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AN ANALYSIS OF LOGISTICS FLEXIBILITY MODEL AMONG DIFFERENT PRODUCT CATEGORIES

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ABSTRACT *: Logistics Flexibility is contextual in nature. This study examines the relationships among the various components of logistics flexibility. The framework of Zhang et al. (2005) has been used in this study to define components of logistics flexibility. The sample unit includes the senior managers of procurement and purchase department, production department and marketing department of firms in perishable, semi-perishable and non-perishable products. The reliability test shows that all the components of logistics flexibility factors have been found reliable to use for this study. The Regression analysis is used to find out the degree of relationships among various components of logistics flexibility scale. Based on results, it is empirically confirmed that flexible logistics competence supports the flexible logistics capability, which ultimately enhances customer satisfaction. The interrelationships among components of logistics flexibility are different among different product categories.*

1. Introduction

Today, the logistics issues are considered as strategic agenda by playing an important role in fulfilling the strategic objectives of the firm (Manzinin et al., 2007). The logistics function can provide a tool to maneuver the competitive marketplace to outperform rivals in meeting the high expectation of stakeholders and customers (Qureshi et al., 2008). Logistics activities can accommodate dynamic and diverse customer delivery requirements.

Customer responsiveness and flexibility are the keys to responding to market volatility and uncertainty thereby gaining competitive advantage (Dreyer and Gronhaug, 2012). Flexibility has been widely used to indicate a firm's ability to respond to market dynamics (Sinkovics and Roath, 2004). The flexibility in logistics system can reduce the amount of buffering needed to mitigate the effects of variability. The diverse customer requirements make it necessary for firms to maintain flexibility from a supply chain perspective (Zhang et al., 2006). The emergence of flexibility as a potential driver of value creation in logistics management has created a need to gain a better understanding of both the issues that lead to the development of competence to be flexible and the outcomes of flexibility in logistics system (Hartmann and Grahal, 2011).

The intricacy of logistics management at supply and demand level has created the need to develop new strategies to gain competitive advantage. Flexibility is complex, comprehensive and multidimensional. The confusion and ambiguity about flexibility seriously inhibits its effective implementation. The concept of logistics flexibility is confounded because the attributes of flexibility and the components of flexibility are often combined. So, it is important to identify the attributes and components of logistics flexibility that are required for value creation in overall logistics strategy.

The literature also suggests that flexibility differs among different categories of products. The interrelationships among different components of logistics flexibility also differ among different product categories.

The above discussion leads to following research questions:

1. What are the interrelationships among different components of logistics flexibility?
2. How do the interrelationships among different components of logistics flexibility differ across different product categories?

2. Literature Review

A great deal of research into defining various types of flexibilities in manufacturing has occurred over the last two decades (Kumar et. al, 2006). Despite this, there is no general agreement on how to define flexibility. Generally, flexibility is a very complex and multidimensional concept and is difficult to define in single word or sentence (Kumar et. al, 2008). The early definitions of flexibility were mostly conceptualized in terms of manufacturing flexibility (Gerwin, 1987; Day, 1994 and Zhang et al. 2002). Some authors have defined logistics flexibility in wider contexts. Reichhart & Holweg (2007) defined flexibility as the ability of any system to adapt to internal or external influences, thereby acting or responding to achieve a desired outcome. Bernardes & Hanna (2009) defined flexibility as enabling ability to change status. They further mentioned that it is the reactive capability of the management to the uncertainty faced by an organization. Flexibility is defined as a bilateral expectation of willingness to make adaptations as circumstances change (Hartmann and Grahal, 2011). According to Swafford et al. (2006) and Chiang et al. (2012), flexibility can be defined as a competence built by an organization to be able to change or react with little penalty in time, cost or performance.

Logistics flexibility adds value at upstream as well as downstream stage at supply chain levels (Hopp et al., 2010). Table 1 below describes the value creation by flexibility in overall logistics management. Although this list may not be comprehensive, it clears that flexibility definitely crates value in overall logistics performance.

Table 1: Values created by flexibility in logistics management

Responsiveness of logistics system
Buyer's satisfaction
Supports and improves innovation
Improves overall logistics strategy
Customization of products and services
Reduction in supply chain disruption
Improves agility of Logistics system
Improve overall logistics and supply chain performance
System flexibility
Improves Profitability of organization

2.1 Components of Logistics Flexibility

Sharma and Shah (2011) mentioned that the dimensions of flexibility are contextual in nature. Flexibility can be reactive or proactive or adaptive or redefined (Bernardes & Hanna, 2009). A number of classifications have been developed to describe flexibility as shown in table 1 below:

Table 2: Types of Flexibility

Product performance, product mix, quality, volume and delivery	Five types (Manufacturing Level)
Mix flexibility, Changeover flexibility, modification flexibility, rerouting flexibility, volume flexibility, material flexibility and sequencing flexibility	Seven types (Operational Level)
Basic flexibilities (machine, material handling, and operation), system flexibilities (process, routing, product, volume, expansion) and aggregate flexibilities (programme, production, market)	Eleven types (System Level)
Product flexibility, volume flexibility, new product flexibility, distribution flexibility and responsiveness flexibility	Five types (SCM level)
Operations system, market, logistics, supply, organizational and information system flexibility	Six Elements (SCM level)
Delivery flexibility, production flexibility, product development and sourcing flexibility	Four level (SCM Level)
Sourcing, developing new products, product customization, responsiveness and delivering the finished products	Five level (SCM level)

(Adapted from Sharma and Shah, 2011)

Zhang et al. (2005) presented the comprehensive view of logistics flexibility from supply chain point-of-view. They further explained that logistics flexibility includes internal competences, that means what the firm can do and control but customers cannot see, and external capabilities, that customers see and value. The literature also suggests that logistics flexibility can be viewed from competence and capability perspectives (Swafford et al., 2006). Charles et al. (2006) mentioned that logistics flexibility in terms of procurement/sourcing flexibility, manufacturing flexibility and distribution flexibility can create positive impact on supply chain agility.

The literature defined flexible logistics competence as physical supply flexibility and purchasing flexibility in logistics and supply chain management (Chiang et al., 2012). Physical supply flexibility is the ability of a firm to provide a variety of inbound materials and supplies for production, quickly and effectively. Purchasing flexibility is the ability of a firm to make agreements to buy a variety of materials and supplies, quickly and effectively. The flexibility has been mostly defined from manufacturing perspective. Swafford et al. (2006) defined manufacturing flexibility as the ability of manufacturing to adapt its capabilities to produce quality products in a time and cost effective manner in response to changing product characteristics, material supply, and demand, or to employ technological process enhancements. The flexibility has been mostly defined from manufacturing perspective. Swafford et al. (2006) defined manufacturing flexibility as the ability of manufacturing to adapt its capabilities to produce quality products in a time and cost effective manner in response to changing product characteristics, material supply, and demand, or to employ technological process enhancements. The literature described flexible logistics capability in terms of physical distribution flexibility and demand management flexibility (Gligor and Holcomb, 2012). Physical distribution flexibility is the ability of a firm to adjust the inventory, packaging, warehousing and transportation of physical products to meet customer needs, quickly and effectively. Demand management flexibility is the ability of a firm to respond to the variety of customer needs for service, delivery time and price, quickly and effectively.

3. Objectives

1. To find the interrelationships among components of logistics flexibility
2. To understand the differences in interrelationships among different components of logistics flexibility among different product categories

4. Research Methodology

This study aims to explore the relationships among various components of logistics flexibility and interrelationships among them. Three different product categories were selected for data collection at various supply chain levels: Perishable Product (Dairy products - Amul), Semi-Perishable Products (Chocolates – Cadbury) and Non-Perishable products (Razos – Gillete). The non-probability quota sampling method was used for data collection. The managers/heads of different departments at various supply chain levels of above mentioned companies, like procurement and purchasing, processing and marketing and distribution were considered as sample universe for sampling procedure. The detailed sample descriptions are mentioned in table 3 below:

Table 3: Classification of Sample

	Perishable (Amul)	Semi-Perishable (Cadbury)	Non-Perishable (Gillete)	Total
Purchasing and Procurement	20	15	12	47
Manufacturing	15	8	10	33
Marketing and Distribution	25	20	18	63
Total	60	43	40	143

Structured questionnaire was used having close-ended questions. To identify an initial set of components to measure logistics flexibility, an extensive literature review is completed. Based on the findings of Zhang et al. (2005), four dimensions of logistics flexibility at supply chain level named physical supply flexibility, purchasing flexibility, manufacturing flexibility, physical distribution flexibility and demand management flexibility were included in the study. Based on the suggestion of Shah and Sharma (2011) manufacturing flexibility has also been included in the study as a mediating factor. The final part contains the five components of logistics flexibility with total of six factors, which include physical Supply Flexibility, Purchasing Flexibility, Manufacturing Flexibility, Physical Distribution Flexibility, Demand Management Flexibility and Customer Satisfaction. These five factors contain 35 statements. All 35 statements are rated using Likert scale with 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree and 5 = strongly agree. The managers are asked to rate the each question in terms of the strength of their agreeableness or disagreeableness with respect to Logistics Flexibility.

4.1 Major Hypothesis

$H_{1(P)}$: The interrelationships among components of logistics flexibility are significant for Perishable products.

$H_{1(SP)}$: The interrelationships among components of logistics flexibility are significant for Semi-perishable products.

$H_{1(NP)}$: The interrelationships among components of logistics flexibility are significant for Non-perishable products.

5. Data Analysis and Findings

5.1 Reliability Analysis

Reliability of Logistics Flexibility Factors

Variables	**Cronbach Alpha**
Physical Supply Flexibility	0.721
Purchasing Flexibility	0.852
Manufacturing Flexibility	0.893
Physical Distribution Flexibility	0.711
Demand Management Flexibility	0.750
Customer Satisfaction	0.899

As shown in the above table, the calculated Cronbach Alphas for all the variables are well ahead of the cut off rate of 0.70 to prove good reliability (Hair et al., 2009). So, it can be concluded that all the factors used to measures the logistics flexibility are found to be reliable. It means these factors will produce consistent results irrespective of time period.

5.2 Regression Analysis

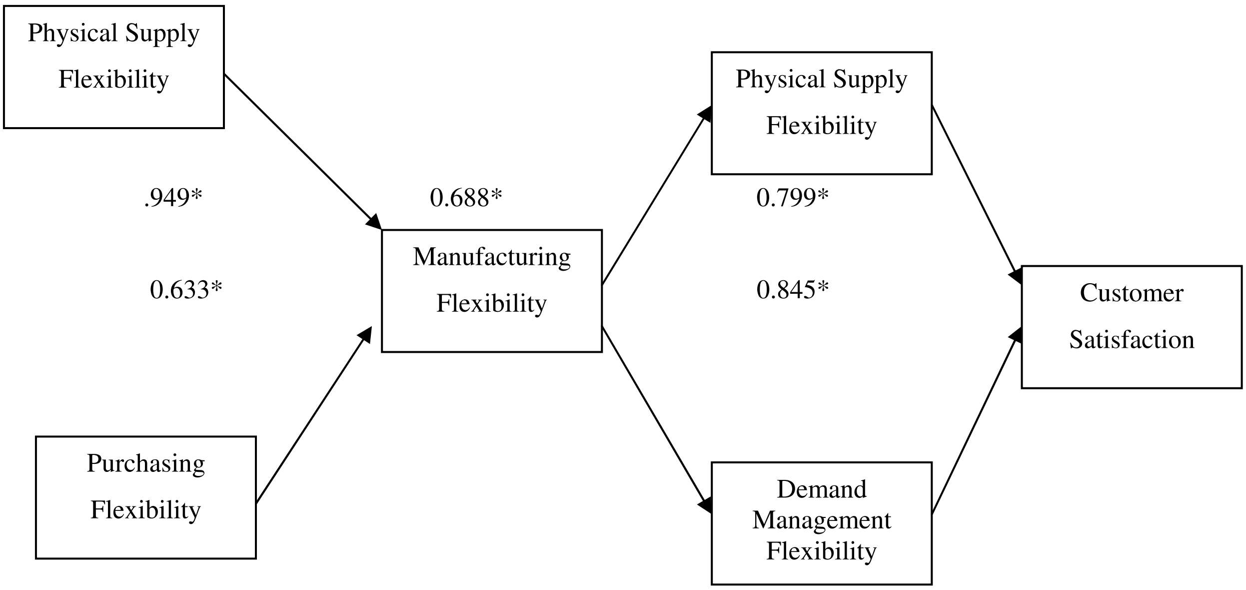
Regression Analysis of components of Logistics Flexibility - Overall

Table 4: Regression Analysis of components of Logistics Flexibility – Overall

Independent Factor	Dependent Factor	Beta Co-efficient	R-Square	Anova	VIF
PSF	MF	0.494*	0.754	F = 815.44 p = 0.000	1.34
PF		0.633*			1.34
MF	PDF	0.688*	0.522	F = 187.12 p = 0.000	
MF	DMF	0.589*	0.478	F = 162.44 p = 0.000	
PDF	CS	0.799*	0.762	F = 709.05 p = 0.000	1.56
DMF		0.845*			1.56

(* Significant at 0.05 level of significance)

Figure 1 Relationships among components of Logistics Flexibility – Overall



(* Significant at 0.05 level of significance)

As shown in table 4 and figure 1, physical supply flexibility and purchasing flexibility create significant positive impact on manufacturing flexibility as regression coefficients are significant (PSF β – 0.949 and PF β – 0.633). The value of R^2 shows 75.4% variations in manufacturing flexibility. The VIF statistics shows the value of 1.34 for both independent factors, which is very far from cut off rate of 10. So there is no concern of multi-collinearity among independent factors.

Manufacturing flexibility creates significant positive impact on physical supply flexibility (MF β – 688). The value of R^2 shows 52.2% variations in physical supply flexibility. Manufacturing flexibility creates significant positive impact on demand management flexibility (MF β – 0.589). The value of R^2 shows 47.8% variations in demand management flexibility.

Physical distribution flexibility and demand management flexibility create significant positive impact on customer satisfaction as regression coefficients are significant (PDF β – 0.799 and DMF β – 0.845). The value of R^2 shows 76.2% variations in manufacturing flexibility. The VIF statistics shows the value of 1.56 for both independent factors, which is very far from cut off rate of 10. So there is no concern of multi-collinearity among independent factors.

Regression Analysis of components of Logistics Flexibility for Perishable Products

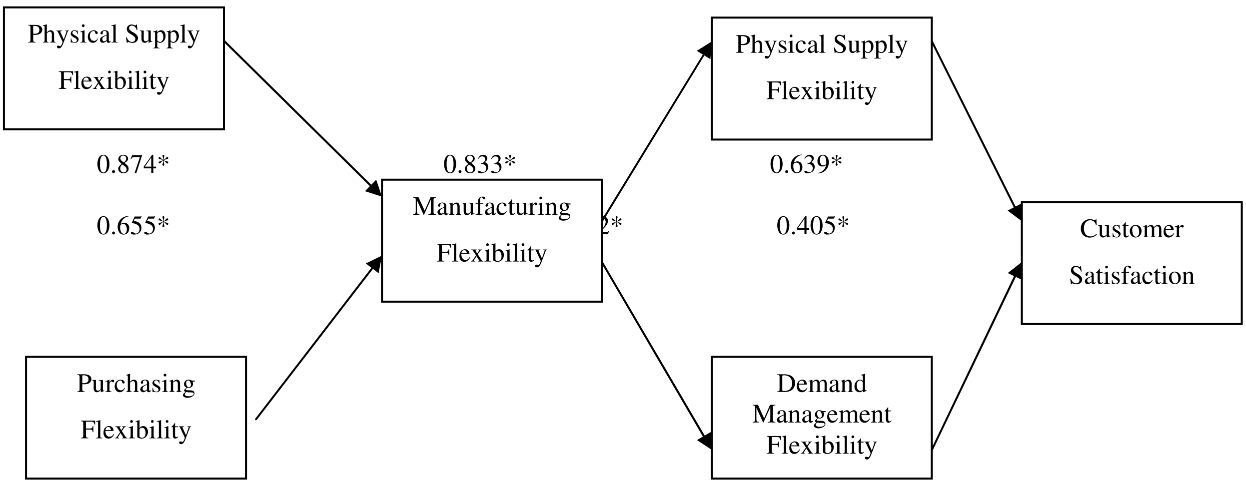
Table 5: Regression Analysis of components of Logistics Flexibility for Perishable Products

Independent Factor	Dependent Factor	Beta Co-efficient	R-Square	Anova	VIF
PSF	MF	0.874*	0.711	F = 951.24 p =	1.22

PF		0.655*		0.000	1.22
MF	PDF	0.833*	0.697	F = 123.39 p = 0.000	
MF	DMF	0.822*	0.648	F = 235.78 p = 0.000	
PDF	CS	0.639*	0.502	F = 905.20 p = 0.000	1.78
DMF		0.405*			1.78

(* Significant at 0.05 level of significance)

Figure 2 Relationships among components of Logistics Flexibility for Perishable Products



(* Significant at 0.05 level of significance)
As shown in table 5 and figure 2, physical supply flexibility and purchasing flexibility create significant positive impact on manufacturing flexibility as regression coefficients are significant (PSF β – 0.874 and PF β – 0.655). The value of R^2 shows 71.1% variations in manufacturing flexibility. The VIF statistics shows the value of 1.22 for both independent factors, which is very far from cut off rate of 10. So there is no concern of multi-collinearity among independent factors.
Manufacturing flexibility creates significant positive impact on physical supply flexibility (MF β – 833). The value of R^2 shows 69.7% variations in physical supply flexibility. Manufacturing flexibility creates significant positive impact on demand management flexibility (MF β – 0.822). The value of R^2 shows 64.8% variations in demand management flexibility.
Physical distribution flexibility and demand management flexibility create significant positive impact on customer satisfaction as regression coefficients are significant (PDF β – 0.639 and DMF β – 0.405). The value of R^2 shows 50.2% variations in manufacturing flexibility. The VIF statistics shows the value of 1.78 for both independent factors, which is very far from cut off rate of 10. So there is no concern of multi-collinearity among independent factors.

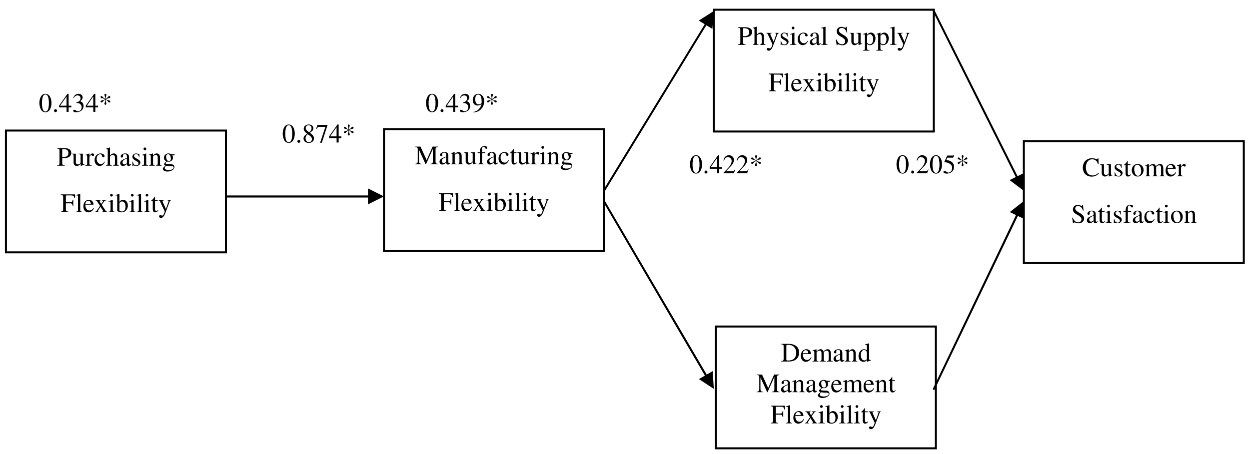
Regression Analysis of components of Logistics Flexibility for Semi-Perishable Products

Table 6: Regression Analysis of components of Logistics Flexibility for Semi-Perishable Products

Independent Factor	**Dependent Factor**	**Beta Co-efficient**	**R-Square**	**Anova**	**VIF**
PSF	MF	0.094	0.267	F = 134.35 p = 0.004	2.32
PF		0.874*			2.32
MF	PDF	0.434*	0.245	F = 123.39 p = 0.000	
MF	DMF	0.422*	0.348	F = 198.22 p = 0.000	
PDF	CS	0.483*	0.377	F = 455.67p = 0.000	2.22
DMF		0.215*			2.22

(* Significant at 0.05 level of significance)

Figure 3 Relationships among components of Logistics Flexibility for Semi-Perishable Products



(* Significant at 0.05 level of significance)

As shown in table 6 and figure 3, purchasing flexibility creates significant positive impact on manufacturing flexibility as regression coefficient is significant (PF β – 0.874). The value of R^2 shows 26.7% variations in manufacturing flexibility. The VIF statistics shows the value of 2.32 for both independent factors, which is very far from cut off rate of 10. So there is no concern of multi-collinearity among independent factors.

Manufacturing flexibility creates significant positive impact on physical supply flexibility (MF β – 434). The value of R^2 shows 24.5% variations in physical supply flexibility. Manufacturing flexibility creates significant positive impact on demand management flexibility (MF β – 0.422). The value of R^2 shows 34.8% variations in demand management flexibility.

Physical distribution flexibility and demand management flexibility create significant positive impact on customer satisfaction as regression coefficients are significant (PDF β – 0.483 and DMF β – 0.215). The value of R^2 shows 37.7% variations in manufacturing flexibility. The VIF statistics shows the value of 2.22 for both independent factors, which is very far from cut off rate of 10. So there is no concern of multi-collinearity among independent factors.

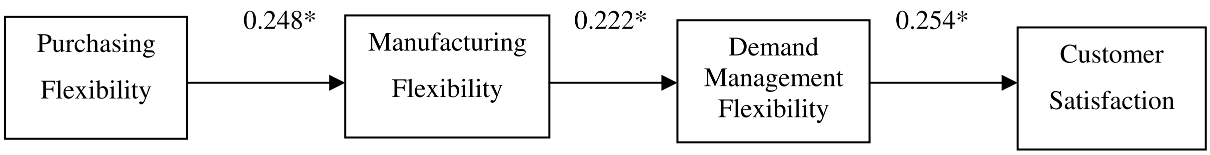
Regression Analysis of components of Logistics Flexibility for Non-Perishable Products

Table 7: Regression Analysis of components of Logistics Flexibility for Non-Perishable Products

Independent Factor	Dependent Factor	Beta Co-efficient	R-Square	Anova	VIF
PSF	MF	0.065	0.139	F = 121.89 p = 0.023	2.05
PF		0.248*			2.05
MF	PDF	0.034	0.025	F = 98.27 p = 0.039	
MF	DMF	0.237*	0.189	F = 104.22 p = 0.000	
PDF	CS	0.039	0.209	F = 327.23 p = 0.000	2.19
DMF		0.254*			2.19

(* Significant at 0.05 level of significance)

Figure 3 Relationships among components of Logistics Flexibility for Non-Perishable Products



(* Significant at 0.05 level of significance)

As shown in table 7 and figure 4, purchasing flexibility creates significant positive impact on manufacturing flexibility as regression coefficient is significant (PF β – 0.248). The value of R^2 shows 13.9% variations in manufacturing flexibility. The VIF statistics shows the value of 2.05 for both independent factors, which is very far from cut off rate of 10. So there is no concern of multi-collinearity among independent factors.

Manufacturing flexibility creates significant positive impact on demand management flexibility (MF β – 0.237). The value of R^2 shows 18.9% variations in demand management flexibility.

Demand management flexibility creates significant positive impact on customer satisfaction as regression coefficient is significant (DMF β – 0.254). The value of R^2 shows 20.9% variations in manufacturing flexibility. The VIF statistics shows the value of 2.19 for both independent factors, which is very far from cut off rate of 10. So there is no concern of multi-collinearity among independent factors.

6. Conclusion

The competence and capability theory brings a systematic resource-based view of logistics flexibility management. It is empirically verified that flexible logistics competence supports the flexible logistics capability, which ultimately enhances customer satisfaction. Firms can achieve customer satisfaction by developing logistics flexibility, which enable quick replenishment of incoming materials and rapid delivery of finished product to customers. Customers value the visible capabilities, physical distribution flexibility and demand management flexibility, rather than the supply-side competences because customers see how capabilities are deployed to meet their needs. However, physical distribution flexibility and demand management flexibility cannot be achieved also without flexible logistics competences in terms of manufacturing flexibility.

Physical supply flexibility and purchasing flexibility are very important in case of perishable products. It requires supply of varieties (customized) of inventory in timely and cost effective manner, so that varieties of perishable products can be produced as per customer requirements. Physical supply flexibility is not important in case of semi-perishable products. The inventory for manufacturing can be stored for a longer period as well as they logistics infrastructure requirements are not as acute as in case of perishable products. But, it is purchasing flexibility, which is the most important to provide varieties of inventory for manufacturing in customized and timely manner. In case of non-perishable products, physical supply flexibility is not important as inventory can be stored for a longer period time as well as in advance before actual manufacturing is done. But, purchasing flexibility is important to provide varieties of inventory for manufacturing in customized and timely manner.

Manufacturing flexibility is important in case of perishable, semi-perishable as well as non-perishable products. Manufacturing flexibility brings the advantage of availability of varieties of products quickly and in customized manner.

The role of physical distribution flexibility and demand management flexibility are very important in case of perishable products. It requires distribution of varieties (customized) of perishable products to large places accurately (timely) and in cost effective manner (efficiently), which brings customer satisfaction. Demand management flexibility is more important than physical distribution flexibility in case of semi-perishable products. Semi-perishable product can be stored for a longer period than perishable products as well as they logistics infrastructure requirements are not as acute as in case of perishable products. But, it is demand management flexibility, which is the most important to satisfy varieties of customer requirements in customized and timely manner. In case of non-perishable products, physical distribution flexibility is not important as non-perishable products can be stored for a long period time and its manufacturing can be done in advance before actual demand is generated. Also it does not require special logistics infrastructure to store. But, demand management flexibility is very important to satisfy customer requirements in customized and timely manner, which ultimately brings customer satisfaction.

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