CHAPTER 6
LOCATION OF THE DISTRIBUTION CENTRE

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Abstract

This paper concerns the problem of localisation of distribution centre and regional depots, under the dynamic development of clients requirements, in particular delivery time. The proposed methodology of distribution network design is taking into account the joint movement of goods in the network, associated with both classical and modern way of sale. The research carried out in the paper is based on simulation model that reflects the operation of this type of distribution system. Based on the generic model different way of distribution processes were simulated and as a result the cost of distribution processes have been calculated. Constructing different variants of distribution processes the following changes have been taken into account: picking processes, the place of their implementation in the structure of the distribution network (central warehouse, regional warehouses or hybrid solution), the method of delivery (by regular routes or courier services). As a result several distribution network parameters have been defined, including the number and warehouses at different levels of the distribution network, the stock of goods dispersed through the network, the time of delivery to the customer, the scope of delivery, etc. Based on this information the final decisions about the shape of the distribution network and distribution processes was made.
Keywords: distribution network, distribution processes, simulation model of the distribution network, e-commerce

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6.1. Introduction

The location of the distribution centre, regional warehouses, and hence the organisation of transport processes significantly affect the smooth functioning of the entire logistics system of the company and are the key elements of the distribution network. Proper location of warehouses as well as effective and efficient organisation of transport processes in the enterprise have a direct impact on the reduction of logistics costs as well as raising the standard of customer service. It is particularly important to determine the number and location of central warehouses, regional warehouses and transshipment points, to determine demand for own or hired means of transport, and select a cost-effective method of transport, e.g. by road, rail, sea or intermodal transport.

By monitoring the market distributors in the traditional market are trying to meet customer needs by opening new channels of distribution of their goods. However, in many cases, this entails reorganisation of the existing distribution network, in particular when the distributor starts to operate in e-commerce, which, depending on the industry, is characterised by a number of advantages and disadvantages (Kolinska, Jelen, Cudzilo, 2016). Customer service in this sales channel is directly related to the organisation of the so-called last mile processes. These are not only transport processes themselves, but also matters related to order picking and the place of their execution, for example, the central or regional warehouse. All these elements affect the speed and efficiency of supply, and therefore the level of customer service and cost effectiveness of the processes.

Due to the popularity of e-commerce (Michalski, 2010, p. 4-6, and Coyle, Bardi, Langley, 2003, p. 157-163) and the annually increasing level of turnover in this sales channel the leading distributors of goods from various industries are massively opening e-shops. They cannot afford that customers who used to came to their brick-and-mortar stores use the services of the e-shop of its competitor due to a change in habits. It would seem that it is easier for the big players operating traditional distribution networks in the B2B channel to adapt to B2C solutions (business to customer). As practice shows, these companies are also facing problems arising, for instance, from the retail size of orders, which in many cases requires the total reconstruction of warehousing and transport processes. Furthermore, an additional complication is the fact that these companies also serve customers in the traditional and e-commerce channel. Logistics services are significantly different in the traditional sales channel and in e-commerce. Logistics processes of distributors so far supporting traditional sales channels used to be extensively optimised. The implementation of e-commerce in many cases requires

the adaptation of logistics processes and additional investment, e.g. in specific storage infrastructure (e.g. automatic cabinets, scanning tables, scales, etc.). In addition, the processes so far used by distributors to a limited extent must be extended for the sake of e-commerce. This applies above all to the return and complaint handling process. In many cases, distributors operated based on their own network of regional warehouses or transshipment points, all of which were operated by local wholesale stores and shops. Transport between the individual points in the distribution network was handled by small operators that in most cases supported only one distributor. In the case of direct services for e-commerce customers, the supply process described above becomes unprofitable. Therefore, there is the need to employ large courier companies providing groupage transport services. This stems from the fact that logistics in e-commerce requires appropriate forwarding facilities and the reliability of the processes of direct supply requires cooperation with specialised companies. In order to determine the method of transforming the distribution structure, these companies take action aimed analysing the current situation and simulating their operating costs in the event of changes in the share of the stream of goods handled in the traditional channel in favour of e-commerce. In many cases these activities entail the need to develop a mathematical model reflecting the existing distribution solutions. Then further variants of the analysed solution are developed to provide alternative means of execution of distribution processes, and the values of the criteria used to assess these scenarios are determined. Decisions on the reorganisation of the distribution processes are made on the basis of the simulation and evaluation of individual models in terms of: number of storage locations, deployment of the stocks of goods, lead time, delivered items, etc.

The fundamental question emerging from this assessment of the current situation in the field of e-commerce solutions that the authors are trying to answer is whether it is possible to effectively combine traditional distribution of goods with the distribution as part of e-commerce? In addition, what level of distribution costs would be acceptable for this solution, with a specific customer service level? Therefore, the aim of this paper is to determine the feasibility of modelling of distribution processes with the use of simulation tools to support the process of determination of the location of distribution centres and transshipment points, and planning routes along the 'last mile'.

6.2. Determining the location of a distribution centre

Referring to the fundamental challenge faced by the distribution logistics (adjustment of supply to market demand), the distributor should collect and provide

the appropriate product range in quantities that are close to market needs. Also the choice of the distribution channel is a strategic matter to each company. Therefore, it is so important to assess the existing model of operation of the distribution network. This assessment allows to redesign the distribution system so as to be able to support sales in the traditional channel and in e-commerce. The developed model of operation of the distribution network supporting the two sales channels should in the first place allow to achieve cost optimisation with a given level of customer service (Pfohl, 2001, p. 248-258). However, in e-commerce, the level of customer service is often interpreted as the lead time. Based on the work of Coyle (Coyle, Bardi, Langley, 2003, p. 160-165) and the authors' own experience, the development of a goods distribution network can be divided into three main stages shown in Figure 6.1, including:

- analysis of existing processes based on collected data,
- development of a simulation model that reflects the functioning of the existing goods distribution network; validation of the model; development of alternative models for simulation,
- simulation, definition of the criteria for the evaluation of solutions and ultimately selection of the best model of the operation of the distribution network along with possible changes.

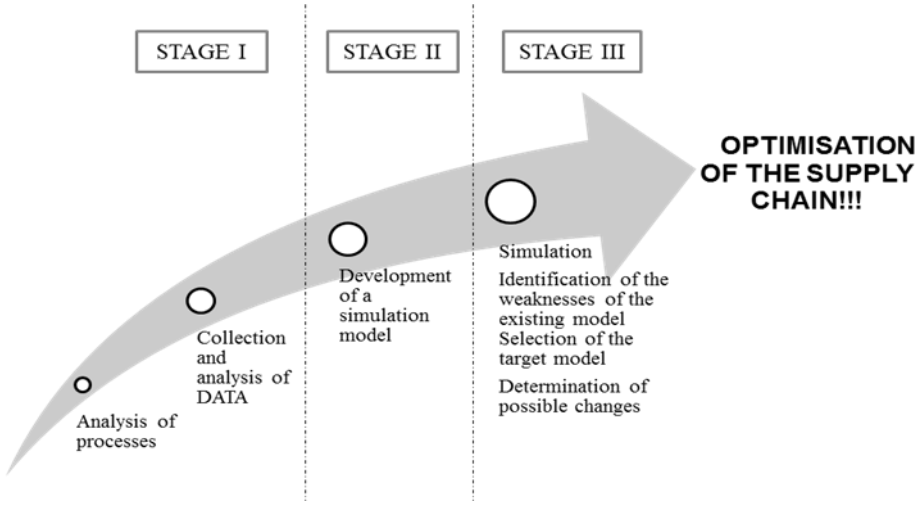

Fig. 6.1. Stages of development of the goods distribution network
Source: own study

The basic element allowing to create further variants used to simulate the distribution network is a very good knowledge of the existing model and

relationships within it (Fig. 6.2). The development of forecasts and simulations is mainly based on historical data.

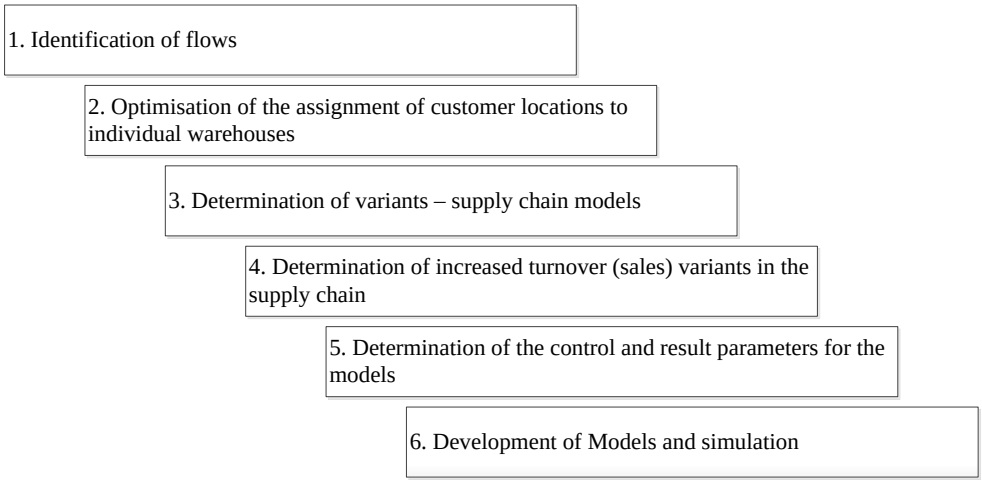

Fig. 6.2. Stages of development of a simulation model
Source: own study

As this chapter presents the case of the distribution network, the basic data for forecasts and simulations concern historic sales to end customers.

The sales volume measured by the quantity or value of goods purchased by a customer must be identified with an accuracy of each delivery point. If the distributor expects changes in the value of sales, for instance, with respect to different types of customers or sales regions, the size of flows of goods to the individual delivery location should be verified. The next step in the methodology of building the distribution network is to assign the location of individual customers within the network of distribution warehouses. This should both depend on the distance between the customer's location and the warehouse, and the size of the goods flow. The current model should also take into account the parameters of the existing storage infrastructure allowing to handle shipments to all customers assigned to the location in question. Then, alternative models of the distribution network considered by the company should be defined. These models generally may differ in terms of such elements as:

- number of storage locations,
- functions of the individual warehouses in the distribution network (e.g. central warehouse, regional warehouse, transshipment point)
- subordination of individual locations reflecting the direction of the flow of goods.

An important element in the subsequent model simulation process is the ability to assess different options assuming different sales forecasts. Therefore, at this stage, it is very important to determine the method of generation of forecasts. The last, but at the same time the most important step before preparing simulation models is to identify the key decision variables and evaluation criteria for the analysed models of operation of the goods distribution network. The correct definition of the above-mentioned elements enables the simulation of different models in several options (changes generate further variants of the model). And the proper definition of the assessment criteria and their relationships with the variables guarantees accuracy of the results of the simulation. Finally, comparison of the results obtained for the different variants of the models allows to determine the shape of the target structure of the distribution network, that is the number, location and functions of warehouses. In addition, the stocks of goods necessary in the structure of the distribution network with a specific lead time will be designated. The next steps of the development of a model of the distribution network are presented in Fig. 6.2.

6.3. Case study – distribution network in the traditional sales channel

A family company operating continuously since 1913 is today one of the leading global suppliers of technical materials. The company offers integrated material services for installers, retailers, the industry and public institutions in the electrical, installation and sanitary, heating, ventilation and air conditioning branches. The network of its retail outlets in the Nordic countries, Russia, Lithuania and Poland employs more than 3,000 qualified people.

In Poland, the company operates on the basis of a network of 40 wholesale stores. They provide the highest standard of service, a state-of-the-art online ordering system, efficient execution of orders and delivery to the indicated destination.

Several technical industries in one place is the main asset of the company. Customer needs are met in a comprehensive manner, and the product range covers electric, installation, heating, sanitation, ventilation and air conditioning materials. The company is not only a supplier, but first and foremost a trading partner, with extensive know-how and many years of experience in building consumer and business relationships. The company offers its customers the best solutions in the management of technical materials, and its suppliers – the most convenient distribution of their products.

Customer satisfaction not only with the goods received, but also with the method of order execution are the priorities of the company. Excellent organisation of retail outlets and the logistics centre guarantees fast delivery to the indicated place throughout the country. Customers can make use of a wide range of industry catalogues offering electric, installation, sanitary, heating, ventilation and air-conditioning materials in the form of an application for mobile devices, available on-line and in printed format at any point of sale in Poland.

The company offers a wide range of logistics services: transport, storage, copacking and other additional services. Professional execution of transport orders to the indicated place in Poland is possible due to: constant availability of goods in the distribution centre, available truck fleet, rapid response to customer requests and high flexibility of the company.

Concern for the environment is a regular part of everyday business, as evidenced by the Integrated Management System compliant with ISO 9001 and 14001 owned by the company.

As can be seen from the above description, the distribution company, whose case is presented in this paper, sells very different sizes of products on the Polish market. Before starting the analytical work, the company served its customers only using the traditional sales channel. The structure of the distribution network was based on one central warehouse located in the central part of the country and a network of several dozen of regional warehouses, which essentially served as local wholesale stores (Fig. 6.3). The distributor sold products both to companies implementing large investment works in Poland and smaller companies engaged in assembly works on behalf of private investors. This diversified customer structure had a direct impact on the size of flows of goods supplied to each location as well as the customer service processes and the method of delivery.

In the case of the largest investors buying from the analysed distributor, goods were very often sent directly to the construction site, bypassing the warehouses within the network. By contrast, smaller companies engaged in the installation work bought directly or placed orders in regional wholesale stores, and goods were delivered to the agreed site.

To ensure that the distribution network operates efficiently, the distributor adopted the principle of daily deliveries from the central warehouse (depending on location) to regional wholesale stores. To this end the so-called shuttle transport services were performed. In contrast, deliveries to end customers assigned to each regional wholesale store were handled by local carriers with a smaller fleet capacity in relation to the vehicles used for the purposes of the shuttles. Depending on the potential of the region, local routes were covered at different intervals, but

not less than 3 times a week, according to a predetermined schedule. This was important from the point of view of the customer service process, because it allowed the seller accepting an order to determine the appropriate delivery date at the stage of receiving the order from the buyer. As a result of the market analysis performed by the sales team, the company's management board has decided to open an e-shop, mainly dedicated to small and medium-sized installation companies. The e-shop available via traditional web browsers was supplemented by a mobile application (Sobczak, 2010, p. 30-36).

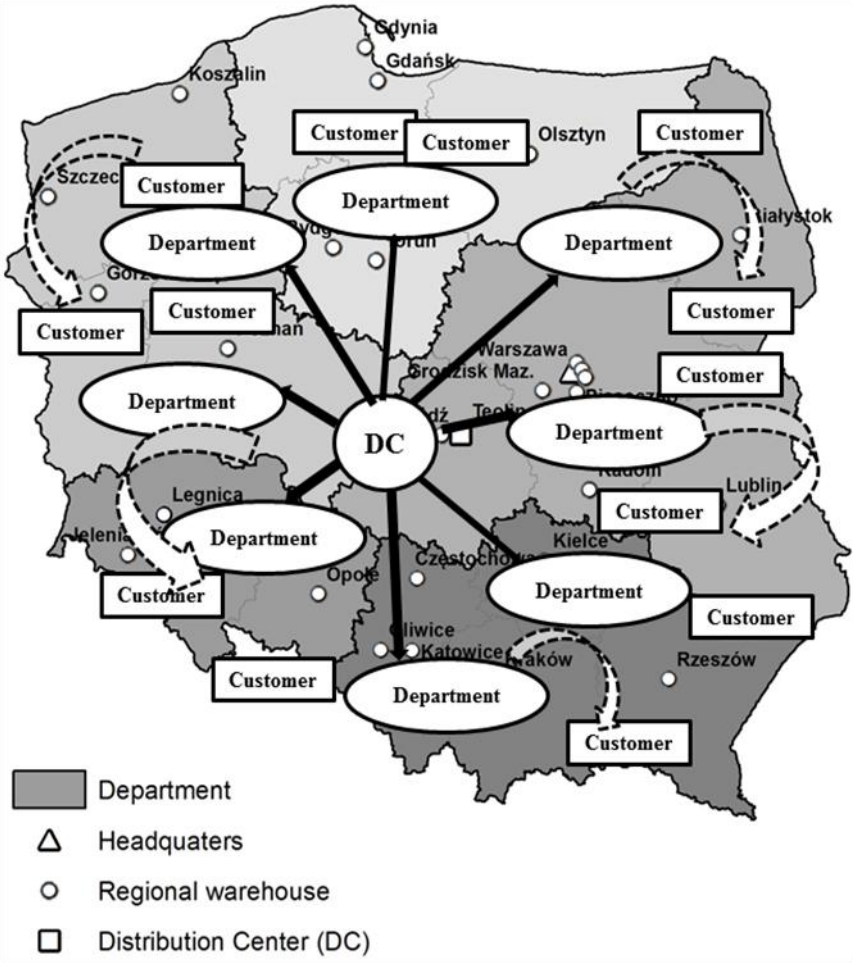

Fig. 6.3. Structure of the distribution network in the analysed case
Source: own study

The aim of the launch of the application was to increase sales by enabling installers to order missing parts from the place of execution of works. This strategic decision entailing changes in the method of taking orders from the market had a very big impact on the logistic processes carried out by the distributor. The task of the sales department was to reconstruct logistic processes (at the stage of development of a new distribution channel). But ultimately, with the assumed growth of sales through the new distribution channel (e-shop), it was necessary to reorganise the structure and the rules of operation of the whole distribution network.

6.4. Case study – variants of the distribution network model

In view of the situation outlined in the previous section, the company has decided to create several models in order to determine the preferred variant of the operation of the distribution network. The development of the models and the analysis were based on the methodology described in the previous section of this paper and the application developed in MS Excel. During the conceptual work, several models of operation of the distribution network were defined, which was followed by a detailed analysis. This paper presents selected variants of the operation of the distribution network different in terms of:

- place of execution, i.e. picking orders from the e-shop in the central warehouse, and both in the central warehouse and regional warehouses,
- method of delivery to the final customer, i.e. using courier services or including items ordered via e-shop in supplies delivered to customers in the traditional sales channel.

In order to simplify the presentation of results, it was assumed that the simulations will be carried out on the basis of historical data, and the main criterion to measure the analysed solution is the ratio of the volume of sales realised by the traditional channel to the size of e-commerce (Fig. 6.4). The analysis found that with an increase in sales through e-commerce the variety of goods is growing, so appropriate stock levels must be available at regional wholesale stores. Therefore, in accordance with the observations made in the literature (e.g. Ciesielski, 1999, p. 83-87), in particular variants there is an increase both in the demand for storage space and storage costs. In contrast, transport costs in each of the variants remain at the same level due to the assumption that e-commerce customers are served using the currently operated local routes. The adoption of this assumption was possible because the company planned to replace traditional customer service with e-commerce. However, due to the fact that customers placing orders via the e-shop

will have access to a wider range of goods than in the case of ordering at the regional wholesale stores and orders will still be executed from regional warehouses, an increase in the volume of stocks in the distribution network has been recorded.

The analysis assumed control of a set of parameters relating to: stocks, transport and storage (Stajniak, 2012, p. 75). These were parameters such as:

- level of availability of goods,
- frequency of delivery at different levels of the distribution network,
- number of lines in one order to be handled by the warehouse employee, etc.
- demand for trucks,
- size of warehouse space,
- number of available employees and warehouse equipment.

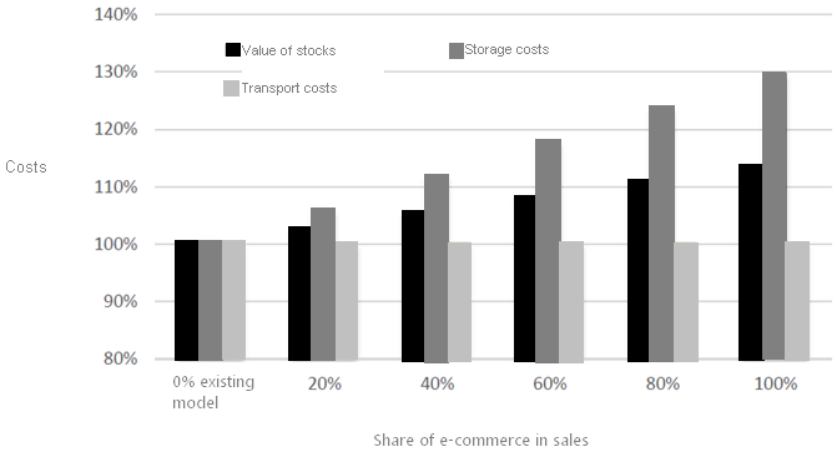

Fig. 6.4. Operating cost structure of the distribution network including change in the share of e-commerce in sales
Source: own study

Each of the control parameters has been determined for individual storage locations (in an extreme case it was more than 60 points). At the stage of determining storage locations, the analysed solutions used an IT tool allowing to determine the location of warehouses on the basis of customer data and the size of good flows delivered, based on the actual distances between the locations.

6.5. Conclusions

The results of the simulations allowed to determine both the target structure of the distribution network and the function of each of its cells. Due to the nature of goods sold (in many cases, the sale of a product is dependent on the technical advice provided by the shop assistant), it has been decided to retain the present location of regional wholesale stores. However, their sales and warehouse function will be minimised to sales. This means that storage space in these locations will be reduced to a large extent and only shop assistants will be retained. This will allow to reduce the cost of maintaining too high levels of stocks (as is the case when the supply of goods is distributed in the network) and the costs of maintaining several dozens of warehouses. In addition, the distributor will gradually increase the number of stores in Poland. These stores will be rather used for exhibition purposes and for placing orders. In addition, the product range will be divided in terms of transportability based on dimensions. Small-sized goods sold together with other products will be picked in the central warehouse and delivered to customers via courier. These are mainly goods ordered via the mobile application. In contrast, large-size goods (regardless of the method of ordering) will be delivered from the central warehouse through transshipment points. However, the transshipment points will be part of infrastructure of a third-party company providing services in this area as well as organising deliveries on local routes. The models created in accordance with the methodology presented in this paper are currently used by the distribution company to carry out periodic analysis. As part of the analysis historical data forming the basis for the simulations are updated and sales forecasts are verified. On this basis, the company makes a decision on the conversion of subsequent regional wholesale stores into shops, defines locations for new shops and identifies places to establish cooperation with local service companies operating transshipment points.

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LOGISTICS MANAGEMENT BASED ON STRATEGY FORMULATION, PLANNING, MATERIAL FLOW CONTROL, WAREHOUSING, INVENTORY, WORK IN PROGRESS, FINISHED GOODS AND ADEQUATE INFORMATION - FROM THE POINT OF OBTAINING TO THE POINT OF CONSUMPTION - IN ORDER TO ADJUST TO THE NEEDS OF CUSTOMERS AND THEIR SATISFACTION. TASKS OF LOGISTICS MANAGEMENT CAN BE DIVIDED INTO SUPPLY LOGISTICS, PRODUCTION AND DISTRIBUTION. THEREFORE, IN THIS MONOGRAPH IT WAS DECIDED TO TAKE INTO ACCOUNT THE BASIC MATERIAL FLOW PHASES IN TERMS OF ENTERPRISE AND SUPPLY CHAIN MANAGEMENT.

THIS MONOGRAPH IS THE RESULT OF COOPERATION BETWEEN RESEARCHERS FROM POZNAN SCHOOL OF LOGISTICS AND POZNAN UNIVERSITY OF TECHNOLOGY, SPECIALISTS FROM INSTITUTE OF LOGISTICS AND WAREHOUSING AND PRACTITIONERS OF THE LEADING POLISH LOGISTICS ENTERPRISES. THE PRINCIPAL AIM OF THE MONOGRAPH IS A COMPREHENSIVE APPROACH OF LOGISTICS MANAGEMENT, INCLUDING BEST PRACTICES. THE RESULTS OF THE RESEARCH PRESENTED IN THIS MONOGRAPH ARE THE RESULT OF A DETAILED ANALYSIS OF NOT ONLY THE POLISH ECONOMY, BUT ALSO OF INTERNATIONAL SCIENTIFIC COOPERATION BY THE AUTHORS OF INDIVIDUAL CHAPTERS, WHICH OBTAINED ALSO THANKS TO THE ERASMUS+ PROGRAMME. THEREFORE, ANOTHER IMPORTANT AIM OF THIS MONOGRAPH IS TO PROMOTE THE KNOWLEDGE AND BEST PRACTICES REGARDING THE LOGISTICS MANAGEMENT AND THEIR CONFRONTATION WITH OTHER RESEARCH INSTITUTIONS IN THE EUROPEAN UNION.

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