Development of procurement strategy and supplier selection for construction projects in Central Java-Indonesia

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Abstract: Material procurement, as well as user satisfaction, is the key factor of a successful construction project. Therefore, the contractors need strategies that support the effectiveness and efficiency of the procurement process in line with gaining the user satisfaction. This study aims to define material procurement strategies by implementing supply positioning model (SPM) and quality function deployment (QFD). There are 24 types of material to be measured using SPM matrix. The respondents are 86 construction companies which are also members of GAPENSI Central Java-Indonesia. The best procurement strategy for critical items is to have a strong partnership relationship and consider replacing suppliers when it is urgently needed. The most important supplier criteria to achieve best construction quality are the supplier's work experience, the quality of the materials provided by the supplier, the completeness of the quality management system, the capabilities and technology used by the supplier, and other criteria.

Keywords: construction projects; materials procurement; quality function deployment; QFD; strategic procurement; supply positioning models; SPMs; Indonesia.

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1 Introduction

Developing countries are never separated from development, such as building roads, buildings and other facilities. In the last five years (2014–2019) Indonesia has succeeded in building 1,387 km of toll roads, 3,194 km of border roads, 811.89 km of railroads, 15 new airports, 65 dams, and many other developments throughout the country – including Semarang – according to datas of Ministry of PUPR, KPPIP in 2019. The infrastructure development process really requires planning time, costs, labour, tools and materials, to design so that the construction process runs with precise and clear planning (Chofreh et al., 2019). In some of the year, that labour, material, and equipment factors have a positive and significant impact on the time strength of project work costs (Berampu, 2014).

In the project implementation process, there are seven elements that intersect with each other, including labour, materials, equipment, place characteristics, managerial, financial, and other factors. Without materials, the project will not be completed properly, so to obtain these materials the contractor needs a procurement division. This division has very large duties and responsibilities, such as planning resource allocation, paying for quality and service at the lowest price, creating good relationships between buyers and suppliers, reducing working capital requirements in order to increase profits for the company, and purchasing the required materials (Panchal, 2013; Altay et al., 2018; Ambe, 2019; Gottschalk, 2019; Suliantoro and Ririh, 2019).

However, contractors often make the wrong purchasing process, because they do not consider about the right strategy and stages in choosing material suppliers. Therefore, the contractor needs a strategy and the right steps in choosing a supplier (Berezinets and Ivanov, 2019). These strategies are called strategic procurement which will appear in a supply positioning model (SPM). Visani and Boccali (2020) explain the stages in choosing suppliers, starting from setting the vision and mission of the organisation, then determining organisational goals, organisational strategy in achieving the goals, establishing organisational policies, and establishing organisational programs. From these stages, the contractor can choose which supplier is able to fulfil the vision-mission and goals of the organisation so that the project built can match the expectations of the construction owner. Furthermore, quality function deployment (QFD) was an important dimension of quick response to customer needs on which a project procurement may compete. The first QFD application was in Japan (1972), and then it widely applied in various sectors and countries including construction projects, aviation, tourism, and many more. This method had been an ideal device of customer's voices, it made possible the projects or organisations to become much responsive and proactive to quality problems (Chen et al., 2020; Nie et al., 2020). Combining SPM and QFD method is a strong way to analyse procurement consolidation strategy in construction projects. Previously, many researches of QFD combined it with analytical hierarchy process rather than SPM. Therefore in this research, the consolidation strategy of construction procurement is evaluated by SPM and QFD.

This research is in collaboration with the regional leadership board (RLB) of GAPENSI Central Java, where until now RLB GAPENSI Central Java has ±5,525 members of contractor companies spread across 35 districts. However, due to limited space and time, this study only focuses on 86 contractors in the city of Semarang, who have medium-large qualifications in the business sectors of road, warehouse, irrigation, and bridge construction.

This research has five main objectives: the first is to analyse what factors are hindering the project development process, the second is to explain the work sequence of the procurement function, the third is to provide the best strategic procurement alternatives to increase effectiveness and efficiency of the project, the fourth is to find out and analyse what the customer needs for the construction entrusted to the implementing contractor, and the last is to find out and analyse the supplier criteria that the contractors are looking for in meeting the material needs.

2 Literature review

2.1 Purchasing and procurement

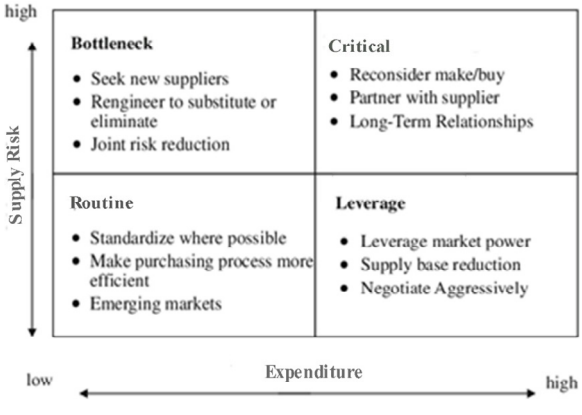
Christoper and Schooner (2007) state that procurement or procurement is an activity carried out to be able to obtain goods or services in a transparent, effective and efficient manner according to the needs of its users. Procurement functions can be divided into two, namely functions internally and externally. The internal function of procurement is to provide information (supplier capacity, logistical data, information on charging prices and also discounts on new products) to other functions in the organisation. Externally, procurement functions to provide accountability for the cost of goods or services, delivery period, quality of products purchased, and procurement decisions (such as selecting the best supplier and relationship with suppliers).

In the connection between the contractor and the supplier, there is a close relationship therein, namely the purchasing relationship. Monczka et al. (2011) stated that purchasing is a functional activity that provides value to an organisation. Because of this, the purchasing process must go through the stages of identification, selection, supplier evaluation, buying goods by individual or groups through contracts and negotiations, market observation, and developing a purchasing system. By carrying out these stages, the principle of getting the right quality, in the right amount, at the right time, for the right price, from the right source can be fulfilled (Thiyagarajan, 2019; Alvanchi et al., 2020; Cherian et al., 2020; Mufleh, 2020; Abutabenjeh et al., 2021).

2.2 Supply positioning model

The SPM is a tool used to classify the weight of material interests into four quadrant categories, namely routine, leverage, bottleneck, and critical. In the SPM there are two factors are taken into consideration before classifying materials (Hesping and Schiele, 2016), those are supply-impact -opportunity-risk, and also the level of annual expenditure for materials. Figure 1 is a picture of the SPM diagram.

Figure 1 SPM diagram



Source: Adopted from Hesping and Schiele (2016)

The horizontal axis is expenditure and the vertical is supply risk (SR). Expenditures are divided into two categories, namely the category 80% items = 20% value. SR is the risk that arises when the company will supply materials. SR is determined based on the rating with the information H (high), M (moderate), L (low), and N (negligible). The SPM diagram has two main objectives, namely guiding the company in choosing business priorities, and also guiding the company in developing a supply strategy.

2.3 Quality function deployment

QFD is a well-structured, cross-functional planning technique where it is used to listen to customers' voices throughout the planning, development, engineering and production stages of any product. The QFD method uses a matrix that is universal and can be used to prioritise most of the tasks of any industry, namely the house of quality (HOQ) matrix (Rajesh and Maligga, 2013). It is generally used to improve understanding of customer's needs and develop products and processes in a more customer-oriented manner (Rampersad, 2006). The HOQ matrix has two main parts, namely voice of customer (VOC) on the horizontal axis, and technical responses (TRs) on the vertical axis (Gaspersz, 2004).

In using the house of quality matrix, some stages that must be passed, including identifying customer needs, studying technical provisions in producing goods or services, making relationships between customer needs and technical provisions, making comparisons or physical relationships to TR performance, evaluating customers (the stage for comparing customer opinions), and making trade-offs to assess the effect between activities (Rajesh and Maligga, 2013).

SPM research is often used to group material items into the SPM diagram so that companies can find out the right procurement strategy in managing them. Whereas QFD is often used to listen to customer voices during the planning, development, engineering and production stages of any product using the HOQ matrix.

Table 1 Summary of previous studies on procurement consolidation of construction projects

References	*Method*	*Variables*	*Findings*
Lee and Drake (2010)	Analytical hierarchy process	Quality, availability, cost, time	Kraljic purchasing portfolio model complements the AHP methods, which quantifies risk based on monopoly condition and size of supplier.
Jafari (2013)	Quality function deployment	Contractor's abilities and project owner's requirement	Procurement strategy relates to project objectives and owner's requirements, which also can affect the contractor pre-qualification.
El-Khalek et al. (2019)	Descriptive statistical summary	Cost, quality, technical capability, management, health and safety, reputation, and time	In the project procurement, tender price – which is recognised by clients – played as keyrole in the subcontractor selection. Moreover, time and reputation are also the most essential criteria.

Table 1 Summary of previous studies on procurement consolidation of construction projects (continued)

References	*Method*	*Variables*	*Findings*
Arabzad and Ghorbani (2011)	Failure mode and effect analysis; data envelopment analysis	Supply risk and profit impact	Leverage items allow the buying company to exploit its full purchasing power, for instance by tough negotiating, target pricing and product substitution. Meanwhile, bottleneck items relates to problems and risks.
Morkunaite et al. (2019)	Analytical hierarchy process and PROMETHEE	Financial soundness, contracts, sub-contractors, management ability, personnel management, risk, and reputation	Qualified contractors for cultural heritage projects are significant influences for project success. Factors of lack of employee number and number of contracts can result low value of income, value of total heritage contracts.
Gambo and Musonda (2021)	Part least square	Procurement planning, the quality performance, construction firm's business partnership	Construction firms, especially in developing countries, should adopt the culture of a firm's business partnership to increase productivity. In addition this would enhance the quality performance of their products.
Enshassi et al. (2013)	Multiple regression	Financial evaluation of the bid, completeness of bid document, past performances in similar projects, staff skills and experience, contractor's reputation/image, quality of work, contractor site management/execution, bid understanding, plant and equipment resources, health and safety performance	Contractor selection system need to be changed from lowest price criteria to multi-criteria selection. Moreover, the multi-criteria selection process involves establishing alternative contractor selection methods (technical and financial criteria).
Yang et al. (2016)	Data envelopment analysis	Technical efficiency, pure technical efficiency, scale efficiency	Bid evaluations of supplier selection process were most efficiently aided by DEA.

Table 1 shows this research position by combining SPM and QFD. The SPM is used to design the right procurement strategy, while the QFD is used to determine supplier criteria in the construction process (Rajesh and Malingga, 2013; Hesping and Schiele, 2016). The results of combining the two methods will benefit in construction projects, such as generating strong procurement strategies and defining proper supplier criteria's (Panchal, 2013; Morkunaite et al., 2019; Mac Donald et al., 2020). This study also adopts many variables from various past researches, which fitted to the research case and questions.

3 Methodology

This research on procurement strategy application is applied using quantitative and qualitative methods. The quantitative method is used to classify each material items into the SPM matrix, and the qualitative method is used in the preliminary study and QFD which contains HOQ matrix. HOQ matrix is being used as an analytical tool for meeting customer needs, in this case is the construction owner (Rajesh and Malingga, 2013). This research, which involving 86 construction companies, contributes to define several main aspects and stages in the procurement process which must be considered by the company apart from only paying attention to the price aspect. On the other hand, this study also wants to show that the QFD method not only be used in the product development process but also be well applied in determining the supplier characteristics required by the contractors in construction projects.

The preliminary study was carried out in two stages, namely literature study and field study. The literature study was conducted by selecting articles with topics 'SPM', 'procurement', 'construction projects', and 'quality function development' from more than 250 reputable journals. Meanwhile, the field study (internal observation) was carried out by meeting the contractors directly in order to understand the company's procurement process.

3.1 Samples and variables

This research is implementing a purposive sampling method. The 86 construction companies are chosen as suggested by GAPENSI Central Java-Indonesia. Research questionnaires were sent through email and regular mail. This study assessed all important materials that were included in the procurement process; such as ready-mix concrete (M1), granites (M2), AC-WC hot mix (M3), paving blocks (M4), iron (M5), stone. split (M6), cement (M7), sand (M8), kerb/kansteen (M9), stake (M10), gabion wire (M11), pipe (M12), bricks (M13), wood (M14), aluminium (M15), glass (M16), galvalum/tile (M17), steel (M18), frame (M19), ceiling (M20), paint (M21), plumbing (M22), ceramics (M23), and nails (M24).

Table 2 SR variable

No.	*Criteria*	*Source*
1	Material transportation and delivery	Prostean et al. (2014)
2	Investment in technology and machinery	
3	Electronic device test and fabrication	
4	Availability of materials	
5	Materials quality	Prostean et al. (2014) and Arabzad and Ghorbani (2011)
6	Materials cost	
7	Material fulfilment flexibility	Seifbarghy (2010)
8	Availability to supplier	
9	Number of suppliers	

According to Hesping and Schiele (2016), the SPM variables were measured by the dimension of material SR and expenditure (EX) because both dimensions played

important role in most procurement processes among construction projects. This research defines the indicator for SR and expenditure dimensions through several related previous researches as can be seen in Tables 2 and 3 and also aligned with GAPENSI standards.

Table 3 Expenditure variable (EX)

No.	*Criteria*	*Source*
1	Impact on profitability	Padhi et al. (2012)
2	Level of importance	
3	Materials value	
4	Project conditions being implemented	Lai et al. (2008)
5	Field conditions around the project	
6	Regulation conditions	
7	Planning and estimation conditions	

Meanwhile, for defining QFD, this study assessed two aspects in QFD namely VOC and TR. Questionnaire items were constructed by using several previous researches. Details as shown in Tables 4 and 5.

Table 4 VOC variable

No.	*Indicator*	*Source*
1	Conformity to construction specifications (VOC 1)	Jafari (2013) and Ahmad et al. (2019)
2	Earthquake resistant construction (VOC 2)	RKS Proyek 88 Avenue (BGA, 2017)
3	The construction health space (VOC 3)	Ahmad et al. (2019)
4	Low emission construction (VOC 4)	
5	Availability of clear and qualified workforce (VOC 5)	Struyk (2007)
6	Availability of materials (VOC 6)	
7	Good control over construction tools (VOC 7)	
8	Technological innovations by contractors (VOC 8)	Mac Donald et al. (2020)
9	The duration of construction on time (VOC 9)	Morkunaite et al. (2019)
10	Speed of delivery of construction to owner (VOC 10)	El Asmar et al. (2013)
11	The growth of project schedule (VOC 11)	
12	Type of construction delivery according to target (VOC 12)	Cengiz et al. (2017)
13	Adaptation of building (VOC 13)	Kronenburg (2008)
14	Transformation of building (VOC 14)	
15	Flexibility of building (VOC 15)	
16	Interaction of building (VOC 16)	
17	Suitability expenditures that have been planned (VOC 17)	Jafari (2013)
18	The budget according to the contract (VOC 18)	Morkunaite et al. (2019)
19	Low lifecycle cost (VOC 19)	Ahmad et al. (2019)

Table 5 TRs variable

No.	*Indicator*	*Source*
1	Supplier financial stability (TR 1)	Jafari (2013)
2	Material prices offered (TR 2)	Cengiz et al. (2017)
3	Material discounts (TR 3)	
4	Payment flexibility (TR 4)	Jafari (2013)
5	The accuracy of the volume of the material (TR 5)	Cengiz et al. (2017)
6	The capabilities and technology used by suppliers (TR 6)	Jafari (2013)
7	Complete quality management system (TR 7)	Morkunaite et al. (2019)
8	Supplier experiences (TR 8)	Markunaite et al. (2019)
9	Materials quality assurance (TR 9)	Jafari (2013)
10	Good managerial skills from suppliers (TR 10)	El-Khalek et al. (2019)
11	Delivery speed of materials (TR 11)	Cengiz et al. (2017)
12	Reliability of material delivery (TR 12)	El-Khalek et al. (2019)
13	Order tracking system (TR 13)	Jafari (2013)
14	Supply security from suppliers (TR 14)	
15	Flexibility to change the volume of materials (TR 15)	Cengiz et al. (2017)
16	Good etiquette and good communication from suppliers (TR 16)	Jafari (2013) and El-Khalek et al. (2019)
17	Complaint handling/customer service speed (TR 17)	Jafari (2013)

3.2 Data collection

Both SPM and QFD questionnaires were sent by online email. The scale used in the SPM questionnaire is 1–4 [scale 1 = negligible (N), 2 = low (L), 3 = moderate (M), 4 = high (H)], while the QFD questionnaire uses a scale of 1–9 (for VOC weights) and 0/1/3/9 (for QFD relationships). Gathered datas will be entered into the SPM matrix as to provide alternative procurement strategies from datas showed in the SPM quadrant. After finishing determining the procurement strategy through SPM matrix, this research will continue to evaluate QFD through VOC and TR. Variables VOC and TRs were obtained from several construction-related journals. The purpose of determining this relationship is to synchronise the criteria for suppliers (TR) with the needs of the owner (VOC), so that the right supplier criteria will be obtained in an effort to meet the needs of the construction project owner. The data process took place with an online questionnaire to 86 contractor companies (with qualifications M1, M2, B1, and B2) which are under the auspices of BPD Gapensi, Central Java. From a total of 86 companies who came to become respondents, there were 62 companies (72.09%) that were willing to answer.

4 Results and discussion

SPM matrix was weighting the SR and EX to conclude which materials group into leverage-strategic-non critical-bottleneck quadrants. From SPM matrix, it shows that most materials are included in the strategic quadrant. After the supply objectives have

been determined, the next step is to calculate the SR and EX of each material used in the construction project. The score of EX and SR is drawn from average points of total answered questions. Table 6 is the weighting of 24 materials that will be plotted into the SPM matrix.

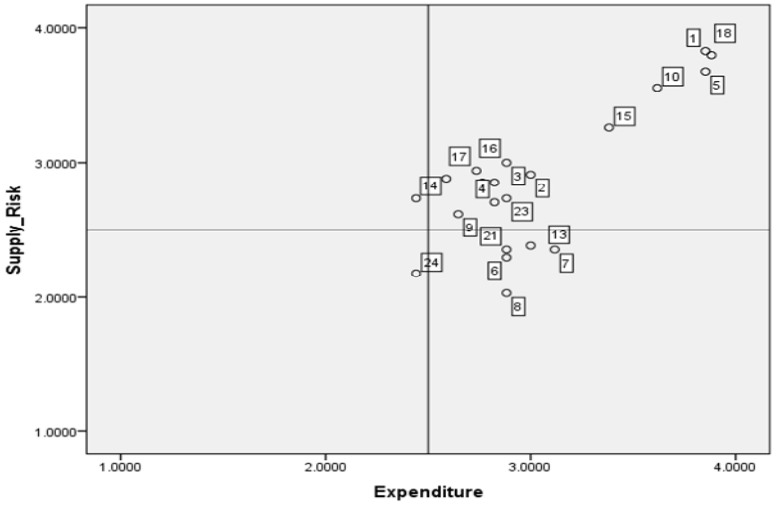
Table 6 SPM weighting

No.	*Materials*	*EX (x)*	*SR (y)*
1	M1 – ready mix concrete	3.852941	3.823529
2	M2 – granites	3	2.911765
3	M3 – AC-WC hot mix	2.882353	3
4	M4 – paving blocks	2.823529	2.705882
5	M5 – iron	3.852941	3.676471
6	M6 – stone split	2.882353	2.294118
7	M7 – cement	3.117647	2.352941
8	M8 – sand	2.882353	2.029412
9	M9 – kerb/kansteen	2.647059	2.617647
10	M10 – stake	3.617647	3.558824
11	M11 – gabion wire	2.823529	2.852941
12	M12 – pipe	2.764706	2.852941
13	M13 – bricks	3	2.382353
14	M14 – wood	2.441176	2.735294
15	M15 – aluminium	3.382353	3.264706
16	M16 – glass	2.735294	2.941176
17	M17 – galvalum/tile	2.588235	2.882353
18	M18 – steel	3.882353	3.794118
19	M19 – frame	2.5	2.794118
20	M20 – ceiling	2.529412	2.852941
21	M21 – paint	2.882353	2.352941
22	M22 – plumbing	2.529412	2.676471
23	M23 – ceramics	2.882353	2.735294
24	M24 – nails	2.441176	2.176471

After determining the coordinate points, the next step is to plot the materials into the SPM matrix, the plotting is done using SPSS software. From the SPM matrix, it depicts that materials 1, 5, 10, 15 and 18 which are ready mix concrete, iron, stake, aluminium, and steel – plot in quadrant which has highest SR and expenditure level. Figure 2 shows the SPM matrix.

QFD data processing utilises the HOQ matrix tools. Before entering into the HOQ matrix, the VOC weight will be calculated first by finding the mean of the answers of respondents who have filled out the online questionnaire. After that, the relationship between VOC and TR will be determined. Table 7 is a recapitulation of VOC weight and HOQ relationships.

Figure 2 Materials plotting (SPSS)



Source: Data processing

Table 7 VOC weighting

No.	*VOC*	*Weight*
1	VOC 11	7.785714
2	VOC 8	7.785714
3	VOC 10	7.75
4	VOC 6	7.75
5	VOC 16	7.678571
6	VOC 2	7.678571
7	VOC 19	7.642857
8	VOC 17	7.642857
9	VOC 15	7.642857
10	VOC 9	7.642857
11	VOC 1	7.642857
12	VOC 12	7.607143
13	VOC 13	7.571429
14	VOC 4	7.571429
15	VOC 14	7.464286
16	VOC 7	7.392857
17	VOC 5	7.357143
18	VOC 18	7.25
19	VOC 3	7.25

There are 19 customer needs for the projects they entrust to the implementing contractor, including VOC 1, VOC 2, VOC 3, VOC 4, VOC 5, VOC 6, VOC 7, VOC 8, VOC 9,

VOC 10, VOC 11, VOC 12, VOC 13, VOC 14, VOC 15, VOC 16, VOC 17, VOC 18 and VOC 19.

The supplier criteria needed by the contractor to meet the owner's needs are TR 8, TR 9, TR 11, TR 7, TR 10, TR 5, TR 6, TR 12, TR 16, TR 2, TR 15, TR 17, TR 3, TR 4, TR 13, TR 14 and TR 1.

The objectives of this study are namely designing a procurement strategy and determining supplier criteria in the construction process carried out by the contractor. Procurement strategy discussions are carried out in each quadrant, starting from routine, bottleneck, leverage, and critical quadrants. Supplier criteria discussed are supplier criteria for each material (be it routine, bottleneck, leverage, or critical).

4.1 Routine

The materials included in the routine quadrant are M24, with the characteristics of having low SR and EX, having the same specifications for each supplier, and having many suppliers in the field. With these characteristics, the relationship between the implementing contractor and the supplier is non-partnership (Lee and Drake, 2010). Even though they run a non-partnership relationship, the implementing contractor must still pay attention to the location factor, as well as the quality of the material provided by the supplier. That way, the right procurement strategy for the material routine is to carry out a spot purchase contract (choose a supplier based on the best price quote and immediately replace the supplier when experiencing a disruption), carry out a re-engineering process, eliminate the material inspection process, automate the process, and conduct electronic trading. to control material procurement more easily.

4.2 Bottleneck

The material included in the bottleneck quadrant is M14, with the characteristics of having high SR but low EX. This material is susceptible to material defects and non-conformity of material quality with company specifications, and other risks. This causes the supplier to have a dominant position on bottleneck items. With the characteristics and conditions of the supplier who is in control of the procurement process, the contractor must be able to establish a relationship and maintain good communication with the supplier so that errors do not occur in the procurement process. The power of supply held by suppliers makes contractors have to be careful in choosing suppliers, this result inline with Arabzad and Ghorbani (2011). The following are some of the supplier characteristics needed by the contractor, such as they do not want to take advantage of the strength of their position, must be able to be relied on in various conditions, and must be able to supply the required material for the long-term. The right procurement strategy in carrying out the procurement process is to use fixed contract types, make commitments with suppliers to determine the volume of purchases within a certain period of time, and supervise the quality of materials sent by suppliers.

4.3 Leverage

Materials included in the leverage quadrant are M6, M13, M21, M7 and M8 with the characteristics of having low SR, but high EX. All materials included in this leverage quadrant are consumable materials. These five materials are also included in the standard

item's category, many suppliers supply and also do not have special specifications such as critical materials. Even though they already have many suppliers and are standard items, the expenses resulting from the leveraged items are still relatively high, because the purchase cost for each leverage unit is important (Visani and Boccali, 2020). With these material characteristics, the relationship that must be established with the supplier of the leveraged item is a non-partnership relationship. This needs to be done to save administrative costs as well as time for the leveraged material procurement process. The company can also replace suppliers when their performance decreases. With the characteristics of the leveraged material materials that have been mentioned, the most appropriate suppliers for leveraged materials are those who are competent in meeting the quantity and quality of company demand, able to offer competitive prices, and are technologically literate. The precise procurement strategy in carrying out the material bottleneck procurement process is to collaborate with spot purchase types of contracts and to establish relationships with many suppliers.

4.4 Critical

Materials included in the critical quadrant are M22, M20, M19, M17, M12, M2, M4, M9, M11, M16, M23, M3, M15, M10, M5, M18 and M1 with characteristics of SR and EX levels tall one. Materials included in the critical quadrant are non-standard items, have unique specifications, are not easily found in the market, do not have many suppliers, and are difficult to find replacements. That way, the right relationship between the contractor and the supplier is to form a partnership and to support the procurement process, the contractor needs to pay attention to some of the characteristics of his supplier (Gambo and Musonda, 2021). Figure 3 are some of the characteristics needed, being able to provide good material quality, stable financial condition, committed to supplying materials with the right quantity-quality-time, having the same business strategy as contractors, having an excellent reputation, being able to provide guarantees, and have clear historical data. With the characteristics that have been mentioned, the contractor must have the right strategy so that the procurement process can run very well. The procurement strategy that can be chosen is to build a partnership relationship (partnership) with suppliers, as well as looking for new suppliers if the supplier's performance deteriorates and cannot be repaired.

Based on the HOQ matrix, the results of the TRs to the rating can be seen. To calculate the technical responses rating (TRR) the formula is used:

$$TRR = 100 \times \sum (relationship\ weight \times RW\ VOC)$$

For example, the TRs rating of 'material prices offered (TR 2)',

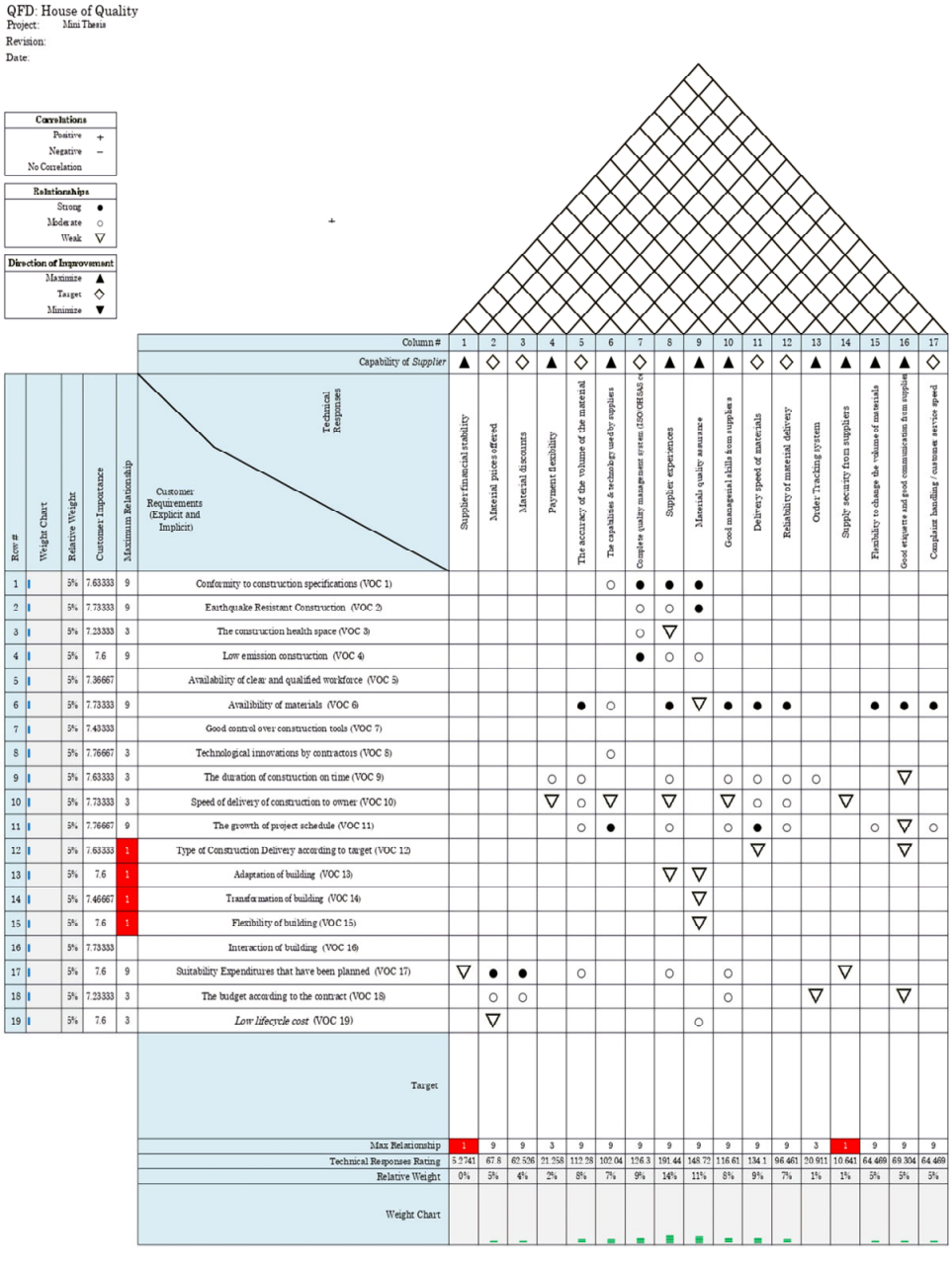
$$TRR = 100 \times \sum (9 \times 5\%) + (3 \times 5\%) + (1 \times 5\%)$$

$$TRR \approx 67.8$$

TRR is used to determine the weight of each TRs. Then, it is used as a basis for determining supplier criteria. From this example, it reveals that the weight for the 'price of material offered' is obtained from 100 multiply by the accumulated relationship weight and the relative weight of the VOC. It should be noted that the relative weight of VOCs is

not absolute 5% but five points. TRR will rank the supplier criterias. Based on the calculation of TRR, Table 8 is a recapitulation of the rankings of TRR.

Figure 3 House of quality matrix (see online version for colours)



Notes: weak ∇ = (1); moderate ○ = (3); strong ● = (9).

Source: Data processing

Table 8 TRs rating

No.	*Technical responses (TR)*	*Technical responses rating (TRR)*
1	TR 8	191.44
2	TR 9	148.72
3	TR 11	134.09
4	TR 7	126.30
5	TR 10	116.60
6	TR 5	112.3
7	TR 6	102.04
8	TR 12	96.46
9	TR 16	69.30
10	TR 2	67.80
11	TR 15	64.47
12	TR 17	64.47
13	TR 3	62.53
14	TR 4	21.26
15	TR 13	20.91
16	TR 14	10.64
17	TR 1	5.274

5 Conclusions

Based on direct observations, the factors that have inhibiting for the project development process are the mismatch between the DED and the actualisation of the condition of the project location, permits from the surrounding community which are quite difficult to obtain even though they have received permission from the local government, the inability of suppliers to supply materials ordered by contractors, non-technical factors (such as force major), and inadequate resources (human resources and financial resources). This findings support previous research which also stated mismatch in DED planning, difficulties getting permission from local governments, time constraints and remote location had been main obstacles for project developments (Chen et al., 2020; Chofreh et al., 2019; Ririh and Hidayah, 2020; Abutabenjeh et al., 2021).

This research also adds some insights that the work sequence of the procurement function starts from knowing the vision, mission, goals, and policies of the organisation or company, then knowing the corporate strategy so that the procurement function will strive to achieve the vision-mission and goals of the organisation, make targets and objectives of the procurement function, then issue the strategies that are needed to support the material procurement process. In reverse, a recent research argued that vision-mission of government organisation can be changed suddenly and depended on the active significant leader and this made procurement strategy need flexible implementation (Christoper and Schooner, 2007; Lee and Drake, 2010).

The customer needs for the building/construction entrusted to the implementing contractor consisting of VOC 11 (the growth of project schedule, which means the

project schedule always has good progress), VOC 8 (technological innovations by contractors, which means with this technological innovations, contractors are able to manage the priority of work and choose the best method of work), VOC 10 (speed of delivery of construction to owner, which means the project must be completed on time according to the contract), VOC 6 (availability of materials, because of materials are the components that must be available during the construction process), VOC 16 (interaction of building, which means that the building or construction must be able to meet the needs of its users), VOC 2 (earthquake resistant construction, meaning that the construction must be resistant from earthquake threats), VOC 19 (low lifecycle cost, which means the maintenance cost or something related to the construction lifecycle), VOC 17 (suitability expenditures that have been planned, meaning that all costs in the project must be suitable with the agreed contract), VOC 15 (flexibility of building, which means that the building have to adjustment, both with their environment, climate, and there inhabitants), VOC 9 (the duration of construction on time, meaning that the project must be finished on time or in time), VOC 1 (conformity to construction specifications, meaning that the construction is in accordance with agreed specifications), VOC 12 (type of construction delivery according to target, meaning that delivery is an important part of the construction supply chain), VOC 13 (adaptation of building, which means that the building can respond to changes that will occur in the future), VOC 4 (low emission construction, especially for the current conditions that demand low emissions in every single construction project), VOC 14 (transformation of building, which means building whose shape, volume, and looks can change based on physical changes in the structure of the building. For example is transformable architecture), VOC 7 (good control over construction tools, this is an obligation that must be owned by contractors in working on projects), VOC 5 (availability of clear and qualified workforce, so that the construction is completed on target), VOC 18 (the budget according to the contract, which means there will be no overload in costs), and VOC 3 (the construction health space, which means the building have a social sustainability).

In line with those needs, the supplier criterias that the contractors look for in meeting the material needs are TR 8 (supplier experiences, which means contractors must looking for the experiences supplier so that all of needed by project can fulfilled well), TR 9 (materials quality assurance, meaning that contractor must find a supplier who is able to provide assurance in supplying materials), TR 11 (delivery speed of materials, meaning that the speed of delivery on a construction project is an important part of succeed), TR 7 (complete quality management system, this is a requirement that suppliers must have before supplying materials to contractors), TR 10 (good managerial skills from suppliers, which means that suppliers must be able to demonstrate their managerial ability), TR 5 (the accuracy of the volume of the material, so that project is not hampered by delivery delays), TR 6 (the capabilities and technology used by suppliers, this factor describe that the supplier has high capabilities in supplying materials needed by the contractor), TR 12 (reliability of material delivery, which means that the material delivery process runs according to its proper function or we can call reliable), TR 16 (good etiquette and good communication from suppliers, this is very necessary in the contractor-supplier relationship because communication will determine the success or failure of the project), TR 2 (material prices offered, this happened because prices is an economic sacrifice that must be spent by the contractor for a specific purpose so that it is an aspect that really needs to be considered in choosing supplier), TR 15 (flexibility to change the volume of materials, which means that the project completion will be more flexible especially when

there is sudden change in volume), TR 17 (complaint handling/customer service speed, this factor is very important because with the speed of customer service, the contractor can communicate efficiently when there is a problem), TR 3 (material discounts, the contractor will choose a supplier with a appropriate bid, not too high but has a good quality raw materials), TR 4 (payment flexibility, this factor often occurs in project implementation because with payment flexibility, contractors can allocate costs for more important things first), TR 13 (order tracking system, actually this is an additional factor that contractors do not really mention when choosing supplier. However, if the supplier has an order tracking system it will be an added value for the contractor), TR 14 (supply security from suppliers. Likewise with this factor, contractor does not really mention to it, but it can be an added value when choosing a supplier), and TR 1 (supplier financial stability, this factor can give an indication that the supplier has a good managerial system) – consecutively.

The alternative procurement strategies for each item are as follows. Policy makers in the procurement should pay attention and review the activities such as: routines carry out spot purchases, carry out re-engineering processes, eliminate material inspection processes, carry out automation processes, and conduct electronic trading. For managerial practice suggestions, the bottleneck item performs a fixed contract type, as well as making commitments with suppliers regarding the volume and duration of material delivery. Leverage items perform the spot purchase type and establish relationships with many suppliers. Critical items establish a strong partnership relationship, and look for new suppliers if the supplier's performance deteriorates and cannot be repaired.

This study also has limitations due to budget and time availability. Moreover, closed questions with self-reported answer may result insufficient point-of-view standard Further study will need to imply the risk averse of procurement team regarding to procurement efficiencies, since risk averse relates to benefit that earned by each parties in the procurement consolidation contracts. Qualitative method using NVivo will be best implemented to figure out precisely the significant factors. Rather than just using the self-report questionnaires, it will be better for future research to use quantitative modelling to define the significant factors in the procurement consolidation chain.

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