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Nikola Simić [1]
Miladin Stefanović
Jovana Nikolić

IMPROVING MONITORING OF EQUIPMENT IN THE LOGISTICS SYSTEM

Abstract: *In the fast-paced world of logistics, equipment management can be a costly and time-consuming setback. From transport vehicles to warehouse machinery, monitoring these crucial assets and their spare parts is essential for maintaining efficient operations. In this document, there will be presented the possibility of data processing automatization, through various classifications of arms and equipment and calculations, as well, which can improve the way of monitoring quantitative and qualitative parameters of items. This would increase the efficiency and effectiveness of the logistics system in one specific organization, the army. Throughout this article, there will be explored an innovative way to improve equipment monitoring in logistics systems and optimize supply chain management, according to the modern trends of automation and data exchange in manufacturing technologies, including cyber-physical systems, the Internet of Things, cloud computing, and cognitive computing, known as Industry 4.0. The most essential part of it, Quality 4.0, will help the integration of management tools into the quality and quantity control process. The main objective of this article is to show the new model of equipment management in quality products, and optimization processes using real-time data analytics, in order to reduce defects, provide greater responsiveness and reduce the strains on human resources.*

Keywords: *Industry 4.0; Monitoring; Logistics; Classification; Quality 4.0; Management.*

1. Introduction

Following the specifics of the missions and tasks performed by the forces of the Serbian Armed Forces, there are demands for accurate, timely, and expedient information, and with the development of technologies, requirements, and applications Quality 4.0. Having the right information at the right time is a good prerequisite for effective command and control in general, and especially in the area of logistical support, which is why there is a need to pay considerable attention to the development of information systems. Due to the volume and complexity of data that appear in logistics processes, the main problem is the impossibility of functioning the modern army without appropriate information support provided by the latest information technology systems. Given that the logistics information system of the Serbian Army is in the initial stage of development and is not sufficiently developed, the main goal of this paper is to see the possible concept of development of the logistics information system, in order to

Corresponding author: Nikola Simić
Email: nikolasimicva@hotmail.com

create the most favorable conditions for monitoring the quantitative and qualitative state of assets. The development of information systems in the logistics support system would shorten the response time of the system to requests, and reduce the number of personnel and the volume of logistics resources (Jovanović, 2013). The primary task of this paper is the affirmation the importance of automated data processing and monitoring of the condition of weapons and military equipment through information technologies in the logistics system, the number of personnel and the volume of logistical resources would be reduced.

2. Informational Needs of Logistics Authorities

The logistics information system should process data and provide information to competent decision-makers about objects of logistics interest throughout the entire life cycle in which the defense system can be found (peace, crises, state of emergency, mobilization, war) (Milenkov, Andrejić, Stanković, Bukvić, 2010). The information system should provide information about the state of elements and subsystems and the system as a whole thing, in qualitative and quantitative forms. The object of monitoring must be well described to facilitate its quantitative and qualitative monitoring and thus better decision-making. Also, the system itself needs to learn how to recognize certain objects and their needs for them. Each object of interest of the system should be described with as many parameters and indicators as are important for making adequate management decisions, and therefore for various types of asset classification in accordance with the needs of competent decision-makers. Also, it is necessary to define the informational needs of each decision-making body and the way of presenting the necessary information: cyclograms, histograms, numerical data, a form of prose description, etc. (Andrejić & Milenkov, 2012). The problem in the logistics support system is the lack of a single application for monitoring the qualitative and quantitative state of assets, non-updated management of assets in already existing information systems, i.e. lack of valid information on the current state of assets in the army caused by the human factor. Previous attempts to solve the problem of monitoring the state of assets in the army have not had much success. The applications "Information System UbS" and "IS VOZILA" have the greatest practical application, but due to the existence of certain shortcomings, they are not adapted for use by all logistics authorities. A proposal to solve the problem would be the introduction of automated information systems, based on Quality 4.0 and machine learning, where the rapid transfer of information would result in the creation of significantly lower inventory levels while increasing the degree of operative availability of funds. Therefore, in modern conditions, time becomes a critical factor due to more frequent requests for replenishment with critical material resources (Milenkov, Sokolović, Milovanović & Milić, 2020).

3. Informational System Model

The information system of the logistics authority is intended for better coordination, information, operation, and speed of response of the logistics system. To comply with the requirements, it is necessary that, in addition to the efforts made for the development of the system, the logistics authorities continuously work on the automation of work and the development of the application, and with the development of modern artificial intelligence, they are also working on its application. The information system of the logistics authority should be based on the organizational and formational

structure of the Serbian Armed Forces, information processes in the command system, and the achievements of modern computer technology. The goal of the system is to provide logistics authorities with accurate data on resources, and tasks that they can perform with the available funds, as well as to provide automated calculations for replenishment planning. The information system of the logistics authority, as an integral part of the logistics support of the Serbian Armed Forces, should enable (Milenkov, Andrejić, Sokolović, Cakić, 2009):

- creation of conditions for effective planning and management of logistic support;
- automation of the process of data collection, storage, and processing;
- efficient work of logistics authorities in planning, organizing, and implementing plans;
- provision of accurate records of available funds;
- automation of calculations and provision of reliable information for decision-making;
- providing information to management bodies in real-time.

The basis of an informational system should be information systems of supply, maintenance, transport, general logistics, health, infrastructure, logistics support planning, and other IS (material bookkeeping, operational records, monitoring the realization of material and financial plans, monitoring data on resources in society, monitoring the state of logistics personnel, monitoring the state of resource protection, etc.) (Zlatnik & Mares, 2020). The concept of the information system is shown in Figure 1.

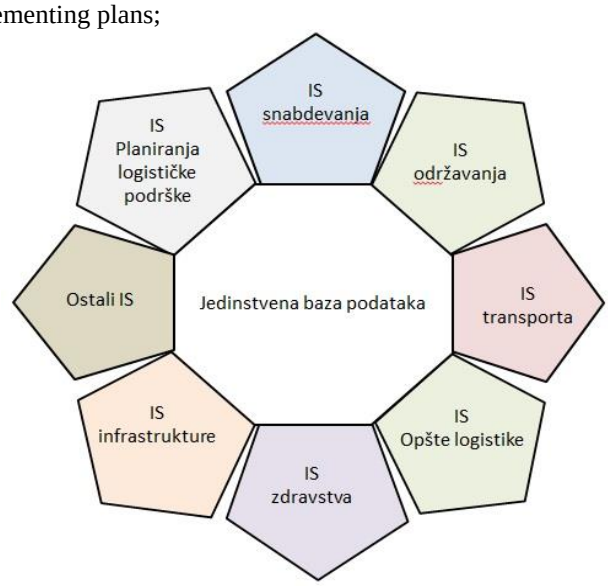

Figure 1. Functional structure of the information system of the logistics authority

The concept of such an informational system is very complex, and in itself represents a "mega project", which is divided into sub-projects according to logistic functions, to which specific resources are allocated and the set tasks necessary to achieve the goals are implemented. The sub-project of the Information System of the Logistics Authority shown in the paper is intended for the implementation of supply tasks. The sub-

project presents small applications for solving specific tactical problems that do not violate the global concept of the information system of the logistics authorities and which can, when conditions are created, fit into the global concept of the development of integrated information systems. The application, presented in the paper, is a model of the information system of the logistics authority and is an integral part of logistics support in matters of supply. It was designed in the Microsoft Access program, and supported for application-oriented artificial intelligence towards Quality 4.0. The decision to project the IS model in this allicative program is the request of the logistics authority to automate data collection, and the program provides input in only one place, ie. it omits redundancy, which greatly increases the efficiency of the work of the logistics authorities. The application model consists of several separate databases that are mutually independent. The reason for this design is the problems of modern technology, where viruses are primarily thought of. In case of an attack on one base, the application can be easily restored, and will not violate the global concept (Milenkov, Simić, Purković, 2015). The starting base is the central base that contains the necessary data for the realization of the requirements of the supply authorities (organizational-formation structure, classification of weapons and military equipment and echeloning of funds by units) and is the starting point for data entry. The central database contains data on the classification of assets, organizational and formational structures and distribution of assets by units, and other separate databases are linked to it, which represent the basis for later transfer and processing of data, preparation of calculations and provision of information in real time. Databases contain data on assets, and by linking to the central database, a connection is made with the classification, which is the basis for further upgrading of the application (Figure 2).

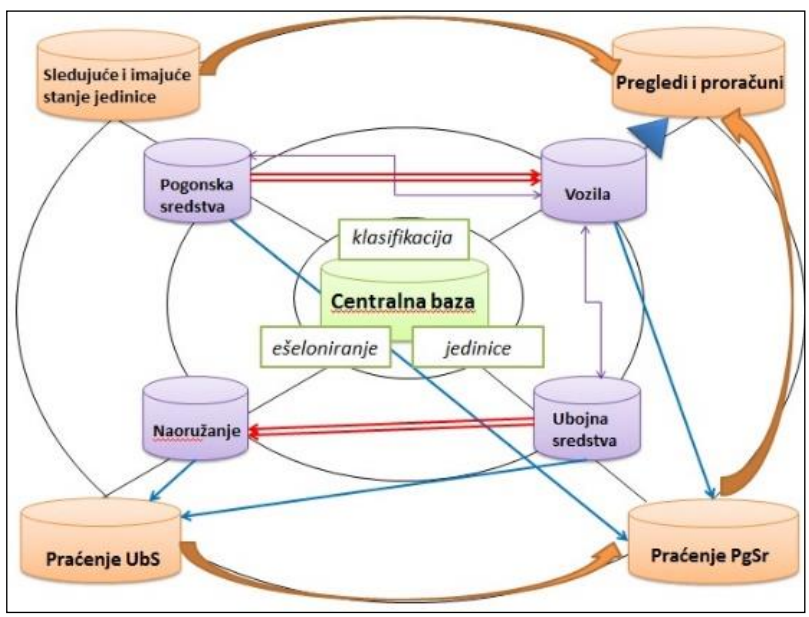

Figure 2. Connection of databases in the application

By creating quantitative monitoring of fixed assets (UbS (eng. ammunition) and PgS (eng. fuel)), the linking of assets and consumers into a single base is realized, and in this way, the condition for budgeting is realized ( ). By linking the database of the following and current state with the monitoring databases, a review and calculation database is formed. However, to obtain the final result, it is necessary to link funds with consumers ( ). For example: to calculate the amount of assets in the cargo box of the vehicle, it is necessary to connect the bases of assets (Sredstva) and the base of the vehicle (Vozila), and where previously it is necessary to enter the dimensions of the cargo box of the vehicle ( ). In the end, by tying all bases in the described way, a calculation is reached, one of the basic elements of which is the base of the vehicle (Vozila). ( ) Data are linked from one database to another and thus ensure constant updating of the complete application. The final outcome is the linking of all databases to the central database and the ultimate goal of the application is achieved, that is, overviews and calculations are displayed, which provide accurate records of the available funds, efficient work of the logistics authorities, and provide information in real-time. Databases that form the basis of the application, are of relational type. Tables that contain data by binding enable the application itself to work. Each table is identified by a unique name that the database uses to find the table. All that is required is that the user knows the name of the table and the data he needs. Tables and their data are displayed using forms.

Starting the application is achieved through the input mask, where the possibility of direct access to the desired content is given. When accessing, the content is opened in the form of a form, where it is possible to view the status and update the data. The form is that part of the database application that allows entering data into tables instead of directly accessing the tables, then modifying the existing data and their sophisticated display. Creating forms is possible if the data is previously defined in the tables and if they are linked. This prerequisite is the basis. The form itself serves as a more beautiful display of the application, while all actions are performed in the background, that is, through tables and their interconnections. The form shown in Figure 3 is a combination of tables that contain data related to the consumer and the means used by the consumer.

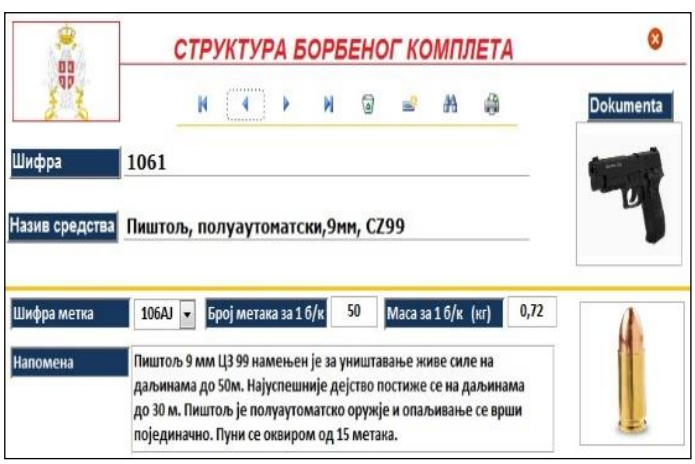

Figure 3. Form for displaying the structure of the combat kit

The form is structured from the main form and subform (Figure 3). On the main form, it is possible to select an asset, using the navigation buttons, where the image of the asset will be displayed in the documents field. The field includes legal and normative regulations that regulate the logistic support system, as well as technical documentation related to material resources. The form also shows a detailed description of the assets shown in the "note" field (Napomena).

The subform shows the structure of the combat kit for the selected tool, expressed through the number of bullets and mass (b/k). The "bullet code" field (Šifra metka) indicates the type of bullet intended for the selected tool. The subform also contains a detailed description of the funds displayed in the "note" field.

For the full operation of an application of this type, it is useful to create queries, which shorten the working time of professional service bodies. The queries used in this application were related to the grouping of assets and the review of the amount and type of assets by unit, all to calculate combat kits and fill tanks, as well as placing assets on a motor vehicle.

The final output of the application is Reports. Reports are based on survey data and calculations for specific units. An example of the report is shown in Figure 4.

Извештај - прорачун п/р за батаљон

пешадијски батаљон

Назив средства и опис	Количина	Опис назива ПгС	Ознака ПгС	једно п/р
Аутомобил, TAM 5000D	44	ГОРИВО за дизел-моторе, DIZEL D2	DIZEL D2	5280,00 l
		МАСТ вишенаменска, мека	УМ-2	264,00 kg
		УЉЕ, за кочнице аутомобила, гликолно, AT 2	UKAG-1	132,00 kg
		УЉЕ, моторно, нарочито детергентно, средње	DS-30/S1	748,00 kg
		УЉЕ, хипоидно, средње	HIP-90	528,00 kg
Аутомобил, PINZGAUER	5	МАСТ вишенаменска, мека	УМ-2	30,00 kg
		УЉЕ, за кочнице аутомобила, гликолно, AT 2	UKAG-1	3,50 kg
		УЉЕ, моторно, нарочито детергентно, средње	DS-30/S1	35,00 kg
		УЉЕ, хипоидно, средње	HIP-90	29,75 kg
		БЕНЗИН, моторни, безоловни, BMB 98	BMB 98	375,00 l

Figure 4. Tank filling calculation report

The report shown in Figure 4 offers data on the quantity and name of motor vehicles, a more detailed description of the propellants used by the motor vehicles, designations of the types of propellants, as well as the amount of fuel that represents one filling of the tank and the amount of lubricants and oils in kilograms that follow the observed motor vehicle. In the Name of Asset and Description column (Naziv/Opis), the exact names and detailed descriptions of motor vehicles are given, based on the Directory of Assets. The next column, Quantity (Količina), shows the number of certain motor vehicles that the battalion has. Then, in the column Description of the name, fuels, oils, and lubricants are described in more detail, more precisely they are described according to the nomenclature name from the directory of motor vehicles, which is used by the motor vehicle that is the subject of our interest. Then, the following table of

PgS designations shows the designations of propellants, which most closely define the matter. The PgS mark (Oznaka) is the most important information for the user. And finally, in the column with the name one p/r (Jedno p/r), the total amount of propellant is shown, which represents one filling of the tank for a certain number of motor vehicles. Tank filling is calculated using the following formula.

$$1\ \text{p/r} = \sum_{i} Nv * q$$

Where:

p/r - the amount of fuel that follows the unit,
Nv - the number of the same type of vehicle,
q - the amount of PgS that fits into the tank.
Reports represent the everyday life of expert logistics authorities, and their automation reduces stress and time spent, above all, on a continuous collection of the same data.

The application also offers a visually processed report, through the realization of graphics (3-D Clustered column), which simplifies the insight into the situation and condition in the unit.

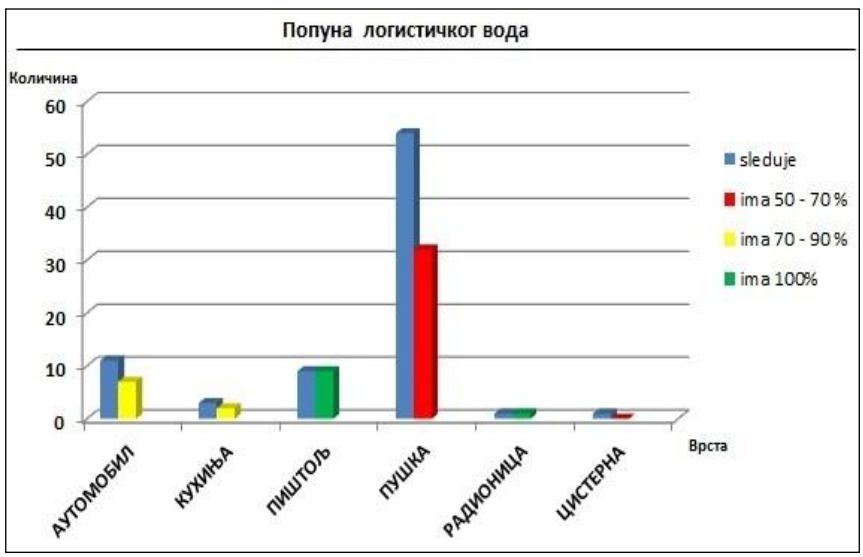

Figure 5. Graphic representation of filling.

The graphic representation in Figure 5 shows the relationship between the following and the current state of assets in the logistics line. The graphic is designed to show a certain percentage of the lack of funds in a certain color, so the amount missing in the range of 50 to 70% is shown in red, which signals to the user that the shortage is alarming and requires a certain action. Further development of the application tends towards the inclusion of machine learning and artificial intelligence to simplify data operations and facilitate the work of logistics authorities.

4. Conclusion

For the sake of compatibility with other systems, it is necessary to provide a comprehensive logistics database designed for application in a wide range of logistics activities and a logistics reporting system that would ensure the timely provision of updated logistics information. Also, it is necessary to work on constant improvement of the application, and above all on:

- development of the system for operational planning;
- development of logistics support instruments that enable: an overview of asset history, exploitation, individual monitoring, and calculations required for planning at the tactical level;
- the development of communication interfaces, which enable the mutual exchange of logistic electronic data and electronic mail services in joint systems.

Designing a logistics information system on one hand develops a global concept and on the other a small application for solving tactical problems.

Contemporary trends in informatics, practice needs, and time constraints require the development of information systems, which can provide a solution for reducing the number of human resources and "reducing the volume of logistical resources". The basic information system of the logistics authority should be integrated into a unified command information system. Its subsystems must function properly, which is achieved by the permanent work of the logistics authorities on the formalization and automation of business operations and the development of applications. The logistics authorities must work on the verification of empirical findings and their translation into theory.

The proposed model of the information system of the logistics authority can be a starting point for the creation of a unique information system that would enable data availability to all users at all levels of an organization, using machine learning and going towards Quality 4.0. This would facilitate the planning and monitoring of the implementation of logistics support plans, provide accurate records of the current state of funds, provide reliable information for decision-making through appropriate calculations, and provide information to the management authorities in real time and they could deal with more tasks, aimed at the organizational improvement of the existing system of logistical support and improvement of the operational capability of the units.

The final effects of applying the proposed model of the information system are gaining time, reducing the strain on the logistics authorities, increasing the quality of information, and efficient planning and management of logistics support.

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Nikola Simić
Faculty of Engineering,
University of Kragujevac,
Kragujevac,
Republic of Serbia
nikolasimicva@hotmail.com

Miladin Stefanović
Faculty of Engineering,
University of Kragujevac,
Kragujevac,
Republic of Serbia
miladin@kg.ac.rs

Jovana Nikolić
Faculty of Engineering,
University of Kragujevac,
Kragujevac,
Republic of Serbia
jovana.nikolic.jag@gmail.com