PRIORITIZATION OF SUSTAINABLE SUPPLY CHAIN MEASUREMENT INDICATORS USING FUZZY AHP

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ABSTRACT
This study deals with prioritization of sustainable supply chin measurement indicators which are calculated by using Chang's extent method of Fuzzy AHP. Within the model of Fuzzy AHP, main attributes, sub attributes and indicators are defined. The weights of them are calculated from the answers of questionnaire, which is formed for pair-wise comparison of attributes and indicators. The results of the study show that "green market share" is the most significant attribute regarding to sustainable supply chain.
Key Words: Sustainability, Supply Chain, Fuzzy AHP, Green Manufacture.

1. INTRODUCTION

As awareness of environmental issues grows in society so do the efforts in making supply chains sustainable and greener. Supply chain management has benefits such as improved delivery performance, increased accuracy of demand forecasts, effective management capacity and resources and consequently an increase in overall customer satisfaction [1]. Commonly sustainability in supply chain was seen as a way to reduce cost, however since last decade it is realized that it brings effectiveness and creates a competitive advantage as a result of good reputation. Sustainable supply chain practices bring three types of benefits: financial, environmental and social [2]. In order to operate supply chain in a sustainable manner, firms follow various strategies such as resistant adaptation, seeking eco-efficiency, competing in environmental reputation and eco-entrepreneurship [3]. They are categorized by their tendency to create differentiation advantage and productivity advantage.

2. HIERARCHICAL MODEL FOR PRIORITIZATION OF MEASUREMENT INDICATORS

Companies, which are aware of the fact that doing business with respect to sustainability, gain competitive advantage over other companies in the market. Because of the fact that environmental sustainability has many different aspects to one and other, managers in the supply chain struggle where to begin to differentiate their way of doing business. Thus, by implementing fuzzy AHP, this paper suggests prioritization of measurement indicators related to sustainable supply chain.

The hierarchical structure is formed, as in Figure 1, in order to prioritize the indicators regarding to enhancing sustainability in supply chain. Ten indicators were chosen and explained below [4].
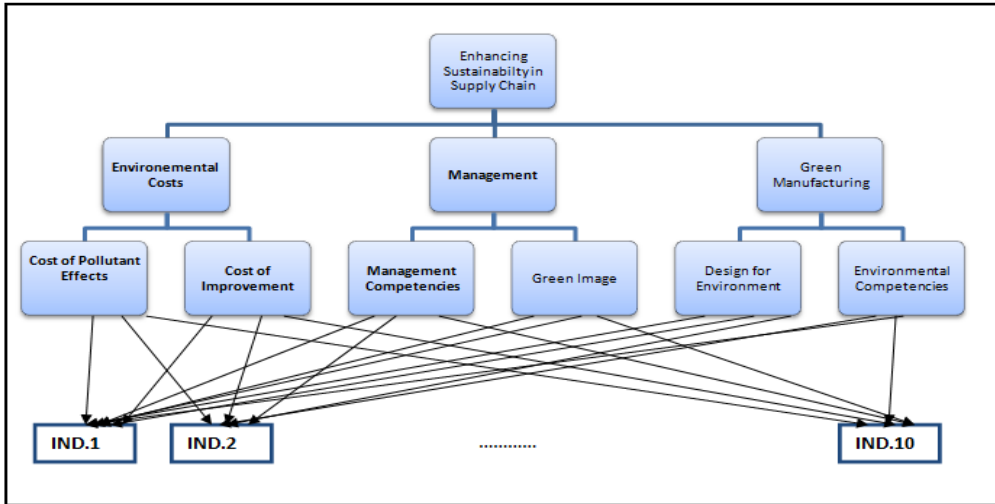
Figure 1. Hierarchical structure of criteria

IND1: The Waste Disposal

IND2: The Cost of Energy

IND3: Staff Training

IND4: Implementing Control Technologies

IND5: Buying Environmental Friendly Material

IND6: Support of Senior Management

IND7: Amount of Green Market Share

IND8: Stakeholders Relationship

IND9: Recycle & Remanufacture Rate

IND10: Disassembly and Disposal Rate

First indicator, which is waste disposal rate, concerns about how the companies in the supply chain handle their waste after production. Especially in the last decade society and foundations are more conscious about how responsible do the companies behave towards environmental issues. Thus, knowing that both the toxic and the non-toxic waste is eliminated with the help of the technology, makes suppliers and customers more satisfied.

Secondly one of the main fixed costs of the companies is the energy cost. The source of energy that the factory or the service facility uses can dramatically change the overall cost. However, companies should not use energy resources that threaten people living in the neighborhood, just since they minimize the cost. Briefly companies need to find an optimum way to choose and use renewable energy sources.

Third indicator is staff training, which is essential for the organizational culture. Trained employees will enhance sustainability in overall supply chain, and also add value to the business. In order to maintain this awareness and deploy it to every single point within the company, employees need to be trained, and even selected systematically.

Fourth indicator is implementing control technologies. Especially with aspect to environmental engineering, control technologies gain importance day by day. In addition to that fifth one is, buying environmental friendly materials, which provide sustainability just from the first stage. As explained

in the literature review, supplier selection is really important to supply "green" raw materials or products. If managers act more responsible to environment, one of the main criteria for supplier selection is "how the supplier handles with environmental problems in the facility or in which conditions supplier produced this product/raw material". In brief, with the commitment of the top management, managers of the purchasing department need to be more conscious about this situation.

Having the support of senior management, which is the sixth indicator, creates difference around the company and eventually throughout the supply chain. If employees feel that they have the management support, they will do their jobs in a more motivated way. In this case, if top or senior management comes up with decisions or implementations about doing green business and act responsibly towards environmental issues, so do the employees. Moreover it is ideal for senior managers in the supply chain to act together or build strategies about it together both with their peers and with their subordinates.

Seventh indicator is the amount of green market share. The amount of their share in the market defines companies' strategies and the way they do business. In last few years green market share is one of the main competencies for the company. Popular brands such as Starbucks, Puma, Hyundai differentiate themselves from their competitors in that way. By marketing and promoting their environmental friendly applications, better usage of energy sources and their right selection of suppliers, they position themselves different from other brands in consumers' minds.

Stakeholder relationship, which is the eighth indicator, plays a significant role for the brand. Stakeholders are people or foundations that are affected by the acts of the company. Selection of suppliers, waste handling, recycling or green market share are more important for every single stakeholder of the company than it used to be. For instance years ago, in Bergama (Izmir) a German company tried to mine gold resources by using cyanide. When it was heard all around the town, villagers protested it in an effective way and the company had to cancel all its activities in Bergama. What it is meant here is, if public (one of the stakeholders) is not happy, satisfied or feels threatened against irresponsible acts against nature, they can react. However, satisfying all of the stakeholders simultaneously is not that easy for almost every company.

Ninth indicator is recycling and remanufacture. Thanks to ads on the media, lectures in schools and increasing level of awareness, encourages companies or even municipalities to provide recycle operations. Basically recycling is processing used products or waste in order to produce a new product. This operation mainly helps to prevent waste and preserve source of the raw materials. If recycling is commonly used throughout the supply chain , then cost of doing business decreases while making it sustainable. Also remanufacturing is another important aspect of green manufacturing. It enables companies to recover worn out components and create a new one by aiming minimum identification loss.

Finally the last indicator is about the way how companies in supply chain, handle their disposal and disassembly activities by coordination with each other.

3. RESULTS
Overall priority weights of the indicators are calculated by using Fuzzy-AHP methodology. The weights of the indicators are: (Ind. 1, Ind. 2, Ind. 3, Ind. 4, Ind. 5, Ind. 6, Ind. 7, Ind. 8, Ind. 9, Ind. 10) = (0.075381, 0.063328, 0.030325, 0.140968, 0.097814, 0.136701, 0.145011, 0.088219, 0.115225, 0.107647). These results are shown in the table 1.

Table 1. Priority weights of main and sub-attributes and indicators

		ENC 0.075		RM 0.377		GM 0.549		Weights
		CP 0.985	CI 0.015	MC 0.269	GI 0.730	DE 0.5	EC 0.5	
Ind.1	Waste Disposal	0.182584	0.044780	0.148225	0	0.045506	0.125024	0.075381
Ind.2	Handling Energy Costs	0	0.128627	0.344709	0	0.098435	0.004390	0.063328
Ind.3	Staff Training	0.055243	0.185515	0	0.084647	0.001775	0.009208	0.030325
Ind.4	Control Techonologies	0.102762	0.213388	0.240262	0.057793	0.161368	0.176942	0.140968
Ind.5	Buying Env. Friendly Material	0.208333	0.008225	0.028611	0.003503	0.115701	0.170452	0.097814
Ind.6	Senior Management Support	0	0.228467	0.049293	0.291886	0.127804	0.058408	0.136701
Ind.7	Green Market Share	0.061564	0.116290	0.106515	0.291886	0.096014	0.083222	0.145011
Ind.8	Stakeholder Relationship	0	0.074709	0.082385	0.231465	0.058577	0	0.088219
Ind.9	Recycle Reuse Remanufacture	0.155431	0	0	0.038821	0.148136	0.190876	0.115225
Ind.10	Dissambly & Disposal	0.234082	0	0	0	0.146684	0.182478	0.107647

4. CONCLUSION

It can be seen that among main attributes highest weight belongs to Green Manufacturing. This is since green manufacturing provides better and more permanent solutions or alternatives for sustainability for long term strategies. In addition to that sub-attribute, Cost of Pollutant Effects has significantly more weight than cost of improvement. The reason for it is probably, long term results of pollutants affect human life more than just monetary cost. Another interesting observation is, establishing Green Image has more importance over Management Competencies. This indicates that brands, which work on establishing its green image, gain more advantage over their competitors by satisfying customers. If a brand can create an effective green image, its recognition among society expands in a positive way.

5. REFERENCES

[1] Chen, I. J., Paulraj, A. (2004). Understanding supply chain management: Critical research and a theoretical framework, International Journal of Production Research, 42 (1), 131-163.
[2] Penny, M.(2009). Sustainable Supply Chain Logistics Guide. Greater Vancouver Regional District.
[3] Gyöngyi, K. (2005). Supply Chain Collaboration for Sustainability, Business Strategy and the Environment Conference.
[4] Humphreys P.K., Wong Y.K., Chan F.T.S.(2003). Integrating environmental criteria into the supplier selection process. Journal of Materials Processing Technology, 138 (1-3), pp. 349-356.