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IDENTIFICATION OF FACTORS CAUSING COST OVERRUN IN INFRASTRUCTURE PROJECTS

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ABSTRACT

Cost is one of the important parameters of the success of a construction project. Rising costs are the biggest challenge faced by the construction industry around the world. There are six groups that cause the overrun in construction, namely, Technical, Financial, Management, Political, Resources, and Environment. The research aims to identify the factors that cause cost oveerun and how these factors affect the costs. The research was conducted on one leading construction company, where 5 infrastructure projects were selected as the object of the research. The research is a qualitative research that uses two types of data, secondary data from documentation studies and primary data from questionnaires. Secondary data was obtained from the study in the document and poured into a fishbone diagram. The results of the initial identification were then outlined in a questionnaire to measure the Relative Importance Indices (RII). RII is a method to determine the relative importance of various factors causing cost overrun. From the results of data analysis, 10 main factors were obtained which were grouped into 3 groups; Very Important, Important and Quite Important. In addition, an additional analysis was carried out by measuring RII based on 4 types of projects, namely road construction, water buildings, pipeline installations, and runways. The land acquisition factor is a very important factor in 2 types of projects, namely roads and water buildings. This is because both types of projects involve a long or large implementation area.

KEYWORDS *infrastructure, cost overrun, factors, RII*

INTRODUCTION

Every construction project carried out by a construction company should be able to fulfill what is the vision and mission of the company. To achieve this, project implementation will not be separated from how project management is carried out. Management is the process of planning, organizing, leading, and controlling the activities of members and other resources to achieve the goals of the organization or company (Sudipta, 2013). Thus, it can be said that Project Management is a process of controlling the entire project implementation process from start to finish

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so that the project can run as planned and can meet the organization/company's targets.

According to Takim and Akintoye (2002), the success of a project is seen from the achievement of an efficient (right quality, on time and right cost) and effective (customer satisfaction, functional project, without defects). Therefore, it is important to identify the factors that cause the cost overrun to be avoided or minimize their impact in the future. By identifying the problem, corrective actions can be determined (Chang, 2002).

Cost is the most important parameter and determinant of the success of a construction project (Azhar et al., 2008). Rising costs in construction projects are the biggest challenge faced by the construction industry around the world. The causes of these cost overrun are often complex, influenced by various internal and external factors that can interfere with the productivity of project implementation.

The causes of the cost overrun in construction costs can be caused by several factors, such as errors in planning and scheduling, design changes, cost estimation errors, lack of skilled workers, government bureaucracy, delays in completion, low quality of work, fluctuations in material prices, quality of technical documents, delays in payment from owners, and resource difficulties (Bekr, 2015). Meanwhile, Abdel – Hafeez et al., (2016), grouped the factors of cost overrun in previous studies into 6 groups, namely (1) Technical: factors directly related to project implementation, (2) Finance: factors related to various aspects including financing, budget, and overall project financial management, (3) Management: factors derived from the overall project control process, (4) Political: factors derived from political conditions and regulations, (5) Resources: factors derived from the procurement of resources for project implementation, and (6) Environment: factors derived from physical environmental conditions such as location and weather. The grouping was carried out to be able to determine which group of factors had the most dominant role in the construction costs overrun (El-Ahwal et al., 2016).

This study aims to identify and analyze the main factors that cause cost overrun in infrastructure projects implemented by a construction company, with the hope of providing additional knowledge that can be used to optimize cost control and prepare for anticipatory actions in the future. The study took a sample of five infrastructure projects that experienced a cost overrun at the end of the project. The methodology used involves quantitative and qualitative analysis, including surveys, interviews with project core personnel, as well as the use of the Relative Importance Index (RII) to measure and prioritize the various causes that have been identified. In addition, additional analysis was carried out to find out the comparison of the combined RII with the RII based on 4 types of projects implemented by the company in the last 3 years (road construction, water buildings, pipeline installations, and runways).

RESEARCH METHOD

The research was carried out in 3 stages. The first stage is to identify the root cause of the overrun in implementation costs and group it into several aspects based on the research of Abdel – Hafeez et al. (2016), namely technical, financial, management, political, resource, and environmental aspects. Identify the root cause using the fishbone diagram concept. This diagram presents the relationship between an event and its consequences and helps determine the cause of the problem using a structured approach (Ilie and Ciocoiu, 2010). The steps in compiling a fishbone diagram are as shown in Figure 1.

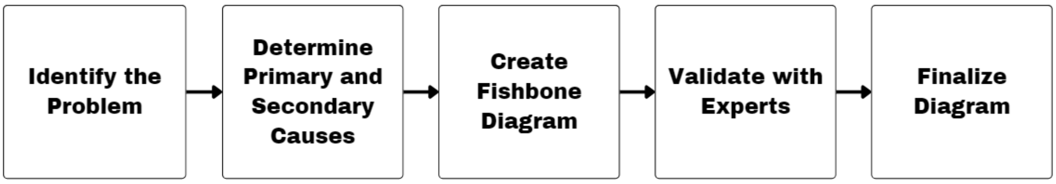

Figure 1. Fishbone Diagram Implementation Process (prepared by the author)

The first step, problem identification, is to find the root cause of the cost overrun of the 5 projects that will be used as the object of research. The basis of these 5 projects is the object of research because these 5 projects have experienced a cost overrun at the end of their implementation period, so it is hoped that a clear picture can be found regarding the causes of the cost overrun. Identification is carried out based on project cost performance reports.

The second step is to find the main and secondary causes of the cost overrun. The causes of the cost overrun are identified through the study of project implementation documentation such as monthly reports, cut off reports, or project book closing reports. In addition, interviews were also conducted with the project manager of the related project to ensure that the root cause of the problem was identified (Mellado et al., 2020).

The third step is to group the causes into 6 aspects in the research of Abdel – Hafeez et al., (2016) and compile the causes found in the fishbone diagram. The 6 aspects are, (1) Technical, factors directly related to how the project is implemented, (2) Finance, factors related to aspects of financing, budget, and project financial management, (3) Management, factors that come from the project control process starting from planning, organizing, supervising, and controlling projects. (4) Political, factors derived from political conditions and regulations, (5) Resources, factors derived from how resources are procured for project implementation, (6) Environment, factors derived from physical environmental conditions such as location and weather.

The fourth step is to have a discussion with experts, to ensure that the results of the identification are easy to understand and represent all existing problems. The fifth step is to finalize the shape of the fishbone diagram according to the results of the discussion with experts (Wasfy & Nassar, 2021).

After identification, a questionnaire was prepared to measure the impact value and frequency of each factor which was then transformed into Relative Importance Indices (RII). Sambasivan and Soon (2007) used this method to determine the relative importance of various factors causing delays in a project. The same method was used in this study, using a rating scale of 1 to 5 to measure the frequency and impact of each cause of cost overrun based on the perceptions of various respondents. To get a relatively similar perception picture, the respondent criteria must be a person who has direct involvement in the project cost control process and has at least 5 years of work experience in this field.

The results of the questionnaire were then calculated to find the RII value. The RII value is obtained by multiplying the Influence Index (IP) by the Frequency Index (IF). The formula for calculating the Influence Index and Frequency Index is:

$$Influence\ Index\ (IP) = \frac{\Sigma W}{A * N}\ and\ Frequency\ Index\ (IF) = \frac{\Sigma W}{A * N}$$

Where W is the total weight given to each variable, A is the maximum weight (in this case it is 5) and N is the total respondents. To calculate the RII value, the formula is used:

$$Relative\ Importance\ Indices\ (RII) = IF \times IP$$

The RII value is used to rank each variable, so that it can be found which factors have a high level of relative importance. After that, an additional questionnaire was carried out for the 10 factors with the highest RII score. The questionnaire was prepared to measure the impact and frequency of these 10 factors when it occurs in 4 types of infrastructure projects, namely road construction, water buildings, pipeline installations and airport runways (Kamandang et al., 2017). These 4 types of projects were chosen because the company has only worked on these 4 types of projects in the last 3 years (2020 – 2023). From this questionnaire, the RII was recalculated and then compared with the combined RII in the previous questionnaire..

RESULT AND DISCUSSION

Initial Identification of Cost Overrun

The initial identification object is 5 projects that have been completed. These projects are projects that have experienced a cost overrun for the implementation cost plan at the end of their implementation. In addition to the similarities in the building group (infrastructure), these projects also have the same scope of work, including excavation work, embankment, and pavement. Earthworks, which have a high level of uncertainty, so that if handled improperly, it can be one of the main factors causing the cost overrun in infrastructure projects. From the five projects, the results of the identification of project cost overrun factors shown in the fishbone diagram are as follows:

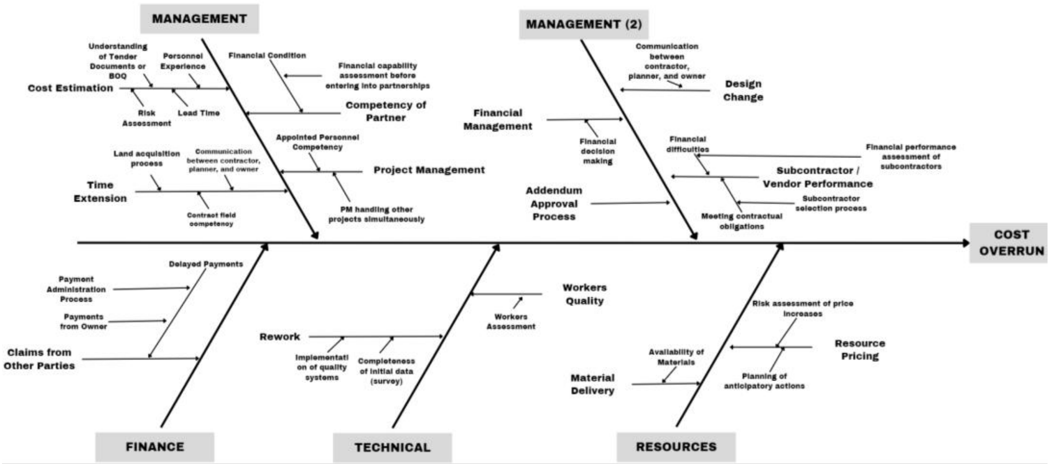

Figure 2. Fishbone initial identification diagram (prepared by the author)

From the results of this initial identification, there are only 4 out of 6 aspects used by Abdel – Hafeez, et al. (2016), namely Technical, Finance, Management, and Resources. Political factors such as political conditions and government regulations have never been the dominant factor that causes the cost overrun. Weather conditions and proximity to the project location can indeed have an impact on the realization of implementation costs, but the impact is not large.

Final Identification from Experts

The results of the initial identification were then validated through experts. The experts in question are 2 Vice Presidents (VPs) with more than 15 years of experience. VP was chosen because it was considered to have 2 points of view, namely the field or project viewpoint and the management viewpoint in the office. In terms of job background, VP Operations is experienced as a Project Manager so that he understands the entire business process of operations in the company. As a result of the discussion, the author added additional identification obtained from the expert's explanation.

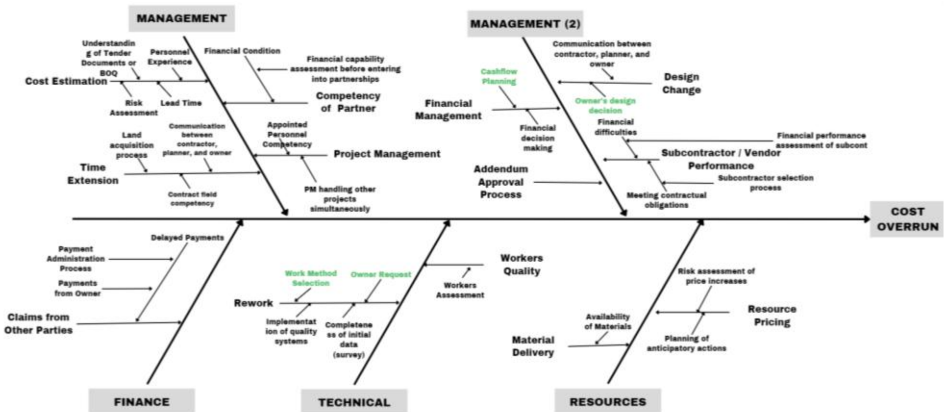

Figure 3. Final Fishbone diagram (prepared by the author)

To facilitate the collection and processing of questionnaire data, the author added variable codes to each factor.

Table 1. List of Cost Overrun Factors

It	Factors Causing Cost Overrun	Code
A	**MANAGEMENT**	
1	PIP experience in project management	A1
2	Cost control competencies	A2
3	Project Core Personnel handle more than 1 project	A3
4	Understanding of tender documents or initial RAB	A4
5	Preparation time from tender to implementation	A5
6	Delay risk assessment	A6
7	Assessment before working with partners	A7
8	Land acquisition process	A8
9	Communication between contractors and stakeholders	A9
10	Competencies in the contractual field	A10
11	Design-related decisions from the owner	A11
12	Assessment of the financial capabilities of subcons/vendors	A12
13	The process of selecting subcons/vendors according to the applicable procedures	A13
14	Addendum approval process, (new items, price, time)	A14
B	**RESOURCES**	
1	Material availability	B1
2	Anticipating an increase in material prices	B2
3	Identify the value of the risk of material price increases at the beginning of planning	B3
C	**TECHNICAL**	
1	Completeness of initial survey data	C1
2	Selection of work execution method	C2
3	Implementation of quality system according to procedures	C3
4	Not conducting an assessment of workers' abilities	C4
5	Continuous design change requests	C5
6	Rework requests from job owners	C6
D	**FINANCE**	
1	Financial decision-making	D1
2	Payment administration process to vendors / subcons	D2
3	Payment from the employer	D3
4	Cashflow planning	D4

Data Analysis and Discussion

Questionnaire Results

Data collection and calculation of questionnaire risk values have been carried out on 60 respondents with the following results:

Table 2. Questionnaire Results

Variable	Influence Index (IP)	Frequency Index (IF)	RII	Ranking
A8	0.97	0.87	0.84	1
A11	0.91	0.77	0.70	2
D2	0.87	0.79	0.68	3
C1	0.90	0.74	0.66	4
A2	0.92	0.72	0.66	5
C2	0.93	0.70	0.66	6
A14	0.85	0.76	0.65	7
C5	0.90	0.70	0.63	8
D3	0.90	0.66	0.60	9
A4	0.90	0.66	0.60	10
A5	0.80	0.74	0.59	11
A1	0.89	0.66	0.58	12
C3	0.89	0.64	0.57	13
B3	0.84	0.67	0.57	14
B1	0.86	0.65	0.56	15
D4	0.85	0.64	0.54	16
B2	0.84	0.64	0.54	17
A10	0.86	0.62	0.54	18
D1	0.85	0.61	0.52	19
A6	0.81	0.64	0.52	20
C4	0.81	0.64	0.52	21
A12	0.82	0.64	0.52	22
C6	0.80	0.64	0.51	23
A9	0.85	0.59	0.50	24
A13	0.83	0.60	0.50	25
A7	0.79	0.61	0.48	26
A3	0.69	0.54	0.38	27

Based on the results of this questionnaire, 10 main causes of infrastructure project costs overrun were obtained, namely:

Table 3. Top 10 causes of rising costs

No	Variable	Factor	Aspects	RII
1	A8	Land acquisition process	Management	0.84
2	A11	Design-related decisions from the owner	Management	0.70
3	D2	Payment administration process to vendors / subcons	Finance	0.68

No	Variable	Factor	Aspects	RII
4	C1	Completeness of initial survey data	Technical	0.66
5	A2	Competence in controlling personnel costs	Management	0.66
6	C2	Selection of work execution method	Technical	0.66
7	A14	Addendum approval process, (new items, price, time)	Management	0.65
8	C5	Continuous design change requests	Technical	0.63
9	D3	Payment from the employer	Finance	0.60
10	A4	Understanding of tender documents or initial RAB	Management	0.60

To assess the top 10 factors, it is determined to assume the division of the value range into 5 ranges, namely (1) 0 – 0.20: Very unimportant; (2) 0.21 – 0.40: Not important, (3) 0.41 – 0.60: Quite important, (4) 0.61 – 0.80: Important, (5) 0.80 – 1.00: Very important. So that only 3 groups of factors in the table above are obtained, namely Very Important (A8), Important (A11, D2, C1, A2, C2, A14, and C5), and Quite Important (D3 and A4).

The first group: Of great importance is the A8 variable; The slow process of land acquisition. In infrastructure projects, it often happens because the owner is unable to provide the land as a whole on time. This can be because infrastructure projects require a large amount of land. In road construction and irrigation projects, land acquisition must be carried out along the track. In dam projects, land acquisition is usually related to the relocation of settlements and disposal of earthworks. From the contractor's side, this condition was previously known at the time of tendering. The decision to continue or forward the tender is up to the office management. If it continues and occurs, the management must be able to collect compensation (time and cost) for the delay because it is included in the "Excusable - Compensable Delay" (Kamandang & Casita, 2018).

The second group: Important, namely the variables A11, D2, C1, A2, C2, A14 and C5. Variable A11; Slow decision related to design changes from owners. This problem occurs from the inreadiness of the work design that should be prepared by the owner at the start of work. Design problems in design-bid-build projects should be the responsibility of the project owner, but what often happens is that these design problems are ignored and the implementation of the tender continues. Variable D2; The long payment administration process, especially in NonJO projects, causes a decline in the performance of vendors / subcontractors so that there are delays and have an impact on implementation costs. Therefore, to be able to speed up the payment process, a commitment from all parties is needed to be able to fulfill the process as outlined in the procedure. Variable C1; rework is caused by the lack of necessary technical data, while the work is forced to continue due to time constraints. Not only technical planning for implementation, but also the costs needed due to delays in implementation or accelerating implementation. Variable A2: The appointment of personnel of this project is carried out by the management at the time the project tender is won. The appointment of personnel is based on a track record and assessment of cost control. From the management side, it is necessary to reconsider how to place personnel according to their needs, for example by adjusting to the scale of the project. Variable C2; The planned method of making ARP is forced to be carried out despite the difference in the real conditions of the field. There needs to be a form of control to ensure that the initial method to be implemented is in accordance with field conditions or changes are needed. Variable A14; The long process of approving addendums, (new items, prices, time) is due to the length of bureaucracy that must be passed in issuing addendums, whether it is addendums related to time or price. Variable C5; the continuous demand for design changes results in inhibited implementation productivity which can have an impact on increasing implementation time and fixed costs that must be incurred. Not to mention if the design change requires renegotiation and procurement of specific materials.

While the third group: Quite Important, the first is the D3 variable; Delays in payments from the employer to the company in addition to affecting internal cash flow, can also affect payments to vendors/subcontractors who support the progress in implementation. Anticipation – anticipation can be done at the beginning of the tender by conducting a stricter assessment of the prospective job owner. Reinforcement of contract administration can also be done. The last variable is A4; Failure to master the tender document or the initial RAB results in inaccuracies in compiling the ARP and there is a cost imbalance in its realization. In addition to ensuring that the appointed project core personnel are competent, mastering tender documents is also the responsibility of management in the office.

If viewed from the group of factor aspects, the most dominant aspect is Management with 5 factors, Technical 3 factors, and Finance 2 factors. It is necessary to pay special attention to how project control management in the entire business process. Management needs to evaluate so that the occurrence of cost overrun due to these factors can be avoided or anticipated.

Comparison with Project Type

To prove whether the identification of the above factors already represents a problem in the infrastructure project as a whole, a follow-up survey was conducted to compare the RII if the problem is viewed from the type of project.

Table 4. Comparison of the top 10 factors between General RII and Toll Road Projects

Rangking	Variable	General RII	Rangking	Variable	RII Road Project
1	A8	0.84	1	A8	0.89
2	A11	0.70	2	A11	0.72
3	C2	0.68	3	C1	0.68
4	A2	0.66	4	D2	0.67
5	C1	0.66	5	C6	0.65
6	D2	0.66	6	A2	0.63
7	C6	0.65	7	C2	0.62

8	A14	0.63	8	A14	0.61
9	D3	0.60	9	D3	0.60
10	A4	0.60	10	A4	0.58

Based on the comparison of the two tables above, it can be seen that the top 2 factors have similarities, namely A8 related to the land acquisition process and A11 related to design-related decisions. While other factors, the bottom 3 have the same order even though there are differences in the third to seventh factors. In terms of value, the lowest value deviation is 0.02, so the difference is not significant.

Table 6. Comparison of the top 10 factors between General RII and Water Building Projects

Ranking	Variable	General RII	Rangking	Variable	RII Bang Project. Water
1	A8	0.84	1	A8	0.84
2	A11	0.70	2	A11	0.73
3	C2	0.68	3	C2	0.67
4	A2	0.66	4	C1	0.66
5	C1	0.66	5	D2	0.66
6	D2	0.66	6	A14	0.65
7	C6	0.65	7	A2	0.64
8	A14	0.63	8	C6	0.63
9	D3	0.60	9	D3	0.51
10	A4	0.60	10	A4	0.49

In projects with water building types, there are still similarities in the variables A8, A11 and C2. Although the fourth to eighth ranks are different randomly, but the bottom two ranks have similarities. In terms of RII value, the top 8 factors have close values, although the bottom 2 are quite far apart.

Table 5. Comparison of the top 10 factors between General RII and Pipeline Installation Projects

Ranking	Variable	General RII	Rangking	Variable	RII Project Ins. Pipa
1	A8	0.84	1	A8	0.71
2	A11	0.70	2	A11	0.62
3	C2	0.68	3	D2	0.59
4	A2	0.66	4	C2	0.58
5	C1	0.66	5	D3	0.56
6	D2	0.66	6	C1	0.55
7	C6	0.65	7	A14	0.55

Ranking	Variable	General RII	Rangking	Variable	RII Project Ins. Pipa
8	A14	0.63	8	A2	0.53
9	D3	0.60	9	C6	0.50
10	A4	0.60	10	A4	0.48

In projects with the type of pipeline installation project, the ranking of the top two and bottom variables is still the same, that is, in order, the variables A8, A11 and A4, although the other 7 variables differ randomly. In terms of RII value, the deviation in the last ranking is wider than the previous two types of projects, which is 0.12.

Table 6. Comparison of the top 10 factors between General RII and Runway Projects

Ranking	Variable	General RII	Rangking	Variable	Runway Risk Assessment
1	A8	0.84	1	A11	0.55
2	A11	0.70	2	C2	0.51
3	C2	0.68	3	D2	0.51
4	A2	0.66	4	C6	0.50
5	C1	0.66	5	A14	0.48
6	D2	0.66	6	A8	0.46
7	C6	0.65	7	C1	0.46
8	A14	0.63	8	D3	0.46
9	D3	0.60	9	A2	0.43
10	A4	0.60	10	A4	0.42

The most significant difference is seen in the type of runway project. The deviation of the value in the last ranking reached 0.18. The equation in rank between variables is also much different than the first 2 types of projects. The proximity of the RII value to the top factor in road and water building projects can be understood because it is indeed the problem that is often faced by this type of project. On road and irrigation projects

CONCLUSION

From the results of the analysis and discussion, 10 main factors were found to cause the cost overrun of implementing infrastructure projects. The aspect that most affects the overrun in project costs is the Management aspect as many as 5 factors, followed by the Technical aspect of 3 factors, and the Financial aspect of 2 factors. Meanwhile, the most influential factor causing the cost overrun is the land acquisition factor (A8) with an RII value = 0.84, or it can be categorized as a very important factor and must be the concern of contractor management in participating in tenders in the future.

To compare the suitability of these 10 main factors to general conditions, a comparison of RII based on project type was carried out. From the results of the comparison, the 10 factors are generally in accordance with the conditions of the type of road and water building construction projects, while in runways and pipeline installations there is a gap in the RII value that is quite far. In particular, the similarity of the Very Important factor, related to the land acquisition process, can be understood to be very suitable for the conditions of road and water building projects because these two types of projects both involve a long and/or large implementation land.

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