>
<th>% Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Technical and economic assessment of the project required resources</td>
<td>14.5</td>
</tr>
<tr>
<td>2</td>
<td>Experience and executive records of the project manager</td>
<td>10.2</td>
</tr>
<tr>
<td>3</td>
<td>Project strategic planning</td>
<td>8.8</td>
</tr>
<tr>
<td>4</td>
<td>The executive experience of the contractor team about the project subject</td>
<td>6.5</td>
</tr>
<tr>
<td>5</td>
<td>Ability of on-time decision making (employer’s agent in project)</td>
<td>6.3</td>
</tr>
<tr>
<td>6</td>
<td>Project control management</td>
<td>6.1</td>
</tr>
<tr>
<td>7</td>
<td>Prioritization of purchasing the needed items considering the project schedule</td>
<td>5.0</td>
</tr>
<tr>
<td>8</td>
<td>Mechanism of forming an experienced technical-legal team at the time of contract</td>
<td>4.6</td>
</tr>
<tr>
<td>9</td>
<td>Authorization in Financial decision makings and cost control considering project type and size</td>
<td>3.7</td>
</tr>
<tr>
<td>10</td>
<td>Mechanism of financial payment in relation to the project commitments and Plan</td>
<td>2.9</td>
</tr>
<tr>
<td>11</td>
<td>Effective implementation of safety, health and environmental standards</td>
<td>2.8</td>
</tr>
<tr>
<td>12</td>
<td>Experience of consultant design team</td>
<td>2.7</td>
</tr>
<tr>
<td>13</td>
<td>Ability of analyzing the project problems</td>
<td>2.6</td>
</tr>
<tr>
<td>14</td>
<td>Mechanism of on-time decision making</td>
<td>2.4</td>
</tr>
<tr>
<td>15</td>
<td>Ability of coordination and principled Agreements with consultant and employer’s agent in meetings</td>
<td>2.4</td>
</tr>
<tr>
<td>16</td>
<td>Providing a Safe Working Environment for Employees</td>
<td>2.4</td>
</tr>
<tr>
<td>17</td>
<td>Executive Application of Indexes of Project Management Body of Knowledge (PMBOK)</td>
<td>2.2</td>
</tr>
</tbody>
</table>
Mechanism of evaluating the and confirming the competence of the second hand contractors before signing the contract

Clear and precise definition of project objectives by employer

Using Experts Consultants to Design and Prepare the Project Executive Maps

Mechanism of appropriate utilization to increase the efficiency of project machineries and equipments

Mechanism of identification and management of project risks

The amount of graduate studies in feasibility stage to decrease the future project problems

Taking Inflation and economic crisis in financial programming into consideration

The accuracy of plan analysis and evaluation by design team

Reducing the errors and inconsistencies of the plans of project’s second phase

The critical success factors obtained from the 10 top effective factors in construction project success are as below:

**Table 3. The critical success factor of Pars Garma Company’s construction projects**

<table>
<thead>
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</tr>
</tbody>
</table>

**Conclusion**

Regarding the completed research, the critical success factors in Pars Garma Company and the obtained results of this research, the conclusions are as below:

- By more concentration on these factors, their effectiveness could be maximized.
- These factors assist the managers in utilizing the resources and facilities and consequently reforming their use pattern.
- They accelerate organization’s success achievement by faster removing the existing barriers, especially in competitive conditions.
They prevent probable perceptual errors and imaginations of the managers based on the importance of some factors to other factors and realize the factors prioritization and impede the realization of various errors.

They help the organization to implement the strategic plans successfully.

**Recommendations**

Considering the obtained results of this research, the followings are recommended:

1. Spending enough time for the studies known as phase zero and ensuring the precise studies which leads to save the time, cost and quality of doing the projects.
2. Surveying the technical-economic briefing report and providing projects’ credit by the employer or beneficiary.
3. Preparing the technical features, maps, and binding and technical documents
4. Prediction the necessary guarantees for doing the obligations of the contracting parties and considering the damages resulting from not accomplishing the commitments
5. Guaranteeing the payment of construction projects statements by finance and credit institutions and project insurance; of course, accomplishment of this task depends on the regulatory approvals and development of Iranian capital markets
6. The necessity to document the technical knowledge and experiences in the implementation of Iranian construction projects
7. Need assessment and education planning for empowering the effective and key employees, in line with strategy and critical success factors. Holding course of knowledge management concepts and principles based on PMBOK standard is recommended.
8. Determining an especial team/committee, selected from the central office and senior authorities in every project, to survey and follow up the results of critical success factors in project (the recommended name: revision committee; it is offered to form in the periods of 6 months).
9. Forming a committee named CRM (Customer Relationship Management) in the central office, to follow the customers’ feedback in order to increase the key customers’ satisfaction.
References


