LOGISTICS PLANNING IN THE AREA OF THE LOGISTICS 4.0 CONCEPT

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Abstract

Logistics 4.0 as a concept that focuses on the increased integration of enterprises within open supply chains, the development of management support IT systems, logistic processes automation and control, generates changes in the logistic planning process. The article presents a method of logistics planning that allows the implementation of the planning process in a comprehensive view in accordance with the assumptions of Logistics 4.0. The proposed approach is oriented towards a given logistics system in capital groups with a large number of raw materials, finished goods and commodities, taking into account dynamic changes in supply chains and emerging external disturbances. The proposed approach is oriented to a given logistic system, taking into account dynamic changes in supply chains and emerging external disturbances. The proprietary method enables modelling of any number of objects integrated in the supply chain according to the same criteria and tools, to ensure comparability of the optimization results of individual scenarios with a relatively small amount of work, shortening the entire logistical planning process and increasing the efficiency of managers and teams responsible for the planning process.

Keywords: Logistics 4.0, logistics planning

1. INTRODUCTION

Supply chains, especially global ones, have always been affected by predictable or unforeseen events that threaten their profitability and continuity. Practitioners and researchers have, thus, been interested in investigating the causes of these events in an attempt to mitigate the effects of the associated risks. With the broad Industry 4.0 paradigm, a specific research stream on the impacts and applications of Industry 4.0 technologies in logistics has been emerging under two different labels: “Smart Logistics” or “Logistics 4.0” [1]. With the rapid development of science and technology, the continuous deepening of global economic integration has greatly increased the intensity of market competition. In order to keep up with the pace of social development, enterprises continue to shift their sights to the supply chain management (SCM) model with logistics planning as the core concept. Currently there is a shift from a seller's (supplier's) market to a buyer's (customers), this change goes hand in hand with the increasing dynamics of the relevant environmental factors. The “Logistics 4.0” is the result of the increased use of the Internet (of Things, Services and Persons (IoTSP)), which allows real-time communication between products, machines, services and humans, and the use of advanced digital tools. Therefore, Logistics 4.0 relies on the use of technological applications that allow the effective planning of resources and the efficient management of warehousing and transportation systems to ensure efficiency in transferring data and materials between departments [2]. The aim of the article is to indicate the benefits of planning logistics processes in a corporate group from a holistic perspective in accordance with Logistics 4.0 by means of ERP software. At the same time, the broader context of the issue of logistics planning in the case of market changes in the situation of disrupted supply chains is indicated. At the same time the wider context of the issue of logistics planning in the case of market changes in the situation of broken supply chains is indicated. The research methods are literature analysis and two models of supply chain planning: materials and finished goods: are presented.

2. LITERATURE REVIEWS

Under the influence of various factors such as consumer demand diversification and product diversity, SCM has been unanimously praised by many companies due to its many advantages, and the SC composed of multiple companies has been continuously developed [3]. This interest SCM has increased significantly over the past three decades for three main reasons. First, the adoption of lean management and just-in-time philosophy in the production and logistics may have increased efficiency but have left supply chains vulnerable to adverse events since they leave little room for error and change [4]. Second, firms are increasingly global and less vertically integrated, increasing the complexity of supply chains and exposing them to much more risks [5]. Third, numerous events have been witnessed to disrupt global supply chains and have attracted worldwide attention. These range from natural disasters, global pandemic Covid -19 in 2019-2021, to man-made disasters such as the Russian attack on Ukraine on February 24, 2022. In today's economic globalization and flexible market demand environment, node companies in the SC can be scattered all over the world [6]. The business activities of enterprises are decentralized, and the performance evaluation of enterprises within the SC unifies the decentralized operations under the same standard -ERP (Enterprise Resources Planning). ERP software is used for comprehensive business management. Hidden in the abbreviation ERP "resource planning" includes control and management of the most important resources and processes in almost every business area of the company: sales, finance, accounting, warehouse, human resources, purchasing, production. Enterprise performance evaluation refers to the use of quantitative statistics and operation research methods, the use of a specific indicator system, and a unified evaluation standard, in accordance with certain procedures, through quantitative and qualitative analyses, to evaluate the operating benefits and operators of the enterprise during a certain operating period [7]. It is science to make an objective, fair, and standard comprehensive evaluation to truly reflect the actual situation of the enterprise and predict the future development prospects of the enterprise [8] and plan for problems associated with disrupted supply chains. Providing a general understanding about the Logistics 4.0 topic, highlighted its three main aspects: (1) the implications of a new production paradigm (i.e. mass-customisation) for logistics; (2) the use of new digital technologies (e.g. Internet of Things (IoT) and Cyber-Physical Systems); and (3) the importance of humans in their roles of employees, customers and stakeholders [9]. The need for a fundamental change in production logistics is often the result of numerous disruptions in production. Symptoms that indicate a need for change can be relatively long process times, delivery times, high inventories and low order flexibility. Supplier selection is an important part of SCM. At present, the research on supplier selection is more and more extensive and in depth [10].

Logistics concept planning or change may also result from, among other things:

- development and/or change of the product mix,
- a change in the production structure and thus a change in the material flow structure,
- changes in the production location (logistics planning at the production site).

Today, with the global and dynamic changes in the market, products are constantly being developed, often redesigned, or adapted to meet specific customer requirements. Often the current company structure, production and flow structures are not sufficiently adapted to the new tasks and challenges of the market [11]. It is known that logistics is a field of knowledge dealing with management, including process planning, hence it has to take into account the different requirements of the different functional areas of the company and the changes in the supply chain, but small and medium-sized companies, due to the cost of software and the implementation of an ERP system, are not able to meet these requirements. This analysis presents that the human factor and software in Logistics 4.0 is one of the most important topics to be addressed in order to support technological development from an SCM planning point of view. An enterprise implementing an ERP software system is bound to work in chain management without being able to freely make decisions regarding suppliers and customers, being only one link in SCM.

3. LOGISTICS PLANNING IN ERP SYSTEM

Developed and operated logistics solutions and systems allow to formulate remarks, guidelines for the development and design of concepts in production logistics. These comments on the design, planning in production logistics are presented below:

- the primary objective according to the definition of logistics is to provide materials in the right quantity, time, place, quality, at the right cost and information,
- market needs are decisive, i.e., appropriate assortment, quantity, and quality,
- the responsibility of cost posts must be clearly assigned to the locations that affect the cost status,
- shorter lead times are the basis for the necessary flexibility in relation to the market. Short lead times are an important indicator of logistics performance. Short lead times are an important indicator of logistical efficiency within a company,
- planned production logistics measures can provide economic solutions in the functioning of the company in the long term, and ensure its competitive ability,
- the logistics concept should be implemented in stages, especially in stages that bring specific benefits in each case.

It is also distinguished by a number of modern functionalities offering customized remote access to data. This enables effective monitoring of company resources and events in production in real time, from any place and at any time. An important benefit for production is also the possibility of integration with CAD, MES. ERP system for management of e-commerce and retail enterprises is distinguished by, among others, an extensive WMS module, (Warehouse management system). It communicates extensively with the warehouse automation, including physical sorters, built-in software sorter, mobile devices. Thanks to the module of cooperation with the RFID system, it gives the warehouseman the possibility of navigation in the premises. ERP systems on the market also have a modern POS module, thus supporting work in the omnichannel model, as well as in stationary stores (e.g. it allows you to collect online orders in stores, return online purchases in stationary stores, and carry out combined orders, partly online, partly from the goods selected in the store, partial online orders and selection of goods from the store- on one receipt). This is possible because online and offline share the same database and inventory levels, which enables planning throughout the supply chain (SCM). The most important characteristic of an ERP system is working on a single database. This means that data entered in one area of the system, e.g. trade, are immediately visible by other users, e.g. a production technologist, and in the accounting department or in the warehouse (**Figure 1**).

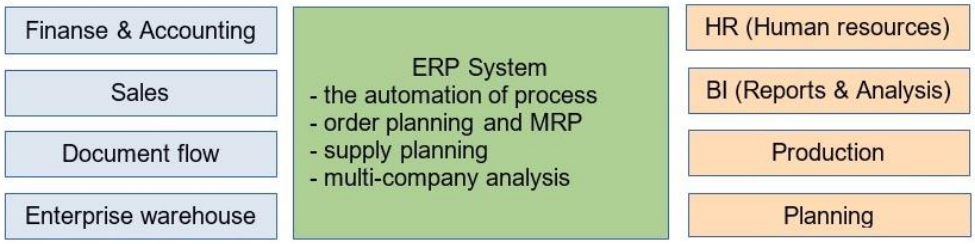

Figure 1 ERP system and its configuration

ERP system has a modular structure, which is one of the factors indicating the flexibility of the solution - that is, its ability to fit into the individual needs of the company and its structure. ERP system manufacturers on the market offer their clients the opportunity to purchase only those components and functions that will actually be used by them. A production module is unlikely to be useful in a trading company -its presence in such a case would decrease the usefulness of the solution, on the other hand increasing its cost. An example of such system is Comarch ERP Optima. A modern ERP system should be a scalable solution - adapting to the size of the company, the specificity of its business processes and the structure of its operations, e.g. many plants in Poland and Europe. This means that an increase in the number of users of the software and the amount of data does not affect the speed and stability of its operation. This is possible thanks to the appropriate software

architecture of the solution (adapted to both smaller and very large customers) - e.g. the use of dynamic infrastructure in cloud solutions (Comarch ERP XL or SAP). ERP system for manufacturing trade and services takes into account all levels of planning, both in the tactical horizon: S&OP (Sales and Operations Planning), taking into account the company's strategy, and in the operational horizon: MPS (Master Production Scheduling) and MRP (Material requirements planning), which allows not only to consider a range of material needs, but also to detail the need for resources with an analysis of their capabilities. Procurement forecasts, ordering, receiving, storage and inventory management, resource allocation to tasks, and further processing such as order picking, issue and quality control support the logistics planning.

4. LOGISTICS PLANNING IN THE METAL INDUSTRY IN A MULTI-SITE COMPANY

When planning logistics processes, customer logistics requirements should be taken into account for a customer-supplied product. As a result, the company should conduct an analysis, which can be in the form of delivery scenarios to determine the needs and evaluate the existing service. The diagnosis helps to determine the length of order fulfillment cycles, delivery volumes and frequencies, shipping information system activities, its marking, labeling and type of packaging. Customers expect more and more efficient and effective logistics services from manufacturing companies, hence the transfer of these functions to specialized logistics operators.

The process of planning logistics activities consists of the following steps [12]: (1) General prerequisites for participation in planning: identification of supported market segments, specification of internal types of logistical processes, consideration of logistical outsourcing, (2) Preparation for participation in planning: identification of groups of logistical processes and the scope of responsibility for activities in the processes, tasks identified in individual areas, definition of procedures and documentation, including the flow of information, data collection and their systematization. In the case of manufacturing companies, suppliers are analysed in terms of punctuality of deliveries, quality and adherence to payment terms, (3) Integrating logistics planning into marketing business planning, (4) Production logistics planning: production handling, material requirements, organization of supplies and replenishment, and planning of production station handling, (5) Planning of delivery service: selection of transport system, determination of technical requirements for deliveries, organization of work of reception of deliveries, principles of storage of deliveries (ABC, among others), circulation of documents, (6) Distribution logistic service planning: determination of product release rules, adaptation of packaging and labeling to the requirements of intermediaries and customers , distribution inventory layout plan, use of logistics services in distribution, (7) Planning of controlling activities.

When preparing a logistics process plan, it is necessary to use appropriate tools and techniques to determine the planned quantities. Proper implementation of logistics process planning is possible only with the use of IT support.

5. SUPPLY CHAIN MODELS IN A METAL ENTERPRISE

The metal company for ventilation and air conditioning production was founded in 1928. The company has three plants in Poland, including one in Koszalin, seven in Germany, one in Mexico (2008), one in Croatia (2015) and one in Mexico (2016). It has hundreds of suppliers across Europe and the world creating logistics supply chains. Calculations in logistics planning are generally carried out with the help of appropriate tables, which can be realized with the help of specialized ERP software and then entered into calculation sheets.

In both cases a two-stage distribution was assumed: in the first case the material is first transported from the Production Plant in Koszalin (PPK) and then to the Main Distribution Center in Berlin (DCB), from there to the Regional Distribution Center in Köln-Dellbrück (RDC). These models differ in the response time in deliveries between DCB and RDC. The former has a long response time of several weeks, the latter a short response time of a few days at most and involves finished goods. Therefore, different approaches to planning will be

applied at this stage of distribution: focus on medium-term planning: in the case of the first model; while in case of the second model: focus on short-term planning short-term planning in case of the second model.

The first model assumes that the RCDs send the projected medium-term demand of galvanized sheet metal for the production of the AIR-JET 71-250 fan to the DCB. Based on this, the DCBs calculate their demands and send them to the RPCs. Next the production planning takes place, then planning of shipments from PPK to DCB and finally planning shipments from DCB to RDC, which closes the planning cycle. **Table 1** shows how planning can be conducted demand planning at the RDC level. A fixed ordering cycle method is used here.

Table 1 Medium-term planning of galvanized sheet metal for AIR-JET 71-250 fan production [t]

The period (month)	1	2	3	4
Forecast demand	368	352	451	443
Delivery schedule (to DCB)	370	350	500	450
Final inventory	100	100	50	150
Safety stock	100	100	150	150
Demand	350	450	500	550

Table 1 shown here performs two main functions: calculating projected inventory levels at the beginning of each month and calculating future demand. The stock at the beginning of each month is calculated on the basis of the delivery plan confirmed by the DCB and the demand forecast. Of course, the beginning inventory is also taken into account. Depending on supply problems, the data can be configured to increase the safety stock. Each week, data on deliveries planned by suppliers is updated. On this basis, an updated plan of stock levels for each month is calculated. By comparing this projected level with the target level, the planner is able to assess whether the deliveries projected by the DCB meet the needs and what deviations from the plan arise. If not, changes to the delivery plan can be negotiated with the supplier (ThyssenKrupp) or other remedies can be sought, for example deliveries from Poland if there is a shortage of steel on the market.

In the second model, planning at the RDC level is focused on the upcoming deadlines and therefore order point scheduling is used. We assume that orders are calculated according to the following rule: if the available quantity falls below a certain level (ordering point), an order is placed equal to the difference between the currently available quantity and the point, plus the demand from two consecutive sales weeks. The quantity available includes not only inventory, but also the stock in transit. **Table 2** includes two types of available quantity: needed, which assumes that orders (demand) will be accurately fulfilled, and projected, which is calculated based on the shipment plan from the DCB or the supplier of the finished product (ventilation grille). It also makes the following assumptions: the response time is 1 day of shipment by the logistics operator in Poland, and the ordering point is set equal to the sum of the demand for the finished product from the current day and half of the demand from the next day.

Table 2 Short-term demand planning in a regional distribution center (RDC) or production plant (PPK) for a ventilation grille in pieces

The period (days)	1	2	3	4
Forecast demand	10	10	20	20
Initial stock	13	3	25	5
Receipts or deliveries on route	-	32	-	25
Total quantity of stock required	13	35	25	30
Ordering point	15	20	30	20
Demand	32	-	25	25
Delivery confirmation	-	30	-	30
Predicted delivery quantity	13	30	13	23

The two bottom rows of Table 2 are for control purposes. They are intended to show how the stock will develop under the assumption that the supplies currently agreed upon with the supplier are received. The remaining rows are used to calculate the ordering plan (the demand plan).

Simply establishing a course of calculation for planning the production and distribution of finished goods is not sufficient to start effective planning, as **Tables 1 and 2** show. One reason for this is the large amount of data and the cost of software and human labour that must be analysed each time the plans are updated. This amounts to PLN 0.05 (EUR 0.01) per unit of goods. If an employee without ERP software were to analyse this data on a daily basis on spreadsheets only, the cost would increase 2-3 times. Hence, despite the high cost of ERP software. The example shown with one material and the finished product illustrates the problems that can occur in logistics planning. First and foremost, any computational solution needs to be combined with mechanisms to facilitate changes to delivery dates and detect possible risks or shifts. Small and medium-sized enterprises not working in SCM but constantly looking for suppliers and customers cannot afford such expensive software, but they are offered a simplified version like Comarch ERP OPTIMA.

6. CONCLUSION

More and more companies are recognising the need to automate logistics planning calculations and data processing with the help of ERP software. In the case of the company analysed, which is part of a group of companies, only trade goods are 1,074 items excluding raw materials and finished goods. The analysis shows that the company saves on the work of specialists and benefits from the quick entry of even one variable. The oversimplification of logistical planning processes to a single material or product can cause recurring problems, such as the flow of information between the production site, the main centre and the regional centre, deliveries in the wrong quantity and at the wrong time, especially late deliveries can cause penalties. It is possible to define and identify key planning indicators in production logistics as they are the basis for planning, but not all external factors can be planned for, such as supply chain disruptions or the war in Ukraine. The software investment pays for itself in a short time. For small and medium-sized enterprises, the payback cycle would be several years. The logistical production planning system is related to the concept of implementing production planning and control in logistical terms, i.e. achieving a high level of adherence to deadlines, short lead times, low inventory levels, which is not always successful nowadays.

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