EVALUATION OF CRITICAL SUCCESS/FAILURE FACTORS
IN EPC PROJECTS

Niken A. Savitri; I Nyoman Pujawan
Department of Industrial Engineering, Faculty of Industrial Technology
Sepuluh Nopember Institute of Technology, Surabaya

ABSTRACT

In order to achieve the success of a project, we must concern about the factors that especially affecting the execution of the project. The factors that are considered critical in affecting the projects are usually known as Critical Success Factors. Critical Success Factors identify the means that are important to meet the preferred expectation of customers.

EPC stands for Engineering, Procurement and Construction. Each stage has a group of activities that is limited by time, cost and performance. Apparently, there is an ambiguity in determining whether the project is a success or a failure. One of the reasons is lists of success or failure factors vary in various studies in the literature. Furthermore, many of these factors do not, in practice, directly affect project success or failure.

To address those problems, Belassi and Tukel (1996) have done a research and gathering information about critical success or failure factors. The factors were illustrated in a framework that can be used to determine the critical success or failure factors in projects. This research was performed in order to identify the critical factors affecting the success/failure of EPC project. The result of this research is a framework that can accommodate the critical factors affecting the project. In this framework, the critical factors are classified into group factors according its characteristics. Generally, there are eleven group factors that are considered critical in affecting the EPC project, such as the factors related to project manager, team members and client. This framework is expected to illustrate the critical factors affecting the project and to be used in determining the critical factors of the project.

Keywords: EPC project, critical factors, project failure

INTRODUCTION

A success of a project is usually determined based on the constraints of cost, time and quality. Generally, when a project could meet its goal within defined time, defined budget and with the appropriate quality, the project is determined as a successful project. The success of the project can also be defined as an achievement of customer’s satisfaction, whether the customer belongs to internal customer or external customer. EPC as a kind of projects stands for Engineering, Procurement and Construction. Each stage has a group of activities that is limited by time, cost and resources according to contract that has been agreed. Like other projects, the success or failure of EPC project is usually determined by criteria mentioned above: cost, time and performance.

Apparently, there is an ambiguity in determining whether the project is a success or a failure. One of the reasons is lists of success or failure factors vary in various studies in the literature. Furthermore, many of these factors do not, in practice, directly affect project success or failure.
This research was performed in order to identify the critical factors affecting the success/failure of EPC project. This research is held by evaluating the monthly reports and minutes of meeting. Some questionnaires were also distributed to support the information that has been gathered. The result of this research is a framework that can accommodate the critical factors affecting the project.

LITERATURE REVIEW

In their paper, Sommers and Nelson (2001) determined a list of Critical Success Factors of ERP implementation projects of vary organizations. The research was carried out by distributing some questionnaires to appropriate respondents of some companies which, in the present time, was implementing the ERP system. The result was a list of Critical Success Factors, which the four highest rank factors consist of: Top Management Support, Project Team Competence, Interdepartmental cooperation and Clear Goals and Objectives.

While in 2004, Torp fetal (2004) reported that Project Organization and Management, Contract Strategy and Project Planning and Control were found highly associated to the Critical Success Factors of projects in Norway. They performed a research among 14 projects and have found out that, even though Top Management support and Objective definition are identifies important in the literature, generally it’s not visible enough in the result of the case studies. Instead, there are five other factors that are considered to be more critical in affecting the execution of the project, which are project organization, contract strategy, project planning and scheduling, stable framework conditions and stakeholder management.

Proboyo (1999) identified the factors that are considered affecting the lateness of construction project. By distributing questionnaires through 28 respondents, Proboyo assured the factors from the literature as the factors that are critical in affecting construction project. There are six categories of factors identified with the most critical one is the readiness of the project resources.

Belassi and Tukel (1996) have grouped the critical factors from some of the previous studies into four main groups of factors:

- Factors related to the project
- Factors related to the project manager and the project team
- Factors related to the organization
- Factors related to the external environment

The four main groups are then developed into a simple framework that will show the influences of each factor to the others, and the relationship between the factors and the system or the project itself. The framework is developed based on the survey performed. The project managers were asked to identify critical factors for the successful completion of their projects. The framework developed by Belassi and Tukel (1996) is shown on the figure below.

Even though the framework could illustrate the factors that are considered critical in affecting the project, it could not show the cause-effect relationship between the critical factors itself. The framework only gives an understanding about the critical factors, without pointing out how a critical factor triggers another critical factor, and furthermore, leads to the success or the failure of a project.

EPC Project

EPC project is categorized as a unique project since it only executed once. It won’t be executed in the same way in another time, even though the object of the project is similar. This situation, however, occurs because of the differences in location, condition of nature, the methodology based on owner requests and others.
EPC Project consists of three main activities in constructing area: Engineering Operation, Procurement Operation and Construction Operation. Below are the phases of Engineering, Procurement and Construction operation in EPC Project.

![Diagram of Phases of EPC Project]

**Figure 1: Phases of EPC Project**

**a) Engineering Operation**

Engineering operation is the initial activity from overall activities. It's related with designing whole project, including the main plan, process flow diagram, the plot plan, facilities drawings, and the work volume, bill of quantity and the schedules of a project.

**b) Procurement Operation**

Procurement operation contains all activities that connected with the replenishment of materials, equipments, machines and others. The start of procurement operation depends on contract and availability of sufficient information to start preparation of equipment and bulk materials inquiry documents.

**c) Construction Operation**

Construction operation related with the execution of a project in plants. The start of construction home office operation depends on contract award and sufficient information to start preparation of construction sub contract inquiry documents. In other hand, the start of construction field operations depends on overall project schedule, drawings, material availability and reasonable continuity of operation. Direct control is needed to make sure that EPC project can be executed as customer’s wish. This means a project should be delivered on time, suitable on cost, resources and also schedules. Schedule, important criteria for measuring all project, must be under controlled, otherwise, overall project will be late.
FRAMEWORK DEVELOPMENT

The framework in figure 1 addresses the critical factors drawn from literature review and discussion with the company representatives. There are 64 factors that classified into three main groups, which are:
- Factors related to project management
- Factors related to vendor
- Factors related to sub-contractor

By classified the factors into specified groups, we could be easier identify whether the success or the failure of project is caused by the internal factors, such as project manager and team members, or probably caused by some external environment, such as political situation.

Factors related to project management

This group of factors divided into six subgroups: project manager, team members, organization, environment, client and cost. As can be seen on the framework, there is relationship between project manager and team members. For example, the leadership of project manager could affect the motivation of team member to work properly, and in the end could cause the project failure.

Factors related to vendor

Vendor provides materials, machines or other equipments that are required in EPC project. Even though factors related to vendor could be classified into external environment group, it was considered to be classified individually since it has its own influences to project success/failure. As an example, the longer fabrication time of materials or equipment, the longer time required to finish the project. And the lateness of one sequence (in this case, material availability) could cause the delay for overall project.

Factors related to sub-contractor

Sub-contractor executes some packages of EPC project based on the approved contract with the main contractor. The performance of sub-contractor will directly affect the performance of overall project. For instance, some of sub-contractors sometimes delivers inappropriate package to the project. What makes worst is that even though the main contractor has confirmed it to the sub-contractor, most of them don't response quickly. This rework activity takes lot of time, and often causes the delay of the project.
CASE STUDY

Two case studies were analyzed in order to evaluate the framework of critical success factors that have been developed previously. Those are the South Sumatra Gas Development Project Package II and South Sumatra Gas Development Project Package III. The analysis of each case study was performed in three ways: evaluating the monthly reports of the project, evaluating the minutes of meeting (MOM) and holding a survey to related representatives of the projects.

Evaluation of monthly report

The evaluation of monthly reports was performed for overall EPC stages; engineering, procurement and construction. Delay happened in a stage is believed to contribute in a delay of a project, and in the end, cause the failure of related project. By evaluating the project progress each period, it is expected to know whether delay happened in project or not. Furthermore, we could find out what factors that affect the delay happened in project.

First, we analyzed the deviation between the planned-progress with the actual performance of project. The bigger deviation happened in the stages, the lower quality of project execution performed. For example, the engineering stage of the South Sumatra Gas Development Project Package II was evaluated to find out the deviation between the plan and actual progress.

As can be seen on the above diagram, most of the activities on engineering stage show deviation between the plan and actual progress. For example, the procedure development activity had deviation about 9%, where the planned progress was 14%, and the actual progress was just about 5%. This fact indicates delay in the activity that contributes to delay happened in the engineering stage. In the end, delay happened in engineering stage (together with procurement and construction stages) cause delay in overall EPC project.

To detail the value of delay, we measure the percentage of weighted progress delay by multiplying the percentage of delay in related stage with the weight factor of each activity in the stage. As an example, engineering stage of package II was used briefly to perform the analysis.

### Table 1: Engineering Weighted Progress Delay of Package II (per February 2006)

<table>
<thead>
<tr>
<th>No</th>
<th>Detailed Activity</th>
<th>W/F</th>
<th>Delay (month)</th>
<th>% Delay</th>
<th>%Weighted progress delay</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Process Documents Works</td>
<td>10.482</td>
<td>1</td>
<td>0.042</td>
<td>0.437</td>
</tr>
<tr>
<td>2</td>
<td>Machinery Equipment Documents Works</td>
<td>2.513</td>
<td>2</td>
<td>0.083</td>
<td>0.209</td>
</tr>
<tr>
<td>3</td>
<td>Static Equipment Documents Works</td>
<td>4.255</td>
<td>3</td>
<td>0.125</td>
<td>0.532</td>
</tr>
<tr>
<td>4</td>
<td>Piping Documents Works</td>
<td>35.083</td>
<td>5</td>
<td>0.208</td>
<td>7.309</td>
</tr>
<tr>
<td>5</td>
<td>Civil Documents Works</td>
<td>30.35</td>
<td>7</td>
<td>0.292</td>
<td>8.852</td>
</tr>
<tr>
<td>6</td>
<td>Electrical Documents Works</td>
<td>5.431</td>
<td>5</td>
<td>0.208</td>
<td>1.131</td>
</tr>
<tr>
<td>7</td>
<td>Control System Documents Works</td>
<td>6.837</td>
<td>7</td>
<td>0.292</td>
<td>1.994</td>
</tr>
<tr>
<td>8</td>
<td>Plant Services Documents Works</td>
<td>2.653</td>
<td>8</td>
<td>0.333</td>
<td>0.884</td>
</tr>
<tr>
<td>9</td>
<td>Procedure Documents Works</td>
<td>2.396</td>
<td>12</td>
<td>0.500</td>
<td>1.198</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>100</td>
<td></td>
<td>22.547</td>
<td></td>
</tr>
</tbody>
</table>

Figure 3: Deviation of engineering average of actual-plan progress (package II)
From the above table, we can see that most of engineering activities were experiencing delays in the completion. This fact assures the conclusion that has been drawn from the deviation analysis previously. Hence, we could draw general conclusion that the projects, South Sumatra Gas Development Project Package II and South Sumatra Gas Development Project Package III, were performing delay in the execution.

Evaluation of minutes of meeting

Minutes of meeting aims to record important facts that need to be concerned in order to give a knowledge or experience to project manager and project team. Lack of labor or materials at site, the late delivery of equipments and inappropriate specification of equipments, for example, are pointed out in the meeting between the main contractor, sub-contractor and owner as barrier in project completion. Thus, three players should collaborate to solve the problem and prevent the project from the same problems.

By evaluating minutes of meeting from South Sumatra Gas Development Project Package II and South Sumatra Gas Development Project Package III, we marked the factors that are considered important in causing project delay or insufficient performance.

Survey through project representatives

Some of factors that cause the failure of project were not recorded clearly on monthly reports or minutes of meeting. The factors usually were not stated because of irrelevant status or considered not critical to be put on monthly reports. But eventually, in many cases, the interaction between the unstated factors with stated factors affect project result.

Questionnaires were distributed to project representatives in order to gain more information about the invisible factors. The respondents were asked to rate how significant each factor affecting the success or failure of project. The scale of significance used for this questionnaire defined as:

1 = Very insignificant
2 = Insignificant
3 = Significant
4 = Quite significant
5 = Very significant

Values of factors were determined by measuring the average of factors significance rate. Calculation of significance rate average results to the formation of factors ranks. The higher average of a factor will put the related factor into the upper rank from others. The factors that have the same average value will be ranked based on the variances, which means the factor with the lower variance will get higher rank than others. The measurement was adopted from Proboyo (1999), and could be defined as follows:

\[
\text{Average (Xm)} = \frac{\sum (n_i \times \text{score}_i)}{n_i}
\]

\[
\text{Variance (Xm)} = \frac{1}{(n-1)} \sum n_i (\text{score}_i - \text{average})^2
\]
Each group of factors will have its own rank formation, with lower to upper rank of each activity or factor in the group. Higher rank indicates bigger influence of the factor to the performance of the project.

### Table 2: Frequency, average and variance of factors related to project manager

<table>
<thead>
<tr>
<th>Factors related to Project Manager</th>
<th>Frequency</th>
<th>average</th>
<th>variance</th>
<th>Percentage (%)</th>
<th>rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Ability to organize and delegate authority</td>
<td>0 0 2 6 2</td>
<td>4</td>
<td>0.44</td>
<td>12.46</td>
<td>3</td>
</tr>
<tr>
<td>2. Ability to tradeoff between team &amp; organization</td>
<td>0 1 6 3 0</td>
<td>3.2</td>
<td>0.40</td>
<td>9.97</td>
<td>7</td>
</tr>
<tr>
<td>3. Ability to coordinate</td>
<td>0 0 4 5 1</td>
<td>3.7</td>
<td>0.46</td>
<td>11.53</td>
<td>5</td>
</tr>
<tr>
<td>4. Competency of Project Manager</td>
<td>0 0 1 4 5</td>
<td>4.4</td>
<td>0.49</td>
<td>13.71</td>
<td>2</td>
</tr>
<tr>
<td>5. Commitment of Project Manager</td>
<td>0 0 0 3 7</td>
<td>4.7</td>
<td>0.23</td>
<td>14.64</td>
<td>1</td>
</tr>
<tr>
<td>6. Relevant Experiences of Project Manager</td>
<td>0 0 6 3 1</td>
<td>3.5</td>
<td>0.50</td>
<td>10.90</td>
<td>6</td>
</tr>
<tr>
<td>7. Availability of Clear Strategy and Policies</td>
<td>0 0 4 3 3</td>
<td>3.9</td>
<td>0.77</td>
<td>12.15</td>
<td>4</td>
</tr>
<tr>
<td>8. Leadership</td>
<td>0 0 0 3 7</td>
<td>4.7</td>
<td>0.23</td>
<td>14.64</td>
<td>1</td>
</tr>
<tr>
<td><strong>Total Index for Factors Related to Project Manager</strong></td>
<td><strong>32.1</strong></td>
<td><strong>1.23</strong></td>
<td><strong>100.00</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Factors that have been collected in questionnaires are classified into four classification based on the significance rate average and the variance of the factors. By classified the factors, we can divide the factors into group of factors that are considered really critical in causing or affecting project failure, and group of factors that don’t affect the project execution directly.

**FRAMEWORK REVISION**

The evaluation of case studies proved that most of the factors listed on the initial framework truly affected the failure of EPC project. Surprisingly, it also indicated new factors that have not been listed yet as critical success factors of project. These new factors then classified into three new groups of factors:
- Factors related to engineering
- Factors related to procurement
- Factors related to construction


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Factors related to engineering

As the name states, factors listed in this group are specifically related to engineering activities and engineering team. Since engineering is the first stage of overall EPC project, delay or failure in this stage affect the sequence of project. For instance, the lateness of drawing causes the lateness of purchasing, and in the end, causes delay in construction.

Factors related to procurement

Purchasing the appropriate and good-quality materials, machines or equipments is an essential requirement of EPC project. Resources with poor quality affect the quality of project result. This could cause the failure in project performance. Yet, delay in materials delivery also causes failure in project since it cause delay in overall project. As been stated before, EPC project related each other. Thus, failure in procurement stage will cause delay in overall project.
Factors related to construction

Delay or failure in engineering and procurement stage contribute to delay in construction stages. For instance, lack of resources availability as result of procurement delay, or inappropriate pot plan as engineering failure, will cause delay in construction execution. Outside of it, geographic and weather condition also affect the execution of construction.

REFERENCE


