Supply chain management and principles to design production and distribution systems

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Abstract: Supply chain management is of key importance in achieving the objectives in different parts of a country. Domestic and foreign purchases, development of outsourcing, partnerships, and attention to some of the legal requirements (especially given the 20-year outlook plan) emphasizing on necessity of government downsizing increase this importance. On the other hand, permanent increase in the depth and diversity of design and specification of products and services in various industries naturally make it more necessary to take advantage of high level technical and managerial knowledge and skills. Hence, the necessity of resorting to effective and innovative solutions in the domain of supply chain management aiming at supporting the key missions of the organization is now more needed than the past. For instance, expanded interorganizational cooperation and also extensive cooperation with other industrial and research sectors have now become a top necessity. This paper aims to extensively discuss key points and principles of designing an appropriate system of production and distribution and propose an integrated logistic model by emphasizing on logistics and multiple-product trends in the production and distribution systems.
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1. Introduction

With the expansion of globalization in recent decades, organizations have no choice to establish effective cooperation with manufacturers, suppliers, and distributors. Hence, proper planning in all these cases is needed. Production and distribution planning is one of the most important activities to achieve overall improvement in a supply chain. Production and distribution should be merged in order to achieve an effective operational performance. Integration of production and distribution activities can leads to further cooperation and lower costs in the system. Researchers have come to the conclusion that reducing each of cost factors will not work more and the combination of costs should be minimized (Chouman, M.et.al.2002). They say that this due to the application of optimization methods in each of the areas of supply, production, and distribution and believe that an overall optimization is the solution to improve supply chain networks. In the current competitive situation, the need to use the latest engineering patterns to enhance supply chain performance is essential. One of the main issues raised in this field is the logistic. It should be noted that there are generally two major attitudes about supply chain. The first attitude is materials management which is from the perspective of logistic. It means the flow of information between different centers including materials and parts suppliers, manufacturers, assembly centers, and distributors. The second attitude is value added (Crainic, T.G.et.al.2002.). In fact, this attitude doesn't deal with operational levels and affects the strategies and structures. These two approaches are not in contrast with each other, but their scope is different.

1.1. Supply chain:

Supply chain is a network of organizations that are involved in some processes and activities through upstream-to-downstream communication which produce value by providing products and services to final customer. As it is shown in Figure 1, a network does not focus only on the flow within a chain, but works on a complex network of convergent and divergent flows. These networks involve a large number of orders that must be met in parallel.

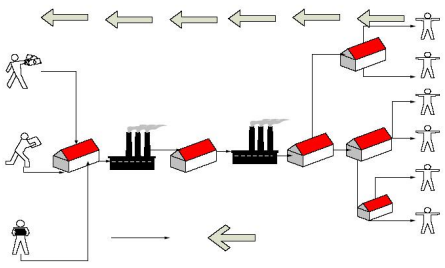

Fig. 1: Schematic model of supply chain

From a different point of view, supply chain management can be defined as all activities associated with material flow and goods conversion from raw material stage (extraction) to the final product (for consumption) and also informational flows associated with them. Supply chain management includes information management, management of current inventory and material flow (logistic), and management of relationships between chain components.

2.1. Distribution and its position in supply chain:

Distribution is making the products available to the markets. In simple terms, distribution means delivering an appropriate product to the appropriate product at the appropriate place. Decision making about the distribution network design is considered a strategic subject. Generally, horizon of planning for strategic programs varies between 3 to 12 years. These strategic decisions include construction or closure of production and distribution facilities, allocation of products to the facilities, and establishment of the main lines of production. The main processes of supply chain from different perspectives and activities are described in Figure 2.

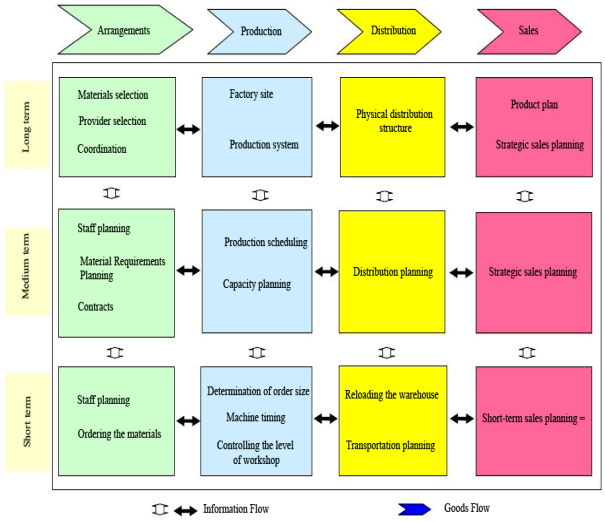

Fig. 2: Position of production and distribution in supply chain

3.1. Importance of distribution:

Poor understanding of distribution can be relatively attributed to lack of understanding of its relationship with strategic planning of company. Distribution is usually associated with marketing(Sheu.2003) . Marketing is usually known as a combination of product, price, promotion, and place, while distribution is something beyond this and involves issues like storage, vehicles. Distribution provides a long-term framework for the company within which it can continue its presence in the market. Peter Drucker believes that distribution management is as important as the last level of management, because distribution affects all short-term and long-term activities of a company. He also states that having great skills is one of the aspects of future management and since distribution is multilateral skill, it is considered as one of the most important work components of the future.

The importance of this topic differs in the companies that have long been established and newly established ones. However, both groups these companies are willing to constantly monitor the environmental changes. Some of key criteria of distribution are summarized in Table 1.

Table 1: Key criteria of distribution

Topic	Distribution criteria
Strategy	Service levels, methods of communicating with customers, distribution channels and their control
Production	Product needs
Logistic	Production areas, location and method of storage, transportation
Support needs	Inventory levels, communication, and order processing
Management	Number, organization, skills, reporting system

4.1. Decisions needed for the design of distribution channels:

A correct design will help to balance the benefits and costs. In order to maximize the profit, a good distribution channel should be consistent with corporate objectives in relation to market share, profitability, growth, and development of new products (Figure 3).

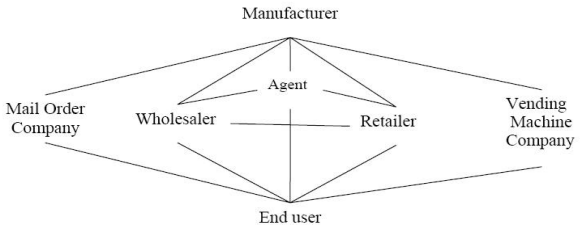

Fig. 3: Distribution channels

1.4.1. Decision on how to distribute:

Answer to the question whether a company should make use of intermediaries or not is tough and complicated. This decision involves benefits and risks which vary in different sectors and markets. However, there are various criteria for products and services that can be used as general indicators to decide which type of direct or indirect distribution

would be more appropriate. However, these criteria should always be modified according to the company's strategic needs (Dasci, A., Verter, V. (2001)). Some of these criteria are listed in Table 2.

Table 2: Effective factors in selection of direct or indirect distribution channels

Factor	High	Low
Geographical focus	Direct	Indirect
Number of buyers	Indirect	Direct
Product complexity	Direct	Indirect
Unit price	Direct	Indirect
Standardization	Indirect	Direct
Service delivery needs	Direct	Indirect

2.4.1. Decision about the selection of intermediaries:

When companies encounter with a new market or channel development for distribution of new products, selection of intermediaries will be of great importance. Various types of intermediaries are as follows:

1. Patented companies
2. Companies with license right
3. Industrial cooperation agreements
4. Management contracts
5. Wholesalers
6. Retailers
7. Mail order companies
8. Agents and distributors

Among these, most companies prefer agents or distributors for their activities in offshore markets. More than 60% of American companies and than 70% of European companies use agents. Agents are not the owner of products they sell, but they act as an intermediary between supplier and consumer. Suppliers monitor the performance of agents through contracts in which agent's powers and the services they must provide are listed (Hinojosa and J. Puerto, F.R. Fernandez, 2000).

1.2.4.1. Advantages of using intermediaries:

1. Sharing the risk of industrial relations
2. Availability of specialized services
3. Reducing the overall risk
4. Ability to meet customer needs with low cost
5. Reducing the number of distribution employees
6. Flexibility of capacity

2.2.4.1. Disadvantages of using intermediaries:

1. Incomplete performance feedback
2. Lack of response to specific demands
3. Higher direct costs
4. Loss of direct control
5. Reduction in inventory turnover and product control
6. Lack of control over customer service

3.4.1. Decision about selecting locations for distribution of technical and complex products:

The companies that supply complex and technical products should always consider this that they must use channels that can provide a full range of required supplies and equipment (Gendron, B.et.al1998). It should be noted that the selected distribution channel will affect the entire range of products. There are changes and dispersions in the ability to provide maintain a full range of products in each distribution channel. For example, a shop which sells computers should provide a lot of such as diskettes, printers, and other equipment. What mentioned above indicate the expertise and assistance that a distribution channel can provide to sell the products. There is always a significant difference between the knowledge and the expertise of distribution channels making the decision about distribution channels for complex products more important, especially when a variety of after-sales service and warranty or service agreement are required for effective marketing of products.

4.4.1. Decision about the selection of static distribution channel:

A distribution channel may always be static and stationary. This can be for many reasons and has outcomes for new suppliers and intermediaries who try to enter the market. Inflexibility of distribution channel may occur in various ways. When the channel of distribution has high fixed costs, other companies are less likely to be able to enter the market. For instance, international trade needs high levels of investment in local offices and transportation systems (Hyun-Jeung KO, Byung-In PARK.2005). When the expenditure needed to maintain and continue the distribution is high, an obstacle for the entry of new companies will be created. The rules and regulations can also affect the inflexibility of distribution channel.

4.5.1. Designing a multi-channel distribution:

When the use of only one channel is not enough to meet the needs of distribution, using multi-channel approach is necessary. Multi-channel systems enable a company to cover more of the market and also allow the company to distribute each its products through a specific channel. So, the company can reduce competition between prices.

4.6. 1.Processing system design:

The entire process of supply is done through distribution channel. This process is an interaction between physical distribution system, sales force structure, stored products, storage, construction

facilities, and information processing system. Many of decisions that are made in terms of information processing system, physical distribution system, and storage level are associated with the location and position of manufacturing and storage facilities (Klose, A., 2000). Management and establishment of appropriate distribution channels to provide efficient and low-cost services to customers or final consumers are vital.

4.7.1. Decision about facilities of centralized or decentralized production:

Most companies make decision about the location of manufacturing facilities by weighting the gravity of organization needs and market demands. The decision that should be made is that whether the company must establish the manufacturing facilities centrally, in form of autonomous units, or decentralized. The items which are considered for decision about centralization or decentralization of manufacturing facilities are as follows:

1. Transportation costs
2. Financial considerations
3. Political factors
4. Economic scale
5. Flexibility
6. Vulnerability

4.8.1. Site selection design and storage strategies:

Investment decisions about the allocation of resources fundamentally affect the way the market is served, because presence or absence of production resources in a market influences the storage strategies. For further understanding of this, two companies are compared which have the same sales pattern but the production unit of one of them is in the market but the other one's is in a point away from the market. The company that its production unit has been deployed in the market can serve customers much faster than the other one with a low level of inventory (Klose, A. and Drexl, A., 2003). Transportation costs may not follow a standard pattern when the number of warehouses increases. Generally, increased number of warehouses reduces the transport distance between warehouse and customers, but increases the distance between production point and storage point. Transportation cost per unit initially decreases, because increased number of warehouses reduces the covered distances. Then, additional warehouses will increase the cost of loading and thereby increase the unit cost of transportation (Leyuan Shi Robert R. Meyer.2003). Level of safety stock of warehouses as a function of the number of warehouses will also increase which is considered an important parameter when the total storage levels will be evaluated. When the control over the exploitation of stored goods, due to the frequency of warehouses, is more difficult, the level of stored goods with low consumption will probably increase. When the number of warehouses increases, the system is more capable of meeting the all needs of customers and the costs of missed orders decrease. Also, the cost of providing emergency orders is less when companies use several warehouses across the market instead of only one warehouse.

5. 1.Design options for a distribution network:

According to different choices of distribution to design a distribution network, the following 6 categories have been proposed by Chopra:

1. Storage at production sites with direct transport
2. Storage at production sites with direct transport and combination during transportation
3. Storage at distribution sites and delivery by the transport operator
4. Storage at distribution sites and delivery by Last Mile method
5. Storage at production or distribution sites and receiving by the customer
6. Storage at retail site and receiving by the customer

Each of the above-mentioned models will be discussed in next parts.

1.5.1. Storage at production sites with direct transport:

In this case the product is directly sent from the manufacturer to the customer, without passing through retailer. This method is also called Drop Shipping. All inventories will be stored in the factory. As it is shown in Figure 4, customer information is transferred from manufacturer to retailer, while products are transferred directly from the manufacturer to customers.

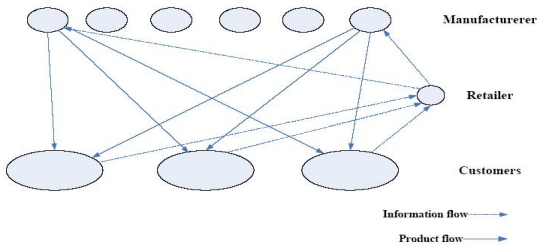

Fig. 4: Storage network at production sites with direct transport

2.5.1. Storage at production sites with direct transport and combination during transportation:

Unlike Drop Shipping in which each order is sent directly from factory to final customer, customized goods from different locations are combined in one place in hybrid method. So, customers will receive their orders in only one stage. Hybrid form in transportation is the best for goods with low demand and high value, in which retailers provide their supply through a limited number of manufacturers. Compared with Drop Shipping,

hybrid model is effective when the volume of sent goods from any manufacturer is higher. Application of this model can pose some problems in coordination and implementation. The best mode to use hybrid model is when there aren't more than 4 or 5 coherent places and customer order consists of multiple products from multiple locations.

3.5.1. Storage at distribution sites and delivery by the transport operator:

The inventory is not maintained in the factory in this method, but they are held in intermediate warehouses by distributors/retailers and transportation operators transfer the goods from these intermediate warehouses to customers (Simchi-Levi, D.et.al.2000). Information and products flow in storage at distribution and delivery sites is done by transportation operators, as shown in Figure 5. This model is not suitable for goods with medium and high speed of transmission. It works when the customer calls for a faster delivery compared with the model of storage at production sites. Diversity of products in this model is less than storage at production sites but is more than when a circle of retailers are involved.

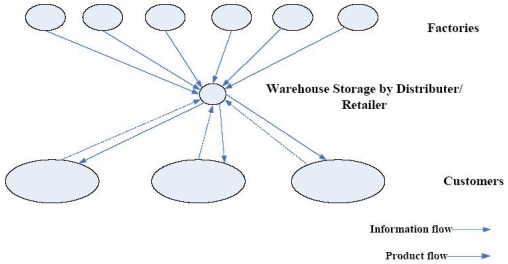

Fig. 5: Storage network at distribution sites and delivery by the transport operator

4.5.1. Storage at distribution sites and delivery by Last Mile method:

Last Mile Delivery (LMD) is a system in which distributor/retailer delivers the good to the customer, instead of a transportation operator. Unlike delivery by transport operator, distributor warehouse should be much closer to the customer in LMD system. Hence, total number of required warehouses increases.

5.5.1. Storage at production or distribution sites and receiving by the customer:

In this method, the inventory is kept at production sites or distribution warehouses but customers send their order online or through a mediator. Then, they go to certain receiving sites to receive their orders. Orders are sent to receiving sites according to the demands. Information flow and product flow are shown in Figure 6.

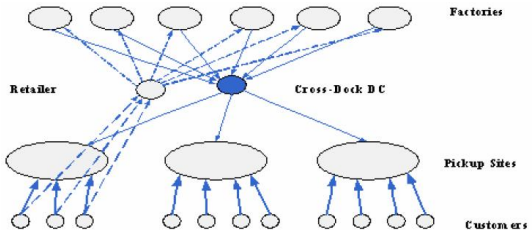

Fig 6: Storage network at production or distribution sites and receiving by the customer

6.5.1. Storage at retail site and receiving by the customer:

Inventory is regionally stored in warehouses of retailers and customers go there to order or send their order online or by other ways and then go to retailer's warehouse to receive their order. The main advantage of a network with local warehouses is that can reduce delivery costs. It is also more accountable than other networks. The major drawback of this network is the high cost of inventory and facilities. Such networks are suitable for agile goods or those in which accountability is a value to customers. The necessity of evaluation of "cost" and "service" is of great importance in each of these 6 networks which can lead to changes in the design of production and distribution. General features of production and distribution networks are shown in Table 3.

Table3: Characteristics of classification of production and distribution models

Service factors						**Cost factors**			
Reversibility	Order track	Customer experience	Availability of products	Variety of Products	Response time	Information	Facility maintenance	Transportation	Inventory

6.1. Design of a native model proposed for the production and distribution system:

We are not always faced with a problem or a general model in logistics and supply chain cycles, because these issues are always influenced by factors such as industry type, mission, product diversification, organizational nature, the number of manufacturing sites, producing country, international

relations, threats, and so on. For example, several types of products are produced in different factory; products may be directly transferred to the markets or firstly transferred to warehouses and then to the markets. A logistics issue should be capable of answering the following questions (as some of the key questions in this context):

1. How many factories, warehouse and distribution center is needed?
2. Where is the best place to factories and warehouses?
3. How is the flow of products through this system?
4. Which product should be manufactured at which factory and for what market?
5. How much good should be allocated to each warehouse according to demands?
6. Through which warehouses should the goods flow through customers?
7. Which transport means and routes should be used for delivering goods from factories to warehouses and customers?
8. Is the designed for production and distribution network compatible with the management of information system of basic logistic?

The answer to all these questions is based on criteria described in the previous section. It should be noted that different standards and criteria can be considered for a production and distribution model. The proposed model for the production and distribution network is described in Figure 7.

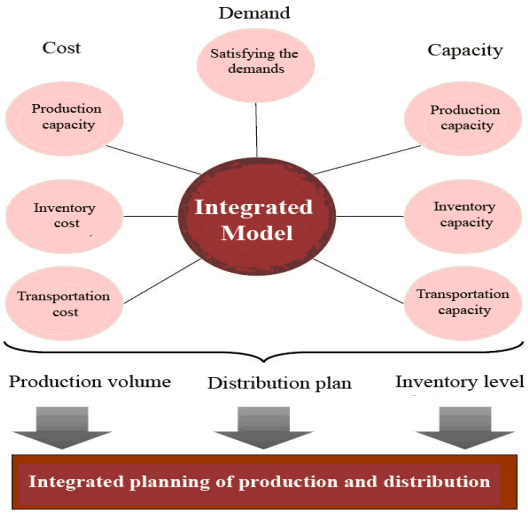

Fig. 7: Proposed model of production and distribution in logistic cycle

General characteristics of this hybrid network are a combination of 6 categories of distribution networks discussed in previous parts. As stated in Table 5, two major factors of "cost" and "service" should be taken into account in order to design a production and distribution network. In addition to dependency analysis in three fields of "capacity", "demand", and "cost", this model emphasizes on proposing an integrated model encompassing the simultaneous relationships of "inventory management", “facility placement ", and "transport policy". Another noteworthy point in this model is its emphasis on compatibility of network with the management of information system of basic logistic. In other words, given the objectives of formation of this network as a system which controls logistic environmental information in the field of goods, an appropriate data base has been created in order to equip the proposed integrated network provides. Emphasizing on the presence of internal dependency between three macro variables affecting the decision making, this model underlies the increase in total inventory of system due to increase in the number of distribution centers. This also leads to higher satisfaction of customers due to faster and more reliable methods of transportation.

2. Conclusion

Since the place of production and consumption is not the same, each industry needs to use distribution networks and transportation services to deliver its products to customers. In many centers, the costs of production-distribution networks, transportation, and consequently inventory management account for a substantial part of prime cost. Regardless of the costs mentioned, the design of an efficient integrated model with its abilities and capabilities can play an important role in competitiveness and success of any chain. So, industries pay a lot of attention to various issues rose in the attitude of integrated production-distribution systems and are trying to get the most of total costs reduction to make the whole cycle successful.

This paper has tried to propose an integrated logistic model according to current situation of Iran's industrial units and with a look at the opportunities and threats to the domestic industries. One of the important features of this integrated model is its compatibility with the management of information system of basic logistic. This leads to the creation of an appropriate informational context in order to meet the goals of the proposed production-distribution network.

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