Optimalization of Business Logistics Processes Through Implementation of Business Information Systems

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Abstract. The basic goal of logistics activities is the complete satisfaction of specific customer wishes at the optimal time. The customer is the central link in the whole chain because the initial impulse comes from him, and at the same time, the whole chain ensures the movement of means of tangible and intangible nature. On the other hand, the internal goals of logistics are focused on the gradual reduction of costs while meeting the external goals. These are mainly the costs of stocks, production, transport, handling, management, etc. This paper aims to analyze and design the operation of the partial logistics process and monitor the wheelsets' entire life cycle in the conditions of a particular company. The proposal also includes a request from the director of the production department to eliminate the shortcomings of the current process of monitoring the registration of wheelsets, restocking, production and consumption in the assembly of chassis. This design ensures traceability of the components used, streamlining the technical documentation, simplifying the handling of the wheelsets, and removing paper labels.

Keywords: SAP · Intelligent transport system · Industry 4.0

1 Introduction

The basis of the entire logistics communication of the company is logistics information systems, which ensure not only effective inventory management, transport or warehouse management, but also effective communication with the customer in the field of receiving and processing orders, where the emphasis is placed on quality and speed of information flow [1]. The flexibility and quality of the company's response to rapid changes in the market are primarily a reflection that the right information is available to the right user in the right place and at the right time. Only enough quality information is a source of more informed decisions [2, 3]. Information is the key to integrated logistics management, and it is inconceivable that any movement of a material or product can occur

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without it. Information drives innovative change, encourages creativity and is considered a renewable and inexhaustible resource [4, 5].

Information increases the value of products and becomes part of them. They have value over time, which they gradually lose, so companies must always consider information systems' time factors [3].

The value of the information lies in its basic characteristics [6]:

- consistency with other findings;
- timeliness;
- reliability;
- processability;
- media portability.

Information technology has been used in logistics for several years and is considered an essential element of competition. Their constant innovation enables companies to increase the economy and efficiency of their activities in many areas. For this reason, their importance continues to grow. Information technologies for information sharing include EDI (Electronic Data Interchange), POS (Electronic Sales Information Collection), EFT (Electronic Money Transfer) or a barcode system. The development of information technology allows companies to work with large databases and adjust the offer according to the wishes and needs of target segments. Without these technologies, it is impossible to manage any inventory or rapid response systems [4–8].

1.1 Information System SAP

SAP is currently the largest provider of enterprise applications and one of the largest software companies in the world. SAP stands for "Systems, Applications and Products in Data Processing." The company is headquartered in Walldorf, Germany. SAP software was developed in 1972 by five former IBM employees in Mannheim, Germany, who had one vision: to develop a software package containing all possible business functions. The first version of SAP enterprise software was the R/one financial accounting system. The R/1 version was replaced by the R/two versions in the 1970s. The idea was to help different companies replace ten or even 15 different business applications. To fulfil its initial vision, SAP has developed a multilingual and multinational platform that makes it easy to incorporate new standard business processes. SAP has revolutionized the monolithic foundations of enterprise applications. They deliberately said goodbye to the monolithic model for mainframe computers that prevailed in the enterprise application market in the 1970s. SAP has developed its system to run on various hardware platforms, operating systems, and databases. In less than 20 years of its existence, SAP has become the largest software vendor in Europe and has begun to play a strong role in the international market for both IBM and other companies. During the 1990s, new players also appeared on the enterprise applications market, including, e.g. Oracle Corporation, PeopleSoft, Baan, JD Edwards. In general, at the same time as new enterprise software companies began to gain market share, new database vendors emerged, such as Oracle, Sybase, and Informix [9–11].

SAP often confuses the term component with enterprise applications, usually abbreviated to applications. On the other hand, SAP modules offer some functionality within some components. The basic SAP modules can be seen in Fig. 1.

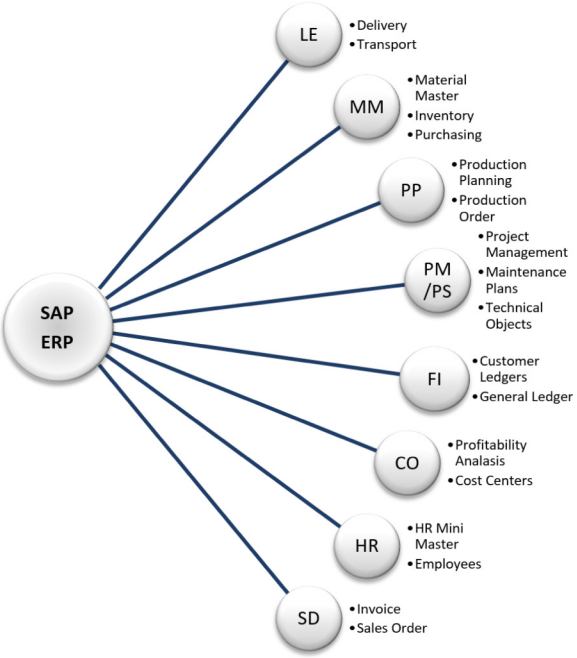

Fig. 1. SAP modules [12]

The basic SAP modules include [9]:

Financial Accounting (FI) - this financial accounting module assists the employees of the finance department in the management of data involved in financial transactions in this unified system. The FI module fulfils the requirements reporting function well, is very flexible and works well in any economic situation. SAP implementation helps consolidate data for various business transactions and legal requirements. The FI module helps the company gain a financial position in the market in real-time. SAP FI combines with modules such as SAP SD, SAP MM, SAP PP for better work results.

Controlling (CO) - The controlling module supports planning, reporting and monitoring operations in the company. These are ways of viewing and organizing the costs necessary for financial statements. The CO module allows you to monitor, plan, implement and report costs. Includes master data management and configuration, covering cost centres, order items, and functional areas.

Sales and Distribution (SD) - The SAP SD module performs all transactions ranging from requests, quotations to quotations and more. The sales and distribution module assists in inventory management and control. SAP SD consists of master data, system configuration and transactions. Some of the sub-components of this module are master

data, sales support, sales, invoicing, shipping and transportation costs, sales information system, credit policy and the like.

Logistics Execution (LE) - logistics operations.

Production Planning (PP) - The SAP PP module is another important module that contains software designed specifically for production planning and management. The module consists of master data, system configuration, and transactions to meet the production process plan. The production planning module cooperates with the main data such as business and operational planning, KANBAN, material requirements planning, distribution planning, cost planning and the like, while working on production management in companies.

Materials Management (MM) - As the name suggests, this module manages the company's material requirements, processes and production. This module controls different types of process procurement. The more well-known sub-components of this module are delivery data, consumption based on planning, purchasing, billing verifications, inventory management and the like. It starts with a quotation, a tender, the issuance of a purchase order, an invoice and the issue of material.

Quality Management (QM) - The SAP QM Module assists in managing the quality of production across the entire process in the organization. This quality management module helps companies accelerate their business by adopting quality management structures and organizational direction in various processes. The QM module cooperates in the field of purchasing and sales, production planning, inspection, control, audit management.

Plant Maintenance (PM) - maintenance management;
Project System (PS) - product module;
Human Resources (HR) - human resources.

SAP offers a range of tailor-made products according to the customer's requirements and the industry in which it operates and provides easy collaboration via the Internet. These solutions can be used as a whole in SAP Business Suite and separately. Some of the most used products [9, 10]:

- SAP CRM - Customer Relationship Management is a unique solution that connects employees, partners, processes and technologies into a comprehensive system. SAP CRM provides functionality for the entire business cycle, providing the tools needed for services, sales, specific centres, analysis, e-commerce, and collaboration with partners.
- SAP ERP - Enterprise Resource Planning - provides human resource management, analysts, operations, corporate services and financiers. Provides support for system administration such as user management, centralized information management, configuration, web services management. The SAP ERP solution is extended with industry-specific functions and workflows. It is a comprehensive solution designed to support international business.
- SAP SRM - Supplier Relationship Management automates processes between resources and intermediaries. SAP SRM controls the entire supply cycle from strategy to its operation within the company and the supply area, optimizing the supplier selection, shortening the cycle duration, and building lasting relationships with suppliers.

- SAP SCM - Supplier Chain Management is the only comprehensive supply chain management solution that improves an organization's ability to adapt deliveries to an ever-changing competitive environment. SAP SCM creates scalable supply networks by building the planning and decision-making capabilities needed to manage business operations and coordinate and collaborate to expand activities beyond the organization.
- SAP BW - Business Warehouse provides data warehouse functionality and a Business Intelligence interface. It provides flexible reporting and analytical tools for data evaluation, interpretation, and distribution. Businesses can thus make important decisions based on these analyzes.
- SAP PI - Process Integration (successor to SAP XI) thanks to this module, business processes can be shared globally and integrated with applications from other vendors. Provides communication and information exchange between internal and external software.
- SAP EP - Enterprise Portal is a single access point for employees, customers, partners and suppliers to access corporate applications, services and information needed for daily work. The portal offers the ability to easily create and edit pages as needed and create their content.
- SAP SMP - Solution Manager Platform for comprehensive lifecycle management of SAP applications. It provides SAP system functions and integrates other tools to ensure a comprehensive approach. It allows central access to all necessary functions and access to the necessary information. In addition, it ensures effective customer cooperation with SAP support.
- SAP BO - Business Objects is a solution that simplifies data manipulation. It allows users to navigate, access, analyze, format, and share information across the enterprise. SAP BO provides a wide range of processes from simple navigation through search to advanced analysis, reporting, business queries and dashboards to visualize and manage infrastructure information.
- SAP Netweaver - currently, the SAP Netweaver platform is used on a technical basis. This platform brings a range of enterprise technologies that allow you to extend the applications used, change business processes quickly and in a controlled manner, make them accessible to more people and introduce new processes. Helps improve team productivity and business integration.

2 Methodology

The company in which the research was carried out implemented the integrated information system SAP as the main ERP system of the company, which provides monitoring of processes in the economic area, logistics, production and human resources using all modules contained in the core of the SAP system. SAP is connected to the WINDCHILL system, which supports the activities of the company's design and semi-technology department. The production planning and control (PP) module also has an extensive functional deployment. In addition to standard functionality, it is complemented by user applications that the company needs for production planning and management processes and monitoring of logistics operations in the company.

The presented paper focuses on optimising the process of procurement, handling and production processing of wheelsets that enter the final assembly of chassis. Wheelsets (Fig. 2) represent a purchased item for the company, supplemented by bearings in further processing in the production process (unless it is procured in the purchase as born wheelsets).

Fig. 2. Wheelsets

As a semi-finished product of its production or purchased bearing wheelsets, it is consumed in chassis assembly. The purchased wheelset has a raw material type assigned in the SAP system. The assignment of the wheelset material type defines its definition in terms of purchasing, layout data, storage data, wheelset posting and their calculation. For the possibility of filtering wheelsets according to certain specific properties, it is defined in the SAP system as a group of materials that is part of the parametric settings of the system. Each wheelset type is defined using a material master record in the SAP system. For further detailed identification and monitoring of the movement of an individual wheelset within the production process processing, the batch system's functionality is used, where the rule applies: each wheelset is assigned a unique number - batch. The batch content of the purchased wheelset currently contains the wheelset number under which the supplier manufactures it.

The supplier provides a certificate with precise technical parameters of the wheelset and measurement protocol. Options for suppliers). For the monitoring and management of each business case, a project team is assembled consisting of employees of individual departments that participate in the project: responsible salesman, designer, technologist, buyer, planner, BU manager. A description of the actual operation of the wheelset operations is shown in Fig. 3.

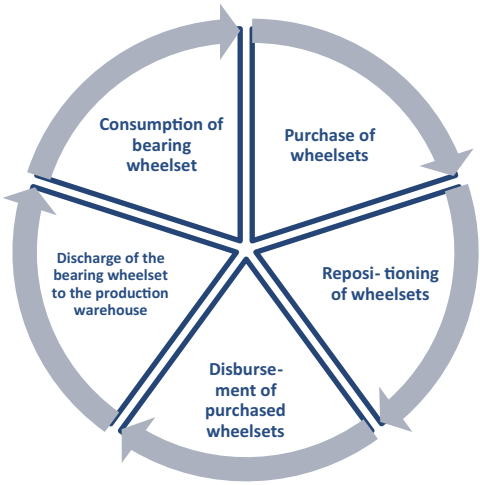

Fig. 3. A description of the actual operation of the wheelset operations

3 Results

The following sub-processes define the new life cycle of wheelsets:

- Issuing an order to purchase wheelsets.
- Receipt of wheels at the warehouse to order.
- Relocation of the wheelset from the wheelset warehouse to the production warehouse (to the depository, only applies to unloaded wheelsets).
- Consumption of wheelsets to production order (bearings).
- Drainage the bearing wheels from the production order directly to the chassis assembly production warehouse.
- Consumption of the wheelset to the production order of the chassis assembly.

The purchasing department provides the process of procuring wheelsets by issuing an order in the SAP system and attaching to it in the appendix a request with a code list for stamping customer numbers of wheelsets. The wheelset itself contains the customer number of the wheelset, which is stamped directly on it. Thus the wheelset is directly intended for a specific business case (in SAP, the business case defined in the project system). Procurement takes place in freely usable stocks and is not blocked for the project. We do not propose any change in this step of the process.

The warehouseman takes over the delivery of the wheelsets. He performs the storage of each piece of the wheelset separately based on the delivery note and the identification label with bar codes affixed directly to the wheelsets. The actual warehousing process in the system will be carried out using a new terminal application, which will ensure that the customer number of the wheelset, which is identical to the stamped number on the wheelset, will be stored in the batch number in the SAP system. At the same time, when receiving, attaching a tag that has an assigned constant number (unchanged during its lifetime, and is also displayed on the tag in bar code), which will be installed on the

bike for the entire life of the bike from receipt at the warehouse. Up to consumption in the chassis. The tag number will be firmly linked to the batch number in the system. The batch will be constant as the tag number will be constant throughout the life of the wheelset, and the connection to the tag will be stored in the batch classification in the system. The terminal application for the reception will require inputs (Fig. 4): order number (from the delivery note in the bar code), delivery number (from the delivery note in the bar code), material number (from the identification plate on the wheelset in the bar code), batch (customer from the identification wheelbarrow in barcode), supplier's wheelset number (from the identification wheelbarrow in barcode), assigned tag number (from the identification tag on the tag).

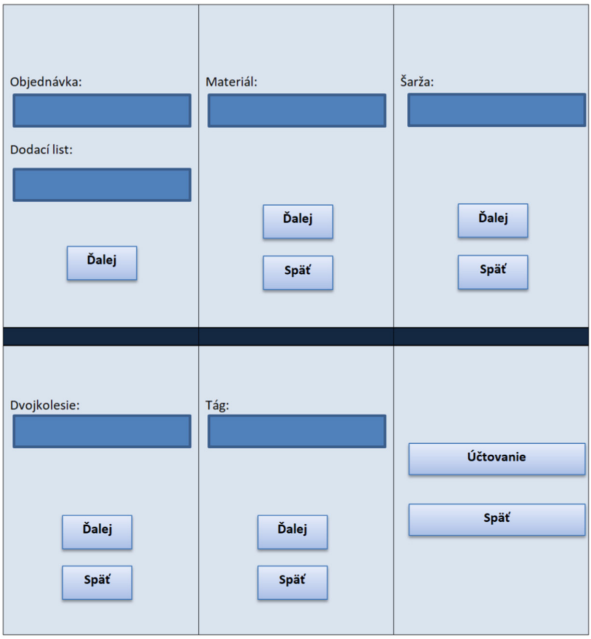

Fig. 4. Terminal application design - material receipt

It is necessary to ensure at the supplier: change the prefix of the barcodes on the label so that they correctly indicate the content of data in the SAP system in the company (Fig. 5) and add the delivery note number in the barcode on the Delivery note.

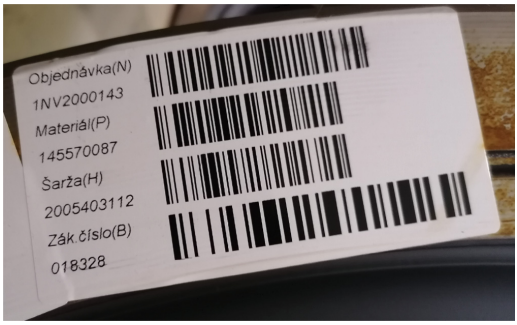

Fig. 5. Wheelset identification plate

Proposed prefix designation on the wheelset identification plate:

- Order (N) - no change.
- Material (P) - no change.
- Batch (H) - change to (B), the content changes. This identification represents the supplier's batch number, stored in the batch attribute after the new one.
- Customer Batch Number (B) - Changing to (H) will represent the batch number (specified by the customer or company). The prefix before the barcode defines the field in the SAP system, and the prefix designation is set in the company by the user.

After storing the scanned data, the SAP system will receive a receipt at the wheelset warehouse, where each piece of the wheelset will have an assigned batch corresponding to the customer's wheelset number. Further processing of the process is different for bearing wheelsets, which are brought directly to the assembly of the chassis and unprocessed proceed to the production process of the bearing.

Bearing wheelsets, the life cycle after admission to the company is realized under the following processes: relocation from the wheelset warehouse (purchasing warehouse) to the production warehouse (chassis assembly) and consumption of the wheelset to the chassis assembly.

Non-bearing wheelsets, the life cycle is realized under the following processes: relocation from the wheelset warehouse to the wheelset bearing warehouse, expenditure of the wheelset on the bearing production order, removal of the bearing wheels from the bearing production order to the chassis assembly warehouse and consumption of the wheelset to chassis assembly.

Transferring wheelsets to the depository will continue to be triggered by issuing a transfer reservation (referred to in the company as the Transfer Request), which includes a two-wheel external procurement warehouse, re-storage two-wheel assembly warehouse.

The transfer will be performed by a modified terminal application, which will require (Fig. 6): reservation number (from the printed reservation in paper form, where the reservation number is also printed in the barcode), material (input type wheelset, identification in the reservation barcode), expense warehouse (preset from the reservation, confirmation will be required), receipt warehouse (preset from the reservation, confirmation will

be required), tag number (scanned directly from wheelset), the batch of wheelset (automatically preset and derived from tag number), wherein the new the operation of the process will no longer store the wheelset number of the supplier. Still, the customer will be identical to the stamped wheelset number for visual inspection.

Fig. 6. Terminal application design - restocking

The picking plan (Restocking Reservation), which provides bringing material into production in the SAP system, will continue to be compiled manually in the SAP system environment, using a modified user transaction. The basis for the reservation establishment will continue to be the chassis assembly plan, where the mounted wheelsets are delivered directly to the assembly line in real-time at assembly time (Just in Time). This terminal application will also transfer loaded wheelsets from the shopping warehouse to the chassis assembly warehouse. A Transfer Transfer will be established in the SAP system for this logistics movement. The transfer reserve remains unchanged in the new process design and will continue to be compiled by the technical staff of the deposit centre.

The process is activated if it is required to change the stamped wheelset number. This occurs when the relevant wheelset (identified by the customer number) needs to be used to assemble the chassis of another business case (in an SAP project). The process requires a change of the wheelset number specified by the supplier in the new operation (a change of the batch). This happens in cases where the supplier did not deliver the wheelset or wheelset within the required deadline, the identified error during the entry inspection or the wheelset was damaged during handling in the company. When changing the customer batch number (physical breakdown of the number on the wheelset), the transfer system must be moved in the SAP system from the original batch to the new batch to ensure that the batch is identified for the wheelset in SAP with the number

stamped on it. In the current operation of the process, this change is not identified. The attribute is not overwritten - the customer number in the batch classification, and in the visual inspection, the numbers on the wheelset plate are different from the stamped number.

The terminal application will require inputs (Fig. 7): tag number (number acquisition), wheelset number (derived from the tag number, preset on the terminal application), the new batch of wheelset (manual entry of the batch number using the terminal keypad according to the number on the wheelset), tag number (reload of the tag, which remains physically attached to the wheelset). If the number is not interrupted, the process is not activated. A new terminal application will be processed to record the transfer.

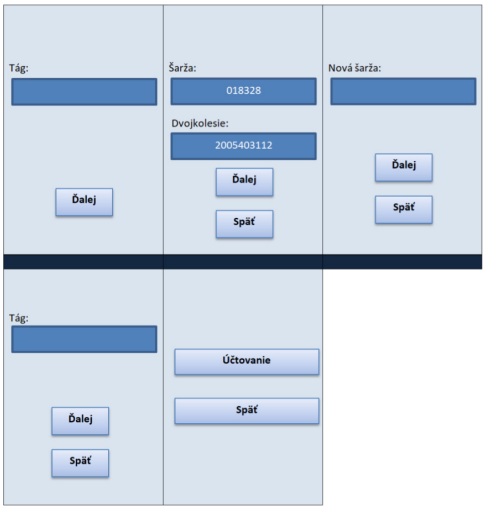

Fig. 7. Terminal application design – batch change

The method of consuming the wheelsets in the production order of the bearing remains the same, i.e. that the expenditure on the contract will be realized by retrograde collection. Retrograde material picking on a production order is a method of material consumption performed against the background of feedback on the operation to which the material is attracted. The wheelsets are brought to the line before bearing. The order is determined by the so-called bearing change plan, which determines the bearing sequence according to the projects to ensure the smooth assembly of the chassis line on which the projects alternate. The assembly of bogies must ensure the production of different types of bogies for the parallel production of assembly lines of railway wagons.

Consumption expenditure on order will be realized by a modified terminal application with the following inputs: bearing operation number from the production order (identification from the production change plan, which contains operations of individual orders), the order number fields and project, tag number (the bar code of the tag is scanned by the terminal directly from the wheelset), the material number (displayed by deriving from the tag number) and the batch number (displayed by deriving from the tag number).

By displaying the batch number on the terminal application, it is possible to visually check the customer batch number with the embossed number on the wheelset, which must be identical. After the wheelset has been posted for consumption to the production order, the tag, which is used to derive the batch of the wheelset (in which the customer number of the wheelset is stored), remains on the wheelset, and the bearing process for surface treatment continues.

The method of removing the bearing wheelset from the production order of bearings to the warehouse remains and will be realized by automatic warehousing of production with feedback of the last production operation of surface treatment. The definition of the automatic discharge of semi-finished or final products from production to the warehouse is performed parametrically in the SAP system by the control key of the operation in the workflow. A terminal application was designed to remove the production of the bearing wheels to the warehouse as follows: workplace number (scanning of the barcode of the surface treatment workplace) *, tag number (scanning of the barcode from the tag of the wheelset), production order (automatically derived from tag numbers), batch (automatically derived from tag number), wheelset (derived from tag number, preset on terminal application). * Each workplace identified in SAP is marked with a bar code for production feedback and material handling in production on site.

The bearing wheelsets are stored directly at the chassis assembly warehouse and are physically ready for assembly. At present, the addition represents the physical relocation of the bearing wheelset to the chassis assembly line. In reality, the pre-sun handling technique is implemented for several tens of meters. Finally, the bearing will be moved to the chassis assembly line. The bearing wheelsets will be moved along the rails for assembly, thus eliminating damage to the wheelsets during handling and transport outside the rails.

The method of consuming the wheelsets in the production assembly order will be maintained by retrograde consumption. The wheelsets are brought to the assembly line. Their consumption will be performed in the background when feedback of the chassis assembly operation to which the wheelsets are attached. Because two wheelsets enter the assembly of one bogie, we propose elaborating a new variant of the terminal application, which will be used to consume wheelsets in the assembly of bogies. The application requires entering two batch numbers of wheelsets.

The terminal application will require the following inputs (Fig. 8): production order operation feedback number (read from the chassis production order wizard that accompanies the entire chassis assembly), the chassis type number is displayed (material master record in SAP), number of wheelsets (preset according to the number of material components in the production order), tag number (read from the wheelset), the batch of wheelset (displayed and derived from tag number) and type of wheelset (master record of wheelset displayed from tag number is displayed). Subsequently, the application requests a scan of the second wheelset. By displaying the batch number on the terminal application, it is possible to visually check the customer batch number with the embossed number on the wheelset, which must be identical. After posting the wheelset to consumption on a production order, the assembly worker removes the tag from the wheelset, which can be used to identify the new wheelset. In the life cycle of the wheelset, the printing of paper labels is eliminated, and the tag can be used repeatedly until it is physically damaged.

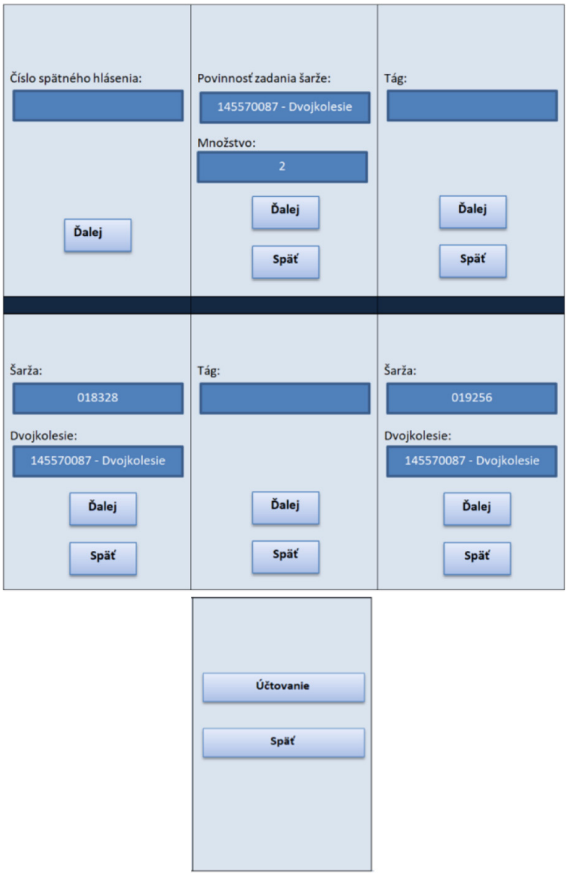

Fig. 8. Terminal application design – consumption of wheelsets

4 Conclusion

Due to the constant increase in the production of the researched company, and thus the increased demand for material handling within a large production area, the optimization of logistics processes, support of new technological equipment in the field of handling technology and identification equipment for marking parts and purchased materials for production. The whole logistics process is divided into sub-processes, and this presented paper deals with one of them - monitoring the life cycle of wheelsets. The process is integrated into the optimization of logistics processes of production and assembly of chassis, which has the ambition in the final solution of process monitoring without the support of paper documentation. The proposal to monitor the sub-process of the life of the wheelsets has approached this goal considerably. The paper background of the processing process occurs at the level of compiling wheel bearing plans, which will be addressed in the 3D company project launched in autumn 2020. It assumes that each production and assembly workplace will be equipped with monitors production instructions

for operations performed at the workplace, displaying the necessary drawing documentation for the performed operation and monitoring performed operations directly at the workplace in real-time. The completion of this project is set for the horizon of 1 and 1.5 years, and the final solution should be put into productive operation in the middle of 2022. During this period, other sub-processes of logistics will be solved, in which a significant role is also involved—the information technology department. A new solution must be designed to identify the marking of chassis production from the production of the main assembly - the basic frame, through the technological frame of the chassis and to the final chassis, delivery of materials to assembly lines - kiting parts and their support in the SAP information system, purchasing materials in sets (purchase of brake elements), etc. The researched company is a modern, rapidly developing, dynamic design and development department with an advanced team of technologists, production workers, logisticians, and the information technology department.

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