Determination of construction supplier evaluation criteria using word tags

Phong Thanh Nguyen *

Department of Project Management, Faculty of Civil Engineering, Ho Chi Minh City Open University (HCMCOU), Ho Chi Minh City, Vietnam

A B S T R A C T

The construction material is one of the critical factors to create products from construction processes. Proper evaluation and selection of building material supplier can increase product quality, reduce defects and costs, etc. To select good material suppliers, defining core criteria for evaluating them is one of the most important economic decisions in the success of any construction contractors. In Vietnam, however, there have not been many publications related to the evaluation and selection criteria of material suppliers. For this reason, this study presents an overview of the criteria for evaluating and selecting construction material supplier based on the reference of domestic and foreign documentation combining in-depth interviews with construction professionals. The research data collected through expert interviews were qualitatively analyzed by word tags. The results show that the five most important criteria are price, quality, number of projects involvement, ability to deliver on time, and supplier relationship.

1. Introduction

Material costs account for a significant proportion of total direct costs of construction investment projects (Nguyen et al., 2017a). It is one of the five crucial M's of modern construction and project management those are machine, manpower, money, and management. In fact, materials are very diverse in types, designs and in each stage of construction projects which need different types of materials. For example, in the construction phase, the primary materials are steel, brick, stone, sand, cement, etc.; meanwhile, in the finishing phase, the materials include interior decoration materials, doors, lights, and heating and cooling equipment.

Monczka et al. (2015) studied about 50% of quality problems directly related to supplier selection and improper supply chain management. The reason is that the importance of quality is not the same among companies as well as in different sectors. To identify and select the right kind of materials, the construction manager has not only gain much professional experience but also know how to evaluate and select a prestigious supplier that has the best possible capability. Hence, bidding for the most efficient and effective supplier has

played an essential role in the success of the construction project. The term efficient construction material supplier refers to the supplying unit specializing in the production or distribution of materials with the right amount at the right time, with reasonable prices, and quality. One of the important steps to efficiently select a building material supplier is to determine the critical criteria in the supplier selection. Therefore, this study presents an overview of the criteria for selecting material supplier in the construction industry.

2. Research background

In the world, one of the first studies related to the importance of supplier selection criteria was presented by Dickson (1966). On the basis of a questionnaire sent to 273 purchasing managers in the United States and Canada, he identified 23 criteria for supplier selection. In particular, quality is considered the most important criterion, followed by delivery, company reputation, warranty policy, and production capacity. Price criterion only appeared in the sixth position in his rankings. It can be said that the 23 criteria presented by Dickson (1966) still encompass most of the criteria embodied in our research today. However, evaluating them in different industries will adjust the relative importance of those criteria. Bache et al. (1987) presented 51 criteria for the selection of supplier and classifies them into eight groups as follows: quality, planning, production facilities, production

control, organization and management of a supplier, suppliers' tools and responsibilities.

By surveying 80 manufacturing companies, Tullous and Munson (1991) found that quality, price, technical service, delivery, trust and delivery time were important factors in deciding supplier selection. Weber et al. (1991) reviewed 74 articles referring to supplier selection criteria. They concluded that the five most important criteria in supplier selection were net price, delivery time, quality, production capacity, and geographic location. Based on the survey of some companies, Stanley and Wisner (2001) demonstrated that quality criterion and on-time delivery were the most critical factors in the supplier evaluation.

Meanwhile, Ghodsypour and O'Brien (1998) studied that cost, quality and service were predominant factors in the supplier selection process. Monczka et al. (1998) proposed 11 criteria in the supplier assessment such as a supplier's management, overall personnel capacity, cost, a comprehensive quality management system, process, and technology capabilities, comply with environmental regulations, financial capability, production scheduling and controlling system, information system capability, strategy, policy and purchasing technique of a supplier; and potential long-term relationships. Tracey and Vonderembse (2000) studied the supplier selection criteria by using the questionnaire survey based on the relationships among selection criteria, performance, and participation of a supplier. The importance of the supplier selection criteria had been tested through six key criteria: product quality, product diversity, distribution reliability, product performance, cost and after-sales products and incentive services.

Lambert and Pohlen (2001) indicated that many companies used logistic measures to evaluate their current and potential suppliers, such as order time, execution rate, or execution time. Juhantila and Virolainen (2003) identified attributes of an outstanding supplier including product quality, delivery as contracted, responsiveness and service, low service costs and competitive pricing. Kannan and Tan (2002) surveyed a total of 4,500 people to set out the supplier selection criteria for items used in production and sales. The authors identified 30 criteria used in the supplier selection where key criteria are cost, quality, distribution efficiency, capacity and culture of a supplier.

According to Chang et al. (2007), there were five critical supplier evaluation criteria, including product quality, purchase price, product distribution, after-sales support and flexibility in changing delivery schedules. Wang and Guo (2007) argued that in addition to the optimal cost, the overall development, culture, transfer technology, reliability, supply chain management, quality and public relation are also fundamental criteria in supplier selecting. Chengter et al. (2007) identified 29 criteria for the selection of a supplier in the Taiwan construction industry, of which the top five were

ranked from high to lower quality; price; ability to meet the deadline; professional skills and knowledge of the industry.

Ting and Cho (2008) studied the evaluation and selection of a supplier of high-tech companies in Taiwan. The authors proposed six main categories of criteria for selecting a supplier, including purchase costs, product quality, reliability, technical support, collaboration and financial performance. Shih et al. (2009) submitted nine criteria for the supplier evaluation and selection based on four research papers. These criteria include price, product quality, distribution, technical support, cooperation and association, brand reputation, geographic location, financial position and available relationship. Eshtehardian et al. (2013) discovered 23 criteria for selecting a supplier of building materials in Iran. The five most important criteria mentioned by the author were quality, on-time delivery, the minimum number of defects, ability to meet large orders and fast delivery. Plebankiewicz and Kubek (2015) classified the supplier selection criteria into two main categories including supplier's capacity; and the quality of the supply. In particular, the supplier's competency criteria include supplier's performance and experience; the development and reputation of the supplier; geographical location; financial situation and annual revenue of the company; product promotion; training capacity; and delivery capacity. Meanwhile, the criteria related to the quality of the supply include price; delivery deadline; product brands; guarantees and conditions of payment; professional support services; the origin of products; and order information system. Tran (2017) identified ten critical factors in the supplier selection process including supplier's capability; delivery time; experience; payment terms; risks or difficulties; transportation capacity; company culture; loyalty and sharing of stakeholders.

However, up to now, there have been no standard sets of criteria for evaluating and selecting suppliers for all area of industries because of the differences in characteristics, production targets and strategies of a company. In addition, geographical differences, as well as the level of development in the construction industry of different countries, make a difference in the importance of evaluation criteria. The reason is that in developed countries, quality standards are usually ensured by the reliability of suppliers, which is less important than in developing countries, including Vietnam (Do et al., 2017). Therefore, the determination of criteria for evaluating and selecting suppliers in a real context in Vietnam is indispensable.

3. Research methodology

This research applied qualitative research methodology to study the commonly used criteria in the evaluation and selection of construction material suppliers in Vietnam. To ensure the diversity of the respondents, the author conducted in-depth interviews with 22 experienced specialists in

construction and civil engineering companies. Then, the author used the method of analysing the word data by keywords combined with the word tags technology. Finally, the research data was processed using qualitative analysis software to present the aggregated word tags from in-depth interviews.

The personal in-depth interview is personal, direct and informal interviewing method (Nguyen et al., 2015). This method is applied in the study to have a better understanding of the commonly used criteria in the evaluation and selection of construction material suppliers in Vietnam. Compared to group interviews, although in-depth interviews do not provide insights into the intrinsic nature of the research problem, they provide accurate answers for each interviewee. Also, it also helps the respondents to freely present their personal opinions, without social pressure as in the group interview. In the qualitative study, with the same question, individuals perceive and explain differently depending on their personal experience (Ismaile and Alhosban, 2018). Although qualitative research does not answer research questions in specific numbers as quantitative research, it provides detailed answers to research questions about many aspects of the problem. In this study, some questions and methods of information collecting were prepared in advance and adjusted accordingly when new information emerged during the collecting process.

Qualitative data analysis studies text; then, it focuses on naming the typeface data for quantitative research in the future. In this study, based on the recordings and handwritten notes, the research has reconstructed the data in written form. Next, it was analysed data qualitatively by the method of keyword in the content analysis which referred to the criteria used in evaluating and selecting construction material suppliers in Vietnam, combining with word tags technology. Word tags, sometimes called word cloud, show the frequency of keywords being answered the most when respondents are asked about factors for evaluating and selecting construction material suppliers.

In this study, the word tags were applied. It is the image representing textual data, often used to describe tags on web pages, or to visualize the main content of texts in interviews or speeches or the research content of social media (Nguyen and Likhitruangsilp, 2017). In particular, the words proportionate to their importance through font size or colour. Although the idea of word tags computing had come a long way, until 2011, thanks to the support of dedicated computer software and websites, cloud computing has been used extensively by faculty study in political science research (for example, comparing the contents of the speeches of President Bush and Obama) and then the social scientists and managers in qualitative analysis. In principle, the font size of a keyword in a word tag is determined by its relative scale (Jin, 2017). In the linear normalization model, the weight t_i of a descriptor is mapped to a magnitude scale of 1 to f,

where x_{min} and x_{max} are specifying the specifying the available weight range (Barrett et al., 2013). The display font size in word tag is as follow:

$$s_i = \left[\frac{f_{\max}(x_i - x_{min})}{x_{max} - x_{min}}\right] \ for \ x_i > x_{min}; else \ s_i = 1$$

where

s_i : display font size
$f_{\max}$: maximum font size
x_i: word count
x_{min}: minimum word count
x_{max}: maximum word count

4. Results and discussion

The visual representation of the qualitative content of criteria in interviews with experienced construction specialists was summarized in the Fig. 1 by using word tag. Based on the results in the Fig. 1, we can recognize that the three most important criteria in evaluation and selection of construction material suppliers in Vietnam are the price of the product, quality, number of construction projects involvement. Previously, contractors were only interested in the price of construction materials (Khan et al., 2017; Nguyen et al., 2017b). They often chose suppliers who proposed the lowest price. However, quality and price are often conflicting because what we paid scarce products are both "fine and cheap." Therefore, the supplier who has the methods and strategies to minimize that conflict could be preferentially selected. A successful construction project requires the quality of the material must be good with reasonable price.

Fig. 1: Qualitative data analysis using word tags

Moreover, in order to ensure sufficient supplies for the construction project, the contractor usually requires the supplier to deliver the products on time, with a steady supply (Khan et al., 2017). In addition, the graph of materials used in construction works is not always linear; there are stages that it is

necessary to increase the amount of provided materials to ensure the progress. Therefore, any supplier who responds to these urgent or special needs promptly will gain credibility. Next, the supplier has good co-operative relationships with contractor tend to be contracted and often preferable. Especially for the construction industry in Vietnam, most business methods are based on accustomed relationships (Nguyen et al., 2018). Many material supplier selection methods are based on memoranda. That is, a contractor is going to build cooperation with a supplier, then in the next project, the possibility of that supplier to be chosen again is high because these projects have familiar methods of doing business and memorandum, mutual agreements. In addition, relationships with big contractors also demonstrate the diplomatic capacity of the supplier.

Combined literature review and interviews, the framework for the evaluation and selection of construction material supplier criteria is proposed in the Table 1.

Table 1: Criteria for evaluating and selecting construction material suppliers

No.	Criteria
1	Price of the product or service
2	Product quality
3	Terms and conditions of payment
4	Discounts and incentives
5	Domestically and internationally certified products and goods
6	Legal capacity, legal entity of the supplier
7	The operation time of the supplier
8	Number of works or projects participated by the supplier
9	Financial capacity of the supplier
10	Operation scale of the supplier
11	Development strategy of the supplier
12	Ability to deliver on time, on schedule
13	The branch network of the supplier
14	Market share
15	Inspection, accreditation, merchandise quality test
16	Precaution or ability to address emerging needs
17	Order processing and invoicing system of the supplier
18	The willingness to share the supplier's confidential information
19	Warranty, maintenance, return of products not meet the requirements of the supplier
20	Professional, technical and consulting support
21	Incentives for delivery
22	The reputation of the supplier
23	Business ethics and social responsibility (frequent and honest communication)
24	Cultural similarities between the purchasing company and the supplier
25	Relationship of the supplier
26	Acquire the buyer's product evaluation
27	Policies on labor safety and environmental sanitation

5. Conclusion

Most people believe that construction contractors must have connected with many material suppliers to minimize the risk of purchasing. However, it is not the best idea in today's competitive and globalized era. At present, most construction companies only want to work with efficient suppliers (Huang and Keskar, 2007). Therefore, the determination of essential criteria which are used to evaluate and select construction material suppliers is indispensable. This article has referred to and set out the core criteria used in the evaluation and selection of construction materials in countries around the world. Hence, based on in-depth interviews with experts, it proposes a framework of 27 criteria to assist in the evaluation and selection of building material suppliers in Vietnam. This list of criteria is expected to be very useful in supporting for evaluating and selecting right construction material suppliers in construction companies.

Acknowledgment

References

Bache J, Carr R, Parnaby J, and Tobias AM (1987). Supplier development systems. International Journal of Technology Management, 2(2): 219-228.

Barrett SA, Spillane JP, and Lim JB (2013). Early implementation of building information modeling into a cold-formed steel company: providing novel project management techniques and solutions to industry. American Journal of Civil Engineering and Architecture, 1(6): 164-173.

Chang SL, Wang RC, and Wang SY (2007). Applying a direct multi-granularity linguistic and strategy-oriented aggregation approach on the assessment of supply performance. European Journal of Operational Research, 177(2): 1013-1025.

Chengter H, Phuong MN, and Ming HS (2007). Supplier evaluation and selection criteria in the construction industry of Taiwan and Vietnam. International Journal on Information and Management Sciences, 18(4): 403-426.

Dickson GW (1966). An analysis of vendor selection systems and decisions. Journal of Purchasing, 2(1): 5-17.

Do ST, Likhitruangsilp V, Kiet TT, and Nguyen PT (2017). Risk assessment for international construction joint ventures in Vietnam. International Journal of Advanced and Applied Sciences, 4(6): 104-114.

Eshtehardian E, Ghodousi P, and Bejanpour A (2013). Using ANP and AHP for the supplier selection in the construction and civil engineering companies; case study of Iranian company. KSCE Journal of Civil Engineering, 17(2): 262-270.

Ghodsypour SH and O'Brien C (1998). A decision support system for supplier selection using an integrated analytic hierarchy process and linear programming. International Journal of Production Economics, 56: 199-212.

Huang SH and Keskar H (2007). Comprehensive and configurable metrics for supplier selection. International Journal of Production Economics, 105(2): 510-523.

Ismaile S and Alhosban F (2018). Students perceptions of audience response system in classroom feedback: A qualitative study. International Journal of Advanced and Applied Sciences, 5(4): 67-72.

Jin Y (2017). Development of word cloud generator software based on python. Procedia Engineering, 174: 788-792.

Juhantila OP and Virolainen VM (2003). Buyers' expectation from suppliers. In the 19th IMP-conference in Lugano, Switzerland: 1-25. Available online at: https://www.impgroup.org/paper_view.php?viewPaper=4361

Kannan VR and Tan KC (2002). Supplier selection and assessment: Their impact on business performance. Journal of Supply Chain Management, 38(3): 11-21.

Khan RA, Gazder U, and Qayoom A (2017). Comparison of delay factors and remedies' rankings for building construction projects in developing countries. International Journal of Advanced and Applied Sciences, 4(4): 33-42.

Lambert DM and Pohlen TL (2001). Supply chain metrics. The International Journal of Logistics Management, 12(1): 1-19.

Monczka RM, Handfield RB, Giunipero LC, and Patterson JL (2015). Purchasing and supply chain management. Cengage Learning, Boston, USA.

Monczka RM, Petersen KJ, Handfield RB, and Ragatz GL (1998). Success factors in strategic supplier alliances: the buying company perspective. Decision Sciences, 29(3): 553-577.

Nguyen PT and Likhitruangsilp V (2017). Identification risk factors affecting concession period length for public-private partnership infrastructure projects. International Journal of Civil Engineering and Technology, 8(6): 342-348.

Nguyen PT, Likhitruangsilp, V., and Onishi, M. (2017a). Developing a stochastic traffic volume prediction model for public-private partnership projects. In the American Institute of Physics Conference Series, AIP Publishing, USA, 1903(1): 060010.

Nguyen PT, Nguyen NV, Pham HL, Nguyen AT, Nguyen QTTHL, and Huynh DBV (2018). Application of supply chain management in construction industry. Advances in Science and Technology Research Journal, 12(2): 11-19.

Nguyen PT, Phuc VN, and Quyen TTHLN (2017b). Application of fuzzy analytic network process and TOPSIS method for material supplier selection. Key Engineering Materials, 728: 411-415.

Nguyen TA, Nguyen PT, and Vachara P (2015). Explaining model for supervisor's behavior on safety action based on their perceptions. Journal of Engineering and Applied Sciences, 10(20): 9562-9572.

Plebankiewicz E and Kubek D (2015). Multicriteria selection of the building material supplier using AHP and fuzzy AHP. Journal of Construction Engineering and Management, 142(1): 04015057.

Shih KH, Hung HF, and Lin B (2009). Supplier evaluation model for computer auditing and decision-making analysis. Kybernetes, 38(9): 1439-1460.

Stanley LL and Wisner JD (2001). Service quality along the supply chain: implications for purchasing. Journal of Operations Management, 19(3): 287-306.

Ting SC and Cho DI (2008). An integrated approach for supplier selection and purchasing decisions. Supply Chain Management: An International Journal, 13(2): 116-127.

Tracey M and Vonderembse MA (2000). Building supply chains: A key to enhancing manufacturing performance. American Journal of Business, 15(2): 11-20.

Tran TT (2017). An empirical research on selecting the targeted suppliers and purchasing process of supermarket. International Journal of Advanced and Applied Sciences, 4(4): 96-109.

Tullous R and Munson JM (1991). Trade-offs under uncertainty: Implications for industrial purchasers. International Journal of Purchasing and Materials Management, 27(3): 24-31.

Wang JW and Guo SW (2007). Research of construction supplier selection model based on grey relevancy. Journal of Wuhan University of Technology, 29(3): 153-156.

Weber CA, Current JR, and Benton WC (1991). Vendor selection criteria and methods. European journal of Operational Research, 50(1): 2-18.