Proposal of Suitable Control System and Measure in Internal Logistic Process

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Abstract

In order to choose the right procedure for optimizing production processes, it is necessary to get acquainted with the issues of logistics, logistic operations and modern logistic methods. Today, the term logistics is used in all companies and industries. The automotive industry is one of the fields in which special emphasis is placed on understanding proper logistics and all its sectors. Its understanding and penetration into the depth of its essence is key to succeeding in the market in leadership positions and leads to gaining new customers, retaining existing customers, saving time and thus increasing the company's financial stability in the existing market. The article addresses the issue of reducing errors at the beginning of the production of individual bus parts and proposes the introduction of new control systems for employees. The aim of the article is to propose a suitable system and measure in the internal logistic process in a manufacturing company. The article is based on research of world literature, in-depth interviews with top managers in a manufacturing company, detailed analysis of internal data of a manufacturing company and analysis of the working environment of employees.

KEY WORDS: *internal logistic process, suitable system and measure, control systems, modern logistic methods*

1. Introduction

In developed markets, where it is generally difficult to increase sales volumes and where corporate profitability shows a long-term declining trend due to pressure from competitors, it is necessary to constantly look for ways to improve productivity. Logistics is an important factor in promoting globalization and developing international trade flows. Logistics has become one of the main factors determining the competitiveness of the economy. A significant part of logistics tasks is performed by logistics service providers, these companies play a key role in more efficient and effective operation of selected industries. Therefore, their operation must be sufficiently efficient, which means that logistics service providers must be aware of the main operational factors of logistic processes. Warehousing provides space and time benefits and helps ensure a high level of customer service. Currently companies are trying to minimize logistics costs [1-4].

The aim of the article is to propose a suitable system and measure in the internal logistic process in a manufacturing company.

2. Theoretical Background and Methodology

It is pointed out that in connection with the delivery of goods to customers, logistics activities arise from the activities of information, handling, packaging, warehousing, identification, transport and other elements in the links of logistics chains. Associated with them are logistics costs, usually related to the unit of logistics performance, to order, to the product, which represent about 80% of the total logistics costs, and standby costs, fixed costs due to the existence (availability) of a warehouse in a particular place [5]. Logistics has been under pressure for a long time to reduce business costs. As a result, areas of logistics are explored where there are opportunities to streamline costs with a focus on individual logistics activities and procedures. Inbound logistics includes activities in the procurement process and supplier integration. Improved supplier integration can affect several aspects, such as logistics performance and cost, quality, technology, flexibility of response, and profit [6-8]. Internal logistics can include operations in the field of production, material handling and performed regular inventories [9]. Internal logistics begins when the raw materials enter the company until the final product is ready for distribution. Internal logistics activities affect numerous aspects of logistics performance and costs. As a result, individual outputs and costs must be constantly monitored and evaluated [10].

Some authors rank the case study among the methods of qualitative research [11-12]. A case study is briefly characterized as a detailed study of one or a small number of cases in order to apply the acquired knowledge in understanding similar cases. It contains an intensive analysis and description of a separate unit or system bounded by time and space [13].

3. The Case Study

There is no employee control system in place at the workplace that will be dealt with in the article. This is a very important and important part in the production process of electrical material, which, if not produced correctly, can cause considerable problems and its production error will only occur after the bus is put into operation. Which is the worst case error rate that can occur. As long as the error rate of the worker results in the production of bad parts, the so-called "scrap", which is visible immediately at the exit of the line, or its incorrect operation, or other shortcomings workers encounter during installation in the bus, it is a serious error, but can be small a number of such shortcomings tolerate. However, if a part is produced which is not defective at first sight, and even after connection it appears to be a functional element, while its hidden defect will only become apparent when the vehicle is put into regular operation and may result in fatal damage, such a fault must be prevented on the assembly line. It is inadmissible for the bus manufacturer to detect the error only by the customer himself while using the purchased product. There are a total of 157 drawers on the lashing template (see Fig. 1), of which 109 drawers are for connectors, without additional detents. Cables are connected to these connectors, the ends of which are provided with their own locking, so it is not necessary to lock the connector after connecting all cables. Another 48 sockets are used to connect the connectors, which must be locked after the complete untying of the bundle. These drawers occupy an area of approx. 65 x 35 cm on the lashing template. There are several free spaces on the template that could subsequently be used to install control measure. When dividing the template into imaginary red sectors 1-6 (see Fig. 2), there are drawers in sector number 5. The space for installation of new control systems or measure is located in sector number 3, where a handling area of 65 x 40 cm is available. In sector number 4 there is a free strip 30 cm wide in the left part, then free space in sector number 5 just below the drawers in question, where there is an area of 35 x 15 cm and in sector number 2 where there is a free space of 20 x 15 cm.

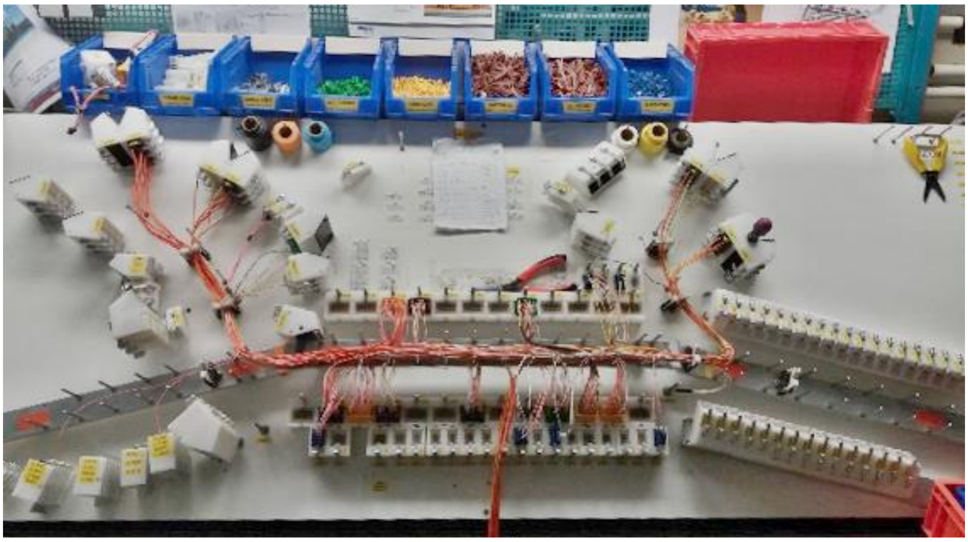

Fig. 1 Mooring template; Source: Authors

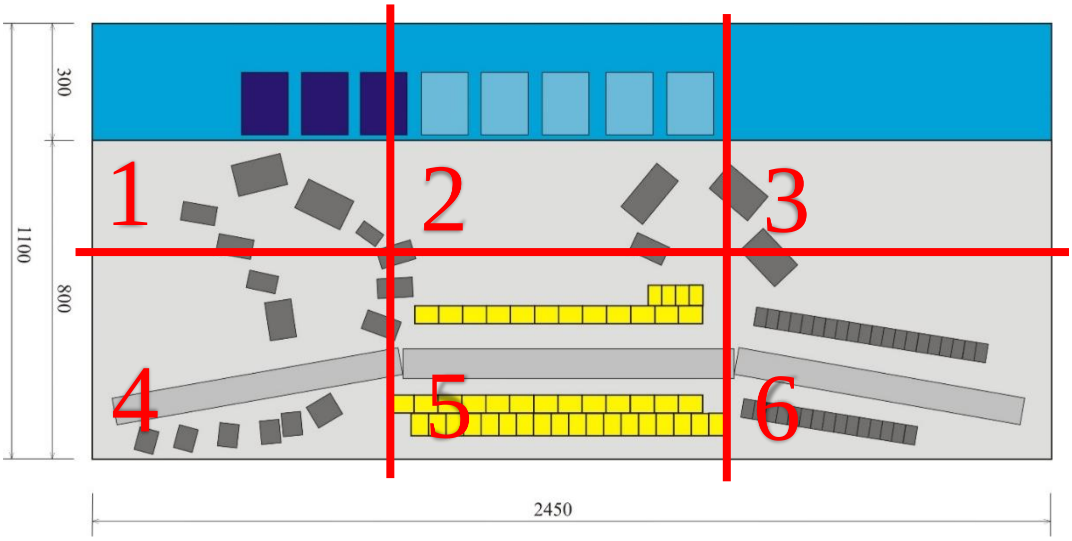

Fig. 2 Scheme of mooring template; Source: Authors

Several factors must be taken into account when designing control systems. The first of them is to maintain the layout of the workplace and not to exceed the free space on the mooring template. Another requirement is financial demands, investment in the modernization of the workplace and the introduction of control systems should be as low as possible. However, the error rate after the introduction of the control system should be zero. The introduction of the system should also not increase the time needed to produce one bundle. Thanks to advance modern technologies, a larger number of control systems are available that are on the market and thanks to which 100% of production errors would be achieved. However, these systems are costly and, even in terms of maintaining the dimensions of the workplace, it would not be possible to implement them due to a lack of free space.

3.1. Proposal of control measure

The first proposal focuses mainly on meeting the requirement of financial demands. Therefore, this proposal is not about introducing a control system, but only about control measure that would contribute to better clarity of arrests, and the worker would know exactly after completing the untying of the bundle, whether he forgot to place an arrest.

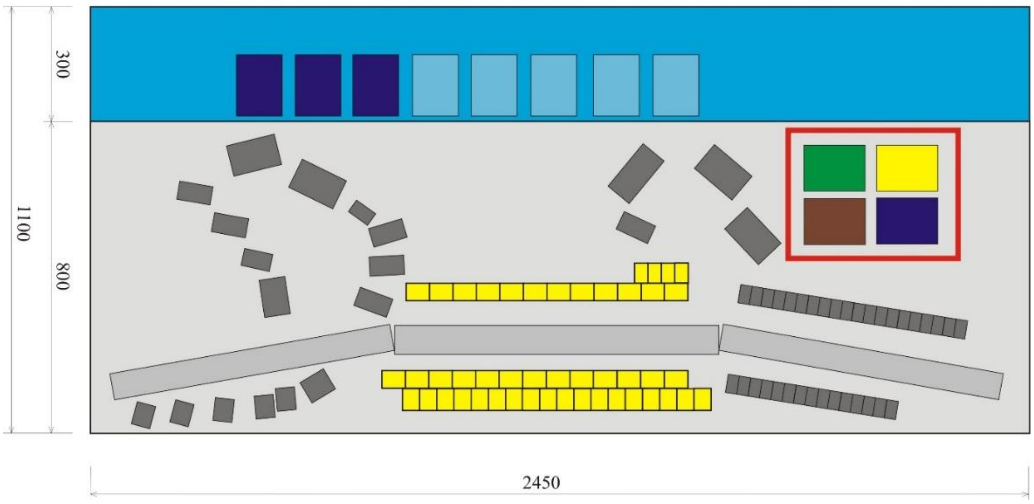

Fig. 3 Scheme of mooring template adjusted for control measure; Source: Authors

Figure 3 is a schematic of a mooring template. In this case, the free space in the red marked sector was used, where four boxes would be placed in colour corresponding to the colours of the arrest at the given workplace. The worker must set the parameters of the volume to be completed on the computer in advance. This program will determine exactly how many locks it will need for a given volume. The worker would first divide the detents and put in each box the appropriate number of detents needed for a complete bundle. After completing the untying of the bundle and its testing, the locking of the forks is placed. Sometimes it happens that some forks are released and fall out of the drawers before the worker locks them, and the worker then jumps over and thinks that the fork is already locked because it is no longer inserted in the drawer with this fork. In the current state, where workers have an unlimited number of detents, it is not possible for them to realize in time that they forgot to place one and send a poorly secured bundle for installation on the bus. If the worker has the exact pieces of the locks ready and forgets to place one during securing the forks, she notices at the end of the process that she has locks left in the box and knows that she has to check the bundle again to find the fork she forgot to secure. The introduction of such a measure would not be costly in terms of finances or space. However, it would still depend on human attention. If the worker recalculated at the very beginning and placed the wrong number of detents in the pits, this measure would not serve its purpose. In the first case, the worker could put a smaller number of detents in the box than she has. If she had properly secured all the forks, she would have come to the end of the mooring that she had miscalculated and placed the locks at the beginning. In that case, she would complete them and the bundle would eventually be properly secured. However, if the worker forgot to place a locking device in the fork during the gradual securing, it would in the final state look as if the bundle was correctly locked. When checking the boxes to see if they are empty, there would be no locking, so the worker would not check the bundle and send it to another workplace, where it would be installed in the bus. In the second case, a situation could arise in which the worker, after completing the securing of the bundle, finds out that she is left with arrest in some box. At this point, however, she would not know what error she had left in the lock. This could have happened for two reasons. Either she could recalculate at the beginning and place one or more extra locks in the box, or she forgot to lock a fork while securing the bundle. In such a situation, it would then have to go fork by fork and check the individual detents to see if they are present on all forks. A big disadvantage of this measure is the time required both for preparation and for the detection of an error and the subsequent search for a fork that is not locked. By counting and dividing the detents, the time to untie one bundle would increase by approximately 3-5 minutes, depending on the size of the bundle. On average, the time required to untie one bundle is 30 minutes. About 16 bundles are created during one shift. With 3 shifts, an average of 48 bundles are exported per day. If we extended the production of the bundle by 5 minutes, it would produce 2.5 bundles less per shift and 7.5 bundles less per day. The introduction of this control measure would not achieve zero production error, and the time required to produce one bundle would be significantly increased.

3.2. Proposal of control system number 1

In this proposal of the control system, the focus is primarily on the requirement of zero error in the production of bundles. With the help of the installation of a control system and optical sensors, this requirement should be met 100%. To implement this system, it would be necessary to provide the mooring template 47 with optical sensors. Each sensor would have to be located next to the inspected socket. The sensor dimensions are 12 mm x 31.5 mm x 21 mm. The location of such sensors would not be a problem in the case of the first, second and fourth rows of marked sockets (see Fig. 4). There is a free space that could be used to install sensors. However, the problem would occur when installing the sensors to the third row of sockets, there is not enough free space for the installation of these optical sensors. It would therefore be necessary to adjust the lashing template so as to obtain more free space above the third row of drawers. Enlarging the template would not be drastic and the space needed for optical sensors could still be made here. Each sensor would then be programmed to monitor colour contrast. The forks and the locks they secure each have a fixed colour. For example, yellow forks are secured by locking brown, blue forks are secured by locking yellow, green forks are secured by locking blue, and brown forks are secured by locking green. If the worker forgets to secure the fork with a lock, the sensor will not detect a colour contrast and will immediately alert the worker to the missing lock. The same warning would occur even if the sensor did not detect a precisely determined colour contrast and, for example, the yellow fork was equipped with a green lock. The introduction of this control system would meet the requirement of zero error in securing cable harnesses. Another requirement that this system would meet is the minimum time required. The time required to produce one cable would not increase in any way. The requirement to maintain the layout of the workplace would also be met. However, the essential condition, which is the financial demands for implementation and subsequent operation, is no longer met. One optical sensor is based at FPC, which specializes in this issue at EUR 1,000, in the case of 47 optical sensors it is EUR 47,000, which at the exchange rate of CZK 26,235 (average exchange rate for the first quarter of 2021) is CZK 1,233,045. Other costs for the installation of sensors and the modification of the mooring template are also not negligible and the total amount for the introduction of such a control system would reach CZK 1,500,000. The return on such an investment would take several years to produce an average of 48 unbound bundles per day.

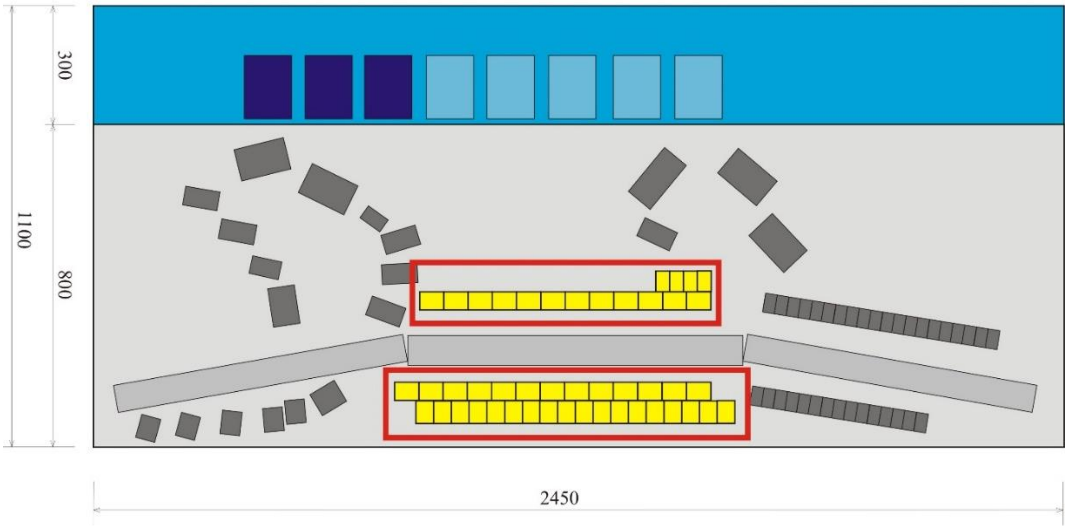

Fig. 4 Scheme of mooring template modified by control system number 1; Source: Authors

3.3. Proposal of control system number 2

This control system is called Pick to Light (or Pick by Light) and is one of the ways of the Poka Yoke method. With its use, zero error rate of the worker at the workplace is achieved. In general, the Pick to Light system guides the worker by means of light instructions on the monitors, thus showing him how many and what components the worker has to remove and where to place them. This system has many forms and is very adaptable to customer requirements. It is most often used in warehouses, where when picking orders, the number of pieces that he has to remove at a given moment and send on for processing is lit on the shelf worker. If the employee does not remove all of them, or possibly removes more, the system immediately notifies him of the error. Until the worker clears the error, the system will not allow him to continue working. If the Pick to Light control system is installed on the mooring template, the free space above the template will be used. This will not interfere with the desktop, nor will it be necessary to modify the template and invest in its modification, as was the case in previous cases. The locking boxes, of which 8 are now in use, would be replaced by 4 special boxes (see Fig. 5), which are equipped with LED rails and scales. Each box would be designed for one type of locking. For even better orientation in the workplace, it is recommended to purchase boxes in colour corresponding to the arresters, i.e. one box of green, blue, brown and yellow. Depending on the colour of the detent, the worker would pour the detent into a box of the same colour. When loading the system, the value of the weight of one detent would be assigned to each box, and after inserting the detents, the number of pieces in the box would be automatically calculated. Before each untying of the cabling, the worker on the computer would enter the program intended for the given bundle, and according to it, she would gradually show on the LED bars which box to remove the lock. If the worker removes the lock from a box other than the one under which the LED bar is lit, the system will report an error, and until the worker returns the bad lock to the box and removes it from the correct box, there will not be much to continue and the system would not allow it print a label about the correct binding of the volume. Implementing such a system is less costly than in the previous case. Pick by Light technology, a system comprising 4 weighing boxes, 4 LED rails with displays, system installation and compilation of special programs for approx. 175 types of cabling, transport and commissioning would cost EUR 19,500, which at the exchange rate of CZK 26,235 (average exchange rate for the 1st quarter of 2021) is CZK 511,583. This system thus meets all the requirements that have been set for the introduction of a new control system. When using it, there will be no increase in time for the production of one bundle, so the average production of 48 bundles per day will be maintained.

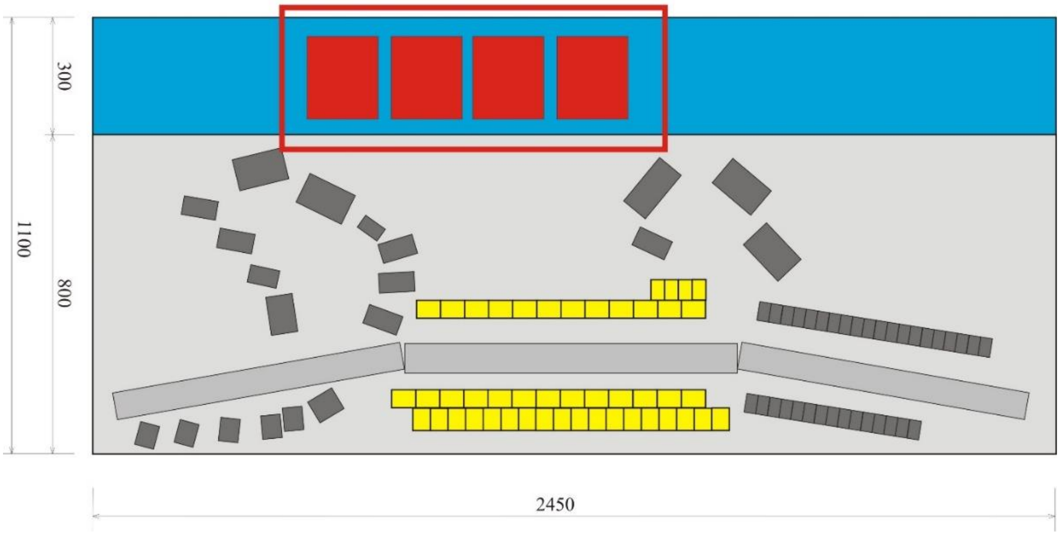

Fig. 5 Scheme of mooring template modified by control system number 2; Source: Authors

3.4. Evaluation of the proposed control system and control measure

All proposed control systems and measure meet at least one requirement set by the company's management. The most important of the requirements for the introduction of a new control system or control measure was the achievement of zero error rate when tying cable harnesses to buses, or when securing their plugs with detents of the appropriate length. Only control systems can meet this requirement, as they are completely independent and cannot be influenced by the human factor in any way. If one of the control measure were introduced, the error rate would certainly be reduced, but zero error would still not be achieved, as the allocation of arrests would be up to the person and he could easily confuse, recalculate, overlook or inadvertently change the type of arrest. The second most important requirement was the minimum financial demands on the implementation of the system or control measure and its subsequent maintenance and operation. Table 1 shows that the financial complexity is acceptable for 2 of the 3 proposed solutions. In the case of control measure, this is a negligible amount of investment and the question therefore arises as to whether it would not be worthwhile to introduce such a measure, even though the measure does not guarantee that production will be 100% without unlocked forks. If the implementation of this measure did not increase the time for the production of one cable harness, its implementation would certainly be useful. However, there is a time increase, which is not negligible, and after being projected into all-day operation, it is assumed that production would be delayed in the event of the introduction of a control measure by 7.5 pieces of the bundle. In production, which is on average 11 pieces of bundles per day lower than usual, after being reflected in the monthly turnover, the production loses about 330 pieces of bundles, which is as if production lasted 7 days a month. This financial loss would be noticeable after only a few months of operation and would very soon exceed the acquisition value of control system number two. In the case of the number one control system, the investment of CZK 1,500,000 is significantly higher. And the cost of subsequent operation would also not be negligible, as small optical sensors that sense the colour contrast of the plug and detent would be installed as close as possible to the plug sockets due to limited space, threatening their frequent damage and the need for repair or replacement. Another requirement for the introduction of a new control measure was the time needed to produce one bundle. The time to untie the cabling should be maintained, in the best case it should be reduced. The introduction of any of the control systems and measure would not reduce the time required to untie a single cable harness. For control systems, the time would at least be maintained, while for both control measure, the time to untie one bundle increases significantly. The last requirement was to maintain the layout of the workplace. Due to the rapidly growing production, the free spaces are constantly shrinking and there is no longer enough free space for new machines, equipment or other equipment in the electrical materials workplace. For this reason, it was not allowed to interfere with the layout of the workplace. This requirement has been partially met for all proposed solutions. The limited space intended for the workplace of untying bundles would not be exceeded in any case, but a part of the workplace is also an untying template, which would have to be intervened in the first three cases of the proposed solutions. For this reason, only the last proposed control system meets the requirement to maintain the layout solution 100%.

Table 1: Evaluation of the proposed control system and control measure

	Requirements for control measure or system			
	Workplace layout	Time required to produce one bundle	Financial burden	Zero error rate
Control measure	It will change	Increases by 3-5 minutes	600 CZK	No
Control sys. no. 1	It will change	It will stay the same	1,500,000 CZK	Yes
Control sys. no. 2	It will be preserved	It will stay the same	511,583 CZK	Yes

Source: Authors

Of the 3 proposed solutions, only control system number two - Pick to Light - meets all requirements. This system guarantees zero error when locking the forks. During its operation, the time required for the production of one cable bundle is not increased. The introduction of the Pick to Light control system will not interfere with the mooring template or change the layout of the workplace. Its financial demands for introduction into production are not the lowest, but its operation does not increase production costs and subsequent maintenance is also not high. As in other cases, the company will not intervene in the financial budget of the company more drastically, and on the contrary, its introduction will reduce scrap and thus increase the profit from production. For these reasons, the requirement for minimum financial demands is also met, although it is not the cheapest option.

4. Conclusion

Both control systems and measure met some of the requirements, but only the Pick to Light control system met all the requirements of the selected company. The introduction of the Pick to Light system will achieve zero error in securing the forks with detents, there will be no intervention in the mooring template, the layout of the workplace will be maintained, the time required to produce one bundle will still be on average about 30 minutes, thus maintaining the average number of bundles produced day. As for the requirement of financial demands, it was also met. The costs amounting to CZK 511,583 are one third compared to the optical sensor system and the subsequent operating costs are significantly lower.

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