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Article

Exploring Interrelationship Between Barriers in Cold Supply Chain using ISM

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A B S T R A C T

Context: Identification and elimination of influential barriers to cold supply chain implementation is attractive very significant and which directly leads to ultimate success of cold supply chain.

Purpose: The purpose of this paper is to present the influential barriers to cold supply chain implementation.

Design/methodology/approach: A peer-reviewed journal articles, survey reports, master theses, doctoral theses are used for causative this paper

Findings: After extensive literature survey 13 barriers to cold supply chain implementation are identified. The major influencing barriers are Lack of standardization; too many intermediaries; improper collaboration planning; Incompetent professional skills etc.

Research limitations/implications: This literature survey is primarily focused on cold supply chain and barriers to its implementation.

Practical implications: This paper identifies the various barriers for implementing cold supply chain. Detailed description has been presented the in the paper.

Social implications: the Indian government advancing the advancement of cold gracefully chain foundation by Providing Financial Support to energize private venture, giving empowering approach system, Promotion, mindfulness crusade, study, reviews, information sharing, and so on. Be that as it may, Cold chain, which is the foundation of the F&V flexibly chain, is experiencing different bottlenecks, which brings about the misfortunes of produce and cash. Creativity/esteem – the key obstructions to cold chain execution has been distinguished. Cold chain organizations and costumers will be profited by this information.

Keywords: Barriers, Cold Supply Chain

Introduction

Which includes the various equipments and facilities to protect the perishable items (Salin et al. 2003). Cold chain contains perishable items such as vegetables, food, fruits, dairy product, flowers, medicine, meat etc. The main backbone of cold chain is the transportation system (Kacimi et al., 2009). Cold supply chain differs from the supply chain of non- unpreserved items and in the cold chain there is may be chances of deterioration of quality and value of the product, which starts from the producer's place till it, is consumed. The cold chain starts at the farm level (e.g. harvest methods, pre-cooling) and covers up

to the consumer level (cooling practices and behavior) (Joshi et al., 2009). The cold chain demands a lot on the operating conditions; second, from the production spots to the consuming place, products in the cold chain have the possibility to spoil (Joshi et al., 2009). Meanwhile, the relationship between supply chain and cold chain is that, cold chain can be viewed as facilities and circumstances required in a supply chain (Salin et al., 2002); and sustainability is Significant for both of them (Maxwell et al., 2006). A typical cold chain infrastructure generally consists of pre-cooling facilities, cold storages, refrigerated carriers, packaging, warehouse, traceability, retailer, and consumers, under the aegis of information management systems (Montanari, 2008, Surajit Bag 2016). The cold chain logistics is at a nascent stage in developing countries like China and India (Xin et al., 2013). There are numerous challenges of cold storage and recently the weak links of fruits and vegetables cold chain has been identified by (Negi & Anand, 2015 a,b). Cold chain management is a more complicated barrier for exporters (Sandrey et al., 2008). Aramyan et al. (2007) included the performance factors ranging from highly qualitative factors like customer satisfaction to quantitative factors such as return on investments. Chan, Chan, Lau, and Ip (2006) stresses that in order to improve performance of the entire cold chain there is a need to look into factors with which the performance of product, services and process can be evaluated. Profitability is a traditional performance factor and all cold chain participants would like to receive an acceptable return on their investments after excluding various costs (Da Silva & Filho, 2007). For agri-natural ways of life, both creation and value solidness influence food security. In this way, the capacity to give enough items to ensure a sufficient gracefully to address food issues is additionally a huge exhibition factor (Da Silva and Filho, 2007). Reasonable execution factors are expected to answer whether shoppers getting the items requested, regarding amount, quality, idealness and costs (Fearne, Barro Schulenberg, 2006). This investigation has four segments. The main segment manages evaluating the related writing on cool gracefully chain, with specific accentuation on the simultaneous usage of key activities. The subsequent area depicts the study procedure used to acquire information in this examination. The third segment recognizes the boundaries for lean virus flexibly chain usage. The fourth area clarifies the aftereffects of the review and talks about the discoveries to explain the targets of this examination. The last segment presents the end and proposes future research territories.

Research Objectives and Methodology

Published research papers have covered diverse domains of cold supply chain. Early papers focused on cold chain monitoring: Cold chain tracking and traceability; cold chain implementation strategies; improve performance of the cold chain; risk prediction in cold chain; However; few were focused on the comprehensive Coverage on barrier to cold supply chain. The primary objective of this paper is to identify the barriers to the successful implementation of the cold supply chain. The secondary objective is to prepare a launching pad for further research, specifically for cold supply chain implementation strategy development and analyzing the interactions between barriers. In this research study, research factors are the barriers for successful implementation of the cold supply chain. 13 Significant barriers for successful implementation of the cold supply chain have been identified after reviewing literature on cold supply chain.

Research Methodology

This work can be characterized as a theoretical concept, specifically for review of literature on barriers in the successful implementation of the cold supply chain. The study is exploratory in nature, which constitutes a secondary source. Extensive literature exists in the field of cold supply chain and supply chain.

Following criteria are used for inclusion of literature:

- literature published on cold supply chain and supply chain
- literature published from 1993 to 2017
- journals stating cold supply chain and supply chain in their editorial scope
- survey reports published on cold supply chain and supply chain by professional agencies
- web articles on cold supply chain and supply chain
- articles published in reputed referred scholarly journals, working papers, master theses and doctoral theses
- articles discussing issues and barriers in cold supply chain implementation sectors
- articles addressing issues related to the problems in cold supply chain implementation
- articles presenting a lean model or framework, specifically in cold supply chain implementation

Keywords used in Article

Primary keywords: cold supply chain, supply chain management.

Secondary key words: Barriers, lack of, failure, obstacles, pitfalls, stumbling blocks, challenges, limitations, constraints, success factors, enablers and benefits. The search was done for the period between the publications of the 1993 until 2017. Detail information of literature search is given in Table 1. The flowchart of the research methodology used in this study is shown in Figure 1. The literature review was augmented by the use of online computerized search engines such as Elsevier Science Direct, Emerald, Taylor & Francis, IEEE Explorer, Google Scholar, Springer Link and Bing using keywords or terms that are often used in the

literature to describe lean-related principles and practices and were therefore deemed to be the most relevant primary search keywords such as cold supply chain, Supply Chain Management (SCM), lean SCM keywords like barriers, lack of, failure, obstacles, hinders, pitfalls, stumbling blocks, challenges, limitations, constraints, success factors, enablers and benefits. Literature was taken from journals in the areas of journals in the domain of production planning and control, production research, production management, operations management, manufacturing technology management, services and operations management, SCM, logistics management, project management, leadership and organizational development and HRM. In addition to this search, articles, master theses, doctoral theses as well as survey reports by professional agencies, such as Forrester Research, Aberdeen and Canadian Manufacturers and Exporters, are also included after scanning the reference sections of the initially selected papers. The ultimate list of articles reviewed for this paper covers articles published in reputed referred scholarly journals. Based on this review, articles that met the criteria of addressing issues related to the problems in lean implementation and presented a model or framework were selected. A survey of literature was carried out on the basis of the editorial scope and contents of the journals, and a list of journals was compiled, Journals stating in their editorial scope such as cold chain and Supply Chain Management. A comprehensive review of the table of content of the journals, abstracts, and wherever necessary, a review of the complete paper was carried out. A literature review primarily focuses on cold supply chain implementation in fruits and vegetable sector, secondarily on other sectors such as human resource, food industries, relationship management, SCM, transportation, healthcare and construction.

Barriers in Cold Supply Chain Implimentation Capability

Lack of Awareness about The use of IT

Now in current scenario the information is great resource and advantage for competition, and if there any lag in adopting information system it would be a treated as great loss in term of opportunity. In India, the majority of IT systems are adopted at retail level, and hence retailers has handle the entire cold chain with help of their strong information system (Kumar, 2008). This irregular implementation of Information Technology from the farmers to retail level chain has result in scattered and lack of collaborative culture (Matani, 2007).

Improper Collaboration Planning

Cold chain in different level and link between i.e., optimize deliveries, share forecasting, inventories management, labor scheduling etc., and hence unbalanced collaborative planning among various levels and links of cold chain can lead to many discrepancies in different links and level of cold chain (Dunne, 2008).

Incompetent Professional Skills

Cold supply processes, operations are changing in relation with change in technology and change in customer requirements this results into lack of skill in cold supply chain sector. Development in term of qualitatively and qualitatively is most advisable to each and every individual in cold supply chain sector (KPMG, 2007). Some of the areas where skill set are lacking which includes awareness with modern equipment. Information technology, temperature monitoring system, data handling and storage system Industry safety system etc. (Swaminathan, 2007).

High Cost For Installation and Operation

Operating costs for Indian cold storage units are over $60 per cubic meter per year likened to less than $30 in the West (Khan, 2005). Liveliness expenditures make up about 28 percent of the total expenses for Indian cold storages compared to 10 percent in the West (Khan, 2005). An ordinary truck that costs about Rs 8-9 lakhs ($18,000), when fitted with refrigeration facility will cost Rs 18-20 lakhs ($40,000)(Viswanadham, 2006). The high capital costs involved in setting up the cold chain facility are a major disincentive. Installation cost is higher also because of the cost of equipment import. High import duties, excise duty, and high running cost due to industrial rate of power tariff are discouraging investments. These factors make setting up cold storages difficult, unviable and uneconomical

Lack of Quality and Safety Measures

Main hurdle for perishable goods is to maintain the exact quality, freshness, hygiene, and safety. For that efficient and effective equipment's with accurate operating characteristics and proper information are required. (Amjadi, 2005). Perishables chain starts from farm to and ends at distribution center in between there are processing center warehouses, distribution centers and finally to retailers. Transportation mainly includes the reefer trucks under difficult conditions (Sahin et al., 2007). Companies are generally unaware of data related to when, where and under what conditions a production of perishable goods occurred. Data related quality and freshness of perishable product are often lost in most of the situations (Tijskens and Polderdijk, 1996).

Inadequate Education of Growers/ Farmers

There are very few training center for farmers and there no any organized institutions to perform this function (Viswanadham, 2006).

Too Many Intermediaries

In India There involves many multipoint, long period, intermediaries in cold chain from the farmer to the consumer level which results in complex food chain. Agricultural price have been increased up to 60 present due to the poor facilities and the middleperson involved. (Ruben, 2007). India is one of the highest producer of fruits and vegetable i.e. 127 million tons of fruits and vegetables (India, 2005).

Lack of Standardization

Standardization can be a powerful tool for improving cold chain efficiency. There can be standards like content, processing, temperature, packaging, logistics and transit time, IT systems, etc. Standardization in packaging has become the competitive tool to reach the consumer and it helps in efficient loading, unloading and cross-docking (Berger, 2007). Cost of packaging ranges from 10 to 64 percent of the production costs. Standardization efforts reduce these costs through use of manufacturing automation and economies of scale (Blanco et al., 2005).

Government Regulation

(Viswanadham, 2006). The cold chain industry is yet not awarded priority status as a continuous process industry for power and facing the power shedding at peak hours. In processed foods, India is amongst the highest taxed in the world (Khan, 2005). There is an urgent need of quick action and demonstration effect from the government

Improper Tracing

Improper product tracing and tracking is a major hurdle to achieve an efficient cold chain. Product tracing states access to when, where and under what conditions a product is from the agricultural origin or point of production through distribution to retailer (Montanari, 2008).

Poor Infrastructure

The deficiency in infrastructure and logistics system results difficulty in transporting goods and reaching consumers. Owing to limited infrastructure support, it is common even for the industrialized zones to suffer from frequent power outages, inadequate water supply and poor roadway connections. This causes unexpected delays in production as well as prevents firms from attaining their best performance. Firms often have to create a contingency plan for basic infrastructure needs.

Lack of Top Level Commitment

(Hingley, 2005). The top management in the partner companies should be enthusiastic to the incorporation of various facilities in order to take benefit of cold chain competences.

Customer Ignorance Towards Quality

Customers are the vital part of the cold chain (Zokaei, 2006) but "cold chain" is not well known among consumers (Ovca and Jevsnik, 2008). In India, usually people go for branded product just for cost reasons, which encourages the poor handling practices. Ahmed Saif, (2015) has stressed on environmental considerations in cold supply chain management. Cold supply chains have high levels of greenhouse gas emissions due to the high energy consumption and refrigerant gas leakages.

Intepretative Structural Modelling (ISM)

ISM Techniques involves following steps:

- Identification of barriers affecting the cold chain
- Formulating the relationship between barriers and pairs of barriers are examined
- Development of a structural self-interaction matrix (SSIM) of barriers
- Construction of a reachability matrix from the structural self-interaction matrix (SSIM)
- Level Partitioning of reachability matrix
- Formulation of directed graph (digraph) from the Level Partitioning of reachability matrix
- Formulate the ISM Model
- Checking the conceptual inconsistency, and formulating the final ISM Model

Structural Self-Interaction Matrix (SSIM)

SSIM is formulated considering the following rules

V: Barrier i will lead to barrier j
A: Barrier j will lead to barrier i
X: Barrier i and j will lead to each other
O: Barrier i and j are not related to each other

The SSIM is converted into reachability matrix by considering the following rules.

Table 2.Rules for formulating Reachability Matrix

(i, j) entry in the SSIM	(i, j) entry in the reachability matrix	(i, j) entry in the reachability matrix
V	1	0
A	0	1
X	1	1
O	0	0

Table 1.Structural Self-interaction Matrix

Barrier no.	13	12	11	10	9	8	7	6	5	4	3	2	1
1	O	O	O	O	O	O	O	O	O	O	V	A	X
2	O	O	O	O	O	A	O	O	O	O	O	X	
3	O	O	O	O	O	O	O	V	O	O	X		
4	A	O	O	O	O	V	O	O	O	X			
5	V	O	O	O	O	O	O	O	X				
6	O	V	O	O	O	O	O	X					
7	O	O	A	O	V	O	X						
8	O	O	O	O	O	X							
9	O	O	O	O	X								
10	O	A	V	X									
11	O	O	X										
12	O	X											
13	X												

Table 3.Reachability Matrix

Barrier no.	13	12	11	10	9	8	7	6	5	4	3	2	1
1	0	0	0	0	0	0	0	0	0	0	1	0	1
2	0	0	0	0	0	0	0	0	0	0	0	1	1
3	0	0	0	0	0	0	0	1	0	0	1	0	0
4	0	0	0	0	0	1	0	0	0	1	0	0	0
5	1	0	0	0	0	0	0	0	1	0	0	0	0
6	0	1	0	0	0	0	0	1	0	0	0	0	0
7	0	0	0	0	1	0	1	0	0	0	0	0	0
8	0	0	0	0	0	1	0	0	0	0	0	1	0
9	0	0	0	0	1	0	0	0	0	0	0	0	0
10	0	0	1	1	0	0	0	0	0	0	0	0	0
11	0	0	1	0	0	0	0	0	0	0	0	0	0
12	0	1	0	1	0	0	0	0	0	0	0	0	0
13	1	0	0	0	0	0	0	0	0	1	0	0	0

Reachability Marix

Following above rules, the final reachability matrix is shown in Table 3, the driving power and dependence of each barrier is also found in final reachability matrix table 4.

Final Structural Self-Interaction Matrix

Table 4.Final Reachability Matrix

Barrier no.	13	12	11	10	9	8	7	6	5	4	3	2	1	DP
1	0	0	0	0	0	0	0	0	0	0	1	0	1	2
2	0	0	0	0	0	0	0	0	0	0	0	1	1	2
3	0	0	0	0	0	0	0	1	0	0	1	0	0	8
4	0	0	0	0	0	1	0	0	0	1	0	0	0	4
5	1	0	0	0	0	0	0	0	1	0	0	0	0	3
6	0	1	0	0	0	0	0	1	0	0	0	0	0	6
7	0	0	0	0	1	0	1	0	0	0	0	0	0	9

8	0	0	0	0	0	1	0	0	0	0	0	1	0	6
9	0	0	0	0	1	0	0	0	0	0	0	0	0	2
10	0	0	1	1	0	0	0	0	0	0	0	0	0	5
11	0	0	1	0	0	0	1	0	0	0	0	0	0	6
12	0	1	0	1	0	0	0	0	0	0	0	0	0	6
13	1	0	0	0	0	0	0	0	0	1	0	0	0	2
Dep.	4	3	3	8	1	6	4	4	10	5	4	10	7	69

Level Partition

For the level partition final reachability matrix is considered. The reachability set and antecedent set for each barrier are calculated. The reachability is nothing but barrier itself the other barrier which help to achieve them, and antecedent set constructed by considering the barrier itself and the other barrier which help achieving it. Intersection set is calculated from all elements. In ISM model the barrier for which reachability Set and intersection set are same are taken to the top level in ISM model. Once the top level barriers are identified they are separated from other. Then by repeating same process next level barrier is found. ISM iteration process is repeated till level of each and every barriers is decided. Finally these identifies levels of barriers used in formulating the ISM model. Table 5 shows the final level partition of each barriers.

Table 5.Final level partition of barriers

Sr. No	Reacha-bility Set	Antecedent Set	Intersection Set	level
1	1,3	1,2	1	VIII
2	1,2	1	2	IX
3	3,6	3	3	VII
4	4,8	4,13	4	XI
5	5,13	5	5	XIII
6	6,12	6	6	IV
7	7,9	7	7	II
8	2,8	4,8	8	X
9	9	9,7	9	I
10	10,	10,12	10	IV
11	11,7	11	11	III
12	12	6,12	12	V
13	3,13	5,13	13	XI

Conclusion

There are 13 barriers to implement cold supply chain are identified based on resources available. Most of researcher has focused the barriers such as lack of quality and safety measures. Customer ignorance towards quality and Improper collaboration planning could be the main barrier for cold supply chain followed by High cost for installation and operation; Lack of standardization; Too many intermediaries; Incompetent professional skills; Lack of awareness about the use of IT; Government regulation; Improper tracing; Poor infrastructure; Lack of top level commitment. In future this research will provide new framework and strategies to remove the barriers to cold supply network in India. this research will be enable to extract maximum benefit out of cold supply chain network with improved life, reduced degradation, more utilization, reduced energy consumption and less project-execution-time/lead time etc. This research will be capable of investigating and mitigating the barriers involve in cold supply chain. This research will be applicable to many knowledge domains and the research will be helpful to emerge new research opportunity, new start-up ideas new business model and techniques, a new means of earning to the society and will uplift the research in the industry. MCDM tool such as interpretive structural modeling (ISM) approach can be used as tool to model barriers in implementing cold supply chain. The inter relationship between the Barriers to implementing a cold supply chain will be quantified and classified in future.

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