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Sustainable Supplier Selection for New Product Development: A Multi-Objective Framework

Amit Kumar Sinha and Ankush Anand***

ABSTRACT

Availability of emerging technology, globalization scenario, use of information and communication technology (ICT), and decreasing transportation cost (logistic optimal fleet selection) are responsible for rapid variation in product demand and these demands can be handled by using the concept of new product development (NPD) under sustainable supply chain (SSC) environment. In today's manufacturing environment, it is a challenging task for practitioners and researchers, how to handle new product development (NPD) in a sustainable supply chain environment. In general, economical, social, and environmental are three aspects of sustainability. Individual aspect of SSC issues for NPD has been found in the literature but integration of all the three aspects for NPD is an emerging topic. Therefore, in this paper, we tried to provide a holistic approach for integrating SSC concerns with NPD.

Keywords: *Sustainable Supplier Selection; New Product Development; Multi Criteria Decision Making Model; Meta Heuristic Algorithm; Fuzzy Logic.*

1.0 Introduction

Krishnan and Ulrich (2001) defined as transformation of market opportunity converging towards availability for sailing is known as product development. Triple bottom line approach-economical, social, and environmental aspects for new product development (NPD) gain attention for manufacturing industries. NPD in a sustainable environment is an emerging issue for manufacturing industries and also it is a demand of customers in day to day life. Critical success factor of NPD has been discussed by different scholars and they have different arguments.

But, without complete optimizing of supply chain network we cannot able to provide sustainable supply chain management (SCM) for NPD.

Sustainable supply chain management for new product development is the integration of social, environmental, and economical perspective of supply chain management of NPD. Economical perspective has been discussed by several researchers (Handfield et al., 2002; Humphreys et al., 2003; Lee et al., 2009) but how to integrate all the three perspectives is still a challenging task for practitioners and researchers. However, integration of sustainability in NPD is still in a primitive stage (Bai & Sarkis, 2010). Therefore, in this paper we tried to provide a conceptual framework which will provide a interrelationship between sustainable supplier selection and NPD.

The rest of the paper is structured as follows. Section 2 introduced the literature survey of NPD, sustainable supplier selection, and multi criteria decision making model for sustainable NPD. Section 3 deals with the framework for sustainable supplier selection model under the domain of NPD. Section 4 illustrates the various solution methodologies for solving sustainable supplier selection model. At last, section 5 concludes our research with future scope which is still need to be developed.

2.0 Literature Survey

To meet the increasing demand of variants in products and stay remains in competitive environment for any manufacturing industry, it is necessary to look towards overall sustanable supply chain management (Büyüközkan & Çifçi, 2011). Thereofre, some of the industries are opting standarized environmental systems like ISO 14001.

**Corresponding Author: School of Mechanical Engineering,Shri Mata Vaishno Devi University, Katra, Jammu and Kashmir, India (E-mail: amitsinha5050@gmail.com)*
***School of Mechanical Engineering,Shri Mata Vaishno Devi University, Katra, Jammu and Kashmir, India*

Defenitely, sustanable supply chain can be achieved only if each and every stage of supply chain has commitmented towards sustanabity because sustanability is not a sole responsibility of individual stakeholders. It is a combined responsibility of every stakeholders starting from raw maetiral upto end customers in SCM of NPD (Grover et al., 2016).

Sustainable supplier selection is a central theme for launching NPD under the domain of sustainable supply chain management (Amindoust et al., 2012). Sustainable supplier selction play a crucial role in the success of any manufacturing industries. Therefore, identification of creteria as well as sub criteria which will helpful for evaluating and ranking of a given pool of suppliers which leads towards sustainable NPD (Büyüközkan & Çifçi, 2011). Noci (1997) identified four different qualitative criteria for green supplier selcetion which are green competency, current environment efficiency, supplier's green image, and net life cycle cost. Quality of suppliers generally strengthen the ssupply chain management. Therefore, optimal selection of suppliers in terms of sustanabity is more important for NPD.

Sustainable development of any manufacturing industry will be possible only through sustanable supplier selction from the network of supply chain management of NPD (Azadnia et al., 2005). Even though environmental consideration is included in the supplier selction problem but more systemetic aspects of sustanable considerations should be included in the supplier selction problem.

Although several efforts have been made for incorporating sustanabilty criteria into supplier selection model problem for NPD, but very less efforts have been made for developing a susatanable supplier selection model.

3.0 Framework For Sustainable Supplier Selection in NPD

New product development mainly consists of following eight steps given by figure 1.(i) Idea generation, (ii) Idea screening, (iii) Concept development and testing, (iv) Marketing strategy and development, (v) Business analyst, (vi) Product development, (vii) Test marketing, and (viii) Commercialization.

A conceptual framework for sustainable NPD has been developed which shows the most important economic, social, and environmental factors. On the basis of proposed conceptual framework for sustainable NPD we can develop selection criteria/factors for supplier selection which will leads towards sustainable supplier selection for NPD.

Now the multi objection sustainable supplier selection model will have three objective functions as follows:

$$\text{Minimize economical impact} = \sum_{i=1}^{l} ECI_i \quad ...(1)$$

$$\text{Minimize social impact} = \sum_{i=1}^{m} SOI_i \quad ...(2)$$

$$\text{Minimize environmental impact} = \sum_{i=1}^{n} ENI_i \quad ...(3)$$

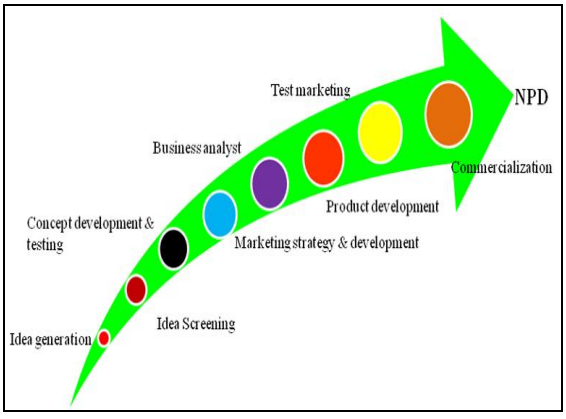
Now the overall objective function will be:

$$\sum_{i=1}^{l} ECI_i + \sum_{i=1}^{m} SOI_i + \sum_{i=1}^{n} ENI_i \quad ...(4)$$

Where,

ECI_i: Economocal Impact for 'i^{th}' factor
SOI_i: Social Impact for 'i^{th}' factor
ENI_i: Environmental Impact for 'i^{th}' factor
l: Total number of economical factors
m: Total number of social impact factors
n: Total number of environmental impact factors

Fig 1: Steps for NPD (Adopted from (Ulrich, 2003))



4.0 Solution Methodology

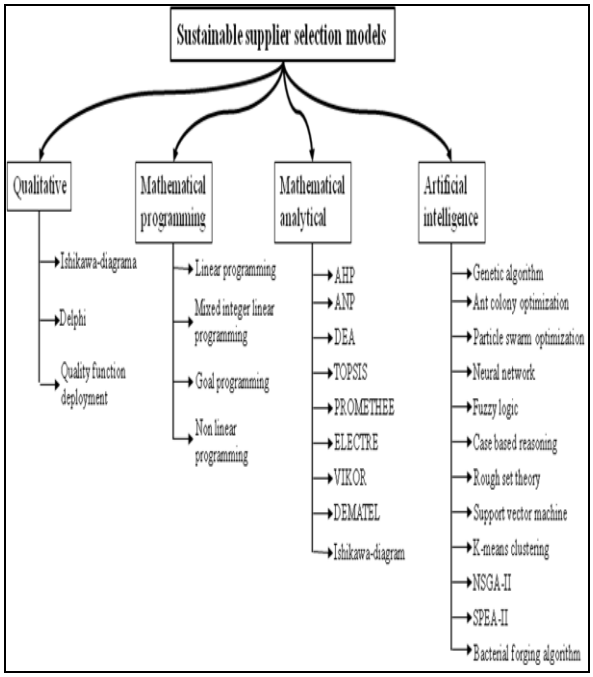
Due to qualitative or intengible nature of some of the criteria for sustainable supplier selection, It is hard to obtain quantitative data from decision makers because,

(i) Vage nature of human judments about decision data

(ii) Decision makers will not be able to evaluate suppliers from each and every aspects of economical, social, and environmental point of view because one decision maker will have experties in one area where different decision makers have experies in different area.

In general, four different sustainable supplier selection models can be developed on the basis of qualitative, mathematical programming, mathematical analytical, and artificial intelligence based model (see Figure 2).

Fig 2: Sustainable Supplier Selection Model for NPD (Adopted from (Zimmer et al., 2016))



5.0 Conclusions

Sustainable supplier selection model for NPD will have following salient features:

1. It will provide a set of criteria in which we can judge the impact of individual supplier in the domain of NPD
2. It will provide the interrelationship among economical, social, and environmental aspects of NPD
3. It will help for incorporating those criteria/information which are qualitative in nature because fuzzy model can help in this regard
4. It will helpful for calculating cumulative effect of different decision makers
5. It helps for integrating sustainability and NPD

The proposed model can be used in any manufacturing industries like automobile, steel and iron making industry, pharmaceutical industry etc.

A complete mathematical formulation for sustainable supplier selection model for NPD is in progress but it needs more excavation because the integration of sustainability and NPD are still in primitive stage. After formulation of mathematical model it should be validated by real life case study. In nutshell, a lot of scopes in this area are open for practitioners and researchers.

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