Small-sized contractors’ strategies of construction material purchasing in road rehabilitation projects

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Abstract. Material management in construction project consists of material requirements planning, selecting suppliers, purchasing process, managing inventories, utilizing material, and managing waste materials. Suppliers selection and purchasing materials are very important stage related to suppliers and contractor relationship that needs to be considered. This paper discusses strategic issues in managing the purchasing of construction materials for road projects accomplished by small-sized contractors in The Greater Bandung areas. Kraljic’s portfolio matrix approach is used to identify strategic construction materials. Initial data were obtained from three projects of road rehabilitation to identify seven strategic materials which further validated by gathering more data from the other 10 small-sized contractors. Based on the result of the identifying stage, it was found six strategic materials subsequently its strategic purchasing method was identified based on the characteristics of each material; building a strategic partnership was proposed for all materials.

1. Introduction
Many infrastructure projects are currently being developed in Indonesia, such as roads, bridges, railways, tunnels, dams, airports, and irrigation channels. The infrastructure projects are expected to be completed at the end of 2024, but the construction project cycle will not stop even after the construction project is completed, it must be continued with the maintenance process so that the infrastructure facilities can reach the optimum building age as planned.

The routine maintenance process of infrastructure buildings will involve small-sized contractors, since the value and complexity of the work following the qualifications of small-sized contractors. Road infrastructure projects carried out by small-sized contractors are projects to restore and maintain roads’ infrastructure and its support elements, such as drainage channels [1]. Construction methods for road infrastructure maintenance are relatively simple and can be done by almost all contractors with the field of road infrastructure works, such as those included in Indonesian Construction Services Development Board (LPJKN) qualifications. Therefore, the technical aspects, in general, are not a serious problem, nevertheless, from the aspect of material costs, some potential things that can be improved therefore resources efficiency are can be achieved.
The value of material costs in a construction project is in the range of 60% to 80% of the total construction costs [2, 3]. In consequence, the aspect of purchasing construction materials needs to be considered by the contractor not only to achieve cost efficiency but also to attain a significant impact of construction operation productivity. Therefore, the step of selecting suppliers and determining purchasing strategies might reduce the risk of material availability on the project. The activity of procuring construction materials must be started from the planning of material requirements that are integrated with a construction work schedule so that delivering materials are appropriate with project needs hence it will reduce the cost of material storage in the site. Besides, determining purchasing strategies is not only deciding on selecting suppliers but also coordinating them throughout the project implementation [4].

The construction materials required for road rehabilitation are very diverse, therefore there is a need to identify construction materials that classify into the strategic commodities category. Hence purchasing strategy will be a focus on the construction materials in this category. The strategic commodities category is a group of materials that has great value in the importance of purchase aspects and supply risk aspects. The assessment of strategic commodities is conducted in terms of quantity and quality analysis and its availability in the long term that will be affected production productivity [5]. In the context of construction, construction material is stated as a strategic commodity if the amount in monetary value is large and meets the assessment of the level of purchase and supply risk importance so that its availability will affect the construction operation process in the site.

This paper discusses strategies in purchasing construction materials for road rehabilitation projects carried out by small-sized contractors, by taking research samples in Bandung and surrounding areas (The Greater Bandung areas). The results of the study are expected to be a reference for contractors, especially small-sized contractors who work on road infrastructure maintenance projects in formulating a strategy for purchasing construction materials.

2. Methodology

The research was conducted with a survey of small-sized contractors working on road rehabilitation projects in Bandung and surrounding areas. In addition, three road rehabilitation projects were applied to validate the result of Kraljic’s matrix in materials value aspect to total material cost for each project.

The determination of strategic commodities starts from determining eligible construction materials to be selected as test commodities taking the Kraljic’s portfolio matrix. The selection of test commodities is carried out by evaluating contract documents related to material needs and costs. From the results of the Pareto diagram with the highest percentage of material costs for overall material costs, seven test commodities were obtained [6].

Furthermore, the seven test commodities are assessed on the supplier’s risk aspects and the level of purchase interest. Tests for commodities were carried out by 10 representatives of small-sized contractors as research samples. Analysis of the results of the questionnaire regarding supplier’s risk and the level of purchase interest is plotted on the Kraljic’s diagram, and 6 out of 7 test commodities are included in the leverage category, namely sand, aggregate, reinforcing steel, cement, asphalt, and concrete. Analysis of building purchasing strategy for strategic commodities which is defined from the previous stage was conducted in a qualitative approach based on literature review.

2.1. Identifying strategic commodities

Identifying strategic commodities in construction materials contexts for road rehabilitation projects are conducted in two studies, assessment by small-sized contractors and calculation of construction materials consumption. Construction materials used in road rehabilitation projects carried out by small-sized contractors are sand, aggregate, landfill, asphalt, reinforcing steel, cement, asphalt, and concrete. Those materials are will be analyzed through small-sized contractor responses in terms of assessment from supply risk and profit impact aspects. Besides, materials consumption in monetary value for the total material cost is analyzed based on the results of contract documents for three road rehabilitation projects as case studies.
Based on the results of contract documents analysis in terms of material cost, each material had. The project description and the percentage of each material’s cost to the total construction costs are shown in table 1 and table 2.

Table 1. Description of project case.

| Project Case | Total project cost | Total material cost |
|--------------|--------------------|---------------------|
| **Case A:** public road works for rural area in Bandung Regency | 1,521,588,00 IDR | 1,038,617,398 IDR |
| **Case B:** public road works, including pedestrian and drainage in Bandung City | 783,276,001 IDR | 502,201,980 IDR |
| **Case C:** public road works, including pedestrian and drainage in Bandung City | 461,813,000 IDR | 294,267,357 IDR |

Table 2. Materials consumption of each case study.

| Commodities     | Case A   | Case B   | Case C   | Means  |
|-----------------|----------|----------|----------|--------|
| Asphalt         | 34.53%   | 28.09%   | 34.68%   | 32.43% |
| Concrete        | 13.31%   | 19.98%   | 15.45%   | 16.25% |
| Sand            | 4.00%    | 4.27%    | 3.81%    | 4.03%  |
| Reinforced steel| 4.90%    | 2.68%    | 2.81%    | 3.46%  |
| Aggregate       | 4.56%    | 2.11%    | 1.65%    | 2.78%  |
| Cement          | 1.62%    | 2.83%    | 0.91%    | 1.79%  |
| Landfill        | 1.23%    | 0.22%    | 0.17%    | 0.54%  |

The study of three road rehabilitation projects carried out by small-sized contractors in Bandung and surrounding areas shows that asphalt has the highest percentage compared to the others. This is finding due to the specifications of the road being studied are flexible pavement roads. Asphalt and concrete are commodities for the road overlay process, which is very in accordance with the scope of the project. Project scope area of road rehabilitation project generally does not attain the subbase works. In addition, the unit price for asphalt and concrete is also relatively higher compared to other commodities, therefore, it will increase the monetary value of them.

The determination of strategic commodities is conducted with Kraljic’s portfolio matrix approach which consists of four quadrants as can be seen in figure 1. The attributes of each quadrant describe the level of importance of commodities in its business process. Kraljic’s matrix classifies four-level in strategic commodities namely, strategic, leverage, bottleneck, and non-critical items. The category levels assess in two dimensions i.e. profit impact and supply risk (low and high level) [5].
In this matrix, the value of each indicator is shown at range 1 to 10, which 1 is for the condition of there’s no impact for supply risk and profit impact, and 10 is for vice versa. The midpoint in range (5 to 5 point) is cutting line to divide four areas in the matrix.

![Kraljic portfolio matrix (KPM)](#)

The dimensions in Kraljic’s portfolio matrix are based on the complexity of commodity supply risk and commodity profit impact. Kraljic’s portfolio matrix is a generic theory that has been used in various industries, ranging from manufacturing, agriculture, and construction. The set of indicators is built as a tool to determine the strategic level of a commodity [7], which can be seen in table 3. Based on the research conducted by Irfanto [8], the results of plotting respondents’ assessment of supply risk variables and profit impact are obtained from all respondents for each test commodities. Kraljic’s portfolio matrix results of each commodity are shown in table 4.

The results of commodity testing on cost percentage and assessment of profit impact and supply risk attributes indicate that the landfill can be eliminated because based on the cost of purchasing material the percentage is very low at 0.54%, and the supply risk aspect is only 3.90 and profit impact level is only 0.75 above the mid-quadrant threshold.

Based on the results of the supply risk assessment all test commodities are at a low threshold (less than 5.00), this indicates that commodities for road rehabilitation projects have no risk to supplier availability or supplier performance. However, based on the profit impact of commodity purchases, the material used in infrastructure projects is at the middle of the upper threshold of Kraljic’s portfolio matrix, which means that purchasing commodities will have an effect on the value of profits related to overall project costs, absence of substitute commodities, and commodity value is very high even without being affected by the costs beyond the purchasing cost the commodity itself, such as delivery costs and other costs.
Table 3. Indicators of strategic commodities determination [7].

| Dimension        | Variables                  | Indicators                                           |
|------------------|----------------------------|-----------------------------------------------------|
| Supply risk      | Market risk                | Availability of suppliers                           |
|                  | Performance risk           | Supplier’s performance in delivering                |
|                  | Complexity risk            | Difficulties in finding suppliers                   |
| Profit impact    | Impact on profitability    | Profit on purchasing commodities                    |
|                  | Critically of purchase     | Substitute commodities                               |
|                  | Value/cost of purchase     | Including tangible and intangible cost for the commodities |

Table 4. The result of each-commodities [8].

| Commodities     | Importance of purchase | Supply risk/Complexity |
|-----------------|------------------------|------------------------|
| Asphalt         | 8.55                   | 4.47                   |
| Concrete        | 6.98                   | 4.55                   |
| Sand            | 7.20                   | 3.92                   |
| Reinforced steel| 8.15                   | 4.48                   |
| Aggregate       | 7.90                   | 4.12                   |
| Cement          | 7.98                   | 4.07                   |
| Landfill        | 5.75                   | 3.90                   |

Based on the results of testing of project contract documents from three case studies as well as an assessment of the dimensions of supplier risk and the profit impact, the test commodities fall into the leverage category in Kraljic’s portfolio matrix. Furthermore, the purchasing strategies to be analyzed are asphalt, concrete, cement, reinforcing steel, aggregate, and sand.

2.2. The strategy of purchasing materials

By using the Kraljic’s approach, an organization can develop a purchasing strategy by focusing more on strategic commodities, because controlling all commodities requires enormous effort. By controlling the commodities that have been identified as strategic commodities, the purchasing strategies formulated can be implemented properly.

The contractor carries out a strategy to purchase construction materials used in the project not only to guarantee the availability of material for the project but also to reduce the risk of material available in the projects that are carried out later. Hence, the sustainability aspect in terms of material supply will not be hampered by the change in the project location or the characteristics of the different projects. The purchasing strategy was conducted based on commodity categories from Kraljic’s portfolio matrix by Caniëls and Gelderman [9] as given in table 5.
Table 5. Purchasing strategy related to Kraljic’s matrix [9].

| Categories                      | Purchasing strategy/scenario                                                                                                                                                                                                 |
|---------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Maintain a strategic partnership| Strategic commodities that have a supply risk must be controlled by building partnerships with suppliers so that sustainable production can be maintained without any obstacles to the availability of commodities                                          |
| Strategic terms                 | **Maintain a strategic partnership**                                                                                                                                                                                         |
| Accept locked-in partnership    | This happens if the supplier’s bargaining position is higher than the buyer                                                                                                                                                    |
| Terminate a partnership         | If the supplier's performance can be accepted again by the buyer, the buyer must start reducing the reliance on suppliers and even stop the partnership contract and start looking for alternative suppliers |
| Bottleneck items                | **Maintain a strategic partnership**                                                                                                                                                                                         |
| Accept dependence, reduce      | Risk analysis needs to be done and determine the most important commodities, so that dependence on suppliers can be minimized                                                                                              |
| negative consequences           | **Bottleneck items**                                                                                                                                                                                                       |
| Reduce dependence and risk,     | Looking for a solution to the use of commodities in the bottleneck category, it can be done by finding new substitute commodities by expanding the required specifications.                                                      |
| find other solutions            | **Leverage items**                                                                                                                                                                                                       |
| Exploit buying power           | The bargaining position of the buyer is higher than the supplier so that the buyer can enter into a cooperation contract with a supplier that can provide more benefits                                                               |
| Leverage items                  | **Leverage items**                                                                                                                                                                                                       |
| Develop a strategic partnership | If the buyer has found a supplier in accordance with the criteria, it is necessary to build a strategic partnership with suppliers to ensure supply availability and can increase the efficiency and effectiveness of the buyers |
| Non-critical items              | **Non-critical items**                                                                                                                                                                                                     |
| Individual ordering, efficient  | For routine commodity needs, steps need to be taken to reduce the complexity of administration and logistics, namely by establishing a system of contracts with fixed suppliers                                                              |
| purchasing                      | **Non-critical items**                                                                                                                                                                                                     |

Based on the results of commodity testing for construction materials in road infrastructure maintenance projects, the test commodities are stated in the leverage category, hence based on the results of the study of Caniëls and Gelderman [9], strategic steps in commodity purchases can be carried out by exploiting purchases and building strategic partnerships with suppliers.
3. Results and discussion

The purchasing strategy for a commodity can not only be determined by referring to the strategic level of the project, the characteristics of the material or commodity is also needed to be seen. In the context of construction, the construction material used is part of the construction design specifications, therefore the determination of the purchasing strategy must also be adjusted to the characteristics of the construction project, related to the technical specifications of the design and project conditions in the field.

Infrastructure projects, in this case, are road maintenance projects, are projects that may be carried out in urban and rural areas, with normal environmental conditions surrounding the project taking place. This is due to the nature of maintenance, so the project location cannot be completely closed from access to community activities. Therefore, it is possible for the location of the placement of material stocks to be very limited so that the amount of material imported to the project location must be adjusted to the project implementation schedule.

Determination of strategic commodity purchasing strategies must also look at the material characteristics or commodities to be purchased. Construction materials used in road infrastructure maintenance projects included in the leverage category based on Kraljic’s portfolio matrix are sand, aggregate, asphalt, concrete, reinforcing steel and cement. Each material must be assessed based on its material properties, whether it is bulk or manufacturing material, whether the material sent is just in time or stock can be carried out in the field, and whether the material storage location in the field requires a safe place and protected from unexpected weather, theft, and whether the material storage location requires large space or not. These things must be assessed before establishing a commodity purchasing strategy. In addition, the external environmental context of material supply must also be considered, whether there are certain times when material supply is difficult or in general the material supply is always stable. Based on the concept of commodity purchasing strategies provided by Caniëls and Gelderman [9], in commodities in the leverage category two purchase strategies can be carried out, namely:

- Exploiting purchasing power, which is when the bargaining position of buyers is higher than the bargaining position of suppliers, in the sense that material suppliers are still available in sufficient quantities compared to the needs of buyers. With such a buyer can choose suppliers that provide more benefits;
- Develop a strategic partnership, although there is no problem in terms of supply risk. However, in certain conditions, the supply in the field must be maintained when the project implementation time occurs during the peak season of the project, especially in road infrastructure maintenance projects. The government generally issues project budgets in time at the same time hence, there is a very possible supply shortage at certain times. Consequently, the step of building strategic intimacy with material suppliers is a necessity to maintain supply availability and the timely delivery and specifications of the ordered materials.

Table 6 shown a set of strategies to purchase construction materials which identified as strategic commodities for road projects that should be conducted, small-sized contractors. Sand and aggregate material is a bulk material category that requires extensive storage in the project location but does not need to be protected from the weather and is a potential crime such as stealing. The quality of the two materials is quite varied, so to maintain the quality of the material that is in line with what is expected by the contractor, a strategic partnership needs to be built so that the contractor can gain confidence in the quality of the material sent. Moreover, because the project location may be far from the supplier's location, delivery costs may arise. To reduce delivery cost it is necessary to do a strategy in terms of economies of scale, where if partnerships have been established with suppliers, indirect costs can be reduced.
Table 6. Strategy of purchasing materials.

| Commodities     | Characteristic delivery and stock material | Purchasing Strategy          |
|-----------------|-------------------------------------------|------------------------------|
| Asphalt         | Just in time                               | Develop a strategic partnership|
| Concrete        | Just in time                               | Develop a strategic partnership|
| Reinforcing Steel| Stocking available                         | Develop a strategic partnership|
| Cement          | Stocking available                         | Exploiting Purchasing Power  |
| Sand            | Stocking available                         | Develop a strategic partnership|
| Aggregate       | Stocking available                         | Develop a strategic partnership|

Asphalt and concrete materials are materials that cannot be stored at the project location and must be used immediately if they have arrived at the project location (just in time). Such supply must be maintained by suppliers so that contractors do not need to take risks in terms of availability, thus a strategic partnership needs to be built.

Cement material, according to a study from the Ministry of Public Works, is a large manufacturing material that is available in Indonesia and it could be exploited. However, due to the location of material storage that is prone to weather and theft crimes, it is better to ship cement material as needed on the material implementation schedule. Although the contractor can store stock of material in other locations; to make storage cost efficiency, cement material should also be carried out a strategy by building strategic partnerships.

Reinforced steel is a material that is still available in its stock but based on the results of the Ministry of Public Works study, at certain times the stock of materials for reinforcing steel is quite difficult to find. Moreover, the storage of reinforced steel material in the project location requires a large area, and this can hamper work activities in the field. Therefore, building a strategic partnership is the right step that can be done by contractors in buying reinforced steel material.

4. Conclusion

In this paper, we conclude that building strategy in construction materials could not only be determined by considering the final result of material plotting in Kraljic’s portfolio matrix but also its should be conceived characteristics of construction materials, project site conditions, project engineering design, material storage and handling, and external conditions that influenced materials supply as a whole that is associated with the time of project implementation. Moreover, even though some commodities declared in strategic quadrants based on Kraljic’s portfolio matrix for road rehabilitation projects can be carried out strategies with the exploitation of purchases. As an anticipation step, contractors should build strategic partnerships with material suppliers to ensure the availability of materials, so that the construction process can be more productive and efficient. This purchasing strategy is expected to help small-sized contractors in managing commodity purchases so that they can increase the efficiency of purchasing construction commodities.

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