

SELECTION OF MATERIAL SUPPLIERS BY THE CONTRACTORS IN
THE CONSTRUCTION INDUSTRY

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DEDICATION

To;

My Parents

&

My family...

Thanks for your pray, attention and spiritual support...

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It is a great pleasure to address those people who helped me throughout this project to enhance my knowledge and practical skills especially in research area. My deepest and most heartfelt gratitude goes to my supervisor, Mr. Bachan Singh. The continuous guidance and support has enabled me to approach the work positively, and make even the impossible seem possible.

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ABSTRACT

Generally, construction materials constitute about 30% of the cost of the building project. Therefore, the selection of the suppliers is important to ensure the successful completion of the project. Past literature show that the main issue with building materials purchasing is the selection of the suppliers, which depends on careful examination of suppliers' price and quality among other criteria. The aim of this study is to evaluate the selection of suppliers by the contractors and to identify the problems faced by the contractors regarding the material suppliers. The objectives of the study are to study the types of material supplied to the contractor through quotation or direct negotiation from the supplier, to identify the main problems faced by contractors in obtaining the materials from the suppliers, to evaluate the criteria for the selection of material suppliers by the contractor and to develop AHP method and criteria analyzing for the right selection of material supplier. The study is carried out in the state of Johor. The study is carried through questionnaires and interviews. The data is analyzed using statistical analysis and Average Index. From the study, the materials supplied by the suppliers to the contractors are timbers for carpentry and formwork through direct negotiation. Other general materials are procured through quotation. The main problems faced by the contractors in obtaining the material from the suppliers are the supplier does not understand the contractors' project schedule, late delivery of materials and the high price of materials. The criteria for the selection of the material suppliers by the contractor are price, production facilities and quality. Through the AHP model a wide range criterion and sub-criteria are identified, data and information for each supplier evaluated, the best supplier selected and finally the consistency of the contractor decision tested.

ABSTRAK

Secara am, bahan binaan merangkumi 30% daripada kos projek bangunan. Oleh yang demikian, pemilihan pembekal adalah penting bagi memastikan projek siap dibina. Kajian literatur lepas menunjukkan bahawa isu mengenai pembelian bahan binaan adalah pemilihan pembekal yang bergantung kepada harga dan kualiti bahan binaan yang dibekal oleh pembekal. Matlamat kajian ini adalah untuk menilai pemilihan pembekal oleh kontraktor dan mengenalpasti masalah yang dihadapi oleh kontraktor mengenai pembekal bahan binaan. Objektif kajian adalah untuk mengkaji jenis bahan binaan yang dibekal kepada kontraktor melalui sebutharga atau perundingan terus, mengenalpasti masalah yang dihadapi oleh kontraktor dalam memperolehi bahan binaan dari pembekal, menilai kriteria dalam pemilihan pembekal oleh kontraktor dan membina kaedah AHP dan analisa kriteria dalam memilih pembekal secara tepat oleh kontraktor. Kajian ini dijalankan di negeri Johor. Kajian dijalankan melalui soalselidik dan temubual. Data dianalisa dengan menggunakan analisa statistik dan Indeks Purata. Daripada kajian, bahan binaan yang dibekalkan kepada kontraktor adalah kayu untuk pertukangan dan acuan melalui rundingan terus. Lain-lain bahan binaan dibekal melalui sebutharga. Masalah utama yang dihadapi oleh kontraktor dalam memperolehi bahan binaan daripada pembekal adalah pihak pembekal tidak memahami penjadualan projek kontraktor, lambat membekal bahan binaan dan harga bahan binaan yang tinggi. Kriteria dalam pemilihan kontraktor adalah harga, fasiliti pengusahaan dan kualiti. Melalui model AHP model julat kriteria lebar dan sub-kriteria dikenalpasti, data dan maklumat dari setiap pembekal dinilai, pembekal yang terbaik dipilih dan keputusan kontraktor diuji.

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LIST OF SYMBOLS

AHP: Analytical Hierarchy process

SCP: Supply chain management

CSCP: Construction supply chain management

MCDM: Multi Criteria Decision Making

TCO: Total Cost of Ownership ()

CR: Consistency ratio

λ_{\max} : Maximum eigenvalue

RI: Random index

CI: Consistency Index

LIST OF APPENDICES

- A. Sample of questionnaire survey
- B. Interview survey template

CHAPTER 1

INTRODUCTION

1.1 Introduction

Construction projects involve several processes whereby the plans, drawings and specifications of designers and engineers converted into physical structures and buildings. Therefore, there are so many different parties with specified responsibilities to implement and direct these processes such as Client, Contractors, Suppliers, and Engineers etc. It includes the coordination of all the resources for the project labour, equipment, permanent and temporary materials, utilities, technology, time to complete project on schedule, within budget and according to the standards of quality stipulated in the contract document. The construction project shall be performed perfectly and properly in order to achieve the desired result, quality product, confined completion period and minimum cost. But problems always exist along construction process. The contractors play a key role in construction industry as the most portions of works are being run by them. They are responsible for the supplying materials and methods to be used in the construction execution of the project in accordance with the documents. Contractors require material, machinery, labour force and other facilities to perform their tasks. Hence, suppliers of materials and equipment, shipping organizations etc., play supporting roles.

Effective execution of projects and keeping them within cost, quality and time estimated depends on the communication and correct decision of the persons who are in charge of projects. The purchasing function of a construction firm is central to materials management and especially includes the commitment of project funds for construction materials. One of the most important elements in construction procurement is the supplier selection by the contractors. The overall purposes of supplier selection process is to decrease project risk, increase the availability of material and build the close and long term relationships between members of the project. The selection process should consider investigation supplier's potential to deliver a service and material of acceptable standard, on time and within budget.

Although there are a lot of differences between the construction industry and other industries, the principle of selecting suppliers is the same: a client buys a product from a supplier. Van Weele (2005) has developed a purchasing model that includes the following steps: identifying the need, selecting the supplier, arriving at a proper price, specifying terms and conditions (contract), issuing the order, and ensuring proper delivery. The process is involved supplier selection as one of the most significant steps in the procurement process. (Figure 1-1)

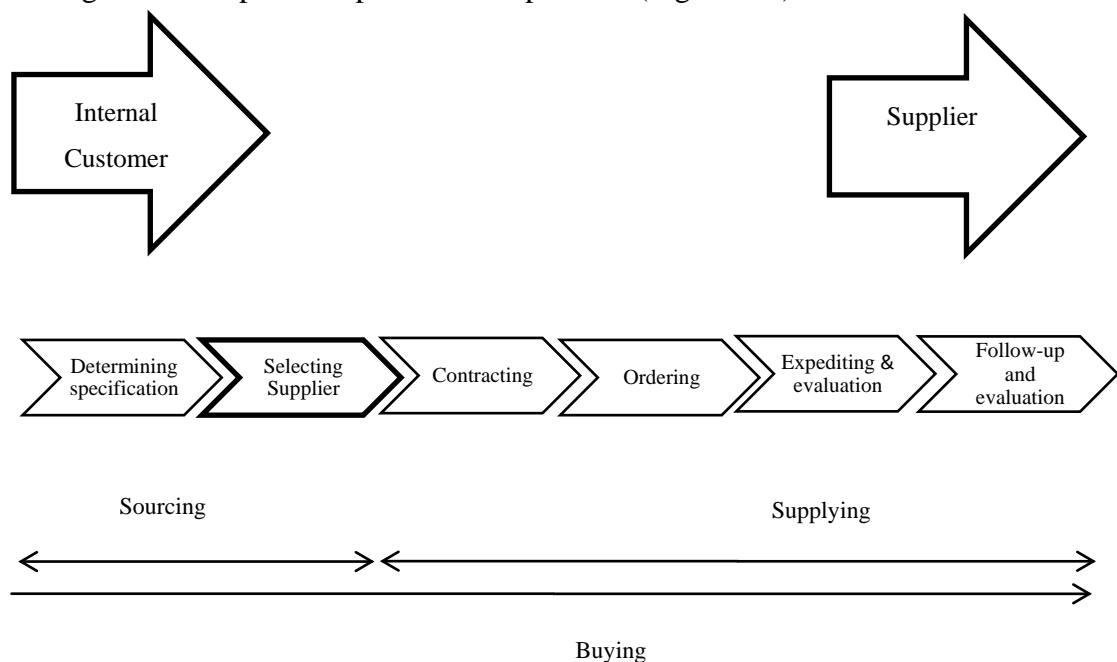


Figure 1.1 Purchasing Process Activities (Source: Van Weele, 2005)

1.2 Background

Supplier selection is a kind of Multi Criteria Decision Making (MCDM) problem, which has been a growing research area since past few decades. Researchers and practitioners to evaluate the suppliers/vendors have already proposed several effective techniques. The background of this study is based on the previous literature, questionnaire and interview with the experts in the construction industry.

Also, Analytic Hierarchy Process is used as a useful technique to improve decision-making problem when there are multiple criteria due to this fact that most people cannot deal with several decision considerations at a time. Poh et al. (2001) stated that the advantage of AHP, a qualitative and quantitative approach, is to determine the priority and weight of each performance criteria through paired comparison of attributes. The weights of the performance criteria, therefore, should be considered and further provide priorities for decision-makers to measure alternatives performance more precisely.

1.3 Problem Statement

A project of medium to large scale typically involves hundreds of different companies supplying materials, components, and a wide range of construction services. The multi-participant and multi-domain characteristic is partly caused by the high fragmentation of the industry. Manufacturing sector has saved large amount of capital by suitably applying Supply Chain Management model and particularly managed well with their relationship with key suppliers. Cost savings has led to better performance and sustainable growth because saved resources are invested in core activities of the company. This fact urges construction companies to pay more attention to supplier relationship management to overcome fragmentation problem. Moreover, in most cases, construction organizations are not proficient at identifying

the capabilities of their suppliers. They sometimes rationalize materials supplier decisions based on convenience. They do not recognize the impact of the economic changes on bulk materials prices and side effects in terms of waste and delay at construction site that occurs due to poor delivery methods by unqualified suppliers.

Benton and McHenry (2010) suggest the following success factors, which are necessary to overcome the mistakes:

- Perform a realistic assessment of the capabilities and expertise of each potential supplying firm (e.g. If core competencies exist, what happens if a key supplier goes out of business? Can the supplier be easily replaced?)
- Evaluate alternative strategic supplier arrangements and select appropriate suppliers.
- Share information with all strategic suppliers and request their input.

There are also continuously new competitors with modern technologies entering the construction materials market. In real world, Conventional method of supplier selection starts with:

- 1- Calling for Public Tender and continue with following stages:
- 2- Initial screening, survey on factory and monitor actual status.
- 3- Interview of Executives of Supplier Company and negotiation with some basic elements; such as cost, quality, and service level.
- 4- Rate the topmost supplier without any proper selection method and visit them again.
- 5- Finally select the supplier.

In conventional supplier selection process, several problems are visible such as:

1. Conventional method does not consider multiple objectives. Only a few criteria are observed and based on these criteria, the decision is made which often proved wrong in the long period.
2. It does not collect sufficient information to evaluate a supplier. Just very few data are collected instead of a comprehensive investigation and so the accuracy of the result is very poor.

In traditional approach, there is no subdivision of the criteria and so mutual comparisons among the subdivisions are absent here, which may help the evaluation process to become more precise.

But the proposed supplier selection model as specified in the following eradicates the drawbacks of the conventional supplier selection process:

- Calling for Public Tender.
- Determination of key supplier selecting and evaluation indicators.
- By using decision-making technique, compute weighted value of each supplier.
- Validation of the result and finally select the best supplier.

The process starts by determining the key supplier selection and evaluating indicators. Then, sufficient data is collected against these indicators. By using decision tools such as AHP, the weighted values of each supplier are computed. The proposed selection process ends by validating the results and thus selecting the best supplier in an authentic and standard way. This selection process considers significant evaluating indicators and each contributes to determine the best supplier. Besides, this process always compares one against another and these comparisons make the total selecting process more methodical than the conventional process.

The fact shows that it is very significant to manage supplier relationship by choosing the right criteria for the supplier evaluation and selection process particularly in construction industry.

1.4 Aim and Objectives

The aim of this study is to evaluate the selection of suppliers by the contractors and to identify the problems faced by the contractor regarding the suppliers while the objectives are:

1. To study the types of material supplied to the contractor either through quotation or direct negotiation from the supplier.
2. To identify the main problems faced by contractors in obtaining the materials from the suppliers.
3. To evaluate the criteria for the selection of material suppliers by the contractor.
4. To develop AHP method and criteria analyzing for the right selection of material supplier.

4.5 Scope of the study

Each study to produce appropriate objectives and results should concentrate on particular scopes. This research is not exception from this rule too. Selection of suitable supplier is a kind of decision-making approach and possible to be applied by different types of methods. Therefore, to obtain desired results in this thesis:

- A. Analytic Hierarchy Process is used on class A contractor in Johor – Malaysia by specified criteria from the literature based on an interview and questionnaire is conducted. I assume that the number of the suppliers to be selected is already given and there is no constraint to produce and purchasing material.
- B. The study does not try to find the best approach of supplier selection. But focus on analytic hierarchy process as one of the decision making tool to assess the suitability of suppliers.

4.6 Significance of the Study

A good supplier usually denotes lower risks and a higher profit. However, there are always various kinds of challenges when a company selects a supplier. Since construction industry is taking steps toward industrialization by providing new technology such as Industrialized Building System (IBS) the same as manufacturing industry methodology, Decision-making techniques besides tendering documents can improve supply chain management concept in this industry.

REFERENCE:

- Aretoulis, GN, Kalfakakou, GP & Striagka, FZ 2009, *Construction material supplier selection under multiple criteria*, Operational Research, vol. 10, no. 2, pp. 209-230.
- Benton, WC & Mchenry, LF 2010, *Construction purchasing and supply chain management*, McGraw-Hill, Mexico City.
- Bevilacqua, M. and Petroni, A., 2002, From Traditional Purchasing to Supplier Management: *A Fuzzy Logic based Approach to Supplier Selection*, International Journal of Logistics: Research & Applications, 5, 3, 235-255.
- Bhutta, K. S. and Huq, F., 2002, *Supplier selection problem: a comparison of the total cost of ownership and analytic hierarchy process approaches*, Supply Chain Management: An International Journal, 7, 3, 126-135.
- Burt, D.N., Dobler, D.W. and Starling, S.L. (2003), World Class Supply Management: *The Key to Supply Chain Management*, 7th Edition, McGraw-Hill Irwin, New York.
- Chan F.T.S., Chan H.K. (2004). *Development of the supplier selection model - a case study in the advanced technology industry*. Proceedings of the Institution of Mechanical Engineers, Part B, vol. 218, pp.1807-1824.
- Chang-Fu Hsu, He-Yau Kang and Amy H. I. Lee (2004), *Control/dummy wafers inventory problem by dynamic programming*, Chinese Institute of Industrial Engineers Conference, Vol. Taiwan, No. Tainan,
- Dickson, G W (1966), *An analysis of vendor selection systems and decisions*. Journal of Purchasing, 2(1), 5-17.
- Drake, P.R., 1998, *Using the Analytical Hierarchy Process in Engineering Education*, International Journal of Engineering Education, Vol. 14, No3, and PP. 191-196.
- Dzever, S., Merdji, M. and Saives, A., 2001, *Purchase decision making and buyer-seller relationship development in the French food processing industry*, Supply Chain Management: An International Journal, 6, 5, 216-229.

- Fredendall, L.D. and Hill E. (2001), *Basics of Supply Chain Management*, St Lucie Press, New York.
- Gidado, K.I. (1996), Project complexity: *The focal point of construction production planning*. *Construction Management and Economics* 14, 213-225.
- Handfield, R. B., 1994, US Global Sourcing: *Patterns of Development*, *International Journal of Operations & Production Management*, 14, 6, 40–51.
- Ho, C & Nguyen, P 2007, *Supplier evaluation and selection criteria in the construction industry of Taiwan and Vietnam*, *International journal of information and management sciences*, vol. 18, pp. 403-426.
- Kannan, VR & Tan, KC 2002 „Supplier selection and assessment: *Their impact on business performance*, *The Journal of Supply Chain Management: A Global Review of Purchasing and Supply*, pp. 11-21.
- Karpak, B., Kasuganti, R. R. and Kumcu, E., 1999, *Multi-Objective Decision-Making In Supplier Selection: An Application of Visual Interactive Goal Programming*, *Journal of Applied Business Research*, 15, 2, 57-71.
- Lambert, L. (1998). *Building leadership capacity in schools*. Virginia: Association for
Lehmann, Donald R. and John O'Shaughnessy (1982) "*The Choice Criteria Used by Purchasing Managers in Buying Different Categories of Products*," *Journal of Purchasing and Materials Management*, spring, 9- 14.
- Liu, F.-H.F. and Hai, H.L. (2005). *The voting analytic hierarchy process method for selecting supplier*. *Int. J. Prod. Econ.* 97 (3):308-317.
- Ma, L & Yang, G 2010, *The selection of construction material suppliers in supplier relationship management (SRM)*, *Proceedings of the International conference of information science and management engineering*, IEEE, Xi'an, China.
- Maggie C.Y.T. and Tummala, V.M.R. (2001). *An application of the AHP in vendor selection of a telecommunications system*. *Omega*, 29:171-182.
- Mendoza, A 2007, *Effective methodologies for supplier selection and order quantity allocation*. PhD thesis, The Pennsylvania State University, Pennsylvania.
- Mentzer, J. T., (2001), *Supply Chain Management*, Sage Publications, 524 p.
- Min, H., 1994, *International Supplier Selection*, *International Journal of Physical Distribution & Logistics Management*, 24, 5, 24-33.
- Monczka, R., Trent, R., and Handfield, R. (2002), *Purchasing and Supply Chain Management*, 2nd Edition, South Western, Cincinnati.
- Ordoobadi, SM 2009, *Development of a supplier selection model using fuzzy logic*, *Supply Chain Management: An International Journal*, vol. 14, no. 4, pp. 314-327.

- Pearson, J. M. and Ellram, L. M. (1990-1995), *Supplier selection and evaluation in small versus large electronics firms*, Journal of Small Business Management, 33(4): pp. 53-65.
- Poh, K. L., Ang, B. W., & Bai, F. (2001). *A comparative analysis of R&D project evaluation methods*. R&D Management, 31(1), 63-75.
- Saaty, T. L. (1990). How to Make a Decision: *The Analytic Hierarchy Process*, European Journal of Operational Research, Volume 48, 9-26.
- Saaty, T.L. (1980). *The Analytic Hierarchy Process*. New York: McGraw-Hall.
- Serra, S. M. B.; Oliveira, O. J. (2003), *Development of the logistics plan in building construction System based vision for strategic and creative design*, Bontempi (ed.), Lisse, Swets&Zeitlinger. (2003), pp. 75-80. *Supervision and Curriculum Development*.
- Talluri, S. and Sarkis, J., 2002, *A model for performance monitoring of suppliers*, International Journal of Production Research, 40, 16, 4257-4269.
- Timmerman, E 1986, *An approach to vendor performance evaluation*, Journal of Purchasing and Materials Management, vol. 22, no. 4, pp. 2-8.
- Weber, C. A., Current, J. and Desai, A., 2000, *An optimization approach to determining the number of vendors to employ*, *Supply Chain Management: An International Journal*, 5, 2, 90-98.
- Weber, C.A., Current, J.R., Benton, W.C., 1991. *Vendor selection criteria and methods*. European Journal of Operational Research 50, 2–18.
- Weele, AV 2005, *Purchasing and supply chain management: Analysis, strategy, planning and practice*. ThomsanRennie, London.
- Womack, J.P., Jones, D.T. and Roos, D. (1990), *The Machine that Change the World*, New York: Rawson Associates.
- Yusuff, R.D. and Poh Yee, K. (2001), *A preliminary study on the potential use of the analytical hierarchical process (AHP) to predict advanced manufacturing technology (AMT) implementation*. Robotics and Computer Integrated Manufacturing. 17:421-427.
- Zainal.B. (2006) *Peluang-peluangpenyelidikankualitatifdalamilmufalak*. InstitutPenyelidikanMatematik (INSPEM), Universiti Putra Malaysia, Serdang.
- Zhang, Z., J. Lei, N. Cao, K. To & K. Ng. (2003), *Evolution of Supplier Selection Criteria and Methods*. European Journal of Operational Research 4(1): 335-342.