Digital transformation of logistics processes in the transport system - basic trend of the modern world economy

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Abstract. The article reveals the main directions of digital transformation of business processes in the logistics activities of transport enterprises to improve information exchange between production, wholesale and retail trading enterprises. The competitive advantages of transport enterprises when using specialized transport management information systems have been identified. We studied the current software used in the logistics activities of domestic enterprises, presented types of information systems in the functional areas of logistics and technologies (WMS, SaaS, ERP, CRM, TMS, SCM), presented the industry distribution of transport management information systems, including those implemented in the format of software as a service (SaaS). The distinctive features of the automation of quantitative accounting operations and the control of logistics operations using innovative software - the Jupiter VBA framework, developed with the participation of the authors, are taken into account, which is a platform solution for the digital transformation of logistics business processes and includes more than 30 modules and about 800 functional blocks (procedures, functions, class elements, etc.). On the basis of Jupiter, more than two dozen projects have already been implemented, including the free Assistant program, popular in the university environment. A description of the characteristics of two software products developed on the Jupiter platform - AWS Forwarder and AIS Logistics is presented, functional characteristics of these software products are presented. A mathematical model of the formation of logistics costs for freight forwarding services in the field of commodity circulation is presented.

1 Introduction

The organization of freight forwarding activities in the field of commodity circulation is aimed at creating a constant and continuous product flow from suppliers to customers in the retail trade network. The functioning of logistics networks is associated with day-to-day

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coordination between participants, who may not be administratively related, but require the organization of targeted information flows. In this case, specialized software is used to automate the control and accounting of logistics operations and the digital transformation of logistics processes.

Digital transformation of business processes is an actual focus area of increasing the efficiency of economic activity, in relation to the specifics of enterprises [1-6]. The term "digital transformation of processes" is usually used as a synonym for the term "digitalization". In our opinion, however, the former is more suitable, since it reveals the content of the development of a certain subject area, for example, logistics and supply chain management. The term "digitalization" is overly generalized and impersonal and does not reveal the content of the process of constant increase in the introduction of digital technologies aimed at automating existing business processes. Therefore the term "digital transformation" is used in relation to the processes being changed (transformed).

Unlike digitalization (introduction of digital technologies), the digital transformation of logistics processes is preceded by both a detailed analysis of the operating processes of the enterprise and the development of documented procedures for changes technologies for accounting and controlling information flows related to product and service flows. When developing and implementing digital technologies in the activities of enterprises, it is necessary to carry out a functional decomposition of the logistics system and compile a nomenclature of logistics operations.

The introduction of electronic computing equipment and means for automation routine operations helps to reduce the costs on logistics and time for performing logistics operations as well as improve the quality of customer service. In view of this, digital transformation activities in the context of increasing process dynamics require additional efforts on the part of the company's management [7, 8].

The aim of the research is to study the main directions of digital transformation of business processes when delivering product batches to the retail network based on the experience of Russian and foreign business entities.

Research objectives:
• to reveal the features of logistics activities in the transport system during the delivery of goods;
• to describe the processes of automation of logistics operations in freight forwarding activities
• to present the proprietary technology for creating business applications for automation of logistics processes based on the Jupiter VBA framework.
• to give examples of implemented applications, as well as describe their features and key advantages for use in the transport and logistics processes of domestic enterprises.

The object of the study is a logistics system for the delivery of goods by a transport system using a wholesale and retail trade network as an example. The subject of the study is the digital transformation of transport and logistics processes.

2 Methodology

The study used the methodology of a systematic approach, modern concepts of logistics and supply chain management, as well as economic, mathematical and statistical methods. In addition to special methods, general scientific methods were used, such as analysis, synthesis, deduction and induction.

The analytical method made it possible to identify the problem and highlight its main components. As a result of synthesis, a system of cargo delivery to the retail trade network was developed, taking into account the quantitative accounting of the volume of logistics
operations that are not displayed in traditional software systems. This aspect constitutes the scientific novelty of the study.

Using the deductive method, the system of cargo delivery to the retail network was characterized and the need for the use of specialized software was justified. The inductive method was used to generalize individual facts and draw the conclusions of the study.

Methods of empirical knowledge used during the study include description, comparison and measurement. Based on the analysis of available literature sources, the description of the main aspects of the problem of forming a system of planning, control and accounting for the performance of logistics operations in the logistics system was carried out.

3 Results and discussion

The processes of globalization of the world economy have accelerated in the recent years due to the intensive development of digital technologies, and this development was boosted in the situation of the pandemic of a new coronavirus infection and restrictions in the operating activities of trading enterprises [9, 10].

The competitive advantages of modern transport companies can be found in their ability to meet customer demand on time and in full as well as in using flexible delivery schemes based on multimodal technologies and new digital technologies (logistics information systems) for the organization of "seamless" cargo flows [Logistics and Distribution, 2021], and for the implementation of freight forwarding activities in the delivery of goods to the retail network.

When organizing the movement of product flows from manufacturing enterprises to retail trade enterprises and households, it is necessary to break up the commodity lots into smaller units and complicate the assortment at the level of cargo units, which are units of orders of individual retail trade enterprises. The great number of customers of commodity lots in the retail trade network and their territorial disunity leads to the need in establishing communication channels with the use of information technology, whereas a significant amount of the commodity mass, that moves in supply chains, requires the creation of a comprehensive accounting system used, among other things, to register supply failures and stock returns from customers.

The current level of use of information technologies in relation to logistics information systems (LIS) allows you to provide digital support at certain stages of the transport and logistics process, but some operations remain a "black box" for commercial and logistics services, which leads to a decrease in the efficiency of logistics operations and a decrease in the motivation of employees to perform certain types of work.

The information exchange between the wholesale and retail trade enterprises begins with an order that arrives at the sales department of the wholesale trade enterprise. After processing, the order arrives at the warehouse, where the picking and moving of the cargo unit to the dispatch expedition takes place. Along with these processes, planning of supply and drawing up routes for the movement of vehicles in the logistics network is performed.

The logistics information system (LIS) is one of the most important components of the corporate information system of a manufacturing or wholesale trading enterprise and allows you to distribute and automate the tasks of managing transport and warehouse resources. The top ten most popular kinds of LIS in practice in the period from 2018 to 2021 are shown in Table 1.
<table>
<thead>
<tr>
<th>Technology</th>
<th>Projects</th>
<th>Systems</th>
<th>Integrators</th>
</tr>
</thead>
<tbody>
<tr>
<td>WMS – warehouse management system</td>
<td>390</td>
<td>60</td>
<td>51</td>
</tr>
<tr>
<td>SaaS – software as a service</td>
<td>206</td>
<td>54</td>
<td>60</td>
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<tr>
<td>Industry Specific Solutions</td>
<td>185</td>
<td>24</td>
<td>23</td>
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<tr>
<td>ERP – enterprise resource planning systems</td>
<td>142</td>
<td>41</td>
<td>76</td>
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<tr>
<td>OC – Operating Systems</td>
<td>93</td>
<td>51</td>
<td>48</td>
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<tr>
<td>CRM – customer relationship management systems</td>
<td>93</td>
<td>34</td>
<td>29</td>
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<tr>
<td>BPM – business process management systems</td>
<td>83</td>
<td>23</td>
<td>23</td>
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<tr>
<td>TMS – transport management systems</td>
<td>77</td>
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<tr>
<td>EDMS – electronic document management systems</td>
<td>61</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>SCM – supply chain management systems</td>
<td>50</td>
<td>21</td>
<td>24</td>
</tr>
</tbody>
</table>

The industry distribution of transport management information systems is shown in Figure 1.

Fig. 1. Industry distribution of transport management information systems (TMS). Source: Author, based on [Logistics and Distribution, 2021].

The most popular are warehouse management systems, as well as solutions made in the software as a service (SaaS) format, i.e. those with cloud access and a subscription payment scheme. Thus, many software products have been implemented that allow optimizing cargo transportation (for example, the Logistics Department service http://logdep.ru, Zig-Zag service for optimizing transport logistics https://zig-zag.org and others).

Corporate solutions are the drive of commercial and logistics activities of enterprises, because they provide important data, intellectual and computational tools necessary for the functioning of a business in a digital economy, and every business area of a commercial organization depends on a variety of applications.

However, despite the presence of many standard software solutions, there is a class of specific logistical tasks and operations that, taking into account the operating peculiarities of particular organizations, cannot be performed by standard software. To solve problems of this class, it is necessary to upgrade existing or create completely new software solutions.

Reducing the cost of creating software solutions in the logistics field of activity is an urgent task of cost management in the digital transformation of business processes, as this transformation covers an increasing number of operations. At present, there appeared cloud constructor services of business applications, such as QuickBPM, Microsoft PowerApps, Google Business Application Platform, etc. These services allow automating business processes and routine operations, creating CRM systems, and connecting users to information resources available in the organization. However, the cost of using these solutions is quite high. For example, using Google Business Application Platform, requires making a deposit of $300 for the test period only.
With the participation of the authors of the article, an original technology for the rapid development of business applications has been developed and tested, which can be of help for small and medium-sized enterprises in the logistics industry. This technology is called the Jupiter VBA framework and is based on the use of the Visual Basic for Applications programming language in an office software package [11, 12, 13].

A framework is a software platform that determines the structure of a software system; software that facilitates the development and integration of various components of a large software project. Jupiter is a framework with a typical set of procedures, functions and classes for rapid deployment of applications based on software products that support the Visual Basic for Applications programming language. Jupiter has both general and specific modules for the following software products: Microsoft Word, Microsoft Excel, Microsoft Access, Autocad, CorelDRAW.

General modules work in all applications that support VBA, and specific modules only work in the above-mentioned ones. At present, Jupiter contains more than 30 modules (Figure 2) and about 800 functional blocks (procedures, functions, class elements, etc.). More than two dozen projects have already been implemented on the basis of Jupiter, including the free software Assistant, which is popular in the university environment and presented in the VKontakte group called Digitalization+ [VK Digitalization + Group, 2022].

The basis for creating business applications on the Jupiter VBA framework is a modular approach, which involves connecting a set of independent or interdependent modules necessary for the implementation of the project. The advantage of using this technology is free of charge basis in terms of access to the basic functions and support service of the project, for example, synchronization of modules is based on cloud technologies. The labor costs of developing applications using the Jupiter VBA framework are reduced many times compared to the traditional technology of creating software in Visual Basic for Applications, due to the presence of standard functionality that performs standard tasks.

With the participation of the authors, a number of software products, based on the use of the Jupiter VBA framework were created, including the popular software system Assistant for automating business processes [5], as well as two logistics business applications: AWP Forwarder [2] and AIS Logistics, which are programs designed for transport organizations in...
order to reduce operating costs in the process of cargo transportation, allowing them to regulate cost accounting, stimulate employees to work efficiently through the introduction of a transparent motivation system, as well as to improve the quality of customer service.

The AIS Logistics program is designed for financial accounting of costs arising from the organization of large-sized cargo transportation. Figure 3 shows a traffic database containing all transportation requests for which expenses are recorded.

**Fig. 3.** Window with requests for transportation (Traffic base). Source: Author.

Figure 4 shows an application card with information about the application date, the customer, the responsible employee, deadlines, route, finance, etc. The characteristics of the route are shown in Figure 5. This window displays information about the contractor, cargo characteristics, vehicles used for transportation, etc.

**Fig. 4.** Application card. Source: Author.
Figure 6 shows a driver report that includes the following elements:

- Information about the driver
- Name of the route and/or order
- Weight of the cargo
- Departure and arrival dates
- Mileage, fuel consumption, etc.

The AWP Forwarder software [4] serves to develop a motivation system for employees of a transport organization or a transport division of a manufacturing or wholesale trading enterprise. The organization of accounting for logistics operations during the delivery of goods to customers and the quantitative assessment of additional actions performed by the forwarding driver when unloading the vehicle contributes to the transparency of logistics processes at all stages of the product flow, as well as fair payment for work. With the help of the software, the cost of forwarding services to consumers is calculated, taking into account the specifics of transportation, the type of transport, the use of its load capacity, the conditions of unloading the goods, etc.

The costs of freight forwarding services are calculated by the following formula [4]:

\[ S = \begin{cases} 
    \sum S_i, & \sum S_i \leq B \\
    \sum S_i k, & \sum S_i > B 
\end{cases} \quad (1) \]
where $S_i$ – the cost of freight forwarding operations, rubles;  
$k$ – the ratio of the available budget $B$ to the total cost of freight forwarding operations $\Sigma S_i$;  
$B$ – available budget for this type of operations, rub.

$S_i$ is calculated by the following formula:

$$S_i = S_{bas}k_{tr}k_{zr}k_{vp}k_{n}k_{gr},$$ (2)

where $S_{bas}$ is the wage rate of one freight forwarder with a district coefficient, rub.; $k_{tr}$ – coefficient depending on the type of vehicle; $k_{zr}$ – coefficient of labor intensity of unloading depending on the zone of the consumer's delivery object; $k_{vp}$ – coefficient associated with the height of lifting the cargo at the delivery point; $k_{n}$ – coefficient of complexity of local delivery conditions (different values for metropolitan or intercity transportation); $k_{gr}$ – the utilization factor of the vehicle's load capacity.

The system of coefficients presented above makes it possible to bring the actual conditions in the company closer to the process of forwarding customer service. The AIS Logistics system is designed to automate the financial accounting of a transport company. At the heart of the system is a database of applications for transportation. AIS Logistics has implemented full costing for all stages of the transportation process.

The software was developed on request of the carrier of oversized cargo. Mainstream to replace the previously operating decentralized cost accounting zones for the stages of the transportation process, and showed high efficiency due to the centralization of accounting and control of the operations of the transportation process and by increasing their transparency. Thanks to the software, the management was able to receive up-to-date information on income and expenses in real time at all stages of the transportation process (from the moment of receipt of the order to the signing of acceptance certificates of services rendered).

The traffic database is the main one when working with the software as application data, directions of transportation, income, expenses, vehicles used, employees, etc. are entered there while organizing transportation. The program contains reports on the work of drivers, an analytical unit that allows you to monitor various indicators: income, expenses, completed and current applications, accrued wages, etc.

The advantage of using the program is its reasonable price available for small businesses as well as independence from the availability of platforms, such as 1C, which is a common factor that increases the cost of ownership of software complexes.

## 4 Conclusion

To sum up, the digital transformation of business processes in the work of logistics companies has a positive effect on the quality of customer service and reduces the cost of transportation by automating and coordinating business processes within the company. It also allows for a more flexible response to changes in transportation conditions, the choice of acceptable alternatives and transportation schemes. The author's technology for the rapid creation of business applications, i.e. the Jupiter VBA framework, is an inexpensive alternative for small and medium-sized logistics companies for the digital transformation of key business processes and increasing the competitiveness of organizations in the transportation industry.

Thus, the use of specialized software makes it possible to provide a more complete coverage of functions and operations when organizing the movement of material flows in the wholesale and retail retail network, which meets the requirements of scientific and
technological progress and the need for digital transformation of business processes. This technology is applicable to work both in domestic companies and among our foreign partners.

References
3. V.K. Gruppa, VK Digitalization + Group, URL: https://vk.com/zifra_plus