Automatization of the technological process of spare parts at the car service company

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Abstract. The article provides general information about the technological process of creating a stock of parts at a car service company. The research of the article is aimed at improving the management of the car service warehouse. In order to implement this idea, it is necessary to effectively supply spare parts to serviced passenger vehicles, by automating the ordering of parts in the 1C program: Enterprise. First of all, the authors have drawn up a concept and defined the purpose of the study - improving the efficiency of service. In order to achieve the goal, the task is to create an automated system for the technological process of ordering spare parts. It is shown that the achievement of the task is carried out in two stages: the first is the creation of an automation algorithm, the second is the implementation of this algorithm in the add-ons of the 1C program: Enterprise.

1 Introduction

Car service companies in St. Petersburg are a network of service and repair stores, auto parts and auto goods stores. The main part of car service enterprises are official representatives of more than 30 largest leading manufacturers of automobile parts and units from Russia, Europe, America and Asia. Technological process of spare parts stock creation at auto service center today is carried out by manual selection of necessary parts and if they are not available, car service sends the order-request to the manufacturer's enterprise. However, this process is completely manual and it takes a lot of time to service the vehicle and have it in repair. This reduces the amount of transport work and increases unproductive costs.

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The introduction of modern information technology, as well as digitalization, allows the efficient use of resources at car service depots. These measures can increase labor productivity, reduce costs and expenses at car service stations, ATP and other enterprises associated with the operation and repair of vehicles.

The decree of the President of the Russian Federation "On the strategy of scientific and technological development of the Russian Federation" № 642 [1] states that there is a need for transition to intelligent, digital technologies, which contribute to a better supply of spare parts in the warehouse. This strategy is a priority for the next 10-15 years and includes the following tasks: transforming the automotive service industry by implementing modern digital technologies and IT solutions.

It is planned to create new promising ways of solving technological processes by applying IT technologies in order to increase the productivity of spare parts supply in the near future.

The purpose of the study is to find effective and promising ways to manage the inventory of the car service industry through the use of digital technologies to improve the efficiency of spare parts supply, which is a pressing problem in the operation of cars.

2 Calculation and justification

Table 1. Factors affecting the operation of the spare parts store

<table>
<thead>
<tr>
<th>Factors</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>The process of issuing and closing documents with legal entities</td>
<td></td>
</tr>
<tr>
<td>Printing price tags</td>
<td></td>
</tr>
<tr>
<td>Marking of price tags</td>
<td></td>
</tr>
<tr>
<td>Receiving process</td>
<td></td>
</tr>
<tr>
<td>Collect online orders</td>
<td></td>
</tr>
<tr>
<td>Keeping the counters clean</td>
<td></td>
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<tr>
<td>Attract new customers</td>
<td></td>
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<tr>
<td>Selecting spare parts</td>
<td></td>
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<tr>
<td>Ordering of spare parts</td>
<td></td>
</tr>
<tr>
<td>Arrangement of goods and spare parts to storage addresses</td>
<td></td>
</tr>
</tbody>
</table>

According to these factors, questionnaires are among experts. The experts are store employees. An example of the questionnaire is presented in table 2.

Table 2. Questionnaire for ballot evaluation of factors

<table>
<thead>
<tr>
<th>Factor No</th>
<th>Factors</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The process of issuing and closing documents with legal entities</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Printing of price tags</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Marking of price tags</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Receiving process</td>
<td></td>
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<td>5</td>
<td>Collect online orders</td>
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<tr>
<td>6</td>
<td>Keeping the counters clean</td>
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<tr>
<td>7</td>
<td>Attract new customers</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Selecting spare parts</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Ordering of spare parts</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Arrangement of goods and spare parts to storage addresses</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Ballot matrix of survey results

<table>
<thead>
<tr>
<th>Factor rank</th>
<th>Sum of ranks $\Delta K$</th>
<th>Deviation of sum of ranks $\Delta K'$</th>
<th>The square of the deviation of the sum of ranks ($\Delta K'^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>10</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>9</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>7</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>5</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>3</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

$\Delta K = \sum_{m=1}^{m} a_{km} = 10 + 10 + 1.5 + 7 + 6 + 1.5 + 9 + 9 + 10 + 6 + 8 = 78$
The maximal task rank cannot be greater than the number of compared tasks:

\[ a_{km} \leq k \]  

where 10 - max. rank, 10 - max. number of tasks.

The maximum value of the sum of ranks of a problem cannot be greater than the product of the maximum possible rank by the number of experts:

\[ (\Delta_k)_{\text{max}} \leq (a_{km})_{\text{max}} \cdot m \]  

The minimum possible sum of ranks cannot be less than the minimum rank multiplied by the number of experts:

\[ (\Delta_k)_{\text{min}} \geq (a_{km})_{\text{min}} \cdot m \]  

The sum of ranks \[ \sum_{k=1}^{k} \Delta_k \] and the average sum of ranks are calculated:

\[ \overline{\Delta} = \frac{\sum_{k=1}^{k} \Delta_k}{k} \]  

The deviation of the sum of ranks of each problem from the average sum of ranks is determined:

\[ \Delta_k' = \Delta_k - \overline{\Delta} \]

\[ (\Delta_k)_{\text{min}} \] corresponds to the most important task, getting the first place (ranking point \( M = 1 \)), then the control tasks are arranged in the order of increasing sum of ranks.

The specific weight of each control task is determined:

\[ q_k = \frac{2(k-M+1)}{k(k+1)} = \frac{2(-38-1+1)}{-38(-38+1)} = \frac{2(-39)}{-38(-38+1)} = \frac{78}{1444} = 0.055 \]  

With the help of Kandell’s concordance coefficient \( W \), the degree of experts’ concordance is evaluated:

\[ W = 12S \]  

\[ m^2(k^3-k) \]  

\[ 10^2(10^3-10) \]  

\[ 99000 \]  

\[ 0.74 \]  

\[ S = \sum_{k=1}^{k}(\Delta_k)^2 = 6119.5 \]
The coefficient of concordance can vary from 0 to 1. If it is significantly less than 0.5, we can assume that there is some agreement between the experts. If the coefficient of concordance is insufficient ($W < 0.5$), then the organizers of the examination analyze the reasons for the low concordance of the experts' opinions. Such reasons can generally be the wrong choice of factors, the selection of incompetent experts, collusion between experts, unclear questions, and poor coaching of experts.

It is not recommended to carry out a repeated examination with the same composition. When $W \geq 0.5$, the hypothesis of non-randomness of expert agreement is tested using Pearson's criterion:

$$\chi^2_p = W \times m(k - 1) = 0.74 \times 10 (10 - 1) = 66.6 \text{ (10)}$$

where $(k - 1)$ is the number of degrees of freedom.

The calculated value of the coefficient is compared with the table value determined at the number of degrees of freedom $k - 1$. If the calculated value of the Pearson criterion exceeds the table one $\chi^2_p \succ \chi^2_t$, and $W \geq 0.5$, this testifies to the presence of a significant similarity of the experts' opinions, the significance of the concordance coefficient and non-accidental coincidence of the experts' opinions.

According to the data of expert estimation we make a diagram (Fig. 1).

Fig. 1. Diagram

Conclusion: The coefficient of concordance $W = 0.74$. Consequently, $0.74 > 0.5$, then we can assume that there is some agreement between the experts.
3 Objects and methodology of the research

It is proposed to create a system to automate the technological process of creating a spare parts inventory on the example of an auto service company. This system will work as an add-on to the 1C:Enterprise program [3, 7].

To create the technological process of automating the spare parts, the authors have developed a concept (Fig. 1).

Then, according to the concept, the first stage of the superstructure creation — development of the superstructure algorithm in 1C:Enterprise (fig. 2) [13]. This algorithm was developed with the help of an online flowchart editor [4, 5]. According to the algorithm, before starting the add-in work, the operator, the customer manager, has to perform a number of actions: select a customer, make a list of parts.

The necessary parts are provided to the client as a list in an Excel table with the articles of original parts and their quantity. Then begins the work of the algorithm itself [10]. The algorithm begins with the reservation of those items that are available in the production area of the car service [14]. To do this, you need to select all positions, and perform automation, by keyboard shortcut ctrl+A. If something is not available, then an order is created to move from the warehouse of the service station.

However, this add-on requires a list of original part codes. If there is an error in the part code or if there is no code, the service employee will have to pick up the part manually.

4 Research results

The authors made concept and algorithm of add-on in 1C:Enterprise. The essence of the concept (fig. 2) is to set the research purpose, that is — increasing customer service efficiency by creating an automated process system of spare parts stocking with the use of add-ons in 1C:Enterprise. To achieve the defined goal, the following concepts are considered: criteria, constraints, scope, stages, technical solution and organizational solutions.

Concept for automating the process of creating a part stockpile

<table>
<thead>
<tr>
<th>The aim of</th>
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<tbody>
<tr>
<td>The criteria</td>
</tr>
<tr>
<td>Limitations</td>
</tr>
</tbody>
</table>

The aim of

To increase the efficiency of customer service by creating an automated parts inventory workflow system for car repair shops, using an add-on in the 1C:Enterprise program.

The criteria

- Increasing the amount of necessary spare parts in unoccupied inventory in the production area of the car repair shop.

Limitations

- Spare parts availability in the service depot.
- Changes in demand.

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Scope

1. Programming.
2. Stock theory.
3. Sales of goods.

Stages

1. Development of the program algorithm.
2. Creation of an add-on in 1C:Enterprise to order the necessary spare parts for a particular customer.
3. Testing and implementation.

Technical solution

Add-on in 1C-Enterprise. Automated technological process system for creating a spare parts stock.

Organizational solutions

Monitoring and management of production area and warehouse free stock, creating a system of automated process of creating an inventory of parts.

Fig. 2. Concept of improvement of the technological process of spare parts stocking

The main criterion is to increase the number of spare parts available for sale to the owners of cars that come into the car service. But not all spare parts need to be in stock, as there are positions, the realization of which is not fast in terms of time. In this case, these items are ordered from the manufacturer, and if even there is no necessary parts, these parts are ordered from the manufacturer.

To achieve the goal of the study, it is necessary to consider the provisions of the stock theory and programming order, which is done with the help of the appropriate tools of the 1C:Enterprise program. To develop an automation program, it is necessary to determine the stages to achieve the desired result, namely, the development of an algorithm, the creation of the add-on itself in 1C:Enterprise and the final stage of testing the automated system and further implementation.

In this work the first stage, namely the development of the program algorithm (Fig. 3)

Before the start of the algorithm it is necessary for the operator (customer manager) to perform a number of actions: to create a new customer order, specify the customer by INN or create a new customer. Then to make a list of necessary spare parts for the order.

After this, the automation steps of ordering parts begin. The list of actions that automation performs begins with highlighting all lines with auto parts (Ctrl+A), then highlighting those parts that are in stock “reserve in stock” and those that are out of stock “to supply”.

For those items that are out of stock in the production area, the automation creates an “order to move”. This order already specifies the sender of the parts “Auto Service Depot”, the recipient and a list of parts to be ordered.

Then the status of the order is switched to “to execute” and all positions to be ordered are switched to the status “to ship”.

After that, it is saved and the “order to move” is closed.

It is assumed that this algorithm, created in the process of research, which is an add-on in the 1C:Enterprise program, will reduce the time spent on the selection, ordering and waiting for spare parts for auto enterprises and legal entities through the automatic performance of this procedure by the program itself. Manager can spend the saved time for the service of retail buyers of parts and materials, displaying price tags, the placement of spare parts and fuel and lubricants in the customer lounge.
Fig. 3. Block diagram of the superstructure algorithms in the 1C:Enterprise program

5 Conclusion

Factors affecting the efficiency of an automated system:
- the reliability of the data received from the production area of the auto service station (which parts need to be replaced);
- accuracy of data transfer about the necessary spare parts;
- availability of parts necessary for the customer. If they are not in the stock of the service station, they manually order spare parts from a third-party supplier (the manufacturer of the car).

This system can be used not only to create a stock of parts at the service station, but also at other enterprises, which have their own warehouse of spare parts, parts, materials and other products. For example, trucking companies, which have a fleet of rolling stock, both mono and multi-marque, but do not have their own site of service and repair.
The second stage will be the creation of an add-on in 1C:Enterprise to order the necessary spare parts and writing the code of the program itself [15].

References


15. 1C:Enterprise 8.3 Version for teaching programming (8.3.8.1933 + 8.3.8.58) [Electronic resource] https://online.1c.ru/catalog/free/18610119/ (accessed 01.02.2023).