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A Delphi-AHP-TOPSIS based benchmarking framework for performance improvement of a cold chain

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ABSTRACT

This paper aims to develop a benchmarking framework that evaluates the cold chain performance of a company, reveals its strengths and weaknesses and finally identifies and prioritizes potential alternatives for continuous improvement. A Delphi-AHP-TOPSIS based methodology has divided the whole benchmarking into three stages. The first stage is Delphi method, where identification, synthesis and prioritization of key performance factors and sub-factors are done and a novel consistent measurement scale is developed. The second stage is Analytic Hierarchy Process (AHP) based cold chain performance evaluation of a selected company against its competitors, so as to observe cold chain performance of individual factors and sub-factors, as well as overall performance index. And, the third stage is Technique for Order Preference by Similarity to Ideal Solution (TOPSIS) based assessment of possible alternatives for the continuous improvement of the company's cold chain performance. Finally a demonstration of proposed methodology in a retail industry is presented for better understanding. The proposed framework can assist managers to comprehend the present strengths and weaknesses of their cold. They can identify good practices from the market leader and can benchmark them for improving weaknesses keeping in view the current operational conditions and strategies of the company. This framework also facilitates the decision makers to better understand the complex relationships of the relevant cold chain performance factors in decision-making.

1. Introduction

A 'cold chain' is comprises of equipments and processes that keeps perishable products under conditioned environment. These perishable products can be categorized into two types: living products (fruits, vegetables, live seafood, flowers, etc.) and non-living products (meat, dairy products, processed food products, medicines, blood, frozen products, etc.), which all require appropriate atmosphere to defy microbial spoilage (Donselaar, Woensel, Broekmeulen, & Fransoo, 2006). In today's competitive environment, perishable products are one of the main drivers through which retailers are attaching additional customers to increase profitability. Heller has stated that the quality of perishable goods assortment is becoming the core reason many customers choose one retailer over another (as cited in Thron, Nagy, & Wassan, 2007). The global market for perishable goods such as cooled products and processed foods is growing due to changing lifestyles and overall declining prices.

Retailers who are in the business of perishables can find a direct correlation between the cold chain performance and the quality delivered to the customer. Any disorder in time–distance or temperature in the cold chain could hamper the net present value of the activities and adversely influence the over all performance (Bogataj, Bogataj, & Vodopivec, 2005). Since long time, the cold chain data has been under utilized and used solely for the purposes of evaluating the integrity of individual shipments (i.e. facilitating the accept or reject decisions). These data can be gathered to measure performance of the cold chain, which in turn can identify flaws and weaknesses in the processes.

Benchmarking is a well-defined tool for improving these weaknesses through improvement processes in which a company measures its performance against that of market leaders, finds how market leaders have achieved their performance levels, and prudently uses this knowledge to improve its own performance (Saunders, Mann, & Smith, 2007). A well defined performance measurement system (PMS) aims to support the setting of objectives, evaluating performance, and determining future courses of action on a strategic, tactical and operational level (Gunasekaran, Patel,

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& Tirtiroglu, 2001). PMS allows comparison of planned and actual parameter values and taking certain reactive measures in order to improve performance or re-align the monitored value to the defined value (Beamon, 1999).

1.1. Research motive

In India it is estimated that around 35–40% of the total production of fresh fruits and vegetables, is wasted only because of inadequate cold storage, poor logistics, ineffective cold chain facilities and lack of other infrastructure supports (Viswanadham, 2006). Although, India is the second largest producer of fruits and vegetables in the world, but at the current level of production, the farm produce valued at Rs 70,000 million ($1400 M) is lost in wastages which is tantamount to the total production of the Great Britain (Khan, 2005). The high margin of product losses offers a significant opportunity for the improvement and advocates for technology and research advancement with in this domain. As one cannot improve what one cannot measure, the necessity of the hour is to measure the current status of Indian cold chain performance.

In light of above, this research paper delves into the performance improvement of the cold chain in Indian context. Here, a framework is proposed for performance evaluation of the cold chain and its improvement through effective benchmarking. This framework is suitable for the actual situations of the cold chains in the Indian retail market. The relevant information was collected from the field visits to various retail stores in India followed by an extensive literature review and consultation with the experts.

1.2. Research goal

This research mainly discusses the Key Performance Factors (KPF) of Indian cold chain, so as to provide a consistent measuring system to establish the basis of an evaluation reference. Based on this consistent measuring system the cold chain performance index of the chosen company can be measured against its competitors'. Subsequently the strengths and weaknesses of the company can be identified and their competitive gains and losses can be examined. These identified weaknesses can be considered as the performance gap or an opportunity for improvement. Further, for improving the weaknesses, the best practices learnt from the market leader are then short-listed and examined against current operational conditions of the selected company to choose the preferred one for bridging the performance gap. This should be a continuous improvement process as the company can improve its weaknesses one after another.

1.3. Research scope and target group

The companies trading in perishable products like fruit and vegetable, flowers, milk and milk product, meat and meat products, etc. are focused upon. The research scope is the cold chain operations of the companies that provide direct link between grower/producers and consumer. Authors specifically targeted on cooperatives governed by Government of India and privately owned supermarket chains offering fresh and processed vegetable and fruits under the same roof.

2. Literature review

Measuring the performance of a cold chain is difficult, because it has many characteristics that set them apart from other types of supply chains like shelf life constraints, seasonality in production, physical product features like appearance, taste, odor, color, size and image, long production throughput time, refrigerated transportation and storage requirement, traceability, product quality and safety, etc. (Aramyan, Oude Lansink, Van der Vorst, & Van Kooten, 2007; Mangina & Vlachos, 2005).

Many researchers (Ghobadian, Gallear, Li, & Clear, 2007; He, Ghobadian, Gallear, & Sohal, 2006; Gunasekaran, Patel, & McGaughey, 2004; Otto & Kotzab, 2003; Brewer & Speh, 2001; Lambert & Pohlen, 2001) have significantly contributed on PMS for supply-chain management and stressed the need of a well-defined set of performance factors for establishing benchmarks. A few studies have been done on agri-food supply-chain at different contexts and at different levels. Van der Vorst (2005) proposed a framework for the development of innovative food supply-chain networks and discussed the implications for performance measurement systems and their respective bottlenecks. 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-food chains, both production and price stability affect food security. Therefore, the ability to provide enough products to guarantee an adequate supply to meet food needs is also an important performance factor (Manning, Baines, & Chadd, 2008; Da Silva & Filho, 2007). Suitable performance factors are needed to answer whether consumers getting the products demanded, in terms of quantity, quality, timeliness and prices. (Fearne, Barrow, & Schulenberg, 2006; Beamon, 1999).

Many researchers (Sahin, Babaı, Yves, & Renaud, 2007; Blanco, Masini, Petracci, & Bandoni, 2005; Mangina & Vlachos, 2005; Jahre & Hatteland, 2004) have discussed about various issues of the cold chain on different links (farmer/producer–processor–distributor–retailer). They resonated in their views that cold chain is frequently broken at various stages. This drastically reduces its performance. In this regard Fearne and Hughes (2000) discussed supply-chain developments in the UK fresh produce industry and identified various success factors like improvement in cost control and innovation, etc. Bogataj et al. (2005) have studied the stability of perishable goods in logistic chains and discussed the disturbances which reduces the hygiene and quality of perishables. For perishables, maintaining the hygiene, safety, and expectedness of quality and freshness requires efficient equipment with guaranteed thermal characteristics, appropriate operating modes and proper information system (Amjadi (2005) & Manning et al. (2006). Montanari (2008) observed that identification of the critical parameters affecting food quality and safety and quantification through a systematic modeling approach will allow monitoring the quality and safety status of food products throughout the cold chain.

The traceability issues were taken by many researchers (Kelepouris, Pramatari, & Doukidis, 2007; Regattieri, Gamberi, & Manzini, 2007; Folinas, Manikas, & Manos, 2006; Joshi et al., in press) and have stated the need for reliable IT infrastructure of cold chain. In supplement to this, Rijswijk & Frewer (2008) investigated that traceability is linked not only to food safety, but also to food quality. Taylor & Fearne (2006) have observed that most significant challenge in cold chain management is continuous imbalance between supply and demand which is supported by Gorton, Dumitrashko, & White (2006) while discussing the issues overcoming the supply-chain failure in agri-food sector. At retail level maintaining cold chain, inventory control and return policy of perishable items are also some issues which have been referred to in the literature (Donselaar et al., 2006 & Likar & Jevsnik, 2006).