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Structural Modeling in Green Supply Chain Management Practices under Chains of Qualitative Indices

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Abstract
The successfully execution of any business is today's dynamic era is possible by integrating the zone of environmental thinking in the business activities. Green Supply Chain Management (GSCM) is a significant view, which needs to be integrated with core business proceedings for the sake of executing sustainable business in today's market life. GSCM is the incorporation of environmental thinking into diverse arena of the Supply Chain Management (SCM). Thus, in this study, the authors presented a framework for modeling GSCM practices by considering the chains of qualitative Indices. The implication of fuzzy sets theory along with DEMATEL (Decision-Making Trial and Evaluation Laboratory) technique under the domain of GSCM is presented in this work. Modeling based on momentous decisive factor responsible for driving the GSCM network is presented in this study. The authors shaped an approach for addressing the green practices under uncertainty and impreciseness for the manufacturing firms. The major intension of the proposed work is to enlarge the views of the researchers and readers towards developing a mathematical framework for implementing GSCM by the concerned firms. An index based on fuzzy information is presented and the computational effort for modeling the green practices is presented, so that the managers can easily understand the proposed work and can model green practices in their decision making.

Keywords- Supply Chain Management (SCM), Modeling, Fuzzy Theory, Green Practices, Qualitative Framework.

1. Introduction and State of Arts

Numerous businesses operated around the world have Supply Chain (SC) activities. Thus, the business should focus on developing efficient mechanism for regulating their internal SC activities (Hamdan and Cheaitou, 2017). GSCM is the incorporation of environmental thinking into diverse arena of the Supply Chain Management (SCM). Thus, in this study, the authors presented a framework for modeling GSCM practices by considering the chains of qualitative Indices. Governments are constantly making more comprehensive laws, rules and regulations for the sake of protecting environment. GSCM is a way, which can improve the performance of the process and products by considering the environmental arena. The SC actions encompassing environmental practices are the need of present business for sustainable environment and should be integrated by the firms respectfully (Kannan et al., 2013). The GSCM practices methodically incorporate the environmental reflection at every stage of the life cycle of created products and goods (Sari, 2017). The green measures along with

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economic measures are mandatory to be developed under GSCM framework to support green environmental issues (Kusi-Sarpong et al., 2015). Table 1 represents the general and momentous green criterions, which are used in this study to model a decision framework based on fuzzy conception and DEMATEL technique.

Supervising environmental thinking throughout upstream and downstream activities has evolved as a significant work in the SCM, which is known as GSCM (Tseng et al., 2014). Modeling based on momentous decisive factor responsible for driving the GSCM network is presented in this study. The authors shaped an approach for addressing the green practices under uncertainty and impreciseness for the manufacturing firms. The major intension of the proposed work is to enlarge the views of the researchers and readers towards developing a mathematical framework for implementing GSCM by the concerned firms. An index based on fuzzy definitions is presented and the computational effort for modeling the green practices is presented, so that the managers can easily understand the proposed work and can model green practices in their decision making.

Table 1. Representation of GSCM criterions

Criterions	Representation
Green Packaging	(G_1)
Green Manufacturing	(G_2)
Green Recycling	(G_3)
Green Logistics	(G_4)
Green Design	(G_5)
Green Research & development	(G_6)
Green Purchasing	(G_7)
Green Marketing	(G_8)

2. Methodology

Implementing green practices by everyone in everyday life is must for growing a degree of greenness in today's dynamic work environment (Malviya and Kant, 2016; Fallahpour et al., 2017). A decision support model can help in portraying the implementation and structure of green aspects with core business activities for doing sustainable business in today's turbulent market life (Keshavarz et al., 2017). Thus, in this study, the authors presented a framework for modeling GSCM practices by considering the chains of qualitative Indices. The implication of fuzzy sets theory along with DEMATEL (Decision-Making Trial and Evaluation Laboratory) technique under the domain of GSCM is presented in this work. The flow chart of the proposed work is shown by Figure 1.

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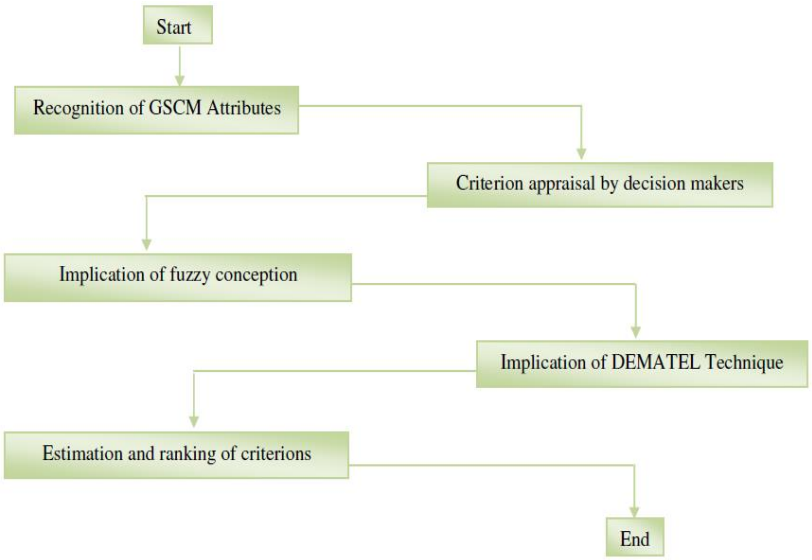

Figure 1. Flow chart of the proposed work

DEMATEL is developed by the Battelle memorial association of the Geneva research center (Fontela and Gabus, 1976). This technique defines the impact relations amongst considered criterions and alternatives (Tzeng et al., 2007; Lee et al., 2013). The technique starts with pair-wise comparisons matrix which further constructed a direct-relation matrix. The procedural steps of DEMATEL as presented by (Wu and Lee 2007; Sahu et al., 2018) are utilized in this study to model a GSCM practices under chains of qualitative Indices. The DEMATEL methodology is amalgamated with Fuzzy theory in this study. Fuzzy sets theory can be employ by the researchers to deal with the problems encompassing uncertainty and incomplete information (Zadeh, 1965; Sahu et al., 2016a; Sahu et al., 2017). Fuzzy set theory and fuzzy logic is successfully applied by variety of researchers in a great variety of applications fields (Zadeh, 1975; Klir and Yuan, 1995; Sahu et al., 2016c). The Triangular Fuzzy Number (TFNs) as proposed by Sahu et al. (2013) is used in this study to furnish decision results. In the presented work, the centroid method proposed by (Leekwijck and Kerre, 1999) is utilized to define the intensity of TFNs.

3. Computations and Estimations

This section deals with the computation arena required for implicating DEMATEL methodology under GSCM. Researchers found that there is a link between environmental performance and financial gains. Firms SC evaluation practices from purchasing of materials to distributing final end products are identified as an important area of research for implementing green policies. GSCM is a significant view, which needs to be integrated with core business proceedings for the sake of executing sustainable business in today's market life. The modeling starts with the selection of the GSCM attributes, which are required for defining and selecting GSCM criterions. Managers of the firm require decision support tools and

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decision making approaches to make their supply chain effectively strong in terms of environment thinking and practices.

This study modeled a decision framework based on the perceptions of decision makers $(\partial m^{1....k})$, which articulated their subjective preferences accompanying GSCM criterions. A TFNs range is used to define the subjective preferences in this study. Fuzzy theory is the tool in the hands of the researchers, which can effectively grab system information. The quantification of the indices can be managed by the exploration of the subjective terms, which can define opinion and perceptions etc. pertaining to a system in an ease way (Sahu et al., 2016b)

Table 2. Direct relationship linguistic matrix by ∂m^1

Criterions	(G_1)	(G_2)	(G_2)	(G_4)	(G_5)	(G_6)	(G_7)	(G_8)
(G_1)	0	VL	VH	L	ML	MH	L	MH
(G_2)	H	0	L	MH	VH	ML	VH	MH
(G_3)	M	H	0	H	M	VH	M	H
(G_4)	M	MH	MH	0	H	M	ML	H
(G_5)	VH	MH	M	VH	0	M	M	VH
(G_6)	L	ML	H	L	ML	0	L	MH
(G_7)	H	VH	VL	M	H	H	0	ML
(G_8)	H	MH	H	VH	MH	VH	VL	0

Table 3. Direct relationship linguistic matrix by ∂m^2

Criterions	(G_1)	(G_2)	(G_2)	(G_4)	(G_5)	(G_6)	(G_7)	(G_8)
(G_1)	0	M	M	ML	M	L	H	MH
(G_2)	VH	0	M	H	MH	VH	L	MH
(G_3)	MH	L	0	M	VL	ML	H	ML
(G_4)	VL	H	MH	0	M	VL	VH	H
(G_5)	VH	VH	M	H	0	M	L	M
(G_6)	MH	ML	H	VH	H	0	L	VH
(G_7)	MH	VH	VH	ML	MH	ML	0	VL
(G_8)	VL	MH	L	M	VH	M	H	0

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Table 4. Direct relationship linguistic matrix by ∂m^3

Criterions	(G_1)	(G_2)	(G_2)	(G_4)	(G_5)	(G_6)	(G_7)	(G_8)
(G_1)	0	M	VL	MH	MH	M	ML	MH
(G_2)	H	0	ML	VH	VH	H	H	MH
(G_3)	H	VH	0	L	MH	ML	M	L
(G_4)	L	M	MH	0	VH	MH	MH	VH
(G_5)	VH	MH	MH	ML	0	ML	VH	ML
(G_6)	MH	VH	H	MH	H	0	VL	H
(G_7)	VL	H	L	VH	M	VL	0	M
(G_8)	VH	MH	VH	M	L	VH	H	0

The authors found that there is demand to build an intellectual framework that can be used as an instrument to assess GSCM practices. Table 2-5 represents the direct relationship linguistic DEMATEL matrix furnished by $\partial m^{1,\ldots,k}$. Next, the centroid method as presented by (Leekwijck and Kerre, 1999) is utilized to define the crisp ratings. Subsequently; the normalized direct relationship DEMATEL matrix is computed (Wu and Lee 2007; Yang and Tzeng, 2011; Sahu et al., 2018), which is followed by Total Relation Matrix (TRM) (Tzeng et al., 2007; Lee et al., 2013). The computed normalized direct relationship DEMATEL matrix is shown in Table 6 and Table 7 represents the values of TRM. Next, the priority importance of green criterion based on prominence is represented by Figure 2. The Prominence is an index, which illustrates the total impact given by the criterion and thus informs about the character of it; by momentarily indicating its degree of importance in the system.

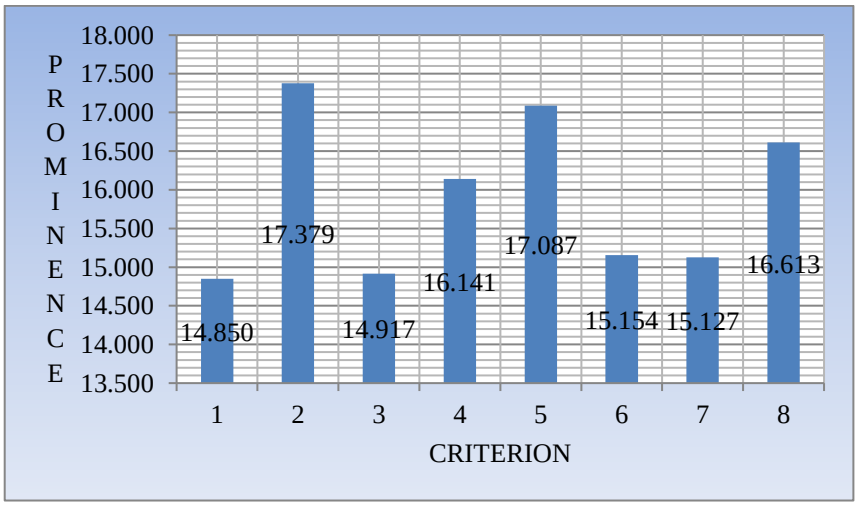

Figure 2. Representation of priority importance of GSCM criterions

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4. Implications and Discussions

Today, GSCM is an important decision area, which helps in attaining the sustainable environment goal to an extend and can enhance the reputation and ethical image of a business firm. For implementing green practices in SCM, the evaluation of performance is an important issue, which represents that firm's activities are cooperating with the environment or not. For the same defining the priority importance of green criterion for manufacturing firms plays an important role. Thus, a structured evaluation model is essential, which can quantify the importance of green aspects relating the performance index of the whole SC, which is presented in this study.

Table 5. Direct relationship linguistic matrix by ∂m^4

Criterions	(G_1)	(G_2)	(G_2)	(G_4)	(G_5)	(G_6)	(G_7)	(G_8)
(G_1)	0	VL	L	MH	ML	H	H	MH
(G_2)	L	M	ML	VH	VH	L	M	ML
(G_3)	H	MH	0	M	M	H	VH	H
(G_4)	M	H	VL	0	VH	L	L	VL
(G_5)	MH	VH	M	MH	0	MH	M	VH
(G_6)	H	H	ML	VH	L	0	M	MH
(G_7)	VH	H	VH	M	H	VH	0	H
(G_8)	MH	VH	MH	VH	ML	ML	VL	0

Table 6. Normalized direct relationship DEMATEL matrix

Criterions	(G_1)	(G_2)	(G_2)	(G_4)	(G_5)	(G_6)	(G_7)	(G_8)
(G_1)	0.000	0.056	0.088	0.097	0.097	0.115	0.115	0.141
(G_2)	0.149	0.000	0.071	0.183	0.190	0.122	0.131	0.124
(G_3)	0.150	0.140	0.000	0.106	0.090	0.131	0.149	0.115
(G_4)	0.063	0.150	0.108	0.000	0.174	0.072	0.113	0.141
(G_5)	0.190	0.174	0.115	0.149	0.000	0.106	0.113	0.147
(G_6)	0.124	0.131	0.150	0.147	0.115	0.000	0.046	0.166
(G_7)	0.133	0.191	0.113	0.122	0.150	0.115	0.000	0.090
(G_8)	0.133	0.158	0.140	0.156	0.113	0.147	0.091	0.000

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Table 7. Total relation matrix

Criterions	(G_1)	(G_2)	(G_2)	(G_4)	(G_5)	(G_6)	(G_7)	(G_8)
(G_1)	0.767	0.864	0.733	0.877	0.854	0.774	0.738	0.886
(G_2)	1.146	1.070	0.927	1.201	1.181	0.993	0.958	1.120
(G_3)	1.060	1.097	0.785	1.049	1.012	0.927	0.900	1.023
(G_4)	0.960	1.076	0.853	0.922	1.047	0.849	0.846	1.010
(G_5)	1.195	1.232	0.974	1.191	1.034	0.997	0.960	1.153
(G_6)	1.040	1.092	0.919	1.085	1.032	0.812	0.819	1.068
(G_7)	1.089	1.182	0.919	1.106	1.104	0.948	0.806	1.045
(G_8)	1.101	1.170	0.956	1.148	1.088	0.987	0.901	0.978

5. Conclusions

The present work modeled a decision framework to fabricate the pictorial view of decision making process relating the GSCM practices. An index based on fuzzy information is presented and the computational effort for modeling the green practices is presented, so that the managers can easily understand the proposed work and can model green practices in their decision making. The proposed work can be utilize to recognizing the significant role of distinguish decision criterions in distinguish decision problems by taking into account momentous factors pertaining to the concerned decision problems. The projected work uses subjective preferences and incomplete information to identify optimal results. This study presented a decision appraisement platform, which can evaluate GSCM extent in fuzzy environment. The discussed model can be used for prospering future managerial attention and strategies by the managers and the practitioners. The projected framework can institute a base for potential research and can estimate uncertain criterions.

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