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Identification of delay factors in construction during Covid-19 Pandemic: Case Study NSUP Program, Indonesia

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Abstract
There are several factors that cause project delays it can from the owners, contractors, consultants or external factors. Project delays not only occur in public and private projects but also in projects whose funding sources come from foreign loans and grants. One of the projects funded by foreign loans in Indonesia is the National Slum Upgrading Program (NSUP) in Banten, Indonesia. The NSUP is funded through a foreign loan from the Islamic Development Bank (IsDB). There are three area-scale NSUP activities in that experienced construction delays. The objective of this paper is to determine the factors causing construction project delays. The research was conducted by distributing questionnaires to 11 respondents of project owners, contractors and consultants of thr NSUP project. Methodology of data analysis with validity, reliability tests and ranking factors through the Relative Importance Index (RII) analysis. The results showed that there are ten dominant project delay factors including the Covid-19 factors, and also five dominant work items that cause project delays. In conclusion, there must be watched out for and anticipated by all project parties so that project delays can be minimized and even avoided. This anticipation can be not only from the planning phase, design, auction, and finally to the implementation of the project, but also all possible force majeures such as pandemic.

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Introduction

The source of financing for construction projects can be viewed from the pattern of infrastructure financing, one of which is the pattern of funding/financing through foreign loan and/or grant mechanisms. The government can make loans and/or receive grants both from within the country and abroad. These foreign loans can be sourced from multilateral financial institutions such as the World Bank, Asian Development Bank (ADB), Islamic Development Bank (IsDB) and other foreign countries.

The Indonesian Ministry of Public Works and Public Housing is one of the ministries that receives allocation of foreign loan funds. Foreign loan projects are spread across several provinces in Indonesia, one of which is in Banten Province. In 2020/2021 it is budgeted projects whose financing sources came from the Islamic Development Bank (IsDB), one of which was in the National Slum Upgrading Project (NSUP) program. In that span of years, two out of three NSUP projects experienced delays in implementation time (DPKPK PUPR, 2021) [3].

One source of problems in foreign loan projects is the low performance of the project at the construction stage. In its implementation, projects funded by foreign loans often experience delays in the implementation of construction which causes the construction implementation time to exceed the predetermined time. Some of the problems that cause low project performance, including extreme weather disturbances, low performance of contractors, slow procurement process of goods/services, and land acquisition problems (Sianipar, 2012) [6]. Especially during the Covid-19 pandemic that hit Indonesia, it became an additional factor in project delays.

In addition to project delays, the Covid-19 pandemic has also had an impact on the distribution of materials and labor, such as cuts in labor/labor (appeals not to crowd), cuts in working hours and even temporary work stoppages for projects in the red zone, as well as material distribution due to lock down policies or large-scale social restrictions.
The objective of this paper is to determine both the factors and work items causing construction project delays.

Methodology
The methodology includes literature study and a questionnaire survey to identify how much influence a factor has on project delays. The respondents survey include the project managers of owner, the contractors (the project manager and the site manager), and the construction management consultant (the team leader and the expert personnels). The data collected is analyzed by Validity Test, Reability Test, and Relative Importance Index (RII) method.

Literature Review
Boy *et al*. (2021) [2] and Yudhagama (2020) [8] mentioned the factors causing delays that occur in construction projects, as follows:

1. Factors caused by the owner
a. Have not mastered the field of work
b. Slow in making decisions
c. Lack of coordination with contractors
d. Changes in contracts (changes in plans and specifications)
e. Financial problems (late payments, financial difficulties and economic problems)

2. Factors caused by the contract
a. Material shortage in the field
b. Errors and defects in work
c. Lack of expertise and experience
d. Lack of work area in the field
e. Low productivity
f. Financial matters
g. Lack of coordination
h. Less skilled subcontractors
i. Lack of equipment in the field
j. Weak management system

3. Factors caused by the consultant
a. Lack of professional experts
b. Lack of consultant experience
c. Lack of experience and expertise in the field of management and supervision
d. Slow in supervision and decision making
e. Incomplete documents
f. Slow in giving commands

4. Factors caused by externals
a. Unavailability of materials in the market
b. Unavailability of equipment
c. Adverse weather conditions
d. Poor project location/area
e. Poor economic state (inflation, weakening currency value, etc.)
f. Changes in government regulations
g. Slow mobilization

Research on delays conducted by Sihombing (2020) [7] has been able to identify several causes of delays, including:
1. Late payment by client owner
2. Poor implementation of work stages by contractors
3. Material mismanagement by contractors
4. Labor shortage by contractors
5. Heavy rain/waterlogged work site
6. Different soil state than expected
7. Additional work requested by the client owner
8. Changes in plumbing, structural, electrical work
9. Errors in planning and specifications
10. Unclear planning and specifications
11. Changes in planning and specifications
12. Change of work method by contractor
13. Error in interpreting drawings or specifications
14. Poor planning of work schedules by contractors
15. Suboptimal productivity of contractors
16. Changes in the scope of the consultant's work
17. Strikes carried out by contractors
18. Fix finished work
19. Repairing damage to a job due to a strike
20. Late approval of shop drawing by consultant

In the scope of government projects there are several dominant factors that affect the delay of construction projects, namely weather, labour, design. While in the scope of private projects, the dominant factors affecting project delay factors are weather, material and finance (Lestari et. al., 2021) [5].

Sianipar (2012) [6] concludes that the impact of delay is incurring losses:
1. For owners, delays lead to loss of income from buildings that should already be usable or leased.
2. For contractors, delays in project completion mean increased overhead due to increased implementation time, thus adverse due to the possibility of rising prices due to inflation and rising labor wages, as well as restraining contractor capital that is likely to be used for other projects.
3. For consultants, delays will experience a loss of time, because with these delays the consultants concerned will be hampered in scheduling other projects.

Results and Discussion
From the data collected from respondents and analyzed, it is discovered ten highest ranks of delay factors in NSUP construction project case study:

Rank 1: Continuous rain conditions that cause flooding
Continuous rain can cause the river water level to rise and cause water to overflow to the side of the river, causing flooding. This item is considered very influential and is the biggest cause of delays in NSUP construction projects in Banten Province. For example, the dock and riverside pavement works. According to the surrounding community, floods can overflow into residential areas. During the construction there was heavy rainfall in, which caused flooding to occur twice and resulted in work being stopped. Not only floods caused by rain but floods also come from seasonal tidal floods. Work that is stopped results in lost working days resulting in project delays. Weather problems are delays that come from external factors. This type of delay

is excusable delays, also known as "force majeure delays" or "acts of God". In this situation, the contractor is entitled to additional time in completing the project but does not get additional costs. As the result, there is an additional 30 days contract implementation time.

Rank 2: Disturbances from the Public

The implementation of construction in settlement locations intersects with the lives of the surrounding communities, causing pros and cons. If the work is considered disturbing the community, the community can raise objections through reports, but if it is at an extreme stage, the community can protest and work can stop. For example, there is work on the People Crossing Bridge (JPO) (Figure 1) with steel structures. The JPO is located above a river which is a place for people's fishing boats after going to sea. At the time of JPO work, it was necessary to close one side of the river for bridge abutment work so that fishing boats could not operate normally and people boat traffic was disrupted. Many times fishing boats passed through JPO work so that construction could not be carried out on time because the work area had to be passed by the community, thus it causes project delays. In addition to interference from the community, interference can also come from other external parties. For example, the work has been delayed by up to one month due to the normalization work of the river carried out by the Banten Provincial Public Work Office (Figure 2) which is located the same as the location of the NSUP project activities.

***Source*:** CM Consultant Documentation

Fig 1: Temporary Construction of JPO

***Source*:** CM Consultant Documentation

Fig 2: Sludge of River Normalization Work

The results of normalized sludge dredging are disposed of in the road body which is the location of NSUP project concrete rebate work. This resulted in the contractor being unable to carry out concrete rebate work. A coordination meeting was held between NSUP project parties and the Banten Provincial Public Work Office to find solutions to this problem. The delay in the implementation of construction is included in the category of external factors, if it has a major impact on the implementation time, the contractor can propose an additional time without additional costs to the owner.

Rank 3: Design Changes/Work Details at Execution Time

In the implementation of construction, it is often found that some designs on working drawings or planning documents are not in accordance with the field conditions. As a result of these discrepancies, owners, contractors and consultants must change the design or details of the work to suit the conditions in the field. For example, in NSUP project activities, there are changes in the JPO bridge abutment design which requires recalculation of the structure. In addition, there is also the addition of additional work items in the form of two bridges (Figure 3) around the settlement site. This led to an additional 30 days of work time and an additional cost of IDR 300,000,000.

***Source*:** CM Consultant Documentation

Fig 3: Two Bridges of Additional Work

Furthermore, there is also an increase in the length of concrete road work and U-Ditch channels, causing the project to experience delays and require an additional 18 days of completion time and implementation costs of IDR 300,000,000. Delay due to changes in design/work details is a delay that comes from the owner's side so that the contractor can propose additional time and costs to the owner. This type of delay can be put into the category of concurrent delays,

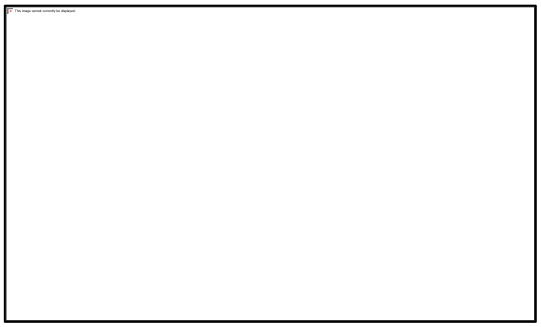
that is, delays caused by several causes simultaneously. In this case, the cause comes from changes in design and needs of the surrounding community. This item is considered influential and is the biggest cause of delays in NSUP construction projects in Banten Province.

Rank 4: Delay in delivery of materials to the project site due to the implementation of Covid-19 Lock Down

One of the government's efforts to suppress the spread of the Covid-19 virus is to impose Covid-19 Emergency Lock Down which cause difficulties in distributing construction materials. The impact caused is a delay in the implementation of work. Delays due to the implementation of this lock down include delays originating from external factors and are excusable delays. This type of delay is only felt during the Covid-19 pandemic. This is quite influential in the implementation of construction in the NSUP Project, because the implementation time is in the range of 2020 – 2021 at which time the spread of the Covid-19 virus was quite high so that the implementation of the lock down was intensively implemented by the government. For example, the project owner instructed the addition of new work items in the form of handling Covid-19 in accordance with the Instruction of the Minister of Public Works and Public Housing Number 02/IN/M/2020 (2020) concerning protocols for preventing the spread of Corona Virus Disease 2019 (Covid-19) in the implementation of construction services. Even, in some areas of NSUP project, the owner issued a letter of instruction to stop work for 7 days due to the high level of spread of the Covid-19 virus and resulted in delays in the delivery of materials to the project site so that additional work time was needed.

Rank 5: Communication between contractor and owner

Communication between the contractor and the project owner is very important because coordination and evaluation of work can be carried out appropriately. If there is no communication between the contractor and the Owner, what happens is the problem of construction dispute cases. Lack of communication leads to differences in perceptions, conflicts and disputes and results in project delays. Therefore, as a project manager must have good communication skills in running a project and the project owner must have a target to solve existing problems. Delay due to lack of communication between the contractor and the owner is a factor of delay that comes from the owner's side. So that the contractor is allowed to get an extension of time and can also file a valid claim to get his extra compensation. Intense communication can be through weekly meetings (Figure 4) and reporting on the progress of activities every day. In this era of communication, reporting by contractors and consultants can be submitted orally and in writing on certain social media so that developments in the field can be monitored optimally and decision making can be carried out. Through communication intents work mistakes and problems can be avoided.



***Source*:** CM Consultant Documentation

Fig 4: Weekly Meeting as a Important Communication Mean

Rank 6: Additional Jobs and Job Changes from the Owner

In the implementation of project work in the early stages of implementation, it is necessary to carry out measurements carried out by owners, contractors and consultants to ensure field conditions according to design documents (drawing, specifications, and cost estimate). However, at the time of implementation, there is often a discrepancy in conditions or measures between the field and design documents, so it requires a change of work. For example, there were work changes contained in the design of bridge abutments and the addition of new work items in the form of rehabilitation of two bridges at the existing location. Another example is an addition to the location of the concrete rebate road and an increase in the length of the U-Ditch drainage. Finally, There were changes occurred in the design of Public Open Space and the addition of work items in the form of the construction of fish auction counters (Figure 5).

***Source*:** CM Consultant Documentation

Fig 5: Additional Work TPI Ticket Window

Such additional and job changes from the owner lead to the need for additional implementation time and costs because changes related to budget additions cannot be implemented immediately. Owners must submit additional budgets to the lenders through the Ministry of Public Work. The process of submitting an additional budget takes time so that construction cannot be completed according to the initial contract or the work is delayed.

Rank 7: Inadequate Number of Workers

There are three main components in the implementation of construction, namely labor, materials and equipment/tools. In the analysis of the unit price of work, the three components have a coefficient to determine the need / amount needed in running a work item. If it is not in accordance with the analysis, work productivity will be disrupted, so thus a shortage of workers can cause project delays. Most projects implement a zone system to divide workers into groups. For example, in some NSUP project activities, the work is divided into 5 zones to facilitate the process of implementation and supervision in the field so that the work can be carried out in parallel. The workforce in each zone has been determined based on the type of work, but labor shortages still often occur. As a result, based on the weekly meeting report of Week 28 NSUP project activities, the realization progress is 71.69% and the plan is 76.47% so that the deviation is -4.78%, one of the problems is the shortage of workers in each job zone, as following:

- **Zone 1 (TPS3R)**

There is a shortage of workers for office roof plate and canopy casting work, floor casting work and ceramic work. Recommendation to increase the workforce by 3 workers and 1 mechanic.

- **Zone 2 (STA 0+420 s/d STA 0+700)**

There is a shortage of workers for 50x50 U-Ditch installation work and box planter work. Recommendation to increase manpower as many as 4 U-Ditch workers and 3 planter box workers.

- **Zone 4 (STA 0+00 s/d STA 0+420)**

There is a shortage of workers for control tub work and box planter work. Recommendation to increase the workforce by 7 people for control tub work and 2 planter box workers.

- **Zone 5 (RTP/Taman Lingkungan)**

There is a shortage of workers on paving block parking areas. Recommendation to increase the workforce by 10 people.

Labor shortages are very influential in the cause of project delays. Shortage of workers is a cause of delays that come from contractors. With the recommendation of increasing manpower, it is expected to accelerate progress by 10% for Week 29.

Rank 8: Delays in Decision Making by the Project Owner

Decision making or approval of work permits for contractor is common in carrying out a work activity such as drawings and sample materials. This decision-making process will be an obstacle that can slow down the process of carrying out work if to obtain the permit it takes a long time to make a decision. Delay due to lack of communication between the contractor and the owner is a factor of delay that comes from the owner's side. So the contractor is allowed to get an extension of time and can also file a valid claim to get extra compensation. For example, in a NSUP project activity, a decision is needed from the owner to replace the specifications of monolithic H-Beam steel material into fabricated H-Beam steel, because the scarcity of monolith H-Beam steel material in manufacturers/suppliers. The project owner must have clear procedures regarding decision-making deadlines and hierarchies of decision makers so as not to waste construction time.

Rank 9: Errors/Incomplete Detail Engineering Design Documents

Detail Engineering Design (DED) documents that can be used in the implementation of the contract are the drawing, specifications, cost budget, and other permit documents. In the implementation of construction, the contractor refers to the documents that have been made by the owner, but often the documents are incomplete and there are errors. One of the tasks of the owner, contractor and consultant is to check in the field before construction work begins so that it can complete things that are not in the design document and correct existing errors in time. If there is an error in the drawing, the contractor can correct the error and pour it into shop drawing and as built drawing. If there are errors and improvements in the calculation of field quantity, the contractor can submit a contract addendum to adjust the needs of work in the field. For example, in the NSUP project activities from the results of joint calculations, limestone work is needed to improve the basic soil on concrete road works. This is not contained in the project design document so it is necessary to add limestone work items and apply for a contract addendum. Errors or incompleteness of work documents can cause project delays because contractors and consultants cannot work immediately and need more time to correct documents if errors or incompleteness on a large scale. This type of delay comes from the owner and is a compensable delay, namely a delay in the contractor's performance that occurs due to the owner's error to fulfill and carry out contractual obligations appropriately. In this case the contractor is entitled to cost compensation and an extension of time.

Rank 10: Shortage of Experienced Workforce

In addition to the shortage of manpower, another factor that comes from the workforce is the shortage of experienced labor. A job requires experts in accordance with their fields. For example, in the NSUP project activities of riverside pavement work requires experienced labor in the field of stone work and dewatering work so that the work can run smoothly. Another example is drainage work which requires surveyors and workers who understand U-ditch leveling so that water can flow and not stagnate (Figure 6). Final example, is in riverside pavement work, due to the lack of experienced manpower, dewatering work has difficulties, especially during high tide. River water enters the dewatering area which causes the masonry pavement to become submerged, this results in stucco that has not dried to come off. As a result, plastering work must be reworked and increase the processing time so that the work is delayed. This delay is a type of delay that comes from the contractor, the contractor must be responsible for the delay of the project by adding experienced labor. The contractor's obligation is to hire experienced workers so that the work can run smoothly.

Furthermore, from the data collected from the respondents and analyzed, it is also discovered five highest ranks of work items of delay factors in NSUP construction project case study:

***Source*:** CM Consultant Documentation

Fig 6: U-Ditch Drainage Work

Rank 1: The Dewatering Method

The factor of choosing the dewatering method is the most influential factor in causing construction delays. In riverside pavement work (Figure 7), dewatering work is needed, which is work that serves to dry excavated land under the groundwater table, usually using the dam method with sandbags and wood stem, so that river water does not enter the turf work site. However, proper consideration of dewatering methods is needed due to fluctuating water conditions due to the influence of river tides. At high tide, water can enter the river side bank work site and soak the bank that has not dried. The river side bank work can be carried out optimally at low tide.

For example, dewatering work is carried out by forming dam using two-layer sandbags and wood stem supports. Water that still enters the site is removed by a pump. Precise calculations are required for the number of pump devices. If the dewatering method is not applied properly, water can enter and damage existing work.

***Source*:** CM Consultant Documentation

Fig 7: The River Side Bank Work

Rank 2: The Number of Pump for Dewatering Work

Similar to the selection of the right dewatering method, the need for a suction pump is also an influential factor in construction delays. The needs of the suction pump must be adjusted to the possibility of the amount of water entering the location and the suction power of the pump (Figure 8). Suction pumps are used at several points so that the riverside work can be completed faster. However, contractors often use makeshift suction pumps so that water still enters the project site. This causes a slowdown in the progress of the riverside work and is a factor of delay coming from the contractor. The contractor cannot provide adequate work equipment.

***Source*:** CM Consultant Documentation

Fig 8: Dewatering Work Using Pumps

Rank 3: Saw Cutter Equipment Condition

Saw cutter or concrete cutter is a tool or construction machine used to cut cast concrete roads with a capacity depth adjusted to the blade cutter or concrete cutter knife and other solid materials. This engine has several sources of power aware of the type of engine, some use gasoline fuel, hydraulic and pneumatic systems, or electric motors. Cutting concrete roads using a saw cutter with a depth of 75 mm per distance of 5 meters. If the saw cutter is damaged, the cutting work can be delayed and the contractor must immediately provide a new saw cutter so that the progress of the work can continue.

Rank 4: The Size of River Stone Construction Materials

Riverside work uses river stone with size of approximately 15 - 30 cm. If the stone installed is too small, there will be a waste of stucco mortar, while if it is too large, the riverside has the risk of rolling or collapsing. The selection of stone sizes that are in accordance with the criteria makes it easier for workers to carry out their work. Supervisors are needed

so that the stones used match the criteria. If the material is not suitable and rejected by the supervisor, it will take time again to provide the appropriate material, so that the work of the riverside cannot be carried out immediately. This can cause construction delays stemming from contractor factors. The contractor is unable to provide materials that meet criteria and specifications.

Rank 5: Construction Method

Apart from materials and work tools, the delay factor can come from improper construction methods. For example, in the installation of the U-Ditch channel (Figure 9), there is excavation work that uses heavy equipment in the form of excavators, but soil conditions that are too soft or hard become difficulties in excavation work. So that the contractor must apply the right construction method and thus equipment according to field conditions, otherwise it will be the cause of construction delays.

***Source*:** CM Consultant Documentation

Fig 9: U-Ditch Drainage Work

This type of delay comes from the contractor because he is unable to use construction methods and equipment that conform to the appropriate specifications and field condition. Contractor-caused delays will generally result in no extension of time and no additional compensation.

Conclusion

From the case study, it can be seen that in construction project work there are many delay factors and also work items that have the potential to significantly slow down project work that must be watched out for and anticipated by all project parties so that project delays can be minimized and even avoided. This anticipation can be from the planning phase, design, auction, and finally to the implementation of the project, so that it can be more effective and efficient. Delay factors can also occur due to the influence of force majeure such as the Covid-19 pandemic and others. Therefore, anticipation of all conditions, including all possible force majeures, in construction projects also needs to be done so that delays in construction projects can be minimized and even eliminated.

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