A Review on Long Distribution Channel's Problems

Wihdat Djafar, Yousef Amer, and Sang-Heon Lee

***Abstract*—An analysis of supply chain system could become more complex when the network system should cover widely dispersed locations. This could happen in a case where a product must be delivered using long distribution channel. By reviewing literatures over the last decade, this paper aims to identify and to gain more comprehensive understanding of the problems related to the long distribution channel's characteristics. The term 'long distribution channel' refers to a multi-tiers in the distribution stages where each tier commonly contains more than one site. The result shows that in order to design an optimum long distribution channel, some prominent problems that impact on both distribution costs and delivery times need to be considered. The problems encompass variability, bottleneck, bullwhip effect, high transportation and logistics costs.**

***Index Terms*—Long distribution channel, literature review, logistics, supply chain management.**

I. Introduction

The high competitiveness in global market requires the companies to be involved in a supply chain in order to stay competitive. The successful implementation of supply chain management (SCM) is the key to global competitiveness [1]. However, companies will face more challenges to succeed in SCM since a supply chain consists of a number of organizations in each level of chain (such as manufacturers, distributors, and end customers) with different objectives. As a consequence, addressing the whole system to increase supply chain performance requires a complex analysis so that focusing on a significant part of the system will enable us to reduce the complexity. In a supply chain system, distribution networks contribute considerably to supply chain performance. Distribution networks play a significant role in customer's responsiveness and ability to deliver products from manufacturers to satisfy customers' requirements, such as lead time and product availability which are also identified as the main parameters in competitive market [2]-[3]. Besides, distribution also generates roughly 20% of manufacturing costs and for commodity products it can be higher up to 30% of production and selling costs [3].

Distribution networks are mainly designed to flow the products through the best configuration of network to fill customer's demand with minimum total cost [4]-[5]. Determining the right number of facilities and locations in the selection of a distribution network configuration is essential policy for mostly every company and supply chain [5]-[7]. This policy is challenging due to some conflicting aspects such as warehouse and transportation costs [8]. Although there is a tendency to reduce the use of more facilities or more stages in distribution in order to avoid extra expenses, yet involving more entities in a distribution network system is necessary to reach a wider market in geographically dispersed locations. Applying long distribution channel in which there are a number of various storage points and product movements [9] creates more challenges to manage the system properly particularly in the supply chain context.

Many researchers have extensively studied distribution networks. However, only a few of them have investigated long distribution channels. The majority of the recent studies have overlooked some important problems that need to be considered when making decisions regarding distribution network planning. This paper reviews the literatures of the last decade to identify problems related with the characteristics of long distribution channel along with their solutions in order to gain a more comprehensive understanding of the problems. Due to there is only a small number of researchers that study long distribution channels specifically so this review surveys some literatures related with supply chain network, production-distribution network, distribution network, facility location and transportation fields which are discussed in multi-tier networks. Suggestions for potential research are also provided. The remainder of this paper is organised as follows, in the next section long distribution channel characteristics are described, continuing to the discussion of problems in long distribution channels and their solutions, finally potential research and conclusions are presented.

II. Characteristics of Long Distribution Channel

Distribution networks are basically classified into two different structures which are: direct shipping to the customer and indirect shipping which contains one or two levels of intermediaries such as distributor/retailer warehouse with different ways to distribute the products from these intermediaries' to customers [10]. Similarly, Dent [11] describes a typical distribution structures as 1) *direct* where the resources are managed by supplier directly to the customers, 2) *one-tier distribution* that employs a set of intermediaries between company and customers, 3) *two-tier distribution* that provides two set of intermediaries to increase service area such as across the country, and 3) *multiple-tiered distribution* with more than two set of intermediaries. Meanwhile, based on the length of the channel, Rushton et al. [9] divide the channel into 'short' and 'long'. A short distribution channel consists of very few buyers in a restricted market area while a long distribution channel consists of several storage sites to move products

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from manufacturers to consumers. Due to the numbers of intermediaries not being clearly defined in the long distribution channel category, hence in this study the term 'long distribution channel' will refer to two or multi-tier of distribution.

In long distribution channel, the flow of products from manufacturers to final customers is conducted through multi-tier distribution where each tier commonly consists of more than one site. Distribution tiers consist of several warehouse levels or distribution centers (DCs) such as production warehouse, distribution centre, regional depot, and shop/store that can function as stock-holding warehouses or stockless depot [9]. To move the products to other levels of DCs particularly into the global market or into geographically dispersed regions often involves some seaports which mainly consist of large ports that connect to inland hubs [11]-[12]. Products mobility from site to site using various transportation mode will depend on the required lead time, product volume and values [9], [10], and [13]. Each stage in the supply chain is commonly operated by many different organisations so that the more involved the stages the more involved the organisations which will have different capabilities. Therefore, problems that commonly occur in distribution networks can become more serious in long distribution channels with their increased complexity.

III. Problems in Long Distribution Channels

Traditionally, distribution network performance is measured by financial aspects or minimum logistic costs, yet with the increase of competitiveness in the global market; distribution networks along with SCM performance are measured by nonfinancial aspects as well, such as customer service level [1] or how to improve customer value and to decrease expenditures at the same time [14]. Most of the current distribution network studies use parameters based on the customer service level, which is service coverage area such as the number of distribution centres and the inventory level with minimum total costs [5], [8], [15], and [16]. However, only a limited number of researchers consider delivery time with minimum total costs or consider all parameters such as inventory level, lead time, service coverage areas, and costs simultaneously [15]-[17].

Long distribution channels mainly generate high distribution costs and long delivery time which are derived from the characteristics of the long distribution channel [9]. Therefore, improving the performance of long distribution channels can be done by reducing distribution costs and delivery time. Since the problems are discussed in the context of supply chain system, they seemed to affect each other; the four following problems are identified as prominent.

A. Variability

The uncertainty along the chains is the main problem that causes misalignment between supply and demand. Distribution networks with long distribution channels become more complex because they involve more organizations, activities and facilities with variability of capabilities. This length of channel is identified as the source of variability [18].

The sources of variability derived from both demand and supply side. On the demand side, variability comes from deviation of the demand quantity prediction due to incorrect forecasting tool applications, seasonal demands, and uncertainty circumstances. Improper forecasting tool application could happen because of misinterpretation of the real demand data and inconsistencies of the data handling processes [19]-[20]. Seasonal demand takes place at promotion season that leads to demand amplification [10], [18], and [20]. The uncertainty circumstances are caused by the lack of information or the altering situations in a dynamic market [21]. Demand variability also happens along with order arrival time uncertainties derived from consumer behavior [22]. As a consequence, the uncertainty of demand will cause difficulty in predicting the future demand [19]-[23]. Besides, demand variability can be problematic because setting base-stock levels will affect inventory system performance through excess inventory or stock outs that will result in the high expenditures of inventory [20], [24], and [25].

Meanwhile, from the supply side, the source of variability can be caused by: insufficient production systems [20], unreliable warehouse facilities and transportation systems [25], the length of distribution channels [18], and inadequate planning and control which consists of the availability, accuracy and throughput times of information [21]. Furthermore, supply variability such as lead times leads to ineffective processing and waste activities [21].

Since the variability being an unavoidable factor, minimizing the impact of variability is essential. This can be achieved by reducing the variability itself and increasing the flexibility to deal with the variability [18]. For this purpose, the sources of variability need to be identified first in order to determine the right solutions.

Dealing with the uncertainties in supply chain's circumstances, some researchers attempt to diminish variability by planning several activities as follows. Holding more inventory in a regular period is purposed to anticipate demand volatile in unpredictable time or in predictable time after promotion policy is released [3], [10], [26], and [27]. This activity enables companies to avoid stock outs, though it potentially generates extra bottlenecks in the chain and requires more inventory capacity and costs. The next activity is to smooth the information interchange flow by developing partner relationships but this activity faces data access and privacy problems, and requires more costs and labour skills due to utilizing various technology tools [19]-[20].

The other activities are associated with adjusting supply capability to demand uncertainty, such as adjusting the processing rate to the uncertainty of order inter-arrival time that will provide an optimal stock level [24]. Providing more flexible supply capacity can also be done by offering the level of price for various job's due date and fitting a production schedule with a job's due date enabling manufacturers to meet customer's requirements punctually [28]-[29]. Nevertheless, these activities are limited in the application of make-to-order products. Lastly, planning a safety lead time is another way to address supply and demand information uncertainties that aims to improve flexibility [30]. However, this increasing supply capability needs to deal with the main

obstacle which is a limited capacity of resource.

B. Bottleneck

In the supply chain, bottleneck is the weakest performance point which is identified as a barrier for the product to flow seamlessly [31]. Bottlenecks occur when the minimum production rate (such as production capacity of the device) is less than the demand rate (customer requirement) in each site and products are stored and moved by using various facilities with different capacities [31], [32]. Along the chains, seaports or airports are identified as the noticeable source of bottleneck [33]. As in the gate or transit area such as seaports, various activities are conducted which include loading and unloading processes and as the meeting point of different transport methods. The different capacity of facilities particularly when product distributed globally from international seaport to inland seaport and inadequate planning of various activities are the main causes of bottlenecks that can give more serious impact on the increasing of lead time and distribution cost [12], [32]- [34].

Although the current research commonly discuss distribution networks as a part of supply chain systems where the entities have high dependability to each other, but only a few of the researchers include seaport or airport sites in their considerations. Considering the existence of terminal sites such as seaports is essential because for instant in Indonesia; survey in 2005 indicated that the costs of some companies are 14% higher due to the logistics inefficiencies as the consequence of unpredictability schedule and logistics bottlenecks which are mainly occurred in the seaports [35]. Some solutions can be applied to overcome bottleneck problems such as determine the priority of products order based on the completion date, determine the right lot size to suit with capacity in order to obtain the high utility of capacity, and balance the size of handling with transport lot [31].

C. Bullwhip Effect

The bullwhip effect is a phenomenon that potentially happens in supply chains where the amplification of orders progresses up as they move from downstream to upstream of supply chain [10]-[36]. This effect occurs due to the lack of coordination among members [10], specifically because of poor information sharing, inadequate market data, insufficient forecast techniques or other uncertainties [36]. In addition, conducting demand forecasting separately at each stage in the supply chain is identified as the major cause of the bullwhip effect [37].

The bullwhip effect will become more serious in a long distribution channel because it involves more stages and organizations that will increase the order of deviation between end-users and manufacture. Although the bullwhip effect cannot be diminished completely, the effect can be reduced by developing demand and forecast sharing strategies [37]. Mentzer *et al*. [19] suggest that in order to minimize forecast error of demand quantity, the characteristics of demand in each tier need to be identified. Similarly, Taylor and Fearne [20] recommend identifying demand data across the chain in short time period particularly for products with high fluctuation such as in the fresh food industry.

D. High Transportation and Logistics Costs

In the context of long distribution channels, only a few research studies discuss multi-tier distribution centers. The structure of distribution network configuration in the current research studies are mainly described as a system that consists of single or multi-production plant, multi-distribution center and multi-retailer [5], [8], [16], [38]-[42]. Multi-tier distribution considerably applied in long distribution channels have the same prime objective of warehouses to fulfill customer requirements in terms of demand quantity and lead time in wider market areas [9]. Adding extra warehouses should be decided by considering the trade-off of some variables because using more warehouses will increase costs of inventory, carrying and warehousing while on the other hand will reduce transportation costs [8]-[14]. Transportation and logistics costs become critical components because products are distributed in a long distance with various vehicles and transited in many sites with different capabilities [34].

The distance between nodes and activities in each tier makes transportation and logistics very critical [34]. The length of time used in the distribution affects to increase the transportation and logistics costs. Spending each one additional transit day will cause the increase about 0.8% to the final cost of goods [12]. Transportation and logistics cost can be reduced by using various alternatives of vehicles (such as, less truck load/LTL, full truck load/FTL, train, sea vehicles etc.) or warehouses (as distribution center or transit-terminal consolidation). Considering various facilities will provide more options to store and to transport the products in small or large quantity which depend on the number of orders and also provide more possible ways to minimize distribution costs without lose the potential demand.

IV. Potential Research

Many research studies in the distribution network field have been conducted, however only a few numbers of these studies are concerned with long distribution channels. Long distribution channel is a critical issue for the supply chain with widely dispersed country like Indonesia. The complexity of multi-tier systems generates some problems that should be included in consideration to achieve better performance. Therefore, a number of problems have been identified for future researches. Among others, the following areas are believed to be the future research opportunities:

- *The structure of long distribution channels for different product types*. The characteristics of products can limit the number of possible channels to be applied, for example products with short life cycle such as newspaper and fresh foods, or frozen foods that require special handling [9]. Therefore, understanding the characteristics of distribution channels for different type of products will enable companies to gain more benefits by using more suitable channel distribution.
- *Variability in long distribution channels*. A better

organizing of companies' suppliers, customers, and partners is the key to reduce variability across the chain [23]. Understanding the variability across the distribution channel that involves many organizations can help managers to develop their strategies to organize the companies that can minimize the impact of variability.

- *Review of long distribution channel models*. The rapid changing market for global has imposed companies to change their distribution strategy to adjust with dynamic circumstance [43]. Reviewing previous studies enables us to understand essential aspects that need to be concerned and provide many possible ways to deliver the products so that we can figure out a model which is more representative for long distribution channel characteristics to generate the best distribution channel. Besides, the study will give understanding the change in logistics and supply chain concept where distribution is a part of the concept from the past to the future that will indicate new challenges of logistics and SCM [44] so that companies can develop the right strategies to remain competitive in the global market.
- *Applicability of research*. Long distribution channels mostly used to reach geographically dispersed market such as in Indonesia or global market. In the future, this study needs to be applied to minimize the gap between the real-life problems with the theory. Applying in the real case will improve the performance of long distribution channels; meanwhile feedbacks from the real case will enrich the body of knowledge for long distribution channels that supposed to generate more applicative solutions.

V. Conclusion

The prominent problems which are variability, bottleneck, bullwhip effect, high transportation and logistics costs in long distribution channel are complex problems and appeared to affect each other. These problems refer to the characteristics of long distribution channels and their impacts on both distribution costs and delivery times as the main distribution network performances. The review also shows some possible solutions which will depend mostly on the characteristics of products. Although many aspects of long distribution channel have not yet been covered, we believe that companies can gain significant benefits when these prominent problems are considered in designing their distribution channels.

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