The Mediating Effect of Strategic Purchasing in Pre-Stressed Concrete Based Construction Project: A Case Study of Construction Contractor in Indonesia

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Abstract: Strategic aspects of purchasing function have been considered in many construction companies as they influence the performance of the projects and hence the company performance in mostly contractors. Some studies have also been done to explore the impact of strategic function in domain purchasing. As on one of construction company in Indonesia, PT XYZ has been experiencing problem with their project schedule performance in the last three years and one of the affecting factors is unorganized purchasing of long lead items. Furthermore, the purchasing activities were performed in an ad-hoc way and not considering integration of purchasing activities from other projects. This study has a purpose to explore the influence of strategic purchasing relationship between the purchasing activities and the project schedule performance. The data was collected from 50 respondents using structured questionnaires. The data was analyzed using partial least square structural equation model with software SmartPLS 3.0. The result of this study shows a significant full mediation strategic purchasing to the relationship between purchasing process and project schedule performance

Keywords: construction, project schedule performance, purchasing process, strategic purchasing

1. Introduction

Purchasing activities have been developing from tactical [1] into strategical and more integrated aspect [2],[3],[4]. Especially in construction industries, these activities are becoming more imperative, as the materials and services will easily sum up to 90% of project cost [5],[6] as well as schedule as purchasing as part of procurement activities are considered under critical path in most Engineering, Procurement and Construction projects [7],[8]. Any issues that is related to purchasing activities, it will affect project cost or schedule performance.

PT XYZ a leading construction multi-national company since 1983 which has been delivering around 1.300 prestressed construction and other special projects in Indonesia has been facing project challenges in the last 3 years as shown in Figure 1

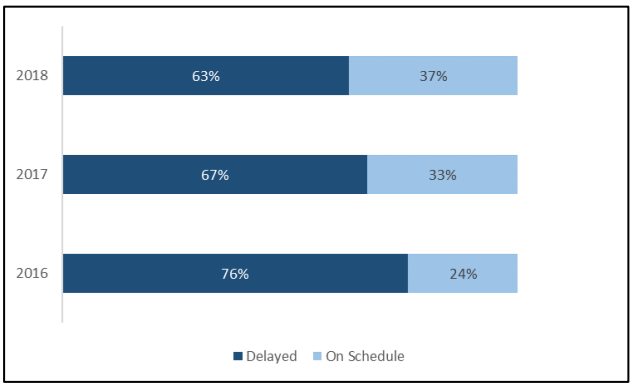

Figure 1. Project completion status of PT XYZ in 2016-2018 (Source: PT XYZ)

There was not any available specific secondary data as a proof that purchasing activities has contributed the delays significantly, therefore the author has initiated an internal survey to explore more how the purchasing activities influenced the delay, although previous study has indicated that the material availability in construction projects is highly dependent how the purchasing activities are managed within the procurement process [7]. To explore about this phenomenon, the researcher conducted as descriptive study in form of pre-survey. The result of the survey found that 45% percent of the respondents agreed and 29% tended to agree that the delay happened during the period of 2016 – 2018 due to purchasing activities as shown in Figure 2 and other activities such sourcing, change of the construction design and limitation of production capacity.

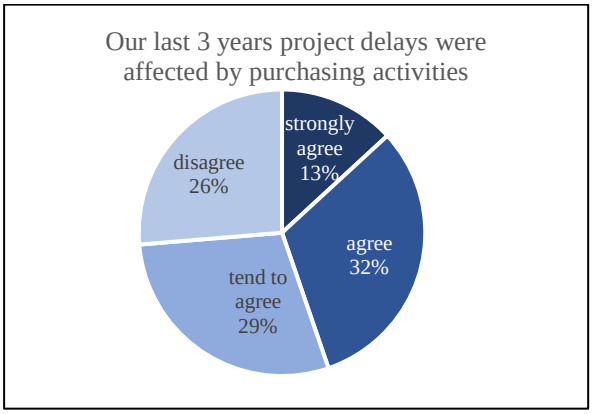

Figure 2. Pre-survey result of PT XYZ in 2019 (Source: PT XYZ)

Based on this phenomenon, it is believed that the role of purchasing activities need to be improved by establishing strategy to improve the project performance. This study has the objective to explore the influence of strategic purchasing in mediating the effect of purchasing process to project performance.

2.Literature Review

To solve this problem, it is necessary to see how the theoretical aspect of strategic purchasing has been developed. The main theoretical framework to be referred for applying the strategic purchasing is the theory of Industrial Organization (IO) or known as Structure-Conduct- Performance (SCP) paradigm [9],[10],[11] in order to improve performance, in this case, project performance. The further theoretical development of competitive strategy [12] and competitive advantage [13] has brought the concept of value chain which highlighted the importance of procurement activities in line with primary activities to achieve financial performance. These aspects are still yet to cover the context of projects, as the theories cover more impact on firm performance rather than project performance.

Apart the purchasing process is acknowledged as important function by academicians and industrial professionals [4], previously purchasing was considered as administration and clerical work [1] that consists in general of steps such as responding to client needs, determining the required quantity based on characteristics of to be purchased item, proposal sourcing, evaluation, source selection and evaluation as well as feedbacks [14]. The purchasing activities have been evolved from buying activities to partnering function to strive mutual benefits between buyers and sellers [15],[16]. Chen et al. [17] argued that strategic purchasing affects the growth of supply management and influence the company performance, while the study of Gonzales-Benito [18] has shown that putting the purchasing strategy as part of business strategy will increase the efficiency of performance of material purchase in project. Cost saving in projects can be achieved by applying early purchasing as part of the strategy [19]. This study, however, did not cover the construction industry. The purchasing strategy can also influence the competitiveness of company using close coupling value chain function method [20] or mainstream value-adding process [21] that leads to supply chain efficiency [22],[23]. Integration of purchasing functions is crucial to the strategic purchasing as this aspect shall provide an overview and it will lead to effective decision-making process. The effective integration of purchasing function will lead to firm performance [24], however this study did not take view in project level. In order to do effective strategic purchasing activities, it requires skilled resources such supplier market knowledge, analytical thinking, communication and general management, especially strategic (long-term) thinking to achieve mutual benefits between sellers and suppliers [25], [26], [27]. As current business environment involves uncertainties, the organization shall consider in purchasing functions to deal with risks both opportunities and threats that related with purchasing activities [28],[29],[30]. The access to timely, relevant and valid information to required resources is also critical to strategic purchasing function as it is required to make decisions [31],[32]. Alignment between purchasing capabilities and objectives of strategic purchasing is defined as purchasing efficacy and it is one of critical factors of strategic purchasing [18], especially if it is related the production function [33]. Furthermore, from perspective of contractors, the strategic purchasing function is also considering the aspect of customer responsiveness, to understand their needs in timely manner and hence to be sustained in the business [34];[35]. Lastly, early purchasing is also one factor to be considered in strategic purchasing to accommodate the long lead time materials and services to be provided by the company in running their business especially for innovative new product development [36], [37],[38], however it is rarely considered to be applied in projects as strategic considerations [19].

The purchasing activities in PT XYZ is herewith discussed and it will be referred to the related studies. there are subsets to be taken into consideration. First of all, it starts with the purchasing plan. It is the strategy in how

the purchasing activities are defined to fulfill the project requirement [39]. Furthermore, sourcing activities. Seeking the availability of right materials and suppliers is essential to purchasing activities based on the relevant information [40],[41],[42],[7],[8]. The next step after source selection activities are purchasing activities that are normally followed by issuance of purchase order [43],[44],[45]. Once the materials are purchased, the next activities are the process of material logistics with activities such as site transport, transport scheduling and communication, weather condition, warehousing as well as site permits [46],[44],[47],[48],[49],[50]. Meanwhile the project schedule will be used to measure the project performance. The schedule performance is very important not only to evaluate the performance against the project plan, but also to be used to decide what action to be taken to keep the project in shape as well as for increasing the efficiency of process [51],[52],[39]. The schedule performance measurement is proposed based on classification of schedule performance with aspects of deviation of project schedule against the plan [53].

Based on the literature review, the identified problem will be solved using the proposed research model as shown in Figure 3. It is believed that by applying the strategic purchasing, the purchasing process will be affecting the project schedule performance more positively.

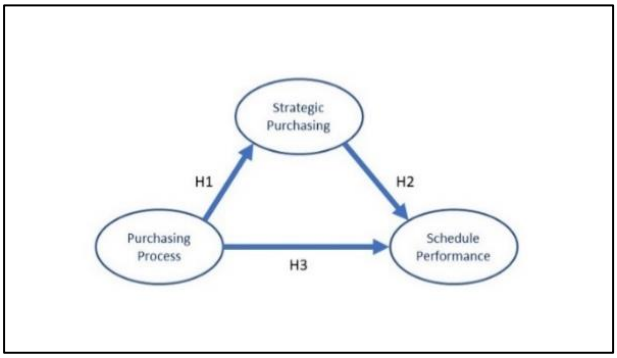

Figure 3. Proposed research model

3.Research Method

This is a case study research that aims to solve the problem of current issues in project schedule performance based due to current inefficient purchasing process that support the project. This research is quantitative and empirical that will be using combination of desktop study and survey. This research requires primary and secondary data that are collected from both desktop study and survey. The author has proposed structured questionnaires with 56 items that will be sent to the relevant respondents. Prior to that the questionnaires and their items are validated by experts which consists of academicians and professionals.

After the validation, a pilot survey has been conducted to test the survey and to gain feedbacks from the pilot respondents. The respondents were asked to rate the proposed statement using even Likert Scale (1=" strongly disagree"; 2= "disagree"; 3="tend to disagree"; 4="tend to agree"; 5= "agree"; 6="strongly agree"). This rating scale has a purpose to force the respondents to commit to a certain position, as there is no mid-point of scale [54]. The population of the data is the personnel of PT XYZ. For this research, the author used non-probability sampling method, in this case a convenient sampling, that is designed as the author knows the relevant respondents to produce better data for further analysis. The electronic questionnaires are sent through emails to the targeted respondents.

As the research model consists of multivariable, the multivariate analysis is suitable to analyze the relationship among variables at the same time. Therefore, the proposed to be used analysis is structural equation model or SEM [55],[56]. However, due to limited number of samples, it is suggested to use Partial Least Square Structural Equation Model of PLS SEM [56]. The analysis result has to be compared against criteria and standard values for reflective measurement as has been shown in Table 1.

Table 1. Criteria and standard values for reflective measurement [56]

Criterion	Standard values

	Criterion	Standard values
Convergent Validity (Indicators)	*Loadings*	*≥ 0.70*
	Indicator reliability	*≥ 0.50*
	Average Variance Extracted (AVE)	*≥ 0.50*
Internal consistency reliability (Latent variables)	*Composite reliability*	*0.60 – 0.90*
	Cronbach's Alpha	*0.60 – 0.90*
Discriminant validity (Latent variables)	*HTMT confidence interval does not include 1*	*Yes*
Collinearity statistics	*Predictor contract's tolerance (VIF)*	*0.02 – 5.00*
Coefficient Determination	*R-Square*	*0.75 (Substantial)* *0.5 (Moderate)* *0.25 (Weak)*
Exogenous construct contribution to endogenous construct	*Effect size (f^2)*	*0.02 (small effect)* *0.15 (medium effect)* *0.35 (large effect)*
Cross validated redundancy measures from endogenous constructs	*Predictive relevance Q^2*	*Bigger than 0*
Model fit	*SRMR*	*< 0.08*
	(RMS_{theta})	*< 0.12*

All criteria must be met in order to have the reliable model that represents the real condition in the organization. These PLS SEM analysis will be done using SmartPLS 3.0 Software as this software is widely used and already proven to be used in many recent studies.

4.Results And Discussion

This study has selected 50 respondents through convenient sampling. Those respondents have been identified by the author that are highly relevant to this study. All respondents are involved in the projects. All sent questionnaires are received and few clarifications were done in order to ensure that the data are valid. The descriptive analysis of the respondents is done as shown in Table 2

Table 2. Demography of respondents (n=50)

Demography (n = 50)		Sum	Percent
Job level	Manager	37	74.00%
	Engineer	5	10.00%
	Staff	8	16.00%
Educational background	Diploma	20	40.00%
	Bachelor's degree	25	50.00%
	Master's degree	5	10.00%

Demography (n = 50)		**Sum**	**Percent**
Experience	Less than 5 years	17	34.00%
	5 to 9 years	8	16.00%
	10 to 15 years	10	20.00%
	More than 15 years	15	30.00%

It can be seen from the Table 2 that most of the respondents are manager. Most of the respondents have bachelor's degree and most of the respondents have working for more than 5 years. From desktop study some secondary data have been collected from period 2016-2018 and all 49 completed projects have been selected from that period. Figure 4 shows that most of the projects are late, meanwhile 4 (four) projects are consistently delivered on schedule. The judgement to the project performance has been done by comparing the planned and actual schedule using Formula 1.

$$\frac{act.proj.duration - contr.proj.duration}{contr.proj.duration} = schedule\ variance\ (\%) \qquad (1)$$

and schedule variance has been scored in 6 categories in order to have similar ranks with the primary data as it uses 6 Likert Scales.

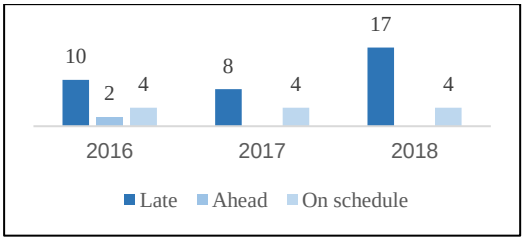

Figure 4. Scoring table to schedule variance

The scores have been set up using the difference between the maximum and minimum variances and divided it into 6 categories (bins) as shown in Table 3.

Table 3. Demography of respondents (n=50)

Schedule Variance (%)	**Score**
7.95 - 9.27	1
6.63 - 7.95	2
5.31 - 6.63	3
3.99 - 5.31	4
2.67 - 3.99	5
0.0 - 2.67	6

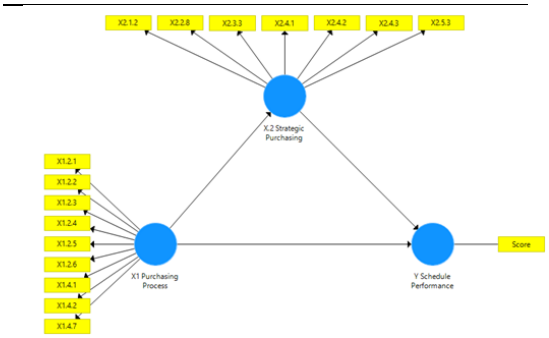

Figure 5. PLS SEM measurement model using SmartPLS 3.0

The analysis was done using Smart PLS 3.0 PLS algorithm and bootstrap with 1.000 sub-samples. The validity

and reliability tests have been performed and the results indicate that the data are valid and reliable, as has been shown in Table 4.

Table 4. Validity and Reliability Test Result

	Cronbach's Alpha	**rho_A**	**Composite Reliability**	**Average Variance Extracted (AVE)**
X.2 Strategic Purchasing	0.817	0.867	0.868	0.503
X1 Purchasing Process	0.881	0.894	0.908	0.534
Y Schedule Performance	1.000	1.000	1.000	1.000

Meanwhile from intercorrelation among variables are tested using Heterotrait-Monotrait (HTMT) test to check the cross-loading factor. The result of the test is within the standard criteria as shown in Table 5.

Table 5. Data Analysis result Heterotrait-Monotrait Ratio

	X.2 Strategic Purchasing	**X1 Purchasing Process**	**Y Schedule Performance**
X.2 Strategic Purchasing			
X1 Purchasing Process	0.567		
Y Schedule Performance	0.217	0.206	

Furthermore, the data is analyzed using bootstrap with 1.000 sub-samples and the result is shown as per Figure 6

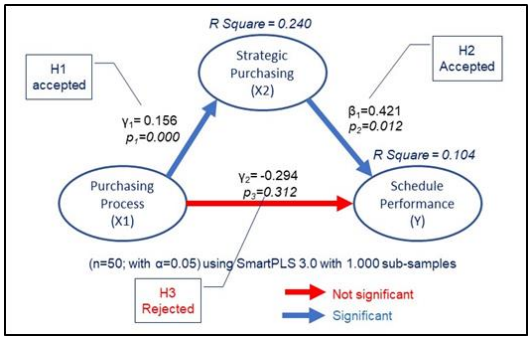

Figure 6. PLS-SEM Measurement Model and its analysis result

The R Square value is shown to be weak because the value is less than 0.25 (Hair et al., 2017) and this could be caused by small number of data that was used for analysis.

Further data analysis shows that $\gamma 1 = 0.156$ and it is significant at $p<0.05$ ($p1 = 0.000$), while the $\beta 2 = 0.421$ and it is significant at $p<0.05$ ($p2 = 0.012$), however $\gamma 2 = -0.294$ and it is not significant at $p<0.05$ ($p3 = 0.312$). The minus sign indicates of the scoring is in the opposite direction. Therefore, as result of hypothesis testing, it concludes that the H1 and H2 are accepted and H3 is rejected.

This result also shows that the Strategic Purchasing (X2) fully mediated the Purchasing Process (X1) and Schedule Performance (Y), as p1 and p2 are significant, but p3 is not [54]. It means, the schedule performance can only be significant and positively influenced by purchasing process through mediation of strategic purchasing.

The outer loadings of respective indicators have been analyzed and it is shown as per Table 6.

Table 6. Outer loading factors (Indicators)

Dimension	**Code**	**Indikator**	**Loading Factor**	**Influencing factors**
Purchasing Status	X1.2.1	Management support to develop purchasing strategy	0.559	Medium
	X1.2.2	Purchasing is considered as important aspect in company strategic planning	0.668	Medium
	X1.2.3	Purchasing is considered to be important in management's decision making process.	0.875	Strong
	X1.2.4	Management emphasizes purchasing function in strategic planning	0.810	Strong
	X1.2.5	Purchasing Leader has a same vision with CEO	0.883	Strong
	X1.2.6	Purchasing function is considered to have a same level with the other function	0.785	Strong
Purchasing Skill	X1.4.1	Purchasing officer has the ability to adapt with market development	0.643	Medium
	X1.4.2	Purchasing officer has the ability to provide feedbacks to the suppliers	0.409	Weak

Dimension	**Code**	**Indikator**	**Loading Factor**	**Influencing factors**
	X1.4.7	Purchasing officer has the ability to understand market development	0.807	Strong
Customer Responsiveness	X2.1.2	Quick responses to customer complaints	0.512	Medium
Purchasing Efficacy	X2.2.8	Supplier has vision of long-term relationship with company	0.512	Medium
Strategic Risks	X2.3.3	Purchasing focus on long torm plan and consider risks and uncertainties	0.708	Strong
	X2.4.1	Purchasing has adequate system to handle routines	0.836	Strong
Resources	X2.4.2	Purchasing has sufficient access to the required products	0.959	Strong
	X2.4.3	Purchasing has sufficient access to monitor production and resources stocks	0.446	Strong
Earlier Purchasing Involvement	X2.5.3	Purchasing participates on design of new products	0.822	Strong

Dimension	Code	Indikator	Loading Factor	Influencing factors

The final analysis shows that the medium determining factors of strategic purchasing are customer responsiveness (X.2.1.2), purchasing efficacy (X.2.2.8), meanwhile strategic risks and long-term vision (X.2.3.3), resources capabilities(X.2.4.1; X.2.4.2; X.2.4.3) and earlier involvement (X.2.5.3) are considered strong factors.

The result of this study is validated using both simulation and interviews with experts that conclude that this model provides a predictive feature of strategic purchasing to the project schedule performance. Both validations confirmed the result. This study has limited view as this might not be the case of other organizations, however the process of EPC projects is relatively the same. There is a need to have further study in using bigger samples from different construction companies.

5.Conclusion

The result of this study proofs that the strategic purchasing indeed mediating fully the purchasing processes to the schedule performance. Without application of strategic purchasing, the purchasing processes experience challenges in meeting the requirement of the projects and align the production and supply chain lead time, hence it will jeopardize the project schedule performance through delays in purchasing activities and this support the previous studies from [7] and [8]. Therefore, purchasing activities shall not be considered as tactical aspect but as strategical aspect, hence this study supports the also the previous study of van Poucke et al [19].

The practical implication of this study shows that there are factors in applying strategic purchasing. There are 5 (five) determining factors that are essential to be considered such strategic risks and long-term vision. These factors will need organizations' support to extend purchasing function capabilities to handle long-term aspects that are required by the projects, without losing focus of uncertainties and risk management. It starts from early engagement of purchasing activities in the project, even in the strategic planning stage. The people aspects from purchasing domain have to be taken into consideration as well, as most of the activities are performed by people, therefore people competence is essential. The purchasing individual must keep on developing their capabilities to handle development in the market as well as fulfilling project requirement but still considering purchasing related risks.

The organization shall also consider good purchasing practices to support the projects. This can be handled by providing policies in managing them in uncertain environments. External factors such customer and its long-term partnership shall secure the purchased project related materials and to avoid delays in getting them in the project. The better the relationship, the better the information exchanges and better security of material availability.

6.Acknowledgement

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