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# AUTOMATIC IDENTIFICATION SYSTEMS FOR MANAGEMENT - MATERIAL FLOW CONTROL AND STOCK STATUS

**Jakub Kovalčík**
Department of Logistics and Transport, FBERG, Technical University of Košice, Park Komenského 14, 042 00 Košice, Slovak Republic, EU, jakub.kovalcik@tuke.sk (corresponding author)
**Michal Balog**
Department of Logistics and Transport, FBERG, Technical University of Košice, Park Komenského 14, 042 00 Košice, Slovak Republic, EU, michal.balog@gmail.com

***Keywords:*** RFID, RFID system, smart logistics, automatic identification
***Abstract:*** The subject of the article is to define the current state of the information system, to describe the use of technology in practice and to understand the principle and benefits of smart logistics. To describe the operation of RFID technology and systems that are necessary for the effective operation of a comprehensive automatic identification system. The issue is to define the current state of information technology and create a project for automatic identification. The aim of the smart logistics project is the overall improvement of the production process, registration of parts and the overall highlighting of the company's reputation. Automatic identification systems are nowadays one of the fastest growing areas, whether information logistics or logistics as such. Manufacturing companies are trying to apply more and more elements of these systems to their production processes. Slovak companies, which have their production process based on international orders, are increasingly trying to optimize their production and thus approach Western countries in the field of automatic identification and registration of parts.

## 1 Introduction

Automatic identification systems are nowadays one of the fastest growing areas, whether information logistics or logistics as such. Manufacturing companies are trying to apply more and more elements of these systems to their production processes. Slovak companies, which have their production process based on international orders, are increasingly trying to optimize their production and thus approach Western countries in the field of automatic identification and registration of parts.

Many leading authors in the logistics and transport sector are dedicated to the areas of RFID technology, with which logistics information systems are closely related and their functionality. They speak of the correct and efficient functioning of the logistics system, of which the logistics information system is a part, as a set of consecutive activities. If one of these activities does not work properly, the proper and efficient operation of not only the information logistics system but also the logistics information system as a whole is endangered and thus the emergence of the so-called bottleneck. About such functioning or malfunctioning LS are mentioned by the authors *M. STRAKA and M. BALOG* in their publications [1]. An important aspect of the logistics system is its construction. More detailed information on the possibilities, variations and construction of the logistics system can be found in the publication *of D. MALINDŽÁK* et al. entitled Design of the logistics system [2].

In the field of RFID technology, there has been a major shift in the last few years, as evidenced by publications from various foreign authors. *Mir-Moghtadaesi of Shahrekord University* describes the operation of the UHF frequency as a frequency that can reduce interference between RFID systems. He describes this study in a work entitled*: A newUHF / ultra-wideband radio frequency identification system to solve the coexistence issues of ultra-wideband radio frequency identification and other in bandnarrowband systems* [3]. The use of RFID technology requires a number of different components that are necessary for its effective operation. The authors *of Babaeian et al. from Monash University in Australia* created a study in which they describe the algorithm of operation of the reading device and detection of the RFID chip at a certain distance [4]. A study by *Occhiuzzi et al. from the University of Rome* talks about the use of simple RFID chips in food packaging. This study assumes an almost unlimited use of this technology in various industries and levels of the logistics process. The study, entitled: *Radio-Frequency-Identification-Based Intelligent Packaging: Electromagnetic Classification of Tropical Fruit Ripening* [5], was an inspiration in creating an article and understanding simple communication through RFID tags.

The issue of RFID technology is described in more detail in the publication *Analysis and Assessment of Management and Control of Component Flows for the Needs of Production in a Specific Company* [6]. This publication narrowly describes the development of RFID technology in Slovakia. It deals with various variations of technology and their use in everyday life. A more specific use of this technology is described in the publication *KOVALČÍK, J: Project of the use of automatic* *identification systems for the needs of management and control of material flows and identification of inventory in a specific company environment* [7]. The work is focused on the specific use of this technology in practice. Describes the positive and negative elements of the technology, points out the way of its use in the assembly and engineering industry.

## 2 Methodology

Company Alfa, which is the subject of the investigation, is a major market player in the engineering and assembly industry. The problem that necessarily concerns Alfa is the system of automatic identification of parts. In connection with the above, their goal is to create a smart logistics project. The project will deal primarily with the identification of parts in the production process, their registration in the production process and, last but not least, the improvement of the information system. . This analysis is carried out directly on the company's premises with the help of responsible employees in individual areas. The system approach and algorithmic thinking are applied in the analysis. The task is to create a project for the use of automatic identification systems, primarily for the needs of registration and management of parts in the production process. The project must take into account all the elements that could affect the proper and effective functioning of the system. In Alfa, it is mainly the diverse nature of individual types of parts [8]. The aim is to characterize the current situation in terms of information system and technical support for process monitoring in a particular company and to design a system that will use SAI. To effectively create a project, it is important to know the type, nature and functionality of each available technology that can be used in the issue [7]. Management and workers in production halls are fully aware that there are areas in warehouses and in the production process where monitoring of logistics processes is insufficient, but they cannot identify them correctly. Therefore, it is necessary to use analytical methods that determine the relationship between cause and effect and make it possible to determine the consequences. These relationships can be illustrated in various diagrams in a simple and clear way. Alfa's production process is too complex and lengthy, so it is not possible to start the planned project in all production halls at once. After a professional consultation at Alfa, we decided to shorten this production process [7].

It includes the monitoring of logistics processes [7]:

- stationary stations for deregistration of production,
- radio frequency scanners,
- forklifts,
- logistics train,
- trucks of internal transport,
- controlled intermediate storage of parts and input material.

The problem areas were analysed during my time at company Alfa. Individual problem areas were identified after professional consultation in the company [6]:

1. Failure to check out the realized operations in production orders in real time (often at the end of the shift), this makes it impossible to relocate work in progress when moving production to other halls (production of a work in several halls).
2. Due to overloading of production capacities and non-fulfilment of delivery dates of purchased materials, is not in accordance with the planned production dates, which are based on the required shipping dates of wagons or bogies according to the project schedule.
3. Materials (most often pallets of various sizes), which exceeds the current state of packaging in TVP. Subsequently, this problem is solved by storing several types of parts in one pallet and thus violates the rules for the smooth transfer of unfinished and finished parts in production and in warehouses.
4. Identification of the contents of the pallet by a loosely enclosed paper guide gives the presumption of its loss during transport, incorrect and incomplete filling by the operator, impossibility of transferring the change to the already existing guide, etc.

## 3 Current functioning of registration processes in the company Alfa

Production in the company Alfa can be characterized as custom variant production, in which the customer has a relatively high degree of freedom to determine the technical parameters of railway wagons. It can be divided into two basic groups: 1. Requirements for the supply of freight wagons and bogies 2. Small orders for the supply of spare parts or services. Both groups of customer requirements are realized by mutual agreement between the customer and the supplier, which in the first case is concluded by signing a business contract and, in the latter case, by placing an order with the customer. The first group of customer requirements, which in terms of time last several months, is realized through projects, the second group of requirements has a short implementation time, several days, weeks and it is realized by special production into stocks of specific sales orders - custom production [9]. in the company it represents an individual business case, with all phases of its life. The project at Alfa manages the part of production whose subject of performance towards the customer is the delivery of agreed numbers of entire railway freight wagons or separate bogies, with gradual dispatch, according to the agreed time diagram - dispatch plan. The production of wagons and chassis represents a significant majority of production, against the production and supply of spare parts for Alfa products, or small supplies of services, which use the free capacity of special technologies available to the company. Monitoring of the entire project life period in the pre-production and production stages is processed in Alfa, in the SAP information system using the Project System module [7]. The whole business case is divided according to the dispatch plan and production capacity possibilities into production batches, which according to the SAP system are referred to as SPP elements of the project (Structured project plan). The realization of production takes place from elementary parts, through the assembly of structural units of wagons and bogies, to the final assembly of wagons and bogies and the vast majority is project production, a certain minority part of the production of basic parts is realized by anonymous production to the warehouse. These are usually universal parts used in several projects, which are produced in economic batches [9].

### *3.1 Identification of production operations*

The complexity of the final products (wagons and bogies) and the prevailing project batch production mean that thousands of production orders are realized in parallel in production, from the production of elementary parts, through orders for subassemblies and assemblies to final assembly: production of wagon and bogie superstructures. Each production order is currently identified in production by a paper guide, which contains all the information needed for production but also identifies the status of the production order with the marking of manufactured pieces for the operation and identification of quality control [10]. The production order guide contains the following basic information [11,12]:

- number of the manufactured component, • required production quantity,
- dates of order production (start, end),
- warehouse where the finished component is stored,
- production centre determining the subsequent consumption of the component,
- supply area production from which consumption is realized in a higher stage of production,
- link to the relevant T-element (if the production is anonymous link to T-bill is not defined),
- complete workflow with determination of time standard for individual operations
- material requirements tied to individual operation.

Work-in-progress production orders for parts are shifted in production, most often in pallets, large parts in bulk. During the life of the order, the transport pallet changes several times (depending on the complexity of the workflow, which includes discrete cutting and machining operations), but the guide moves with the work in progress. In the case of division of the order, when the production order proceeds to production in several transport batches, a new guide is printed for each batch. Each sublot of the production order must be identified by a guide [13]. In the SAP system, transport batches are defined for each part transported in pallets, specifying the type of pallet in which the part is to be moved in production (determined by the part size) and the transport batch quantity (determined by the load capacity of the selected pallet and part weight). After the end of the production of parts, these are stored in a central warehouse (WM warehouse) from where the parts are delivered on the basis of the requirements of the assembly workers in the area of supply of production in the assembly halls. In the case of time slips in the production of parts, these are delivered directly to the assembly lines [14].

At the central warehouse, the guide represents an identification element about the stored part, which contains information [15]:

- part number,
- quantity in the pallet,
- project SPP number,
- production warehouse (assembly line where the material is to be stored),
- production supply area on assembly line where the part is to be delivered.

The environment of production of parts corresponds to classical engineering production and therefore the paper form of identification of production orders about the content of parts in the pallet is not optimal, it is prone to damage and loss (Figure 1). The subject of optimization of logistics processes within this project is the process of controlled material flow of production of parts up to delivery to assembly lines and threads connected with it:

- ensuring the consumption of input materials for production orders with identification of the batch consumed in the operation,
- operations with assignment of quantity of good and bad pieces produced,
- identification of causes of deviations, identification of the person or working group who performed the operation,
- check-out of quality control operations,
- storage of parts in the warehouse unless automatic reception is set for reporting with the last operation,
- optimization of warehouse structure [7].

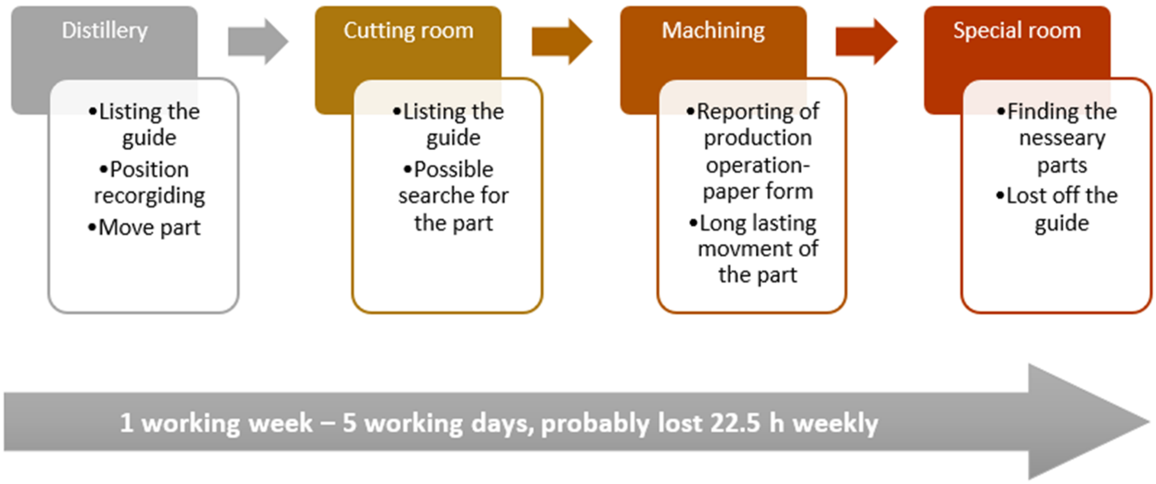


*Figure 1 Current operation of parts process monitoring [7]*

### *3.2 Summary of the analysis of the current state of operation of processes in the company*

The subject of the optimization of logistics processes in Alfa is the elimination of weak points in the current process monitoring, using modern technologies of data collection directly in the production process and in warehouses. It is necessary to optimize the process of monitoring the production of parts and their material flow, allocation of pallets and their content. A wide range of manufactured parts and a high degree of completion of production orders, which are realized in several production halls and are stored in multiple warehouses (controlled and unmanaged) requires quick availability of information on the current allocation of work in progress, identification of pallet number in which it is located and quantities. pieces in the appropriate pallet [16].

Within the project, the priority is to solve the following specific tasks [17-22]:

1. Monitoring the flow of work in progress over time - its exact position and degree of work in progress, quantity in packaging.
2. Automatic restocking of work and finished part during its transfer between export points or export point and intermediate storage.
3. Removal of the paper form of the guide as a basic identification element in the current functioning of the logistics process.
4. Removal of the paper form of the request for delivery of material to assembly lines.
5. Navigation of the import of material to a specific area of production supply.
6. Places in production with recording: production order numbers, operations, good pieces, bad pieces, the cause of the deviation and the personal number of the worker (or group of workers) who carried out the operation. If the input material has been used for the operation and is batched, it is necessary to record the number of the consumed batch.
7. Reporting the quality control operation and releasing blocked stocks in quality to free use.

## 4 Smart logistics project proposal

### *4.1 Pilot version of the project*

This project is to be a pilot version of the implementation of the automatic identification system in Alfa into the entire operation. At the moment, the project is commissioned only for a certain part of the material flow, due to the fact that for a wide range of production in the company Alfa, it is not possible to implement this project at once in all production halls and on all necessary parts. The project currently concerns four production halls, the visualization of which together with the parts will be presented in the following section. For the successful implementation of the project into the entire operation, the pilot version should be a kind of simulation of the behaviour of workers and production, to the system of automatic identification. As already mentioned, the project does not cover the whole operation, and the same applies to parts in production. Three types of parts were selected for the project, three types of their storage and three types of marking of these parts. The parts represent all possible storage variants in Alfa. Each tag / chip used for labelling must be rewritable (Table 1) [18].

| Pieces | Type of storage | Label type |
|---|---|---|
| Type A | On leave | Magnetic tag/chip |
| Type B | Ind corral pallets | Fixed tag/chip |
| Type C | Plastic crates | Adhesive tag/chip |

*Table 1 Types of parts, storage and type of marking [7]*

| Pieces | Type of storage | Label type |
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| Type A | On leave | Magnetic tag/chip |
| Type B | Ind corral pallets | Fixed tag/chip |
| Type C | Plastic crates | Adhesive tag/chip |

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Alfa's requirements include both software and hardware requirements. In terms of logistics and focus, however, we will focus only on components of the hardware type, which are necessary for an effectively created project and also the correct operation of the material flow in the company Alfa (Figure 2). A high percentage of RFID components on the market are made to order. In the case of the smart logistics project and Alfa, which is the contracting authority, this is the same [19]. Custom components are compatible with a large number of software modules used to output technology, so there is no need for a more detailed analysis at this time. The project is currently in the phase of finding a supplier of these components, so there are no relevant outputs for it in the form of orders. However, for the needs of the research, there are similar components on the market that can be used [20].

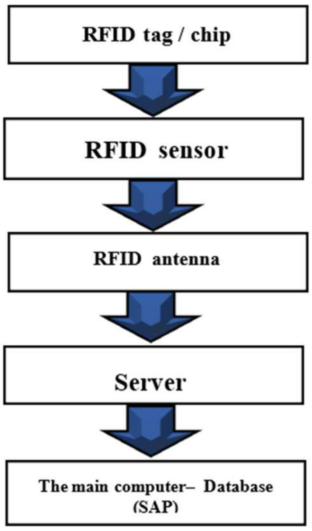


*Figure 2 Components needed [7]*

### *4.2 Number of required components and visualization of components in production halls*

When visualizing the halls (Figure 3, Figure 4), it is necessary to take into account the area in $m^2$, each of the stationary sensors and mobile sensors has a maximum scanning distance. In the case of mobile sensors, this problem of logical range is logically eliminated; an adequate number of such sensors will be allocated to the halls after consultation with Alfa, due to the size. However, stationary sensors require efficient placement in production halls. In table no. 2 we process the individual halls and find out how many stationary sensors we have to use to cover the whole space (Table 2).

The same principle applies to RFID antennas, as the antenna we choose will collect and send data from both stationary readers and mobile ones. The selected stationary sensor has a maximum range of 25 m perpendicular to the object. The signal from this sensor can be defined as a circle, where the centre is a stationary sensor, and the radius reach perpendicular to the object. In our case, it is necessary to calculate the content (1) of this circle. A simple equation for calculating the content of the circle suggests that one stationary sensor covers about 1970 $m^2$.

$$S = \pi \times r^2 \quad (1)$$

*Table 2 Number of required components [7]*

| Hall | Process | Area in $m^2$ | Number of components | | |
|---|---|---|---|---|---|
| | | | Sensor | | Antenna |
| | | | Moving (pcs) | Stationary (pcs) | |
| Hall n.1 | Distillery | 4 532.22 | 7 | 3 | 2 |
| Hall n.2 | Cutting room | 2 649.45 | 4 | 2 | 1 |
| Hall n.3 | Machining | 6 345.84 | 8 | 4 | 2 |
| Hall n.4 | Special room | 11 371.62 | 10 | 6 | 4 |

## 5 Results and discussion

During the analysis of the current functioning of logistics processes in the company Alfa, it was found that the current system primarily prolongs the production time of the complete building. Whether it is a complete railway wagon, bogie, resp. another necessary part of the product. In a manufacturing company and especially in logistics, the individual processes are consecutive, and therefore the time of production of a particular object is closely related to finance. It is therefore necessary to convert the time lost in the current system into financial form. In this work, we focused mainly on the parts called A, B and C. When calculating the return on investment, it is currently pointless to define a specific part [7].

If we define a working week for 2 changes, after 7.5 hours, 5 days, then we will get the working time. **75 hours per week.** After the analysis in the company, it was found that the time that employees lose when writing a guide, unnecessary relocation of parts, respectively. parts search accounts for about 30% of that time. This figure represents exactly **22.5 hours per week and 90 hours per month**. As mentioned, time is closely related to finances, so it is necessary to convert the figure of 90 hours per month using the so-called "Man-hours" for finance. According to an available calculator from the Ministry of Labour, Social Affairs and Family, 1 "man-hour" represents several **16.80 € per hour**. This fact, after a simple mathematical operation, determines the amount of **1.512 €** per month, which represents a loss caused by unnecessary manipulation of parts, irresponsibility and inconsistent material flow.

After the implementation of the smart logistics project, this amount and especially the time should be significantly reduced. During the consultation of the project at Alfa, it was found that the implementation of the project had a figure **of 22.5 hours per week and thus 90 hours per month reduced by several 75%.** This fact represents an investigation **of 17 hours per week and thus 68 hours per month. From a financial point of view, this represents a final amount of 1,142.4 €** (Figure 5, Table 3).

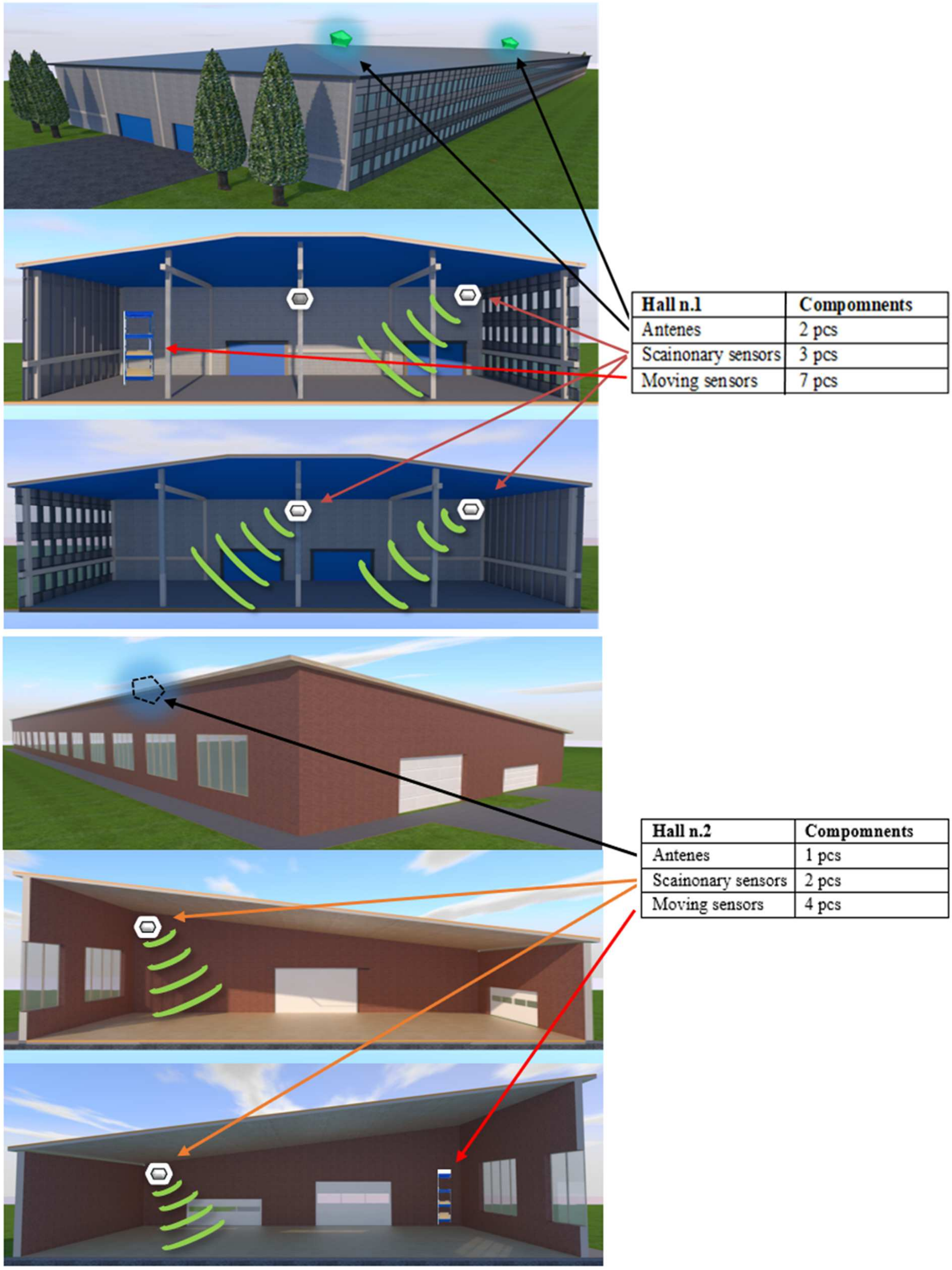


*Figure 3 Hall n.1 and n.2 components [7]*

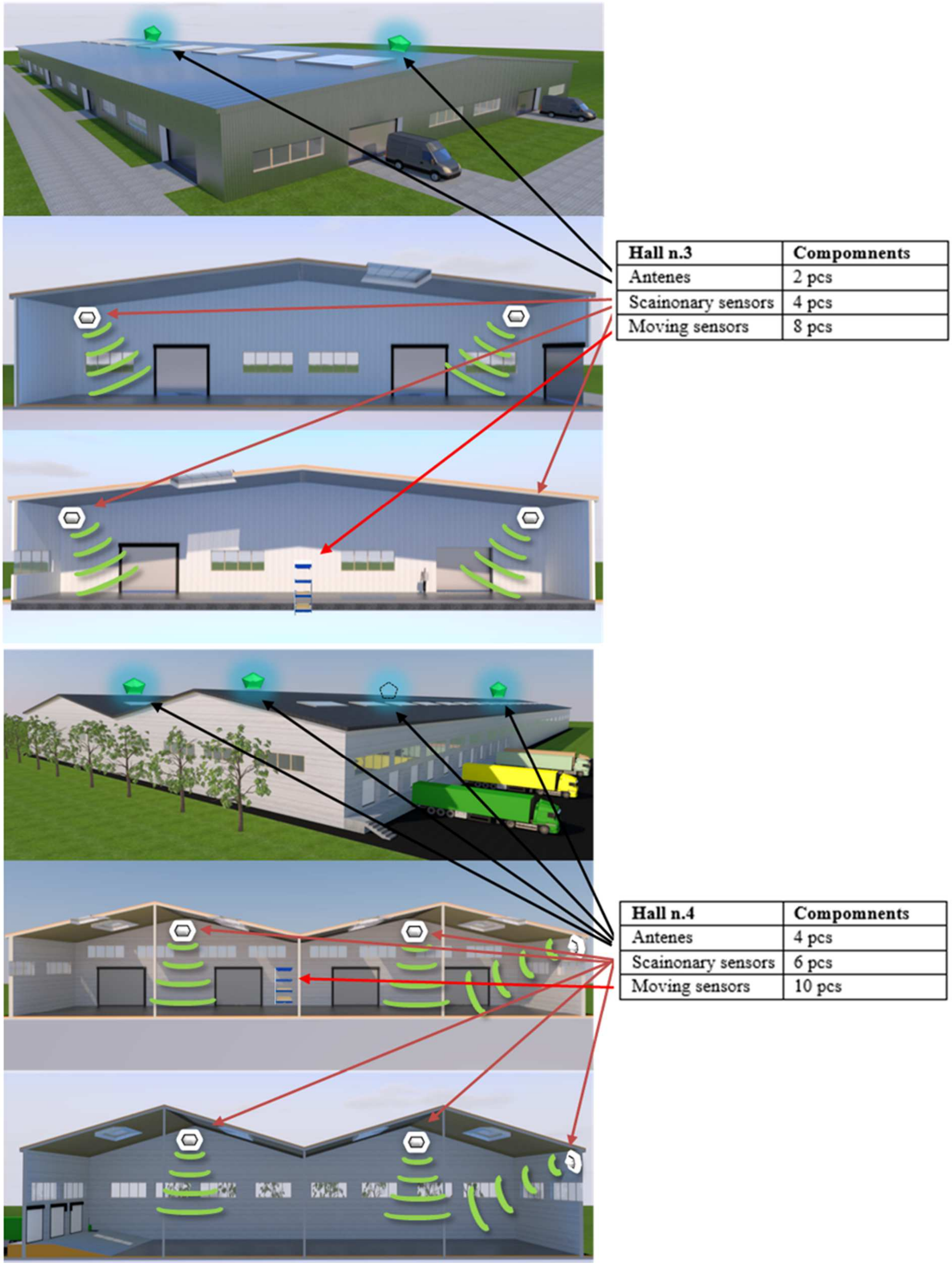


*Figure 4 Hall n.3 and n.4 components [7]*

The data from the economic enumeration [7] tell us that the investment in the pilot project is **58,425 €**, and thus the return on investment for the pilot part of the project is € 58,425 / € 1142.4. In our case, the investment in the project

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should return within some 52 months, which represents **4 years and 3 months.**

Even after the implementation of the project, the company will not avoid certain financial losses. However, these are related to the operation of RFID technology. This amount is € 1512 **-** € 1142.4, which gives us the amount of € 369.6 per month. It is obvious that the implementation of the project will achieve a significant monthly decrease in the number.

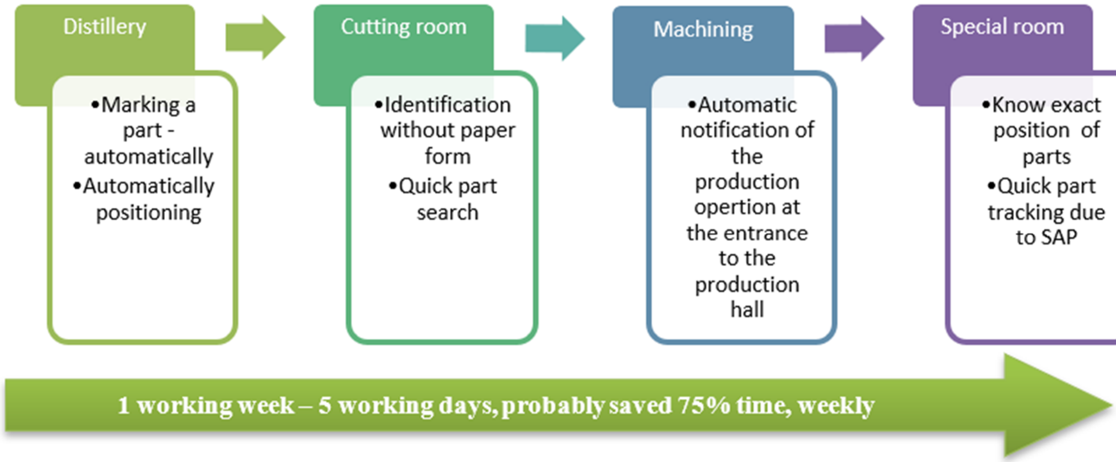


*Figure 5 Scheme of operation of logistics processes - SMART logistics [7]*

*Table 3 Results of the project*

| ---------------- | Curent function | - | --------------- | New function |
|---|---|---|---|---|
| Working week / month | 300 h | - | Working week / month | 300 h |
| Lost time in %/ month | 30% | - | Save time in % / month (from 30%) | 75% |
| Lost time in hours/ month | 90 h | - | Save time in hours / month | 68 h |
| Lost money / month | **1512 €** | - | Save money / month | **1142.4 €** |

## 6 Conclusion

Automatic identification systems are among the models with high implementation costs. This is mainly due to the need to incorporate many timeless elements into Alfa's system. However, its advantages outweigh any existing solutions for the material flow control and inventory identification system. As mentioned, implementation requires many elements. For the pilot version only, the cost of implantation can climb to large amounts. The pilot version of the project requires the purchase of tags / chips, sensors, antennas, servers, the main computer, cabling and, last but not least, assembly. In addition to the mentioned elements, there are also items related to the storage of parts. Of course, the company has a number of such elements, but it is up to the company to consider whether its investment will concern the purchase of new, respectively. keeping old handling units. The loyalty of the company's employees is also a very important fact in the implementation of the project. The core of this project is automatic identification, but even with this fact it is not possible to completely remove the human factor. The nature of production does not allow it. A larger percentage of sensors in the pilot version of the project is of the mobile type. This fact will logically require quality training of staff.

The implementation of the smart logistics project should be a part of the entire operation in Alfa after successful testing. Its benefits will be felt after only a few production cycles. From the point of view of logistics, the project will significantly help to monitor the material flows of work in progress over time. Thanks to tags / chips, which are rewritable and have a relatively high memory, it is possible to monitor the exact position, degree of work in progress, resp. the number of pieces in the package for the parts in question. The use of SAI can be understood in the Slovak market as an innovative use of modern technology. With the help of this project, it is possible to get rid of an obsolete identification element in the logistics process. The paper form of the guide is a problem nowadays. Especially if it is such a lengthy and demanding production as production at Alfa. Assumption of loss, resp. damage is very high. It is this fact that company Alfa paid significantly for. **If we define logistics as a way, a philosophy of management, including material flows, then the loss or damage to a single identifier in the production process is a significant problem for the further continuation of the material flow. We are talking mainly about the planning of production capacities or production dates**. This situation logically results in non-compliance with export deadlines, which results in a damaged reputation of the company. By implementing the project, we can achieve significant progress in the field of logistics, inventory monitoring and material flow. The nature of production in the company is extremely complex. However, it is appropriate that the company is constantly introducing various elements to accelerate and innovate it. Therefore, the question is whether the company does not want to focus on complete automation of production in the future. I believe that a major player in the market, such as Alfa, can make a big difference.

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