MULTI-CRITERIA DECISSION MAKING IN INDUSTRIES

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Abstract

Selecting the right suppliers significantly reduces the purchasing cost and improves corporate competitiveness, which is why experts believe that the supplier selection is the most important activity of a purchasing department in the manufacturing industries. Supplier selection is the process by which suppliers are reviewed, evaluated, and chosen to become part of the company's supply chain in order to reduce the purchasing cost, quality problems, and long-lead times so that corporate competitiveness can be achieved. PZ Cussons Nigeria Plc. is the largest and most diverse single market, operating in Personal Care, Home Care, Food and Nutrition and Electronics, with over 3,500 people working across its extensive network and procures production materials from four (4) major supplying companies (Impco. Industry, Beta Glass, Divine Jacy Ltd. and Multipack Nig. Ltd.). To determine the best supplier for PZ, Different criteria with various alternatives were obtained for the purpose of this study i.e. Price, Insurance, Quality and Time and Impco Industry, Beta Glass Ltd, Divine Jacy Ltd and Multipack Nig and analyzed using Analytic Hierarchy Process (AHP). The result of the study shows that Impco Industry was identified as the best supplier that meet the criteria for PZ Cussons Nigeria Plc.

Keywords: Normalization, Synthesisation, Consistency, Multi-criteria, consistency index

Introduction

Multi criteria decision-making (MCDM) is a modeling and methodological tool for dealing with complex decision problems. Multi-attribute decision-making (MADM) is the most well-known branch of decision making. It is a branch of a general class of operations research models that deal with the decision-making problems under the presence of a number of decision making criteria. The MADM approach requires the selection to be made among decision alternatives described by their attributes. MADM problems are assumed to have predetermined, and limited number of decision alternatives. Solving a MADM problem involves sorting and ranking. (Babak and Turan, 2011). The Analytical Hierarchy Process (AHP) is a well-known method for solving decision making problems; it is one of the most widely used multi-attribute decision making (MADM) methods.

In business environments, it has become more important to improve the productivity of a firm in global competition. An ever-increasing trend in industrial firms is to exploit outsourcing for those products and activities deemed to be outside the company's core business. In manufacturing industries, a very high percentage of their total earnings go back into the business in procuring the raw and packaging materials needed for the industries to run. Selecting the right suppliers significantly reduces the purchasing cost and improves corporate competitiveness, which is why experts believe that the supplier selection is the most important activity of a purchasing department in the manufacturing industries (Stephen, 2009).

Supplier selection is the process by which suppliers are reviewed, evaluated, and chosen to become part of the company's supply chain in order to reduce the purchasing cost, quality problems, and long-lead times and definitely improves corporate competitiveness (Vokurka and Fliedner, 1998; Meade and Sarkis, 1999).

With physical presence in the major countries of the world, from Manchester in the United Kingdom, the United States, Greece, Poland, Indonesia, Thailand, Australia, United Arab Emirate, Nigeria, Ghana and Kenya, among others, PZ Cussons Nigeria Pic is the largest subsidiary of PZ Cussons global group. The company was established in Nigeria. over a hundred years ago, precisely in 1898, just ten (l0) years after it was found in 1884 by George Paterson and George Zochonis as a trading post in Sierra Leon, trading goods between West Africa and the United Kingdom across challenging geographies in a period of slow and difficult transportation system.

PZ Cussons Nigeria Plc. Lagos procures production materials from four major (4) supplying companies. This is done by placing requests for the needed materials by the procurement department. However, these materials are subjected to various quality tests through the quality control unit and defective materials are reported to the supplying companies within fifteen (15) working days for replacement otherwise; materials that are found detective and rejected cannot be returned to the suppliers and the company (PZ Cussons Nigeria Plc, Lagos) bears the expenses. The delay that is recorded in reordering same materials if the rejection is made within fifteen days (15) as given by the suppliers affects the production running of the company which also affects the business relationships with their customers (loss in customer goodwill).

Materials and Method

A direct interview method was used to source data from both managers of the procurement department and the quality control unit. Questionnaires were administered to all staffs of the procurement department, quality control unit, and the mangers of the four (4) major suppliers of PZ Cussons Nigeria plc. Lagos. The following criteria were identified: Price (Competitive pricing) $=$ (P), Warranty (Insurance and bonding provisions) = (I), Quality (Product and service quality) $=$ (Q), Time (Reliable delivery time) (T)

Finally, a pair wise comparison matrix for the identified criteria was formulated as shown below:

$$A_{ij} = \begin{matrix} & \begin{matrix} P & I & Q & T \end{matrix} \\ \begin{matrix} P \\ I \\ Q \\ T \end{matrix} & \begin{pmatrix} 1 & w_1/w_2 & w_1/w_3 & w_1/w_4 \\ w_2/w_1 & 1 & w_2/w_3 & w_2/w_4 \\ w_3/w_1 & w_3/w_2 & 1 & w_3/w_4 \\ w_4/w_1 & w_4/w_2 & w_4/w_3 & 1 \end{pmatrix} \end{matrix}$$

Where A_{ij} = Pair wise comparison matrix for the weights of the criteria identified

n = number of criteria (4)

w_2 = weight for criteria 1(Price)

w_2 = weight for criteria 2 (Warrantee)

w_2 = weight for criteria 3 (Quality)

w_2 = weight for criteria 4 (Time) and λ_{max} = Eigen value

Consistency Ratio $= \frac{CI}{RI}$ (1)

Where *CI* consistency index of *A*.

$CI = \frac{(\lambda_{max} - n)}{(n-1)}$ (2)

RI = random consistency of W_{ij}

$CI = \dfrac{Empirical\ value\ of\ n(n-2)}{(n-1)}$ (3)

The random consistency index RI is determined empirically as the average CI of a large sample of randomly generated comparison matrices A_{ij} .

Analysis, Result and Discussion

Table 1: Comparison Scale for the Criteria (Level of Importance).

Judgment	Rating Scale
Absolutely more important	9
Much more important	7
More important	5
Somewhat more important	3
Equally important	1
Intermediate values (Compromise)	2,4,6,8.

Table 2: Summary of Pair wise Comparison for Criteria

Comparison			Criteria Of Interest	Judgment	Rating Scale
P	Vs.	I	P	Somewhat more important	3
P	Vs.	Q	P	More important	5
P	Vs.	T	P	Somewhat more important	1
I	Vs.	T	I	Much more important	7
I	Vs.	Q	I	Somewhat more important	3
Q	Vs.	T	T	Somewhat more important	3

Table 3: Initial Pair wise Comparison Matrix

	Price	Insurance	Quality	Time
Price	I	3	5	3
Insurance	1/3	I	7	3
Quality	1/5	1/7	I	1/3
Time	1/3	1/3	3	I

Table 4: Normalization of Comparison Matrix

	Price	Insurance	Quality	Time	Priority
Price	0.535733	0.670226	0.3125	0.409093	0.481888
Insurance	0.17856	0.223409	0.4375	0.409093	0.31214
Quality	0.107147	0.031903	0.0625	0.04545	0.06175
Time	0.17856	0.074462	0.1875	0.136364	0.144222
Column Total	1	1	1	1	

From table 4: above, Price has been identified as the most important criteria in the supplier selection process with priority of 0.48189. Insurance has been identified as the second most important criteria with priority of 0.31214, Time has been identified as the third most important criteria with priority of 0.1443 and Quality is the fourth most important criteria to be considered in the supplier selection process with priority of 0.06175.

Consistency computations

$$0.48189 \begin{bmatrix} 1 \\ 1/3 \\ 1/5 \\ 1/3 \end{bmatrix} + 0.31214 \begin{bmatrix} 3 \\ 1 \\ 1/7 \\ 1/3 \end{bmatrix} + 0.06175 \begin{bmatrix} 5 \\ 7 \\ 1 \\ 3 \end{bmatrix} + 0.14422 \begin{bmatrix} 3 \\ 3 \\ 1/5 \\ 1 \end{bmatrix} = \begin{bmatrix} 2.15972 \\ 1.31667 \\ 0.21066 \\ 0.59415 \end{bmatrix}$$

$$\text{Eigen value} = \lambda_{max} = \frac{4.48179 + 4.2182 + 3.4115 + 4.1197}{4} = 4.0578$$

$$consistency\ index (CI) = \frac{\lambda_{max} - n}{n - 1}$$

$$(CI) = \frac{4.0578 - 4}{4 - 1} = 0.019266$$

Random Index (RI) was obtained from the random index number table where $n = 4$ is given as 0.90.

$$consistency\ ratio\ (CR) = \frac{CI}{RI}$$

$$consistency\ ratio\ (CR) = \frac{0.019266}{0.90} = 0.02141$$

Since the Consistency Ratio (C.R) is less than 0.10, the rating of the criteria and the Consistency ration is considered acceptable.

Table 5: Priorities of Alternatives in Pairwise Comparison Matrix Showing Preferences for Suppliers with respect to Price.

	Impco,Industry	Bela Glass Ltd.	Divine Jacy Ltd.	Multipak Nig.	PRIORITY
Impco. Industry	0.22059	0.416667	0.409093	0.642866	0.422304
Beta Glass Ltd.	0.044118	0.083333	0.04545	0.071422	0.06 I 08 I
Divine lacy Ltd.	0.073523	0.25	0.136364	0.071422	0,132827
Multipak Nig.	0.66177	0.25	0.409093	0.214289	0.383788
COLUMN TOTAL	1	I	I	1	I

Table 6: Priorities of Alternatives in Pairwise Comparison Matrix Showing Preferences for Suppliers with respect to Insurance.

	Impco,Industry	Bela Glass Ltd.	Divine Jacy Ltd.	Multipak Nig.	PRIORITY
Impco. Industry	0.1	0.17856	0.071422	0.035711	0.096423
Beta Glass Ltd	0.3	0.535733	0.642866	0.535716	0.503579
Divine Jacy Ltd.	0.3	0.17856	0.214289	0.32143	0.25357
Multipak Nig.	0.3	0.107147	0.071422	0.107143	0.146428
COLUMN TOTAL	1	1	1	1	1

Table 7: Priorities of Alternatives in Pairwise Comparison Matrix Showing Preferences for Suppliers with respect to Quality.

	Impco.Industry	Beta Glass Ltd.	Divine Jacy Ltd.	MultipakNig.	PRIORITY
Irnpco. Industry	0.214289	0.409093	0.32143	0.073523	0.254583
Beta G lass Ltd	0.071422	0.136364	0.035711	0.66177	0.226317
Divine Jacy Ltd.	0.071422	0.409093	0.107143	0_044118	0.157944
Multipak Nig.	0.642866	0.04545	0.535716	0.22059	0.361156
COLUMN TOTAL	1	1	1	1	1

Table 8: Priorities of Alternatives in Pairwise Comparison Matrix Showing Preferences for Suppliers with respect to Time.

	Impco.Industry	Beta Glass Ltd.	Divine Jacy Ltd.	Multipak Nig.	PRIORITY
Irnpco. Industry	0.22059	0.416667	0.642866	0.071422	0.337886
Beta G lass Ltd	0.044118	0.083333	0.071422	0.071422	0.067574
Divine Jacy Ltd.	0.073523	0.25	0.214289	0.642.866	0.295169
Multipak Nig.	0.66177	0.25	0.071422	0.214289	0.29937
COLUMN TOTAL	1	I	I	1	1

Table 9: Final Priority Matrix for Each Supplier

	PRICE	INSURANCE	QUALITY	TIME	PRIO,RfTY
Impco, Industry	0.422304	0.096423	0.254583	0.337886	0.277799
Beta Glass Ltd.	0.061081	0.503579	0.226317	0.067574	0.214638
Divine .lacy Ltd.	0.132827	0.25357	0.157944	0.295169	0.209878

Multipak Nig.	0.383788	0.146428-	0.361156	0.29937	0.297685
COLUMN TOTAL	1	1	1	1	1

Conclusion

Analytic Hierarchy Process (AHP) is a Multi criteria decision-making (MCDM) as a modeling and methodological tool for dealing with complex decision problems. To determine the best suppliers for PZ Cussons Nigeria Pic, Lagos, Different criteria with various alternatives were obtained for the purpose of this study i.e. Price, Insurance, Quality and Time and Impco Industry, Beta Glass Ltd, Divine Jacy Ltd and Multipak Nig. and analyzed using Analytic Hierarchy Process (AHP). The result of the study, shows that the most reliable and efficient supplier for PZ Cussons Nigeria Pic, Lagos was determined from among the four major suppliers of packaging materials that were considered, namely; Irnpco Industry, Beta Glass, Divine Jacy Ltd and Multipak Nig. Ltd. Impco Industry was identified as the supplier that meets the most important criteria from the analysis carried out with the data provided by the company. It can therefore be concluded that AHP is a vital tool for multicriteria criteria decision making problems.

Recommendation

PZ Cussons Nigeria PIc. Lagos should consider "price" as the most important criteria in selecting suppliers since it has been identified as the criteria with the highest priority weight in the supplier selection process from the analysis. Impco industry was also identified as the supplier that meets the most important criteria identified above. It is therefore recommended that, PZ Cussons Nigeria Pic. Lagos should consider Impco Industry as the most reliable and efficient supplier for the packaging materials, with price as the most important criteria.

References

Babak D. R. &Turan E. E. (2011) "Selecting the best supplier using analytic hierarchy process (AHP) method't.African Journal of Business Management Vol.6 (4), pp. 1455-1462.

Behzadian, M. (2013). PROMETHEE: "A comprehensive literature review on methodologies and applications". *European Journal ofOperational Research,* 200(1): 198-215.

Meade L andSarkis J (1999)."Analyzing organizational project alternatives for agile manufacturing processes"Ananalytical network approach. Int. J. Prod. Res., 37(2): 241-261.

Saaty, T.L., (1980)'The Analytic Hierarchy Process" McGraw-Hili, New York. Stephen M. R. (2009), "Supplier Selection School of Business".

Tahriri F. E.(2008) "AHP approach for supplier evaluation and selection in a steel manufacturing company." *Journal of Industrial Engineering and Management* 1 ,110.2 (2008): 54-76. http://www.pzcussonsng.com/history_of__pz cussons.html [Nov 17,2016] .

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