Advanced Engineering Letters Vol.1, No.3, 88-97 (2022) e-ISSN: 2812-9709

DEVELOPMENT OF THE SYSTEM FOR CUTTING TOOL FLOWS MANAGEMENT IN A SMALL MANUFACTURING COMPANY

UDC:004.6:621.9.02
Original scientific paper https://doi.org/10.46793/adeletters.2022.1.3.3

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Abstract:
Information systems in small manufacturing companies can have a big impact on increasing economy and productivity. Due to limited human and financial resources, these companies generally use cheaper commercial solutions or develop specialized information system solutions that are adapted to their needs. In order to properly solve the problem of introducing an information system, a thorough analysis of information flows in the company and corresponding business processes is necessary.
The main subject and goal of the research in this work is related to the investigation of time losses due to the absence of an information system from the aspect of managing the flow of cutting tools, as well as the presentation of the foundations for its development in a small manufacturing company.

ARTICLE HISTORY
Received: 16.05.2022.
Accepted: 15.08.2022.
Available: 30.09.2022.

KEYWORDS
Small manufacturing company, Information flow, Time losses, Cutting tool management, Information system

1. INTRODUCTION

High-quality management of a company cannot be imagined without the necessary resource that is information [1,2]. A good and timely decision requires that the information must be accurate, precise and at the right time [3-5].

If we accept the importance of the meaning of information, we can say that information becomes available to everyone and is used for the purpose of the overall business of the entire company, not some of its organizational parts [6].

A lot of information becomes a person's property, which is transformed into knowledge through use over time, and the path to knowledge goes from data through information management [7]. Therefore, it is important to emphasize the basic characteristics of each piece of information: it always contains new data, causes a reaction to its content, through information an individual increases his fund of cognitive facts, greater knowledge of an individual contributes to faster development of his personality [8].

The information system is a system that, based on formalized procedures, will provide management based on information from internal and external sources, and those decisions will be used for the purposes of planning [9-11], management and control of activities [12,13]. In a broader sense, it represents a complete system of information flow, exchange and processing [14,15]. The information system is a set of organized components that enable: Registration, Collection, Transmission, Processing, Storage, Analysis and Distribution of information for various purposes [16]. An information system can also be understood as an organized set of interconnected components: Software Resources, Hardware Resources, Network Resources, Data Resources and Human Resources [17-18]. Software resources include programs and procedures, hardware resources include computer devices and media, network resources include

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communication media and computer networks, data resources include databases and knowledge, and human resources include specialists and IT users (Information Technology) [19].

The company under consideration belongs to the group of small manufacturing companies, which is oriented towards providing services in the production of parts and assemblies for the needs of foreign and domestic companies. With the growth of the company itself, and thus of the complete inventory, the amount of information that needs to be monitored and managed also grows. One of the aspects of the company, where modernization is needed, is the monitoring, that is, the management of the flow of cutting tools. The paper analyses the time losses due to the absence of an information system from the aspect of managing the flow of cutting tools, as well as presenting the basis for its development.

2. IMPLEMENTATION OF INFORMATION SYSTEM IN THE COMPANY

2.1 Motives for the implementation of information systems

Companies must constantly develop, improving knowledge, following trends and novelties on the global market [20,21]. The key to success is the desire for success, the understanding of modern trends and the implementation of an exclusively optimal ratio of novelty in the existing company [22,23] which will clearly improve the business and facilitate certain activities for the employees [24,25]. Some of the motives that decide to implement the information system can be the following [16,19,26]:

- ✓ ***Integrating information from customer relations*** – The information systems implemented in the company can be understood as a virtual world of continuous monitoring of orders from customers in real time. This means the complete flow from the order from the customer, that is, from the moment of receipt in the sales department, to the shipment of the goods and the sending of the invoice by the financial department.
- ✓ ***Standardization and acceleration of production processes*** – A well-crafted strategy and plan that will ensure a well-solved issue of production and technology databases, with the addition of production and capacity planning, can facilitate the monitoring of total costs, as well as the implementation of quality control, with money savings and increased productivity.
- ✓ ***Integrating financial information*** – As autonomous software applications are increasingly used today, as a result different functions have their own databases and information about business results, business transactions and their own contribution to the overall performance of the company. Based on that, we get information systems that create a unique version of the truth about the company's performance and the contribution of individual segments to the company's results.
- ✓ ***Stock reduction*** – Proper regulation of the database that covers the information of production procurement and storage enables efficient management of stocks of materials, raw materials and unfinished products, as well as finished products and goods. If this part is done correctly, it is possible to achieve additional savings in terms of material storage.

However, there are still different views on the motives of implementing information systems, so another division is distinguished, which reduces the motives into three groups, and they are:

- ✓ ***Strategic motives*** - Development of new business strategies, application of business strategies, globalization of business, expansion of supply/demand chains, increasing responsibility towards customers.
- ✓ ***Tactical motives*** - Integrated business processes, standardization of business processes, improvement of specific jobs, increase of flexibility, reduction of costs, increase of productivity.
- ✓ ***Technical motives*** - Standardization of systems, better technical infrastructure, integration of software applications, better quality of information, platform standardization.

2.2 Ways of implementing information systems

The implementation of such solutions can last from one to five years, although that term is significantly shorter if the suppliers present a shorter implementation time requirement. There are the following ways of implementation:

- ✓ ***BigBang strategy*** – This strategy implies that at the same moment, you switch from one way of doing business to another in accordance with the requirements of the information system. It is required that the complete information system be worked out in detail and that after the transition to that system it is used in its full

capacity. This is precisely why errors occur that must be corrected as soon as possible. The success of the implementation of the information system in this way is visible only after several years. It has been always the topic of dilemma among the system integrators, service providers as well as the ERP vendors whether to go for Big bang strategy or not as it always involves the huge risks. However, the implementation of Big bang is fast and less expensive [27].

- ✓ ***Franchising strategy*** **-** It is characteristic of large corporations where there is a network with remote business units that have a high degree of management autonomy. The franchising strategy implies the installation, setup and commissioning of one license of the information system in a specific business unit. If the implementation is successful, it becomes a reference for new implementations in other business unit. Therefore, Franchising is a method of doing business where one end called the franchisor (who owned the business or create the opportunity) permits other end called the franchisee (who buy the franchisor business/right) to use the franchisor' name and products with predetermined fees [28].
- ✓ ***Slam Dunk strategy*** **–** This strategy aims to implement the information system only within the core processes of the business system. Based on that, when implementing an information system, such a system is selected and adapted to already existing business processes. The advantages of the strategy are that it is low risk precisely because it is implemented gradually, and therefore no significant reengineering is carried out, but only a new tool is introduced to support business processes [29].

2.3 Costs of implementing information systems

The implementation of the information system requires appropriate financial resources that must be calculated and foreseen within the budget [30]. Costs within the implementation of information systems can be reduced to the following:

- ✓ ***Software license*** **–** Like many software, information system software should have a license, which will allow the use of the software in a legal way. The license itself has a fixed cost, however it is subject to variation when there is demand for some other software components;
- ✓ ***Consulting*** **–** During and after the implementation of the information system, it is not necessary to have experts in this field within the company. The convenience is reflected in the fact that there are external experts who perform an objective evaluation of the business system and advise in the event of a possible revision and implementation of the system;
- ✓ ***Infrastructure audit*** **–** The information system can be used in all business activities of the company. Accordingly, if the IT infrastructure does not correspond to the availability, security and speed of the information system itself, the logical solution is to perform its audit;
- ✓ ***Adaptation*** **–** The implemented information systems do not have to be identical to the ones offered, that is, if there is a need to change the information system to some extent in order to adapt it to the business process, it must be done. Costs related to customization vary depending on the changes that need to be made and the chosen information system;
- ✓ ***Internal costs*** **–** The biggest responsibility for the implementation of the information system lies with the organization implementing this project. Hiring an implementation team is extremely expensive, and they often make up the largest part of implementation investments;
- ✓ ***Maintenance of the information system*** **–** Along with the conclusion of the license agreement, it is necessary to foresee clauses on system maintenance to be performed by the supplier. Contracting related to system maintenance is carried out periodically. Responsibilities of suppliers are precisely defined so that there are no misunderstandings and unnecessary losses in the later period;
- ✓ ***Costs of customizing the business system*** **–** The components of these costs are as follows: declining profits, customer satisfaction, increasing total production and delivery times, occurrence of scrap, etc. This does not represent a direct connection with the implementation of the information system, but rather the costs caused by the adaptation. Therefore, the team that implements the information system should anticipate the costs for the negative impacts of the performed transformation on the business results.

3. FLOW OF INFORMATION IN THE COMPANY

Companies that are predominantly oriented towards individual and small-batch production, have a basic goal that is oriented towards the fulfilment of customer requirements.

For a clearer representation of the functioning of the observed company, Fig.1 presents the flow of order monitoring in the company, from the moment of receiving the request from the customer until the delivery of the product.

The information flow steps are explained in detail in Table 1, where information about the flow of tools in the company is also presented. Tool information is important to multiple segments of the displayed departments, so it is also an introduction to further analysis of the tool flow.

Table 1. Description of activities in the company

FLOW	ACTIVITY
1	The customer contacts the company (sales) to order the product according to his requirements.
2	Delivery submits the customer's request/order to the technical production preparation service. The construction preparation of the production considers the novelty of the product and whether its activity is needed. If the order contains product drawings, it is forwarded to the technological preparation of production. After that, consultations are carried out between technological preparation of production, operational preparation of production and procurement in order to define the possibility of production, capacity, rough delivery dates and cost estimation - delivery price.
3	Sales sends the customer an offer (product concept - if there is such a request, delivery dates and price) for approval. If the buyer agrees with the offer, a contract is signed on the production and delivery of the product.
4	When the contract is signed, sales issues an order for technological preparation, which includes the operational preparation of production and procurement in order to agree on deadlines (procurement, completion of construction and technological documentation, start and end of production, and product delivery date).
5	As part of the technical preparation of the production, the construction preparation of the production sends the construction documentation to the technological preparation of the production. Creation and addition of technological documentation (content of the technological process, maps of operations, control programs...) is carried out. Defining production costs.
6	Submission of construction and technological documentation to the service of operational preparation of production.
7	Checking the stock of preparations, components (parts and assemblies), etc. Request for procurement of preparations and components in the procurement department.
8	Contact with suppliers and answer about deadlines and quantities of delivery of preparations, components (parts and assemblies), etc.
9	Contact with subcontractors and answer about terms and quantities of goods delivery.
10	Checking the correctness of existing tools, accessories, gauges, devices, etc. and an order for the repair of the same or the production of new ones.
11	Technical documentation (construction and technological documentation) of special tools, accessories, gauges, devices, etc.
12	Order tools, accessories, gauges and devices from suppliers.
13	Launching construction documentation, technological documentation and work orders into production. Feedback on the realization of work orders from production to operational preparation of production.
14	Launching documentation from operational preparation of production to accounting.
15	Communication between production and control on the correctness of manufactured products.
16	Launching production documentation into accounting.
17	Continuous sales information from production on the state of completion of the product, difficulties, possible contacts with customers, etc.
18	Notification of the sales department on the completion of production.
19	Delivery of finished products to the customer.

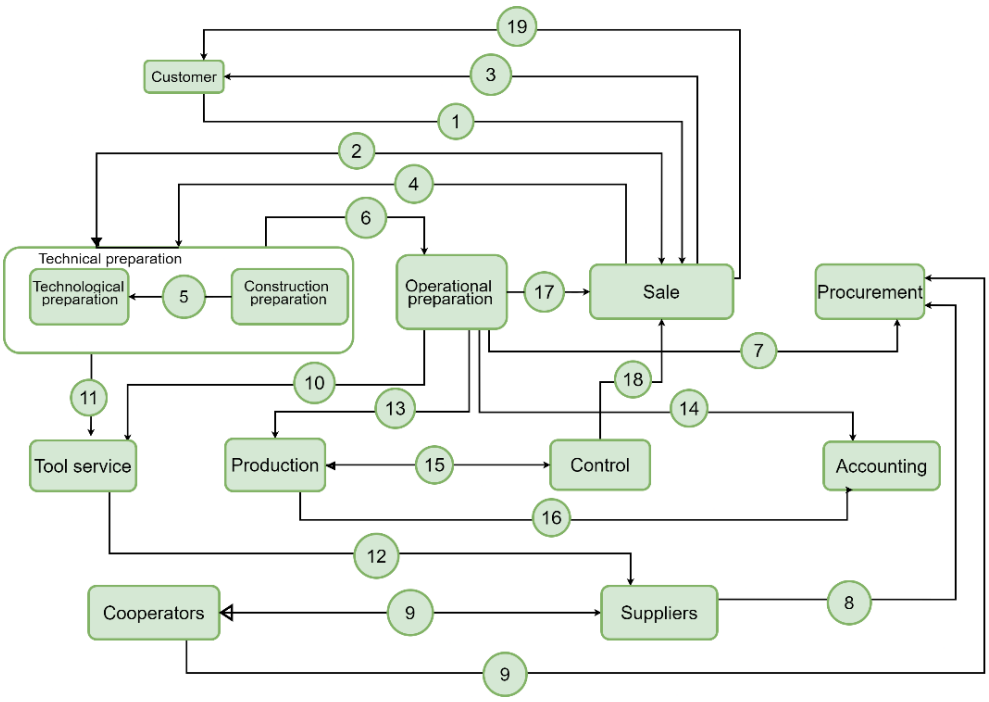

Fig. 1. The flow of information in the company from the order to the delivery of the product

4. TIME LOSSES OF CNC MACHINE PROGRAMMERS

The development of the information system for monitoring tools is conditioned by the time losses of CNC machine programmers, and therefore an insight into the criteria of their creation is given. Various criteria were observed over the course of three weeks, which are given below.

As the first parameter for insight into programmers' time losses, the number of NC programs created on a daily is singled out, Fig.2. These data are very variable, because they depend on many factors, the most important of which are the complexity of the workpiece geometry and the programmer's knowledge of manufacturing technology. Since this research is done within a company that does service production, i.e., in a company that does not produce its own product, the programmer may have different amounts of completed programs on a daily.

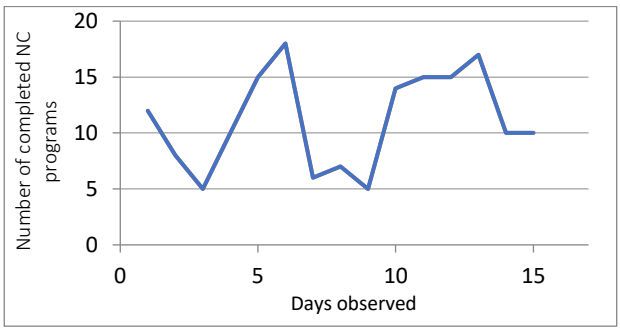

Fig. 2. The number of NC programs performed on a daily for a period of three weeks

The next parameter taken into consideration is the number of tools used on a daily. Fig.3 shows the daily average of the use of different tools (numerical values). The number of tools used depends on the choice of technology that will be used to process a certain piece. It may happen that for the same product, two different programmers access different technologies and thus get a different number of tools that they will use in the processing itself. This explanation shows how it is possible for the same product to be processed with different number of tools, and in real production it will not happen that two programmers work on the same product, but only one programmer writes the technology for one product.

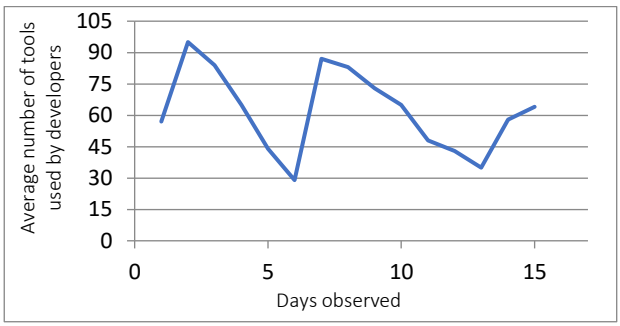

Fig. 3. The number of tools used on a daily for a period of three weeks

Fig.4 shows how often the programmer had consultations with other participants regarding a specific tool or searched for a tool in the tool room on a daily. This problem is especially pronounced

among newly employed programmers who find it difficult to navigate this part of the job.

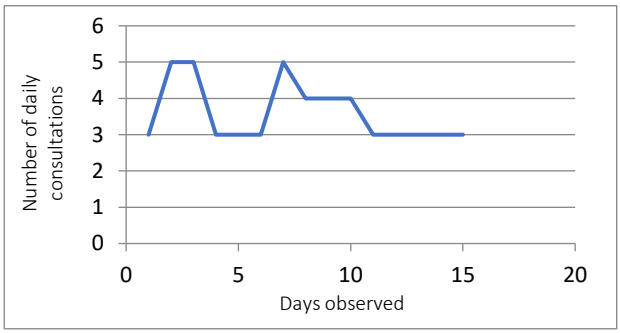

Fig. 4. Number of tool consultations per day for a three-week period

Time losses related to consultation with the head of production, quality and procurement manager or independent search for tools in the tool service cannot be precisely defined and tied to a fixed period but can vary from situation to situation. Those loss values can be from a few minutes to over 15 minutes, which is a long period of time considering that it represents a stoppage in the work of at least one employee. For a clearer presentation, tentative values of time losses were introduced for the previously listed scenarios, in order to show through graphs how much time would be lost. In the case of consultations with the head of production, it was assumed that a time interval of 5 minutes was lost from the programmer's point of view (time losses of the head of production were not taken into consideration), in the case of consultations with the quality and procurement manager, it was assumed that 4 minutes were lost, while for independent search a time loss of 3 minutes was taken in the tool room.

Fig.5 shows the programmer's time losses. Time losses vary, and the average for the observed three weeks is 15 minutes per day. In the observed period of three weeks, the CNC programmer lost a total of 225 minutes, which is a serious loss, especially if you consider that there are several programmers in the plant.

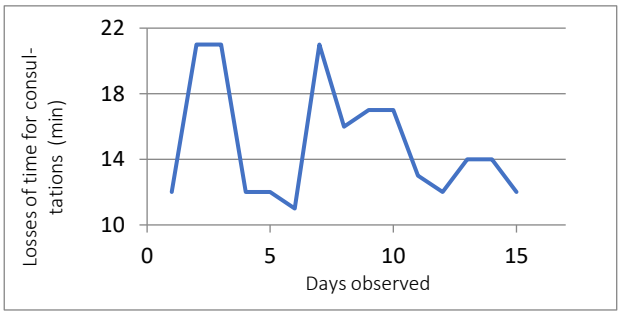

Fig. 5. Time losses of CNC programmers

The previous analysis indicates significant time losses of CNC programmers in the selection of available cutting tools, which speaks of the importance of an information system that will include information about them.

5. CONCEPTUAL SOLUTION OF THE INFORMATION SYSTEM FOR MANAGEMENT OF TOOLS FLOWS

Since the information related to the tool flow, in the observed company, concerns the quality and procurement manager, the CNC machine programmer and the head of production with the machine operators, the presented solution concept will be presented from their point of view. At the very start, database information for tools, machines and operators is defined. The application that was used to create database elements is MS Excel, and the application that created various interfaces and database connections is MS Access.

Table 6 shows the information of the tool database, in which only general data is currently entered. This database of information is stored by the quality and procurement manager. If a new tool is purchased, he has the duty to enter the information into the database, by entering all the necessary data, or in the "Quantity" column, update the new numerical balance in accordance with the number of new tools and currently existing within the company. Under the column "Type of tool" is meant the type of tool, so for the sake of easier search, the type of tool is entered first, and only then the subtype (such as, for example, mill_spindle or mill_full). In the "Diameter" column, enter the diameter of the tool, while in the "Depth of cut" column, enter the maximum depth that the tool can handle. Columns "M_A" and "M_O" represent the material of the tool and the material of the workpiece, which are significant if iMachining is used within SolidCam - where by entering this data, the software determines the optimal processing modes according to the criterion of the maximum quality of the machined surface or the maximum amount of chips removed. Columns "Cutting speed", "Feed" and "Depth" represent the recommended machining modes according to the tool manufacturer's catalogues.

The operator database contains the operator ID and is important for tracking the location of the downloaded tool.

The machine database contains 8 machining centres for milling (Machining centre G) and 3 machining centres for turning (Machining centre S).

In addition to the name of the machine, the database contains the geometric characteristics of the machines ("X axis", "Y axis" and "Z axis") and the maximum number of revolutions of the machine's main spindle.

Table. 2. Display of tool database elements

No.	Type of tool	Diameter	Depth of cut	M_O	Quantity	M_A	Cutting speed	Feed	Depth
1	Drill	7	8	Al	7	TiN	80	0.1	1.5
2	Drill	10	14	Al	11	TiAlN	95	0.1	1
3	Drill	8	10	Al	6	TiAlN	100	0.1	1
4	Drill	12	16	Al	8	TiAlN	85	0.1	1.5
5	Mill_spindle	8	12	Al	5	TiAlN	100	0.1	2
6	Mill_spindle	12	20	Al	9	TiAlN	85	0.1	1
7	Mill_spindle	15	15	Al	12	TiAlN	80	0.1	1
8	Mill_spindle	16	12	Al	5	TiAlN	80	0.1	2
9	Mill_spindle	10	10	Al	7	TiAlN	100	0.1	2

The difference in the interface is made by the different needs of the employees in the sense that if, for example, the programmer wants to choose a machine on which the processing will be carried out, he should also know the characteristics of the machine so that he does not create and send an NC program to a machining centre that is not suitable due to the dimensions of the workspace. On the other hand, if the operator takes a tool from the tool shop on the order of the programmer - technologist, it is important for him to note on which machining centre the tool will be located.

5.1. Operator interface

Fig.6 shows the operator interface for retrieving tools from the warehouse. The operator's duties are to select from the drop-down menu the fields related to the tool he is selecting, then to which machine he carries the tool and finally which operator assigned the tool. If there is a need for a note, enter it in the field on the right. This interface automatically records the time the operator has retrieved the tool. The same interface is used when returning tools, with the addition of a "Broken Tool" section, where you need to enter the word YES if the tool is broken (in order to order a timely replacement) or enter the word NO if there is no damage. In the "NOTE" section, it is preferable to describe in words if minor damage to the tool or the like has occurred.

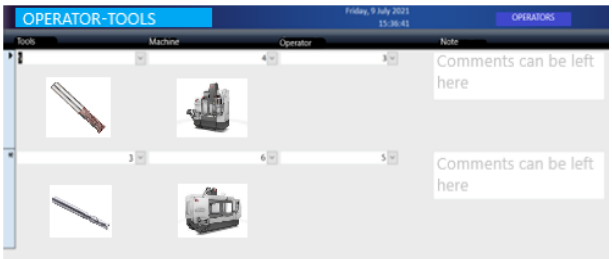

Fig. 6. Tool download interface layout

5.2. Quality and procurement manager interface

The interface for viewing the availability of tools regarding the items "Tools" and "Machines" are identical to the previously described images. Additional fields represent "Quantity" and "Available", Fig.7. Based on the selection of the tool, the following fields are filled in automatically, thus obtaining "Quantity", which means all the tools found in the company (which are currently use and which are not used). This number is important so that the quality and procurement manager, in case of a smaller number of tools, can order additional quantities in a timely manner. The item "Available" means the number of tools that are not currently being used on the machines but are available for use.

Fig. 7. Interface for viewing tool availability

5.3. Programmer interface

Fig.8 shows the layout of the planned tools interface used by the programmer. Within it, you can select the exact tool and machine on which the tool is planned to be used, as well as an additional note if necessary. The drop-down menus under the items "Planned tools" and "Machines" are identical to the description of the previous ones. This part is important from the aspect that by marking the planned tools for use, the other programmer sees it and plans the tools accordingly.

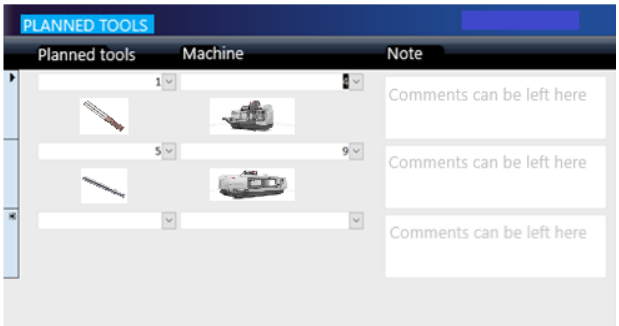

Fig. 8. Interface of planned tools

6. CONCLUSION

Information systems are more and more widespread today. More and more companies decide to implement one of the information systems or to pay to get a version of the information system adapted to their business. In times of better connectivity, adapting to an information system does not represent such a big problem, because systems that work with more familiar or at least simpler interfaces are sought, thus giving users the impression of ease of use.

The goal of this paper is fulfilled by presenting in detail the problem of managing the flow of tools in the company, and the solution is presented in the form of a concept of how that problem could be solved. Improvements in employee communication when managing the flow of tools in the enterprise in turn provide great time and money savings. Therefore, a logical conclusion is imposed that such a system should be developed and implemented in the observed company.

ACKNOWLEDGEMENT

This paper is part of a study in the project "*Collaborative systems in the digital industrial environment*" No. 142-451-2671/2021, supported by the Provincial Secretariat for Higher Education and Scientific Research of the Autonomous Province of Vojvodina and "*Innovative scientific and artistic research from the FTS domain*", No.451-03-68/2020-14/200156, supported by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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