

Critical Success Factors during Execution of EPCC National Strategic Project in Indonesia

Dika Fajar Pratama Setiadi, Rahmat Nurcahyo and Farizal

Department of Industrial Engineering

Universitas Indonesia

Salemba, Jakarta, Indonesia

dika.fajar@ui.ac.id; rahmat@eng.ui.ac.id; farizal@eng.ui.ac.id

Abstract

A large of scaled development ongoing in industrial and infrastructure sectors in Indonesia. The government has designated a number of those projects to become the national strategic project. Some of the projects in the oil & gas industry include in the national strategic projects are categorized as megaprojects due to the cost of projects more than \$ 1 billion. The scheme of projects is Engineering, Procurement, Construction and Commissioning (EPCC) or turnkey projects. Megaproject performance is considered disappointing due to almost of megaproject found will be over budget, delay and under quality. This performance is due to the complexity and uncertainty in megaprojects. Megaprojects delay will become a problem for contractors, project owners, and the government. There are indications of problems related to the schedule, quality, and cost of the project in ongoing mega projects in Indonesia. This research was led to analyze critical success factors during the engineering, procurement, construction, and commissioning phase of megaprojects in Indonesia, by a literature review and developing questionnaire to people who involve during the execution of megaprojects as project owners and contractors. The results found that the financial aspects category is the most important category apart from other categories such as unexpected events and commissioning related factors.

Keywords

Critical Success Factors, Megaprojects, EPCC, Project Management and Quality Management.

1. Introduction

Large-scale development is being carried out in the industrial sector, including the oil and gas processing industry in Indonesia. This is by following under the National Medium-Term Development Plan 2015-2019 (RPJMN) which has a policy direction for the development of basic infrastructure and connectivity. The policy direction target is a leading sector development target. The budget required to carry out the development reaches \$ 409 billion. In practice, the government has designated a number of projects in the infrastructure sector as well as petroleum and gas processing into the category of national strategic projects through Presidential Decree No.3 of 2016 concerning the acceleration of the implementation of national strategic projects. Then in 2018 a Presidential Regulation Number 56 of 2018 was issued, as an amendment to Presidential Regulation Number 3 of 2016. In Presidential Regulation Number 56 of 2018 there is a change in the number of National Strategic Projects as well as the grouping of the National Strategic Project in Indonesia. The definition of a National Strategic Project according to Presidential Regulation No.3 of 2016 is a project carried out by the Government, Regional Government, and / or business entities that have a strategic character to increase growth and equity to meet basic needs and improve community welfare and regional development.

Several national strategic projects in Indonesia, especially in oil and gas processing projects, are included in the megaproject category. According to Flyvbjerg (2017) in the *Oxford Handbook of Megaproject Management*, a megaproject definition is a large and complex project with a budget around \$1 billion or more, required many years to develop and construct, engages multiple stakeholders (public and privates), transformational and have a big impact to society welfare.

Most of the megaproject contract schemes in Indonesia are Engineering, Procurement, Construction and Commissioning (EPCC) contracts. Meanwhile, the definition of the EPCC project is a form of the project management concept that assigns responsibility to EPCC contractor for all stage of the project (Engineering, Procurement, Construction and Commissioning). This EPCC project normally found in large-scale projects, such as industrial or factory development such as oil refineries, fertilizer factories, which require large funds and have thousands of work

activities. The EPCC project is completed as a result of a combination of a lot of work and interactions therein, both planned and unplanned, with a lot of processes and parties involved which will affect to overall project performance (Saqib *et al.*, 2008). In the execution of the megaproject, there will be more activities and more people involved than medium and small projects. The performance of megaprojects considered disappointing because almost of megaproject found will be over budget, delay, and under quality once in operation (Misic & Radujkovic, 2015). One of the criteria for project success is that it can be completed on time, but in an EPCC project that has a construction phase, project delays are a challenge that must be faced due to the complexity of the work (Alsuliman, 2019). There are also indications of delays in ongoing mega projects in Indonesia, this can be seen in the delays in each phase shown in Figure 1 as below :

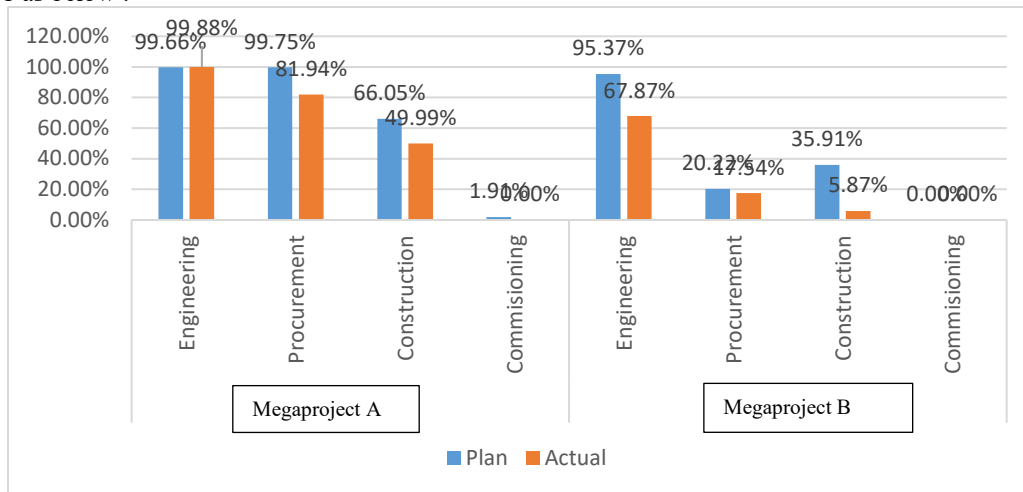


Figure 1. Delay in 2 Megaproject EPCC Indonesia

In the research of Lee *et al.*, (2009) states that project success is difficult to be measured because it can change during the project phase and each party involved has its own criteria for project success. But generally, the criteria success of project is excess time, cost excess and expected quality (Baccarini & Archer, 2001). However, project delays are a challenge that must be faced due to the complexity of the work (Alsuliman, 2019). According to Alsuliman (2019), project success influence by several factors consist of factors during the process before the tender, during the tender, and after winning the tender. Various previous studies have stated that the human factor plays an important role in determining the success of a project (Gudiene *et al.*, 2013). According to Misic & Radujkovic (2015), managing a megaproject certainly requires a lot of people, so understanding the behavior and actions of the people involved in the project is very important for the megaproject to be successful. In addition, there are other factors that influence the successful execution of a project, including economic conditions, social conditions, political conditions, technological developments and so on (Chan *et al.*, 2004). According to Hu *et al* (2015) contextual elements such as culture, social and environment are very important in the management of megaprojects and these differences will cause various research results. Therefore, researchers see that there are still gaps in research due to the lack of research on critical success factors carried out thoroughly in the project cycle from engineering, procurement, construction, and commissioning phases to the execution of oil and gas processing megaprojects, especially those included in the category of national strategic projects in Indonesia. This is in line with research conducted by He *et al* (2018), which states that critical success factors (CSF) in megaprojects and CSF research in developing countries is a research gap in the project management field because current research only focuses on small and medium scale projects and is carried out in developed countries.

1.1 Objectives

With many EPCC megaprojects in Indonesia, especially the oil and gas processing sector, which are included in national strategic projects, it becomes a challenge for EPCC companies in Indonesia to successfully execute megaprojects on time, on cost and on quality. However, the problems that currently exist in the 2 megaprojects that are currently running show that there is a tendency for delays in each phase. Based on data in September 2020 project name “A” there was a delay in the procurement (-17.18%), construction (-16.06%) and commissioning (-1.91%) phases, while in the project name “B” there was a delay also in the engineering phase (-27.49%), procurement (-2.68%) and construction (-16.02%). The schedule performance index value of the two projects is still below 1.

Then the CPI (cost performance index) data in one of the megaprojects that are currently running is below number 1, namely the number 0.985, this indicator shows that the absorption of the project budget is greater than the original plan.

In addition, data regarding the quality of work in the megaproject is reflected in the level of rejection of the results of welding work (welding rejection) of 6.69%, this indicates that there are problems regarding the quality of the megaproject execution. Problem in Quality also reflected in the existence of non-conformity reports from the project owner totaling 6 NCRs for the two megaprojects. All these things are of course a problem for EPCC companies to be able to complete projects on time, on cost, and with quality.

Based on the developed background and existing problem data, the problems that can be formulated are:

1. What are the factors that influence the success of the EPCC project which is included in the megaproject in Indonesia, especially the oil & gas sector?
2. Do the factors during the engineering, procurement, construction and commissioning phases affect the success of megaproject execution in Indonesia?

2. Literature Review

2.1 Megaproject EPCC

A project concept is a collection of short-term or long-term activities aimed at producing a product or service. Projects aim to identify and achieve the objectives of the project owner (Kabirifar and Mojtahedi, 2019). According to Yeo & Ning (2002), Engineering is the critical phase which can significantly influence project performance because in this phase the needs, wishes, and objective of project owner are defined become project requirements that will be communicated to EPCC contractors. Procurement is the phase after the engineering phase when the EPCC contractor begins to procure project equipment or materials with reference to approved engineering drawings, datasheet, and project specification (Yeo and Ning, 2002). Construction is the phase when EPCC contractors establishing or building the installation of equipment which have been purchased during the procurement phase and according to the scope decided in the engineering phase (Dachyar and Sanjiwo, 2018). Commissioning is the phase before hand over to the project owner, which is specified as the process of testing and starting up the plants to verify their performance in accordance with engineering and project specifications (Brito et al., 2015).

Commonly projects are categorized into small, medium, and large projects or megaprojects. The project with a budget of more than \$1 billion and have an impact on the climate, society, and economy is described as a megaproject (Flyvberg, 2014). Megaprojects can be found in a project such as airports, dams, bridges, high-speed railways, oil and gas projects, and varied (Flyvbjerg, 2017). Definition of a megaproject in all industries based on International Project Management Association is a project with a budget 100 million euro (Hu et al. 2013).

2.2 Megaproject Challenge

One of the key contributors to the development of infrastructure and economy in developed and developing countries is the construction industry, therefore the construction industry shall grow to support the economy and population (Santoso and Gallage, 2019). Indonesia is including as developing countries. Most studies carried out have shown that megaprojects are had problems with timely completion, cost overruns, and low quality or performance compared to project specification (Santoso & Galage, 2019). Davies et al. (2009) included safety as objective criteria of a successful megaproject in addition to their time, cost, and quality.

According to He et al. (2015), poor performance of megaprojects influenced by complexity of megaprojects, he classified complexity of megaprojects become 6 that is technological complexity, organizational complexity, goal complexity, environmental complexity, cultural complexity and information complexity. The increasing of complexity of megaprojects is directly proportional to the risk of that projects. According to Sanderson (2012), Apart from being faced with high complexity, the megaproject is also faced with potentially severe conflicts between various groups of public and private stakeholders (Nachbagauer and Boeck, 2018).

Due to their high complexity, long duration, and ambivalence caused by diverse interests between public or private stakeholders megaprojects are confronted with a high level of uncertainty (Nachbagauer and Boeck, 2018). The greatest challenge for project managers in the execution of projects is uncertainty (Wang et al. 2018). According to Giezen (2012), many changes and ex-post negotiation which made megaprojects have high uncertainties on behavioral and environmental during project execution because there are many parties involved in megaprojects, megaproject complexity, and the broad variety of social pressure. Koopmans (1959) notes that uncertainty is divided into primary uncertainty and secondary uncertainty. Primary uncertainty, including multiple unpredictable natural disasters and secondary uncertainty, means that the partner's behavior is not understood because of a lack of coordination between megaproject participants (Wang et al. 2018).

The impact delay in construction projects will influence the economy of the country, especially in developing countries where the GDP is influenced by the construction industry, besides will impact to the contractor, consultants, and project owners (Oyegoke and Al Kiyumi, 2017). According to Rahmat et al. (2019), Oil and Gas play an important role in the national economy in Indonesia to fulfill domestic fuel demands and industrial raw material. Developed countries such as United Kingdom, United States and Australia have enjoyed significant advantages due to a lot of megaproject research in developed countries, but in developing countries such as India, Turkey, Vietnam, and Indonesia the megaproject research remains weak or lacking (Hu et al. 2013). Improving megaproject performance an urgent and necessary issue especially for developing countries such as Indonesia (He, et al. 2020)

2.3 Critical Success Factors

Project success is very difficult to measure because it can change during the project phase, and many parties involved (project owners, government, contractor companies) have different criteria for working on a project (Lee, et al. 2009). However, according to Baccarini & Archer (2001) and Williams (1993), it has been assessed that projects are measured by excess time, cost excess, and expected technical performance or quality (Lee et al. 2009).

One of the successes of the project can be achieved through of a good project manager performance factor. Various previous studies have stated that the human factor plays an important role in determining a project (Gudiene et al. 2013). Apart from human factors, there are still several factors that can be relied on to implement projects, including economic conditions, political conditions, technological developments, and so on (Chan et al. 2004).

Certain factors are more important in the success of a project than others. These more important factors are called Critical Success Factors (CSF) (Saqib et al. 2008). According to Zawawia et al. (2011), CSF is known as a tool to measure the performance of a company to achieve its goals (Gudiene et al. 2013).

There is a lot of challenges during the execution of megaprojects because of limitation of schedule, budget but shall keep the quality of projects. Santoso (2019) suggested that some factors which influenced megaproject performance such as project characteristics, financial management, project management-related factors, human-related factors, etc. Kabirifar (2019) also found some factors during engineering, procurement and construction have impact to megaproject performance. According to Caldas (2016), the complexity and risk of megaprojects make megaprojects are difficult to be executed. One of key megaproject success can be obtained if we can mitigate existing risks found during the execution.

3. Methods

This research is intended to find critical success factors during the execution of EPCC national strategic project in Indonesia to know determinant factors that influence the success of projects. By knowing the determinant factors, EPCC contractors and project owners can prepare the mitigation to minimize the risk caused by that factors. According to Sahu (2013), proper selection research methodology is very crucial in the research. For this study the research methodology can be classified into 5 major steps as below:

1. Literature Study

At this stage of the research, we did a systematic literature review of megaproject-related papers to define important megaproject success factors and success requirements for megaprojects in developed countries or developing countries.

2. Develop Likert-Scale Questionnaire

The findings of the literature review were used to prepare questionnaire surveys to produce essential factors and the performance criteria of megaprojects as a means of gathering quantitative data in the execution of EPCC national strategic projects in Indonesia

3. Data Collection

The questionnaire data produced were distributed to the people who involve during the execution of the megaproject EPCC strategic national to ensure that factors were acceptable for the context in Indonesia. Participants were selected from project owners and contractors of megaprojects in Indonesia.

4. Data Analysis

For the study, the Relative Importance Index (RII) method was used in the ranking of the degree of perceived importance of the factors listed. It can be clarified as follows:

$$\text{Relative importance index} = \frac{\sum W}{A \times N}$$

Where: W = the weight given to each factor by the respondent ranges from 1 to 5 (where “1” is “not important” and “5” is “strongly important”); A = highest weight of likert scale; and N = total number of respondents.

5. Conclusion

From the data analysis, the result was analyzed to answer the research objective

4. Results and Discussion

4.1 CSF from Literature Review

As discussed earlier, literature study was conducted to know the critical success factors during the execution of megaprojects in developed and developing countries. As you can see in the table 1 critical success factors that importance during execution of projects that was compiled from previous studies.

Table 1. Summary of literature review

Category	Details	Factors	Code	Source
Engineering	Engineering is the most critical phase in the EPCC project, because all of the decision which decided will influence the next phase (procurement, construction, and commissioning phase). Delay in the engineering phase automatically effect to delay in the procurement, construction, and commissioning phase also.	Design change due to technical issue	A1	Santoso & Gallage (2019); Kabirifar & Mojtahedi (2019); Ramabodu & Verster (2013); Caldas & Gupta (2016).
		Mistake during Engineering	A2	
		Software & Technology	A3	
		Delay on detail engineering	A4	
		Interface between engineering	A5	
Procurement	Supplier selection especially for long-lead item and capability of the subcontractors and vendors will influence project performance. And because of procurement phase is a phase after engineering, clear detail engineering is required to minimize variation cost from vendor.	Proper Procurement Scheduling	B1	Banihashemi et al (2017); Kabirifar & Mojtahedi (2019); Cepeda et al. (2017)
		Competitive procurement	B2	
		Capability and performance of subcontractors or vendors	B3	
		Good monitoring and expediting	B4	
		Long lead item delivery	B5	
Construction	Skilled workforce and productivity of construction teams including subcontractors are two critical factors during the construction phase. Both factors will influence to the quality of construction. The quality issues will influence project delivery and cost overruns due to rework activity.	Productivity rate of construction teams	C1	Kabirifar & Mojtahedi (2019); Santoso & Gallage (2019);
		Construction's Defects (Rejection, rework, and repair issue)	C2	
		Method & Sequence of Construction	C3	
		Availability of tools and skilled workforce	C4	
		Uncertainty during construction (scheduled arrival & quality of material or equipment)	C5	
Commissioning	Commissioning is an activity to testing plant systems prior to initial operation and handed over to project owners. Well planned or execute during commissioning will influence commissioning and project performances. The commissioning stage shall be	Availability of tools, check sheet and procedure (good commissioning plan)	D1	O'connor et al (2016)
		Accurate as-built information	D2	
		Good integration schedule between construction and commissioning	D3	
		Alignment among all project team member (commissioning, engineering,	D4	

	successful to realize commercial objectives.	construction, project manager, etc)		
Project Characteristics & Scope of Works	Long megaproject period will trigger more frequent mobility of projects participants. Uncertainty influenced by complexity and scale of scope projects, and increasing of uncertainty will increasing project risk also. Scope of works shall be clear because it is importance to avoid any overlap works between EPCC contractors and projects owners.	Project Location	E1	Olaniran et al. (2015); Locatelli (2014); Santoso & Gallage (2019); Cepeda et al. (2017); Caldas & Gupta (2016) ;
		Project Duration	E2	
		Complexity of Projects	E3	
		Adequacy information during bidding stages	E4	
Project & Risk Management Aspect	In megaproject, some of the project managements aspect is difficult to be implemented. EPCC contractors shall successful effectively plan and execute megaprojects including managing the risk in the megaproject.	Clear Project Organizational	F1	Caldas & Gupta (2016) ; Santoso & Gallage (2019)
		Good Risk Management	F2	
		Good Quality Management	F3	
		Speed and Accuracy of Decision Making	F4	
		Detailing of Project Schedule	F5	
		Clear Strategy from Project Management Team	F6	
Financial Aspect	Financial is one driver of megaprojects. In some cases, financial is the reason to terminates the project. Without good financial planed will influence the activity of procurement and construction.	Financial Problem of Contractors	G1	Santoso & Gallage (2019); Oyegoke & Alkiyumi (2017);
		Financial Problems of OWNER	G2	
		Delay on Payment	G3	
Human Resources Aspects	EPCC contractors that are able to manages human resources will achieve high performance efficiency.	Competent Project Team	H1	Caldas & Gupta (2016); Kabirifar & Mojtahedi (2019)
		Educational Backgrounds	H2	
		Change of Key Personnel during Engineering	H3	
		Good Communication Skills	H4	
		Training	H5	
Unexpected events	Poor performance of project can happen due to unexpected events. Unexpected events can influence project performance (schedule and cost)	Unexpected natural disasters pandemics such as Covid 19	I1	Ramabodu & Verster (2013); Kabirifar & Mojtahedi (2019);
		Unexpected safety condition (accident)	I2	
		Social and Environmental issue	I3	

After categorizing the success factor from the literature review of the previous study we found there are 9 categories and 40 factors which influence of megaprojects performance based on literature review. The megaprojects success framework from literature review shown in figure 2.

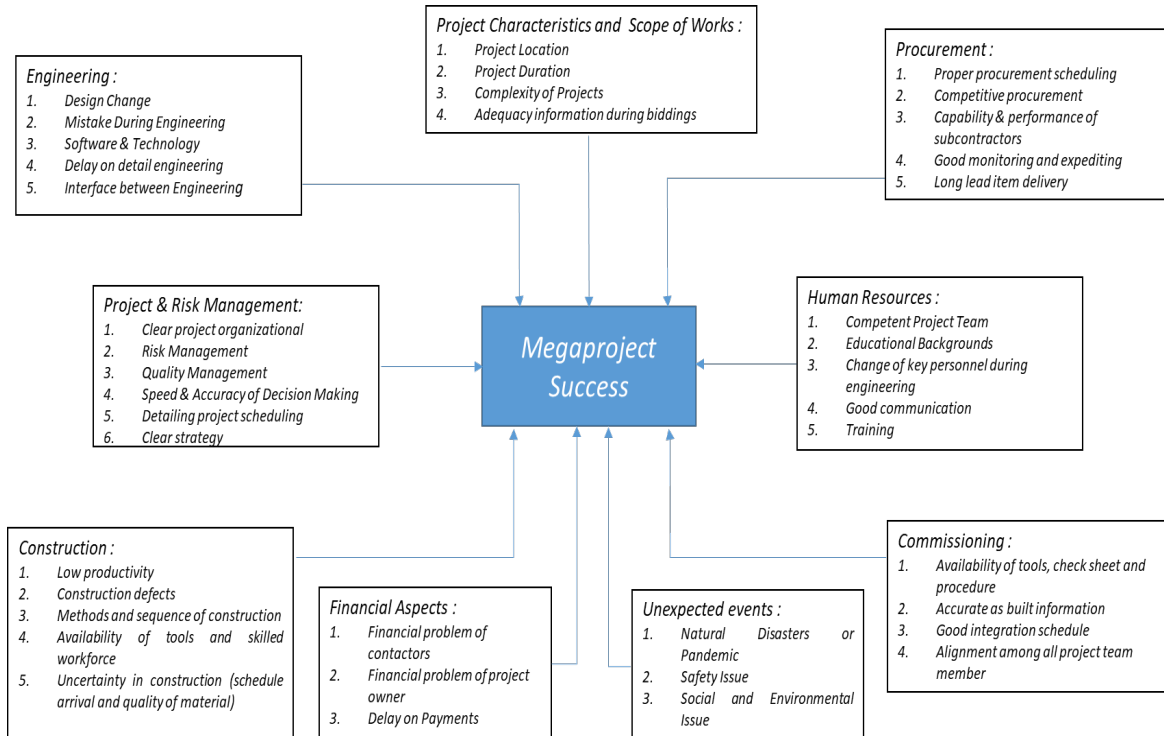


Figure 2. Megaproject Success Frameworks

4.2. Questionnaire Distribution

Next stage is to distribute a questionnaire to people who involved in execution of strategic national megaproject especially oil & gas projects as a project owner or contractor. In this questionnaire method, the authors use a Likert scale where the users determine the number of points according to the factors mentioned. Points Likert scale was used to record the respondents' views of the importance of each item, anchored by 1, "not important" to 5, "highest importance".

There are three strategic national megaprojects EPCC oil & gas in Indonesia, which each valuation is more than \$1 billion. Location of megaprojects is in Java (Megaprojects A), Borneo (Megaprojects B), and Papua (Megaprojects C). The questionnaire was distributed to 30 respondents who come from that three megaprojects. The distribution of respondents is presented in Figure 3 and Figure 4.

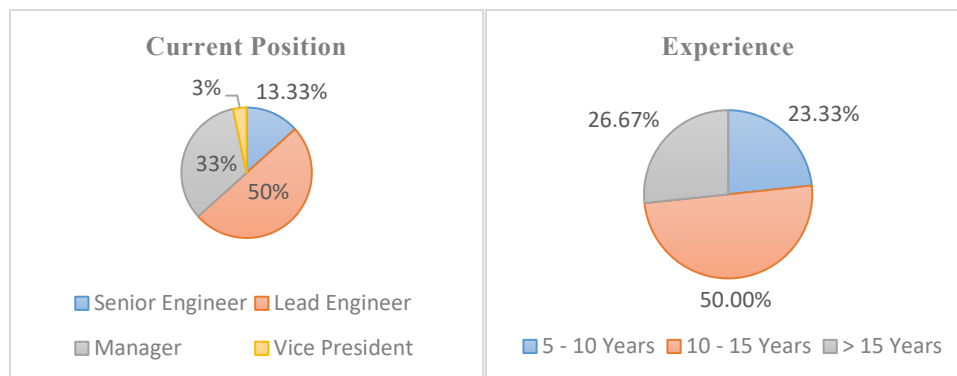


Figure 3. Position and Experience Work of Respondent

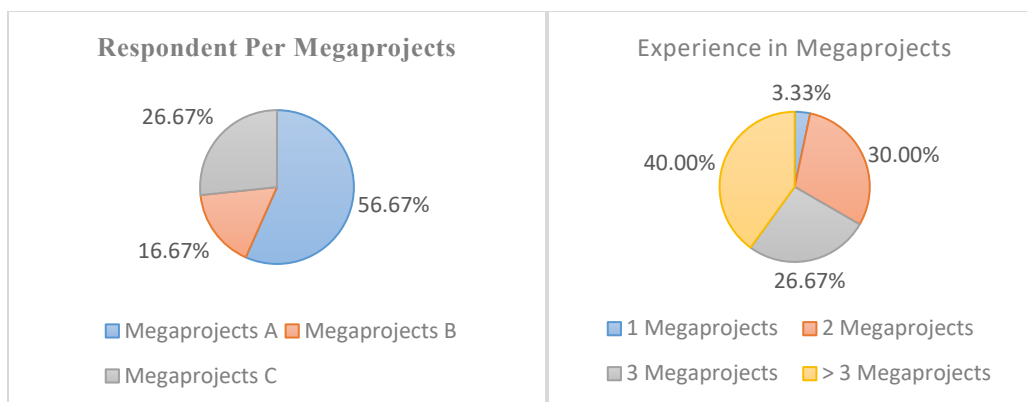


Figure 4. Distribution of Respondents

Almost all respondents have positions middle to up in their company from lead engineer until vice presidents. 76,7% of respondents have experienced more than ten years working in EPCC projects, and they have experience involved in megaprojects EPCC previously.

The answer from each respondent then processing with a relative importance index as mention in section 3 to know important factors which influenced the success of the execution of megaprojects EPCC in Indonesia especially in the oil & gas sectors. The top 10 influence factors shown in table 2, and the bottom 5 influence factors are shown in table 3.

Table 2. CSF Ranks based on survey (Top 10 of important factors)

Factors	Code	RII Value	Rank
Long lead item delivery	B5	0.9733	1
Financial Problem of Contractors	G1	0.9733	1
Financial Problems of OWNER	G2	0.9733	1
Competent Project Team	H1	0.9666	2
Delay on Payment	G3	0.9600	3
Alignment among all project team member (commissioning, engineering, construction, project manager, etc)	D4	0.9600	3
Fatality Issue	I2	0.9533	4
Proper Procurement Scheduling	B1	0.9466	5
Unexpected natural disasters pandemics such as Covid 19	I1	0.9466	5
Productivity of Construction	C1	0.9400	6

Table 3. CSF Ranks based on survey (Bottom 5 of important factors)

Factors	Code	RII Value	Rank
Project Location	E1	0.8400	34
Software & Technology	A3	0.8266	35
Educational Backgrounds	H2	0.7933	36
Change of Key Personnel during Engineering	H3	0.7866	37
Training	H5	0.7800	38

The table 2 shows that there are 3 factors which most important factors with have same RII value which is long lead item delivery (B5), Financial problems of contractors (G1), and financial problems of owner (G2). Followed by competent project teams (H1) with RII value 0.9667, followed by delay on payments (G3) and alignment all project team members during commissioning (D4).

From table 3 There is 3 factors which not considered important because of RII value below 0.8. That factors are educational backgrounds (H2), Change of key personnel during engineering (H3), and Training (H5).

Table 4. Category Ranks based on Survey

Category	RII Value (Groups)	Rank
Financial Aspects	0.9688	1
Unexpected Events	0.9355	2
Commissioning	0.9294	3
Procurement	0.9279	4
Project & Risk Management	0.9199	5
Construction	0.9146	6
Engineering	0.9052	7
Project Characteristics & Scope of Works	0.8916	8
Human Resources Aspects	0.8493	9

In table 4, we rank the category based on the average RII value on each factor, from table 4 we found that the most important category is financial aspects followed by unexpected events and commissioning. RII value of category from rank 1-7 is still more than 0.90 shown that all category is very important during execution of strategic national megaproject EPCC in Indonesia.

Besides of critical factors, during survey we also measure megaproject success criteria from each respondent which shown in figure 5.

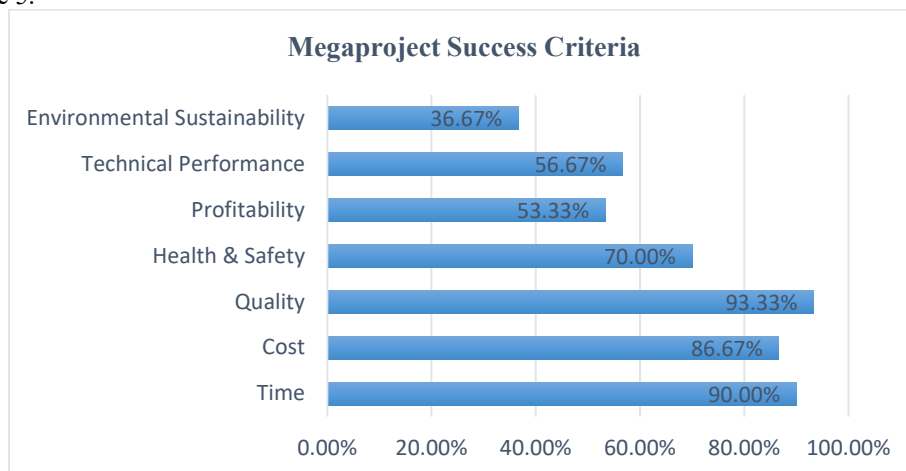


Figure 5. Megaproject Success Criteria

From the survey, respondent concluded megaproject success criteria are quality (93,33 %), time (90 %) and cost (86,67%). Followed by health and safety with percentage 70%, technical performance (56,67%), profitability (53,33%) and sustainability of environmental (36,67%).

5. Conclusion

This study aimed to understand the most important factor for the execution of megaproject strategic national in Indonesia. The authors believe that the research presented could be useful for EPCC contractors and project owners. EPCC contractors and project owners shall consider the financial aspects as the most critical category, and also consider other categories such as unexpected events, engineering, procurement, construction, project management aspects, and project characteristic as the important category during the execution of megaprojects. The authors also found that quality, cost, and schedule are criteria of megaprojects. Only 36,67% of the respondent that considered environmental sustainability as success criteria, it means that almost all megaprojects are not considering the sustainability of environmental as the parameter of success a megaproject.

The research was limited to factors through literature review. In contrast, future research could observe other factors from more experienced management of EPCC contractors and project owners and experts on project managements.

Besides the quantitative method, we also suggest using a qualitative method to explore mitigation from identified critical success factors which should be implemented by EPCC contractors to increasing the megaproject performance in Indonesia. The limitation of this research is that we only ranking of each factor using RII methods, we also suggest using other methods such as DEMATEL, ANP, SEM, or Fuzzy DANP to know the interaction between each factor.

References

- Alsuliman, J.A., Causes of delay in Saudi public construction projects, *Alexandria Engineering Journal*, vol. 58, pp. 801-808, 2019.
- Baccarini, D., & Archer, R. The risk ranking of projects: a methodology, *International Journal of Project Management*, vol. 19, pp. 139-145, 2001.
- Banihashemi, S., Hosseini, M., Golizadeh, H., and Sankaran, S., Critical success factors for integration of sustainability into construction project management practices in developing countries, *International Journal of Project Management*, vol. 35, pp. 1103 – 1119, 2017.
- Brito, M. E., Lopes, R., Rocha, L. and Qualharini, L., Beyond buildability: operability and commissioning of industrial facilities, *Procedia – Social and Behavioral Sciences*, vol. 226, pp. 67-74, 2016.
- Caldas, C., and Gupta, A., Critical factors impacting the performance of mega-projects, *Engineering, Construction, and Architectural Management*, vol. 24, no. 6, 2017.
- Cepeda, D. M., Sohail, M., and Ogunlowo, O., Understanding critical success factors for delivery of megaprojects in Colombia., ICE Publishings, 2017.
- Chan, A. P. C., Scott, D., and Chan, A. P. L., Factors affecting the success of construction project, *Journal of Construction Engineering and Management*, vol. 130, pp. 153-155, 2004.
- Dachyar, M., and Sanjiwo, Z. A. H., Business process re-engineering of engineering procurement construction (EPC) project in oil and gas industry in Indonesia, *Indian Journal on Science and Technology*, vol. 11, 2018.
- Davies, A., Gann, D., and Douglas, T., Innovation in megaprojects: systems integration at London Heathrow terminal 5, *California Management Review*, vol. 51 no. 2, pp. 101-125, 2009.
- Flyvbjerg, Bent, *The Oxford Handbook of Megaproject Management*, First Edition, Oxford University Press, United Kingdom, 2017.
- Flyvbjerg, B., What you should know about megaprojects and why; An overview, *Project Management Journal*, vol.45, pp. 6-19, 2014
- Gudiene, N., Banaitis, A., Banaitiene, N., and Lopes, J., Development of a conceptual critical success factors model for construction projects: a case of Lithuania, *Procedia Engineering*, vol.57, pp. 392-397, 2013.
- He, Q., Lan, L., Hu, Y., and Chan, A. P. C., Measuring the complexity of mega construction projects in China – a fuzzy analytic network process analysis, *International Journal of Project Management*, vol. 33, pp. 549 – 563, 2014.
- He, Q., Wang, T., and Chan A. P. C., Identifying the gaps in project success research, *Engineering, Construction and Architectural Management*, vol. 26, pp. 1553-1573, 2019.
- Hu, Y., Chan A. P. C., Le, Y., and Jin, R., From construction megaproject management to complex project management: a bibliographic analysis, *Journal of Management in Engineering*, 2013.
- Kabirifar, K., & Mojtahedi, M., The impact of Engineering, Procurement, and Construction (EPC) Phases on Project Performance: A Case of Large-scale Residential Construction Project, *Buildings*, vol.9, 2019.
- Locatelli, G., Littau, P., Brookes, N. J., and Mancini, M., Project characteristics enabling the success of megaprojects: an empirical investigation in the energy sector, *Procedia – Social and Behavioral Science*, vol. 119, pp. 625 – 634, 2014.
- Lee, E., Park, Y., and Shin, J.G., Large engineering project risk management using a Bayesian belief network, *Expert Systems with Application*, vol. 36, pp. 5880-5887, 2009.
- Misic, S., and Radujkovic, M., Critical drivers of megaprojects success and failure, *Procedia Engineering*, vol. 122, pp. 71-80, 2015.
- Nachbagauer, A., and Schirl-Boeck, I., Managing the unexpected in megaprojects: riding the waves of resilience, *International Journal of Managing Projects in Business*, vol. 12 no. 3, pp. 694-715, 2019.
- Nurcahyo, R., Hutasoit, E. L., Muslim, E., and Wibowo, A., D., A strategy of local content enhancement in petroleum and natural gas industry, *Proceedings of the International Conference on Industrial Engineering and Operation Management*, 2019.
- Olaniran, O. J., Love, P., Edwards, D., Cost overruns in hydrocarbon megaprojects: A critical review and implication for research, *Project Management Journal*, 2015.
- O’connor, J. T., Choi, J. O., and Winkler, M., Critical success factors commissioning and start up of capital projects, *Journal Construction Engineering and Management*, 2016.
- Oyegoke, A., and Al Kiyumi, N., The causes, impacts and mitigation of delay in megaprojects in the Sultanate of Oman, *Journal of Financial Management and Construction*, vol. 22, pp. 286-302, 2017.

- Ramabodu, M. S., and Verster, J., Factors that influence cost overruns in South African public sector mega-projects, *International Journal Project Organisation and Management*, vol. 5, 2013.
- Santoso, D. S., and Gallage, P., Critical factors affecting the performance of large construction projects in developing countries; A case study of Sri Lanka, *Journal of Engineering, Design, and Technology*, vol. 18, pp. 531-556, 2020.
- Saqib, M., Farooqui, R.U., and Lodi, S., Assesment of Critical Success Factors for Construction Projects in Pakistan. *First International Conference on Construction in Developing Countries*, Karachi, Pakistan, August 4-5, 2008.
- Yeo, K. T., and Ning, J. H., Integrating supply chain and critical chain concepts in engineer-procure-construct (EPC) projects, *International Journal of Project Management*, vol. 20, pp. 253-262, 2002.

Biography

Dika Fajar Pratama Setiadi is Master Degree student in Industrial Engineering Department, Faculty of Engineering Universitas Indonesia. He holds a Bachelor of Engineering in Mechanical Engineering from Universitas Diponegoro. Mr. Dika Fajar currently works in PT Rekayasa Industri as Senior Quality Control Engineer. His research and job are project management, management of quality and strategic management

Rahmat Nurcahyo is a Professor in Industrial Engineering. Universitas Indonesia. He earned Bachelor of Engineering degree in Mechanical Engineering from Universitas Indonesia, a Master of Engineering Science degree in Industrial Management from University of New South Wales, Australia and Doctoral degree in Strategic Management from Universitas Indonesia. His research interest in total quality management, production system, lean system and maintenance management. His research interests include management system and business management

Farizal is a senior lecturer in Management System in the Industrial Egeenring Department, Faculty of Engineering Universitas Indonesia. He earned Bachelor of Engineering degree from Universitas Indonesia, Master degree from Oklahoma State University and Doctoral degree in from University of Toledo. His research interest in reliability design optimization, renewable energy, supply chain management and techno-economy.