

## Distribution Network and the Role of Information and Communication Technologies (ICT)

### RÉSEAU DE DISTRIBUTION ET RÔLE DE TECHNOLOGIE D'INFORMATION ET DE COMMUNICATION (TIC)

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**Abstract:** Distribution as a function of marketing, consisting distribution channel management and physical distribution, has significantly improved the physical distribution as a result of developments in the field of information and communication technologies. In this sense, the companies are working towards establishing alternative distribution channels. The most important tool strikes us in this sense is technology. This research provides examples of the innovative distribution systems enabled by ICT and the role and importance of ICT in these systems. Applications from the practice are also presented to exhibit the positive results achieved through the use of technology.

**Keywords:** Marketing; Distribution Network; Supply Chain Management; Information and Communication Technologies.

**Résumé:** La distribution en tant qu'une fonction du marketing, composée de gestion des canaux de distribution et de la distribution physique, a considérablement amélioré la distribution physique à la suite du développement dans le domaine des technologies d'information et de communication. En ce sens, les entreprises sont en train d'établir des canaux alternatifs de distribution. L'outil le plus important est la technologie. Cette recherche donne des exemples de système de distribution novateurs reposant sur les TIC et le rôle et l'importance des TIC dans ces systèmes. Les applications dans la pratique sont également présentées pour exposer les résultats positifs obtenus grâce à l'utilisation de la technologie.

**Mots-clés:** Marketing; réseau de distribution; gestion de chaîne de provision; technologie d'information et de communication

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## **INTRODUCTION**

Distribution channels can be defined as a network or structure established by the units inside the firm and the agencies, wholesalers, retailers outside the firm in order to market the goods and services (Tek, 1997). On the other hand, distribution as a function of marketing, consisting distribution channel management and physical distribution, has significantly improved the physical distribution as a result of developments in the field of information and communication technologies (ICT).

The biggest constraint of conducting a successful marketing in many market is distribution. Unless the problems in the distribution channel are effectively handled, delivering the goods to the target market can result in high costs. Thus, it is a difficult, yet highly critical task to build a dynamic, dependable and well-functioning distribution channel for the companies operating in the international market (İşbaşı, 2001). In this sense, the companies are working towards establishing alternative distribution channels. The most important tool strikes us in this sense is technology.

The number of alternatives for the consumers has significantly increased as a result of developments in technology following the industrialization, improvement of transportation and communication enabled by new technologies, and increasing number of companies producing similar goods and services (Soysal and Koçkaya, 2004). In an ever-increasing fierce competition along with the developments in technology, these companies have started to use the innovative distribution tools as a source of competitive advantage by implementing these tools. Using the same distribution channels with the competitors, brings difficulties for the companies in competition. Thus, using different channels poses as an opportunity of gaining competitive advantage over the competitors.

Building a competitive environment, technological developments offer more alternatives to the customers as technology gets more and more involved in daily lives, and changes the customer profiles as a result. Better informed customer requests better service and larger selection of goods for lower prices. This situation forces the companies to evolve their marketing techniques and offer more alternatives (Akkılıç, 2005). Distribution is an important marketing field to generate alternatives for the customers.

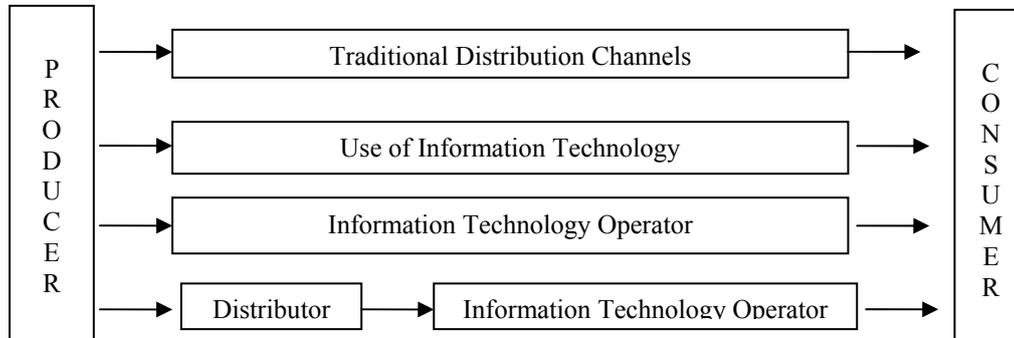
Utilization of technology in the distribution system is observed as an important competition factor since it enables unlimited location, time and even product types to the customers. Thus, the companies have had to change or improve their channel designs or structures related to the recent technological developments. Generation of distribution system which is a vital cost figure in global competition, and adopting it according to the innovations and developments by time have become an important function for companies. The role of the fact that the costs of traditional distribution channels are high as opposed to the lower costs of new distribution channels involving high technology, has a lot to do with this new function (Eroğlu et al, 2008).

Technology is an important factor by helping to reduce the distribution costs and run the channel successfully, along with its channel management and physical delivery of the goods functions. For instance; followed by the utilization of information technologies in the distribution in the medicine wholesale industries, the percentage of distribution costs in sales has decreased to 2,5 since 1970-1990 period where it was 16%. Moreover, the widespread use of information technologies has caused the distribution channels become electronic with a high extent and evolved the intermediary organizations, even eliminating them in some cases. (İraz, 2004). This way, shorter distribution channels have emerged.

The rapid developments in recent years in the information technologies have resulted in distribution channels with different characteristics in industries such as banking, tourism, and traveling (Buhalis, 1998). The affects of the developments in information technologies on the distribution channels of service industries have been larger than its affects on the distribution channels of the goods. Due to its characteristics, service industries require more intermediaries in the distribution channels than a physical distribution channel (Sarı, Kozak, 2005). Thus, according to the traditional distribution approach, in spite of the powerful role of information technologies, the power of the relation between the buyer and seller will continue as it is a main feature of service businesses (Lin, 1998).

Using the technological developments in the design of distribution channels, more effective and innovative channels are emerging, along with shorter channels. Two different situations exist at this point.

The first one is, the company designing the distribution by utilization of information technology; the second one is, the company foreseeing the the distribution over the information technology operators (Rimington and Kozak, 1997). These new channel types are presented in the figure below. On the other hand, the traditional and the new distribution channels developed based on the information technologies are also used together in some cases.



**Figure 1: New Distribution Channels Based on Technology**

Source: Rimington and Kozak 1997.

According to the innovative approach, the information technologies will propose revolutionary opportunities in service industries by eliminating the intermediaries; thus, re-shape the distribution channels (Steiner and Dufour 1998; Schuster 1998; Hamil 1997).

Widespread use of internet technologies have also changed the classical distribution channels of the banks. For instance; machines such as ATM and BTM have completely changed the distribution channels as a new channel that does not require level of contact in banking. Internet as one of the most important information technology tools, is being widely used in exchange, distribution, and communication fields.

Another feature of the Internet is the fact that it can be used as a distribution channel as well. This way, the intermediaries in the channel structure are eliminated while new types of intermediaries are being emerged as a result. These are the companies resulting from the market space. These new intermediary types are organizations such as search directories (yahoo, excite, etc.), search engines (altavista, google, infoseek, etc.), virtual shopping centers, virtual sellers (amazon), banks offering digital money, financial intermediaries offering stock exchange services etc., opinion forums on virtual environment, and many more. The distribution channels over the internet are in the form of electronic networks. The distribution channel customer being in contact can be integrated to the system. Especially, new supply chain management as one of the e-business components can be utilized as a result of the adaptation of the Electronic Data Interchange (EDI) systems to the Internet. Thus, a binding relation between the intermediaries and the customers, and a vertical market network can be established. Elimination of the burden of search for supplier, elimination of the waste of time and effort as a result of changing the supplier, and the advantages stemming from the long-term relations can be mentioned among the advantages of this new system (Ventura, 2003).

Use of technology responds positively to all of the important factors listed among the distribution channel mix, such as low-cost distribution channels, convenience for the customer, the quality of the goods and services to be delivered to the customer, and the speed of the delivery (Toraman, 2002).

Technology shortens the distribution channel by combining the units involved. The information technologues and power of the retail industry has led the developments in the fields such as virtual supply chains, virtual networks, and e-business by acting as a catalizor in this process. Internet businesses such as Amazon.com have obtained major successes in the flow of goods and supply processes by adapting the information flow to the electronic environment (Johnson and Pyke, 2001).

The research by Mourits and Evers discusses the design of large-scale distribution networks which entails taking decisions on a large number of issues that are all closely interrelated, making it difficult to develop a competitive distribution strategy. Many support systems for distribution planning have been

developed, but, they do not facilitate a coherent approach to the design process. The authors present a logistic planning system that provides dedicated support for all issues involved in distribution planning. The foundation of which is an integrated planning support framework. The research proposes that small models dedicated to only part of the total design process provide the best support for logistic planning and that such models encapsulated in a framework lead to optimal system design. Suggests that when the support system is applied to strategic/tactical distribution planning, the design process requires less time and less expert capacity, while resulting in a more competitive logistic supply chain (Mourits and Evers, 1995).

Jayaraman and Ross describe 'PLOT' (Production, Logistics, Outbound, Transportation) design system. The system addresses a class of distribution network design problems, which is characterized by multiple product families, a central manufacturing plant site, multiple distribution center and cross-docking sites, and retail outlets (customer zones) which demand multiple units of several commodities. The resulting system focuses on two key stages: the planning stage where we incorporate a *strategic* based decision-making process of selecting the "best" set of distribution centers and cross-docks to operate. The second phase consists of the execution stage that includes an *operational* based decision-making process. In this phase, the model decides the required quantity of product families that need to be transported from the plant to distribution centers and transshipped to cross-docks from warehouses, and later distributed to customer outlets (Jayaraman and Ross, 2003).

The distribution system design considered here is derived from current operations of a major retailing organization that manages products for nationwide distribution. The PLOT system developed to implement the model provides for a high degree of user interaction in the generation of solutions. The overall system generates globally feasible, near optimal distribution system design and utilization strategies utilizing the simulated annealing (SA) methodology.

Ambrosini and Scutella study some complex distribution network design problems, which involve facility location, warehousing, transportation and inventory decisions. Several realistic scenarios are investigated. Two kinds of mathematical programming formulations are proposed for all the introduced problems, together with a proof of their correctness. Some formulations extend earlier models for some warehouse location-routing problems; other formulations are based on flow variables and constraints (Ambrosini and Scutella, 2005).

## **1. LOGISTICS NETWORK CONFIGURATION**

The strategic problem of designing distribution systems has been important since not long after the dawn of the industrial revolution, but only in recent times has it become possible to design complete distribution systems that are truly optimal for all practical purposes. Using optimization to design distribution systems became available a little more than three decades ago, and developments have occurred at a rapid rate ever since. These developments can be understood in terms of evolution of algorithms, data development tools, model features and software capabilities.

The logistics network consists of suppliers, warehouses, distribution centers, and retail outlets as well as raw materials, work-in-process inventory, and finished products that flow between the facilities. Network configuration involves issues relating to plant, warehouse, and retail location. These are strategic decisions because they have a long-lasting effect on the firm.

Designing a supply chain consists of configuring the network so as to satisfy customer demands while minimizing fixed costs for facility construction or leasing and technology acquisition, and variable costs for production, storage and transportation. Because of the complexity of the problem, it is often decomposed into several components treated separately. For instance, one may first locate plants and distribution centers and then plant a transportation network to link these facilities. However, because of the interactions between these decisions, important benefits can be obtained by considering the various components of the supply chain simultaneously.

Although there is an abundant literature on facility location and distribution network design problems, very few planning models integrate all decisions from raw material procurement to finished product distribution (Arntzen, Brown, Harrison, and Trafton 1995; Vidal and Goetschalckx 1997).

### **1.1 Data collection**

A typical network configuration problem involves large amounts of data including information on:

- Location of customer, retailers, existing warehouses, manufacturing facilities, and suppliers.
- All products, including volumes, special transport modes.
- Annual demand for each product by customer location.
- Transportation rates by mode.
- Warehousing costs, including labor, inventory carrying charges, and fixed costs.
- Shipment sizes and frequencies for customer delivery.
- Order processing costs.
- Customer service requirements and goals.

#### *Data Aggregation*

It is obvious that the size of the data involved in any optimization model for this problem is overwhelming. For that reason, data aggregation is essential. This is carried out using the following criteria:

Customers located in close proximity to each other are aggregated using a clustering technique. All customers within a single cluster are replaced by a single customer located at the center of the cluster. This cluster is referred to as a customer zone. An effective technique that is commonly used is to aggregate customers according to the five-digit zip code.

Items are aggregated into a number of product groups, based on distribution pattern or product type.

An important consideration is the impact on the model's effectiveness caused by replacing the original data with the aggregated data. This issue can be addressed in two ways:

1. Even if the technology exists to solve the logistics network design problem with the original data, it may still be useful to aggregate data because our ability to forecast customer demand at the account and product levels is usually poor. Because of reduction in variability achieved through aggregation, forecast demand is significantly more accurate at the aggregated level.

2. Researchers report that aggregating data into about 150 to 200 points usually results in no more than a 1 percent error in the estimation of total transportation costs. (Ballou, 1992; House and Jamie, 1981)

#### *Transportation Rates*

The next step in constructing an effective distribution network design model is to estimate transportation costs. An important characteristic of most transportation rates, including truck, rail and other, is that the rates are almost linear with distance but not with volume. We distinguish here between costs associated with an internal and an external fleet.

#### *Mileage Estimation*

The transportation cost is a function of the distance between two points. Thus, the distance between points has to be estimated accurately. We can estimate distances using either street network or straight-line distances.

### **1.2 Warehouse Costs**

Warehousing and distribution center costs include three main components:

1. Handling costs which include labor and utility costs. These costs are proportional to annual flow through the warehouse.

2. Fixed costs which cover all cost components that are not proportional to the amount of material that flows through the warehouse.

3. Storage costs represent inventory holding costs, which are proportional to average inventory levels.

Thus, estimating the warehouse handling costs is easy while estimating the other two cost values is quite difficult. When constructing the data for the DSS, annual flows have to be converted into actual inventory amounts over time. Similarly, annual flow and average inventory associated with this product tell us nothing about how much space is needed for the product in the warehouse. This is true because the amount of space needed in the warehouse is proportional to peak inventory, not annual flow of average inventory.

An effective way to overcome this difficulty is to utilize the inventory turnover ratio. The inventory turnover ratio is the ratio of the total annual flow through the warehouse to the average inventory level.

### **1.3 Warehouse Capacities**

Another important input to the distribution network design model is the actual warehouse capacity. The question is how to estimate the actual space required, given the specific annual flow of material through the warehouse. Again, the inventory turnover ratio suggests an appropriate approach. Annual flow through a warehouse divided by the inventory turnover ratio allows us to calculate the average inventory level. Assuming a regular shipment and delivery schedule, it follows that the required storage space is approximately twice that amount. In practice, every pallet stored in the warehouse requires an empty space to allow for access and handling, thus, considering this space, the required storage space is multiplied by a factor ( $>1$ ). This factor depends on the specific application and allows us to assess the amount of space available in the warehouse more accurately. A typical factor used in practice is three.

### **1.4 Service level requirements**

One of the various ways of defining service level is specifying a maximum distance between each customer and the warehouse serving it. This ensures that a warehouse will be able to serve its customers within a reasonable time. In cases where it is not possible to satisfy the same level of service for customers in isolated areas, it is helpful to define the service level as the proportion of customers whose distance to their assigned warehouse is no more than a given distance.

### **1.5 Solution techniques**

Once the data are collected, the next step is to optimize the configuration of the logistics network. In practice, two techniques are employed:

1. Mathematical optimization techniques that include:

- Exact algorithms that are guaranteed to find optimal solutions, that is, least-cost solutions.
- Heuristic algorithms that find good solutions but not necessarily optimal solutions.

2. Simulation models that provide a mechanism to evaluate specified design alternatives generated by the designer.

These tools can determine strategies that will significantly reduce the total system cost. In such models, there is the need to establish optimal locations for warehouses, distribution centers, and cross-dock facilities. These decisions render linear programming inappropriate and require the use of a technique called integer programming. On the other hand, integer programming models are significantly more difficult to solve.

The mathematical optimization techniques have important limitations. They deal with static models, and they do not take into account changes over time. Simulation-based tools take into account the dynamics of the system and are capable of characterizing system performance for a given design. Thus, it is up to the user to provide the simulation model with a number of design alternatives. This implies that simulation models allow the user to perform a micro-level analysis.

Simulation models only model a pre-specified logistics network design. In other words, given a particular configuration of warehouses, retailers, and so forth, a simulation model can be used to help estimate the costs associated with operating that configuration. If a different configuration is considered, the model has to be rerun.

## **2. INNOVATIVE DISTRIBUTION SYSTEMS**

The role and importance of ICT in the modern distribution systems follows an ever-increasing pattern. As opposed to the previous decades when it was considered to be an extra value to the companies, it is now a compulsory tool without which the companies cannot compete in the market. As the profit margins decrease, and the production processes have reached very high levels of productivity, the companies are obliged to find other ways of decreasing costs. Distribution channels which is the current focus point of companies in this sense, are designed through the use of computer technologies to provide the next competitive edge. The role of ICT can be summarized as follow:

1. Increase of Sensitivity to the Markets
2. Simplification of the Distribution System
3. Increased Number of Channel Types
4. Increased Market Size
5. Widespread Use of E-commerce
6. Internationalization and Easier Entry to the Global Markets
7. Change of Distribution Channels

The most popular innovative distribution systems enabled by ICT are listed as follow:

1. IP Tracking Technologies
2. Geographic Positioning System (GPS)
3. Optimum Route System
4. Automated Distribution System
5. Virtual Organization System

### **2.1 Satellite Fleet Positioning System**

By tracking the company vehicles distributed in the field of operation over the satellites, the new generation satellite fleet positioning systems involves tracking and obtaining detailed and simultaneously updated information such as when and where a given vehicle being used by whom, where it currently is during the day, the speed of the vehicle, how long and where it is standing by, and how many miles it has traveled. By using the internal soft shock sensor placed in the unit, it is even possible to find out the way (sudden acceleration, stops) the drivers use the vehicles. Utilizing such a system gives the companies an edge in distributing the produces very effectively.

### **2.2 IP Tracking Technologies**

Every computer connected to the Internet possesses an Internet Protocol (IP) number. This number makes it possible to determine the country or city of the computer connecting to a certain website. This feature provides an opportunity for the companies to design their distribution systems based on the number of connections from different regions. This application has been successfully implemented by VESTEL and the company has started to make direct deliveries to the countries where it had not delivered its products directly previously.

Given the objective of instituting a better measurement system, in 2000 Vestel decided to implement Manugistics' Network Transport Management (MTM) module as the next stage of improvement efforts for the distribution system. This package was chosen based on the service options made available in Turkey by

the various SCP providers and subsequent negotiation on price. Vestel Durable Goods Marketing was the first company in Turkey to implement such a transportation planning system.

The transportation optimization software program utilized, schematizes the optimal route and truck volume for daily-prepared deliveries. The inputs to the system include the location of Vestel's warehouses, transfer stations, and customers, customer orders, transportation modes, and associated costs. The optimization program uses these inputs and finds a solution within the constraints imposed by the management to minimize total transportation costs. The route and truck planning is made according to the inputs and constraints.

There are three different location types in Manugistics: warehouse, transfer station and customer. All locations have zip codes generated specifically for Manugistics. These codes are different for each province. Some big provinces are divided into two or more regions. The distances between each two zip codes are put in a network table, and the distance between two points located in the same zip code is set to three kilometers.

The volume information for each product is provided as an input into the system. Three different truck sizes can be used for transportation, in addition to a direct cargo alternative. The costs of using each alternative are set in the system. Ten-wheel or eight-wheel trucks are used for transportation from the warehouses to transfer stations. Small trucks then make the deliveries from the transfer stations to customers. There is also a direct cargo alternative from the warehouse in Manisa. Dealers with high volume demands can receive direct deliveries with large trucks. The software selects the direct cargo option based on transportation costs. Truck utilization constitutes an important criterion for deciding on the mode of delivery.

The management uses two policies related to efficiency and customer service. The first policy is related to truck utilization. A truck must be at least 65% full in order to depart for its destination, otherwise it waits until this rate is achieved. The maximum waiting time is the other policy related to customer service. Waiting time is restricted to a maximum of three days, in order to provide good service to distributors. After three days, even if an appropriate truck is not 65% full, an order will leave the warehouse by truck or by cargo, whichever is more efficient. The software does not optimize truck loading. Since it does not plan inside the truck, loading problems may occur: Given the difference in the shape of various goods being transported, not all items planned by the software may be loaded on a truck due to space constraints. As a result, volumes were increased to enable the feasibility of the plans generated by the software. While truck load optimization would be feasible for simple deliveries between two points, the Vestel distribution problem is significantly more complex due to routes that have multiple drop-off points. As a result, the planning objective is not to find the loading that maximizes truck utilization, but rather the loading that facilitates the best unloading of trucks without having to load and unload different items at the various drop-off points.

The results obtained from the implementation of the system were phenomenal. Truck utilization went up while the transportation costs decreased immediately following the implementation. In the first two years alone, transportation costs were decreased by 46% despite the increase in diesel prices and increase in the Consumer Price Index. The unit cost of transportation per item went down in some cases by as much as 75%. In addition to the new planning system, a number of other factors were also instrumental in achieving high utilization rates. First, the number of orders entered manually into the system decreased. Moreover, the total volume also increased. Finally, an increase in pre-paid orders helped to achieve a more even distribution of the orders within a month.

The success that Vestel has experienced after implementing a DSS model in the distribution planning process has once again demonstrated the important and vital role of DSS in effective supply chain practices.

### **2.3 Automated Distribution System**

Being successfully implemented by Wal-Mart, the automated distribution systems have become to occupy a vital role in the distribution systems of many industries working on tight schedules. In such industries, as soon as the level or number of products in the point of sales decreases below a safety stock, the system automatically places an order to the supplier, thus making it possible to replenish the stocks before the seller

runs out of stock. Successful management of the system avoids losing the customers to the competitors by providing them with the same quality product continuously.

Innovations introduced by Aygaz in the area of service include its Integrated Order System (ESS) and the largest mobile POS system in Turkey, developed in partnership with the Worldcard and Maximum credit card brands.

Integrated Order System (ESS), designed for cylinder gas to be delivered to consumers as fast and problem-free as possible, was improved in August of 2009 as ESS Web is launched. Not only does ESS Web facilitate system installation and maintenance, it also makes it easier for regional sales staff to access the system, closely track customers through customer reports and additional applications, and to carry out follow-up and customer relations activities that increase customer satisfaction. As of the end of 2009, 614 dealers were using ESS and 59% of sales were being processed on ESS. The system has 2.5 million active individual customers registered.

An example order process works as follows: The process starts with the customer calling the closest Aygaz retailer, and the retailer placing the order to the Aygaz and the Customer Service Agent simultaneously through the computer. The agent receiving the order through the mobile hand terminal, delivers the product to the customer and passes this information to the retailer and Aygaz through the hand terminal once again.

## **2.4 Virtual Organization System**

This system is especially being efficiently utilized by the wholesalers in the computer technologies industry. The system involves using the databases of the giant computer OEM wholesalers such as INDEX, ARENA, and PENTA by the small virtual firms without taking any risk, and forwarding the orders received from the customers over the internet to the suppliers, forwarding the payment directly to the account of the supplier and taking the profit to its own account. Currently, the system is being extended by adding the databases of wholesalers in several other industries to the system.

## **2.5 Optimum Route System**

This is a system used especially by the logistic companies and retail distributors to distribute the products with the minimum costs by minimizing the traveling distances. Heavily dependent on the use of information technologies, the system requires information such as the locations of the customers to be delivered a product, the detailed maps of the region, and other information related to the delivery as input, in return for alternatives of distribution routes for the decision makers to choose from. This way, the distribution is made on time and at minimum feasible costs. The system is especially vital for the distribution of products consumed freshly and requiring specially equipped vehicles.

# **CONCLUSIONS**

Important issues in the design of the distribution systems are examined in this study. The role of computer information technologies in this design process are mentioned along with the examples of modern distribution systems. Applications of such systems are also provided for better understanding the systems and intended to show the effectiveness of them.

Another important issue often raised in practice is the need for a decision-support system to optimize the logistics network. The question is whether a sophisticated tool is required or spreadsheets alone are sufficient. This study argues that a thorough logistics network analysis should consider complex transportation cost structures, warehouse sizes, manufacturing limitations, inventory turnover ratios, inventory costs, and service levels. These issues require the use of optimization-based decision-support systems that can solve large scale problems efficiently.

The future research is intended to include in-depth case studies for each of the innovative distribution systems mentioned in this study, as well as others that promises advantages to the firms.

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