INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH & DEVELOPMENT

ISSN 2278 – 0211 (Online)

Prioritization of Supply Chain Flexibility Dimensions Using Topsis: A Case Study of Indian FMCG Sector

Shreyash Bansal
Student, Symbiosis Institute of Operations Management, Nashik, India
Partha Parmanik
Student, Symbiosis Institute of Operations Management, Nashik, India
Sounak Mukherje
Student, Symbiosis Institute of Operations Management, Nashik, India
Natalie Pandit
Student, Symbiosis Institute of Operations Management, Nashik, India
Rohit Kr. Singh
Student, Symbiosis Institute of Operations Management, Nashik, India

Abstract:
The purpose of this study is to prioritize the supply chain flexibility dimensions (extracted from literature) using TOPSIS Methodology in Indian FMCG industry. Authors have visited case firm to have an idea of issues related to flexibility. Flexibility is the ease by which an organisation can adapt or change itself to the changing business environments and customer needs. It is the ability of a system to respond to internal or external changes which may affect its value delivery in cost effective and timely manner. Flexibility enables an organisation to swiftly respond to any uncertainty by sustaining its output and profitability. These uncertainties may be in a form of a risk or an opportunity, in former case the primary objective of flexibility becomes to sustain while in the latter case the primary objective is to increase or enhance the value delivery system of the organization. Thus, being flexible has helped many organisations to pass the test of the time with flying colours. The factors of changing consumer behaviours, frequent innovations in technologies across various domains and raging price wars have made flexibility the need of the hour. One such industry which is constantly driven by these factors is the Fast Moving Consumer Goods or FMCG industry. To thrive in the unpredictable, uncertain and turbulent modern business environment flexibility in supply chain is must.
To carry out this study authors have done extensive literature review and extracted supply chain flexibility dimensions, most suited for Indian FMCG firm, accordingly designed the self-administered questionnaire and floated it among executives of case industry. The feedback authors received in terms of filled up questionnaire become the input of data analytics using TOPSIS, and finally designed the structured hierarchy of supply chain flexibility dimensions. This study will help firm to understand which area to focus upon the most to make firm's supply chain flexible enough to cope up with uncertainties present in external environment.

Keywords: *Supply chain flexibility, FMCG, TOPSIS, Uncertainty*

1. Introduction

1.0. Flexibility
Flexibility is the ease by which an organisation can adapt or change itself to the changing business environments and customer needs. It is the ability of a system to respond to internal or external changes which may affect its value delivery in cost effective and timely manner. Flexibility enables an organisation to swiftly respond to any uncertainty by sustaining its output and profitability. These uncertainties may be in a form of a risk or an opportunity, in former case the primary objective of flexibility becomes to sustain while in the latter case the primary objective is to increase or enhance the value delivery system of the organization. Thus, being flexible has helped many organisations to pass the test of the time with flying colours. The factors of changing consumer behaviours, frequent innovations in technologies across various domains and raging price wars have made flexibility the need of the hour. One such industry which is constantly driven by these factors is the Fast Moving Consumer Goods or FMCG industry. To thrive in the

unpredictable, uncertain and turbulent modern business environment flexibility in supply chain is must. Following flexibility dimensions have been taken into consideration.

1.1. Product

Product flexibility refers to the amount of changes that can be made while introducing a new product or including the derivatives of the new product. It refers to the responsiveness or the adaptability for any changes in the product design. An organization has to follow the product flexibility in order to be alive in the market.

1.2. Volume

It is used as a tool in the organization to control the flow of volume of a product. It refers to producing a high volume when the demand is high and a low volume when the demand is less. It is defined as the capacity to produce above or below the actual capacity of the product.

1.3. Transhipment

Shipment of a product can be a big issue for any organization. The ability to transfer goods from one place to another within a desired time limit is referred to as the transhipment flexibility. This ensures that a product is available on a given location at a particular time when needed.

1.4. New Product Development/Launch

New product development is somewhat related to product flexibility. It enables the organization to think in diversified ways. It includes new product design, product specification and new style in order to satisfy the needs of the customers.

1.5. Sourcing

Flexibility in sourcing helps the firm to keep more than one supplier in case there is surplus demand or any problem faced from one supplier. In FMCG sector speed is of essence .So it is very important for industry to get the raw materials for production in time and maintain flexibility in sourcing. Due to globalization and implementation of ERP the ordering and tracking of sourcing resource is becoming increasingly easy.

1.6. Physical Distribution Process

Generally in supply chain, movement of goods from supplier to manufacturer is called physical supply .The process is generally inbound. Goods moving from manufacturer to customer are physical distribution process, the process is generally outbound. The ability to change the distribution process so that product reach the customer on time is called flexibility in physical distribution process.

In physical distribution the customer is the final destination and it's very important to deliver the goods to final customer on time. So each and every player in distribution process should work efficiently.

1.7. Demand Management Flexibility

The objective of demand management flexibility is to meet the customer demand in most effective and efficient way. The demand management process is concerned with balancing the customer demand with capabilities of supply chain. With flexible system in place demand the customer demand can be met proactively and when the demand is unanticipated the demand is met reactively.

1.8. Coordination Flexibility

In FMCG sector the output of one process is input to another process. So it is very important to have a good intra department relationship .The various departments, supplier should always be in sync for coordination flexibility.

1.9. Logistic Flexibility

India is fourth largest country in terms of purchasing power, increase in global business has increased the logistic business manifolds .Increase in logistic also creates bottle neck and inefficient utilization of resources. Logistic flexibility in FMCG sector is the ability to quickly respond to the needs of both inbound and outbound process and making optimum utilization of transportation resources.

1.10. Manufacturing Flexibility

It is a critical dimension of supply chain flexibility which explains the ability to produce various types of products more quickly and more rapidly to respond strategically to competitive threats for enhancing competitive position and winning customer orders.

1.11. Information System Flexibility

It can be defined as the adaptive ability of a collective information system to support changing functional requirement of business. It generally covers development of product, product manufacturing and logistics, and other strategic functions.

1.12. Delivery Flexibility

It is defined as the process which allows organisation to fix the delivery of product in minimum possible time, by using appropriate way as per the customer's need.

1.13. Access Flexibility

The kind of flexibility which is performed in close coordination in the downward stream activities of the supply chain whether internally or externally, to provide wide spread or extensive distribution coverage. It is associated with the company's ability of providing the product close to the customer.

1.14. Process Flexibility

Process flexibility of any supply chain plant can be explained as the competitive strategy taken by it to improve responsiveness to uncertain demands.

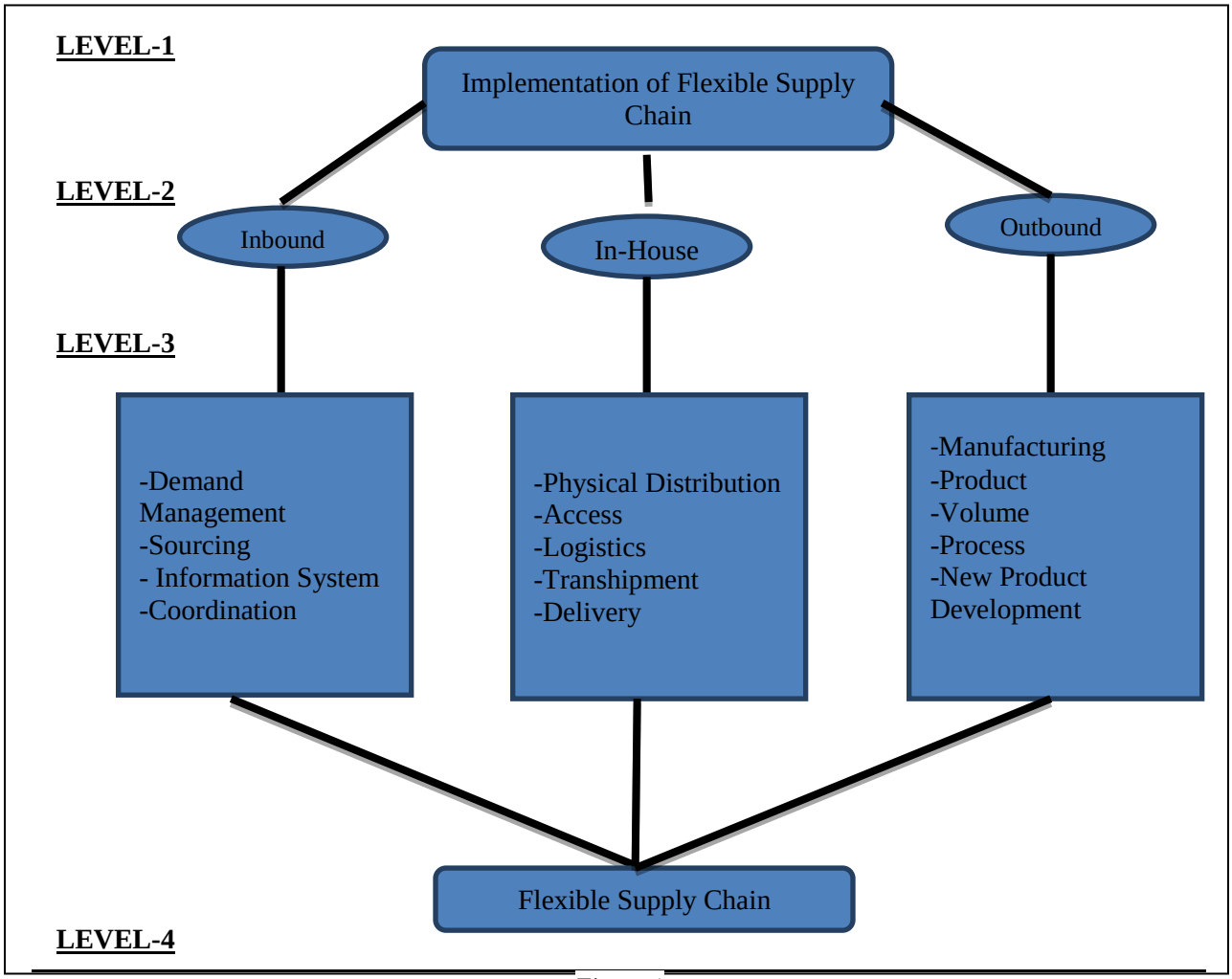

Figure 1

2. TOPSIS

TOPSIS was originally proposed by Hwang and Yoon in 1981. It stands for Technique for Order Preference by Similarity to Ideal Solution and is used for prioritization of preferences based on their similarity to ideal solution. The Ideal solution is the solution that maximizes the benefit and minimizes the cost. It is also called as positive ideal solution. The solution that maximizes cist and minimizes benefit is call negative or anti-ideal solution. Thus, we have prioritized the dimensions by their proximity to ideal solution and distant from negative solution. The dimensions that are closest to the ideal solution get highest priority that is those dimensions are most critical for the flexibility of the supply chain.

2.1. Steps for TOPSIS

1) Construct the multi-criteria decision matrix. Let's say, we have m alternatives which in this case corresponds to the three stages of supply chain (inbound, in-house & outbound). So, here m=3.

Each of these m alternatives have n attributes, which in this case corresponds to the 14 flexibility dimensions. So, n=14.Thus decision matrix of the problem is

$$X=(x_{ij})m \times n = \begin{bmatrix} X11 & X12 \cdots & X1n \\ X21 & X22 \cdots & X2n \\ Xm1 & Xm2 \ldots & xmn \end{bmatrix}$$

Where x_{ij} denotes j^{th} criterion of the i^{th} alternative (i=1, 2….m; j=1, 2…….. n).

The criteria can be divided into benefit-type and cost-type, based on the relationship between values of the criteria and their relative superiority. For benefit criteria the more the value is the better it is, while for cost-type the lesser the value is the better it is.

Multi-criteria Decision Matrix			
Weight	0.4	0.35	0.25
Attributes	Inbound	Inhouse	Outbound
Demand Management	9	7	5
Sourcing	9	6	6
Information System	9	6	4
Coordination	9	8	6
Manufacturing	7	9	6
Product	8	9	4
Volume	8	8	7
Process	9	9	5
New Product Development	8	9	4
Physical Distribution	6	4	9
Access	5	7	9
Logistics	3	6	8
Transhipment	6	5	8
Delivery	4	4	9

Table 1

2) Based on the multi-criteria decision matrix X= (x_{ij}), we calculate the normalized decision matrix, using the equation given below:-

$$r_{ij}=\frac{X_{IJ}}{\sqrt{\Sigma_{M=1}^{K} x_{kj}^2}}$$

Where r_{ij} is the normalized criteria. Normalization is done so as to make different criteria comparable.

Normalized Decision Matrix			
Attributes	Inbound	Inhouse	Outbound
Demand Management	0.32476	0.261785	0.1998402
Sourcing	0.32476	0.224387	0.2398082
Information System	0.32476	0.224387	0.1598722
Coordination	0.32476	0.299183	0.2398082
Manufacturing	0.252591	0.336581	0.2398082
Product	0.288675	0.336581	0.1598722
Volume	0.288675	0.299183	0.2797763
Process	0.32476	0.336581	0.1998402
New Product Development	0.288675	0.336581	0.1598722
Physical Distribution	0.216506	0.149592	0.3597123
Access	0.180422	0.261785	0.3597123
Logistics	0.108253	0.224387	0.3197443
Transhipment	0.216506	0.186989	0.3197443
Delivery	0.144338	0.149592	0.3597123

Table 2

3) Now, we calculate the weighted normalized decision matrix V = $(v_{ij})_{m \times n}$. Where $v_{ij} = w_j r_{ij}$ (i=1, 2…m; j=1, 2…….. n) and w_j is the relative weight of the j^{th} criterion and $\sum^{n}_{j=1} w_j = 1$.

Weighted Normalized Decision Matrix			
Attributes	Inbound	In-house	Outbound
Demand Management	0.129904	0.091625	0.04996
Sourcing	0.129904	0.078536	0.0599521
Information System	0.129904	0.078536	0.039968
Coordination	0.129904	0.104714	0.0599521
Manufacturing	0.101036	0.117803	0.0599521
Product	0.11547	0.117803	0.039968
Volume	0.11547	0.104714	0.0699441
Process	0.129904	0.117803	0.04996
New Product Development	0.11547	0.117803	0.039968
Physical Distribution	0.086603	0.052357	0.0899281
Access	0.072169	0.091625	0.0899281
Logistics	0.043301	0.078536	0.0799361
Transhipment	0.086603	0.065446	0.0799361
Delivery	0.057735	0.052357	0.0899281

Table 3

4) Calculate positive and negative ideal solutions.

$A^+ = \{ V_1^+, V_2^+, \ldots\ldots V_M^+ \}$

$= \{(MaxV_{ij} | j \in \Omega_g), (\text{Min}V_{ij} | j \in V_{ij})\}$

$A^- = \{ V_1^-, V_2^-, \ldots\ldots V_M^- \}$

$= \{(MinV_{ij} | j \in \Omega_g), (\text{Max}V_{ij} | j \in V_{ij})\}$

Where Ω_b is benefit criteria & Ω_c is cost criteria.

Positive Ideal Solution	0.129904	0.117803	0.089928
Negative Ideal Solution	0.043301	0.052357	0.039968

Table 4

5) Calculate the distance of measure from positive and negative ideal solution.

$d_i^+ = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^+)}$ i=1, 2……m

$d_i^- = \sqrt{\sum_{j=1}^{n} (v_{ij} - v_j^-)}$ i=1, 2 …m

Where d_i^+ is the separation or distance from positive ideal solution and d_i^- is the separation or distance from negative ideal solution.

Attributes	**Separation of each alternative from negative ideal solution**			**Separation of each alternative from negative ideal solution**		
	Inbound	**In-house**	**Outbound**	**Inbound**	**In-house**	**Outbound**
Demand Management	0	0.000685	0.0015974	0.0075	0.001542	9.984E-05
Sourcing	0	0.001542	0.0008986	0.0075	0.000685	0.0003994
Information System	0	0.001542	0.002496	0.0075	0.000685	0
Coordination	0	0.000171	0.0008986	0.0075	0.002741	0.0003994
Manufacturing	0.000833	0	0.0008986	0.003333	0.004283	0.0003994
Product	0.000208	0	0.002496	0.005208	0.004283	0
Volume	0.000208	0.000171	0.0003994	0.005208	0.002741	0.0008986
Process	0	0	0.0015974	0.0075	0.004283	9.984E-05
New Product Development	0.000208	0	0.002496	0.005208	0.004283	0
Physical Distribution	0.001875	0.004283	0	0.001875	0	0.002496
Access	0.003333	0.000685	0	0.000833	0.001542	0.002496
Logistics	0.0075	0.001542	9.984E-05	0	0.000685	0.0015974
Transhipment	0.001875	0.002741	9.984E-05	0.001875	0.000171	0.0015974
Delivery	0.005208	0.004283	0	0.000208	0	0.002496

Table 5

6) Relative closeness of i^{th} alternative with respect to the ideal solution C_i is calculated as

$d_i = \frac{d_i^+}{d_{i+d_i^-}^+}$ i=1, 2,….m

Where $d_i^+ \geq 0$ & $di^- \geq 0$, thus $D_i \in [0,1]$.

Attributes	Positive Ideal Solution d_i^+		Negative Ideal Solution d_i^-		d_i
Demand Management	0.002283	0.04777822	0.009142	0.095612752	0.666798
Sourcing	0.002441	0.04940162	0.008585	0.092653525	0.652236
Information System	0.004038	0.06354498	0.008185	0.090472729	0.587418
Coordination	0.00107	0.03270919	0.010641	0.10315338	0.759248
Manufacturing	0.001732	0.04161605	0.008016	0.089531621	0.682678
Product	0.002704	0.05200327	0.009492	0.097424587	0.651984
Volume	0.000779	0.02791098	0.008848	0.094064629	0.771176
Process	0.001597	0.03996804	0.011883	0.109009436	0.731718
New Product Development	0.002704	0.05200327	0.009492	0.097424587	0.651984
Physical Distribution	0.006158	0.07847431	0.004371	0.066113587	0.457255
Access	0.004019	0.06339281	0.004871	0.069794683	0.524033
Logistics	0.009142	0.09561275	0.002283	0.047778225	0.333202
Transhipment	0.004716	0.06867386	0.003644	0.060363671	0.467799
Delivery	0.009492	0.09742459	0.002704	0.052003266	0.348016

Table 6

7) The dimensions are prioritized according to their relative closeness to the ideal solution. The dimensions with highest relative closeness to the ideal solution are most important dimensions for the flexibility of supply chain.
Volume > Process > Coordination > Manufacturing > Demand Management > Product >Sourcing > New Product Development > Information System > Access > Transhipment > Physical Distribution > Delivery > Logistics

3. Conclusion

The current business environment is becoming increasingly uncertain, unpredictable, and competitive as a result increasingly more complex. In today's context flexibility in supply chains allows firms to grow at rapid rate, make reach to maximum number of customers and helps in avoiding any future disruption. The main reason of acquiring flexibility concepts in Indian FMCG industry is customer highly volatile demand. This paper has tried to identify different dimensions of supply chain flexibility through extensive literature review and tried to prioritize them through TOPSIS. By this prioritization, firms will have an idea of flexibility dimensions having more impact or importance in achieving supply chain flexibility in organisation. Thus, by using TOPSIS me we can conclude that volume flexibility followed by process flexibility, coordination flexibility, manufacturing flexibility and demand management flexibility are the 5 most important flexibility dimensions crucial for the flexibility of a supply chain.

4. References

i. Anand M.C.J. and Devadoss A.V. (2013), Application of TOPSIS Method to Analyze Causes of Suicide Thought in Domestic Violence, International Journal of Computing Algorithm 2, pp.354-362.
ii. Singh R.K. and Acharya P. (2014), Identification and Evaluation of Supply Chain Flexibilities in Indian FMCG Sector Using DEMATEL, Global Journal of Flexible Systems Management15 (2), pp.91-100.
iii. Singh R.K. and Acharya P. (2014), An AHP Model Approach to Supply Chain Flexibility: A Case Study on Indian FMCG Firm, Operations and Supply Chain Management 7 (2), pp.64-69.