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PROJEKTOWANIE SYSTEMU LOGISTYCZNEGO W WARUNKACH PRODUKCYJNYCH

Streszczenie: W filozofii szczupłej produkcji wykorzystywane są metody zmniejszające ilość odpadów w systemie produkcyjnym bez zmniejszania produktywności. Optymalizacja przepływów materiałów w systemach magazynowania pomaga zmniejszyć koszty odpadów. W artykule przedstawiono optymalizację takich systemów poprzez wprowadzenie Lean Management z wykorzystaniem algorytmu Milk-run. W efekcie skrócono czas dostawy materiału na miejsce pracy i czas oczekiwania. Wyniki przedstawionego projektu zostaną zastosowane w nowo powstałej hali produkcyjnej.

Słowa kluczowe: szczupła produkcja, przepływ materiałów, algorytm milk-run

DESIGN OF LOGISTICS SYSTEM IN PRODUCTION

Summary: Lean manufacturing uses methods that reduce waste in the production system without reducing productivity. Optimizing material flows in storage systems helps us reduce waste costs. This article presents the optimization of such systems by introducing lean management using the Milk-run system. Within the results, the delivery time of the material to the workplace was shortened and the waiting times were reduced. The results of the presented design are applied to the newly created production hall.

Keywords: lean manufacturing, material flow, milk-run

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1. Introduction to lean manufacturing

The transformation from traditional production management to advanced lean management can be challenging, but the results that the company will achieve are worth the effort [1]. The main theme of lean manufacturing is how the customer sees the product and what he considers most valuable in the product, and we need to know the customer's requirements in order to increase value. The philosophy of lean manufacturing is the idea of shortening the time between the customer and the supplier by eliminating all kinds of waste in the chain between them. The most fundamental types of waste we encounter on a daily basis are overproduction, waiting, unnecessary supplies and excess transportation, which are closely linked to material flows and warehousing solutions [2].

Every time, when there is a disruption to the material flow, there is a high chance that financial losses will occur. One of the main tasks is to strive for a consistent material flow that creates more reliable delivery and greater value for customers, teams of employees and all stakeholders. That is why it is very important that internal logistics are clear and properly planned [3]. The easiest way to eliminate supply shortages is to create a smooth flow of material and information. There is also an effort to reduce large production stocks and keep only the necessary amount of material in stock. We can optimise all this thanks to the already familiar Milk-run and Kanban systems.

1.1 Milk run

Milk run is a popular "lean" concept for material delivery in internal logistics and external logistics. With the help of the milk run train, we can maintain the optimal amount of stock, and the system facilitates the delivery of material [4-6]. The system is based, like Kanban, on the pull philosophy. However, the system is useful only for mass-produced goods or more precisely for identical components and identical parts, even if they are different product variants [5].

Figure 1 shows a flow chart of the design of the Milk run system. It is divided into ten processes. To create a reliable system, the key is to collect and continuously update data so that the system can adapt in time, especially if there are changes in production processes.

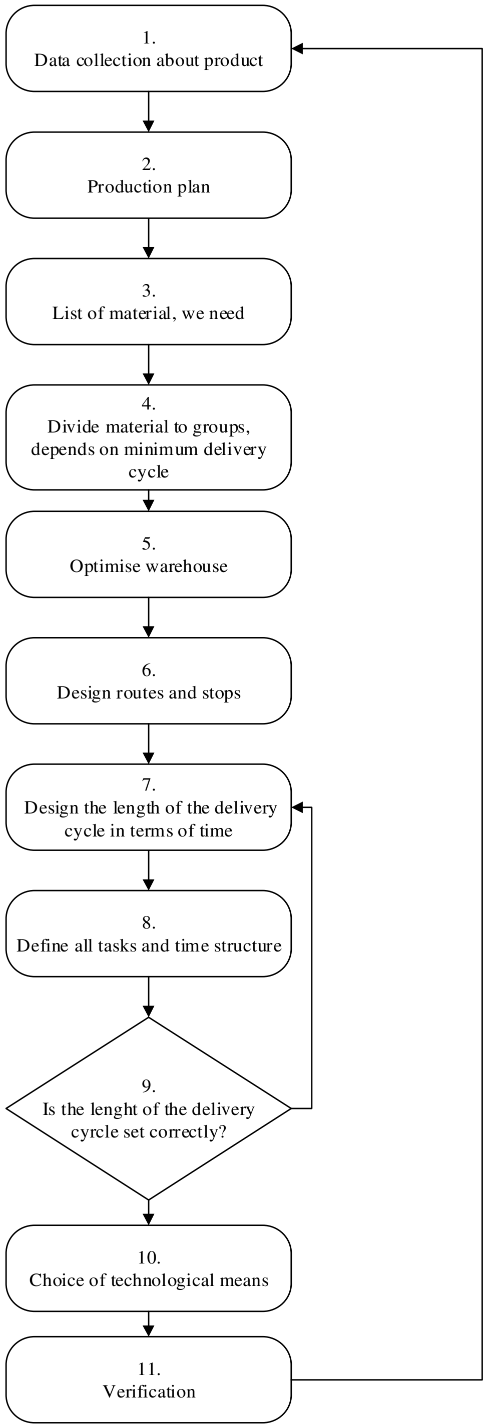

Figure 1. Design of Milk run system [Authors]

2. Procedure for designing a logistics system

Design of the logistic systems represents an important part of the production system design. Therefore it is necessary to think and to find the right strategy for logistics. Not only technologies directly connected to execution of different logistic operations, but also technologies used in the preproduction phase of planning and in the control of logistic processes play an important role as enablers for the high efficiency in the logistic processes.

2.1 System analysis

In production, there are 19 workplaces on which it is planned to assemble 92 different items, which are divided into individual workplaces. The total number of products that will be mounted on the PH segment is 40 pieces of different products. Each product has a different number of components table 1.

Table 1. List of materials [1]

Material number	Processing time (min)	Workplace
04425490	32,6	1
04413710	32,7	1
04401710	58,55	2
04398190	62,75	2
...	....	...
04430210	12,47	20
04430200	15,67	20

2.2 Data processing into a structured database

Schedule of supply of each component to the workplace will not be oriented according to the working time, because the number of pieces in the boxes is different for each part First must be calculated how often one box in the workplace must change. In this case the minimum part delivery cycle based on formula 1.

$$Minimum\ delivery\ cycle\ = \frac{Number\ of\ piecrs\ in\ the\ box * Processing\ time}{Number\ of\ pieces\ in\ the\ assembly} \quad (1)$$

According to the minimum delivery cycle, the components were divided into three groups, which were assigned different delivery times of the components to the workplace. First group has delivery time every thirty minutes, the second one every 150 minutes and the third part is specific, and delivery depends only on the Kanban system. The result is a plan for every part, where information such as the size of the inventory in the workplace, the number of handling units per cycle.The Plan for every part (PFEP) database is an ideal form of data processing.

2.3 Design of warehouse, route and stops.

There is no space in the warehouse to create a separate supermarket for specific orders, nor is it necessary if the organisation of the material is based on turnover. So the most turnover stocks will be available on the lower floors without handling.
The beginning of the route and loading will be located in the warehouse where space should be reserved for both empty boxes and full boxes. Two variants of the route are proposed, one Figure 2 with six stops and the other Figure 3 with four. How the number of stops will affect our delivery time can be seen in the next subchapter „Time structure of Milk run".

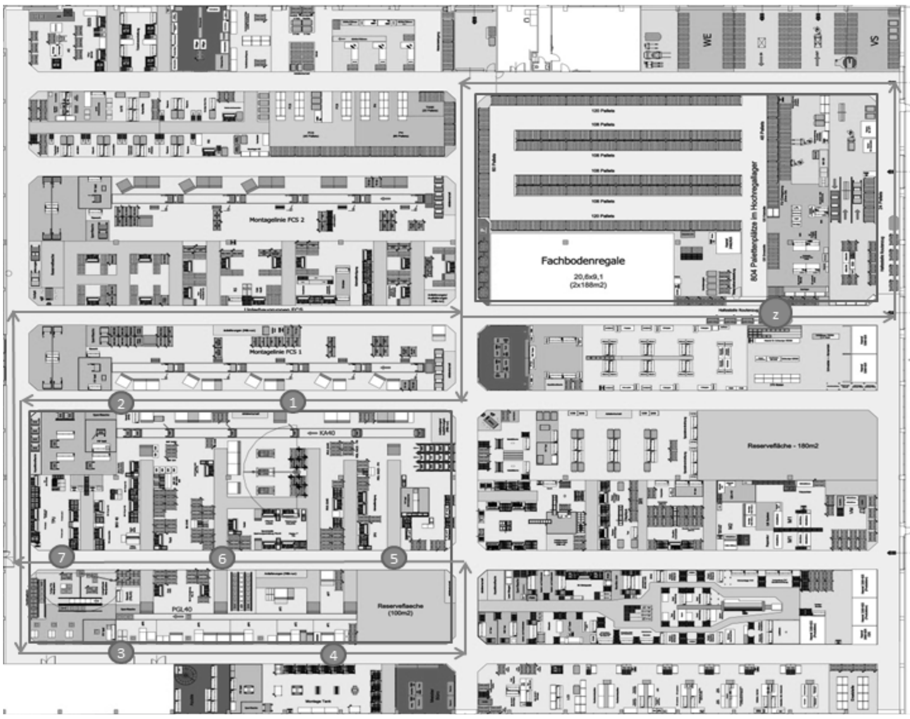

Figure 2. Vizualization of routes and stops Variant1 [1]

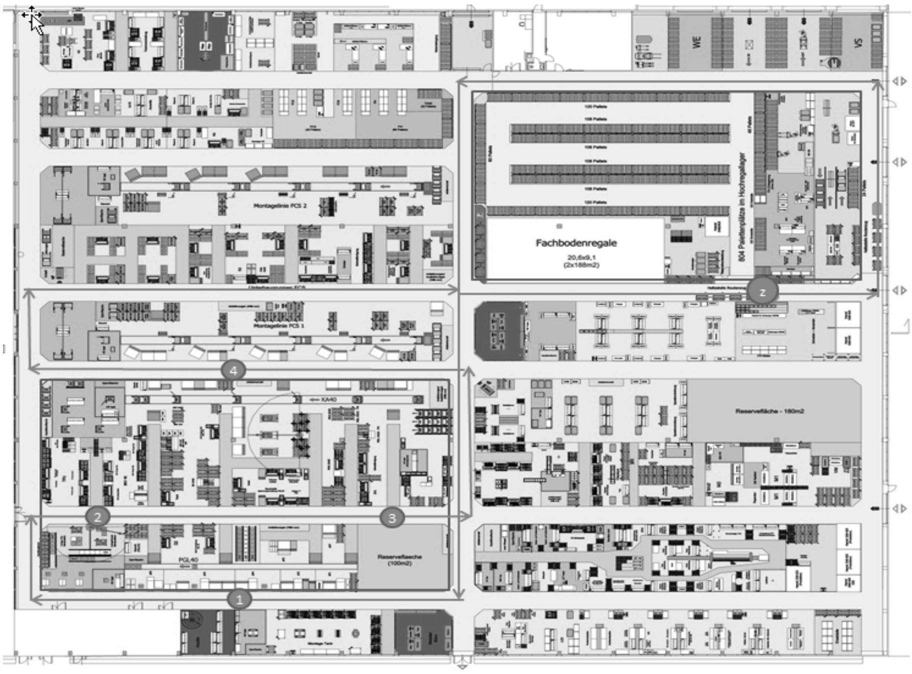

Figure 3. Visualization of routes and stops Variant2 [1]

2.4 Time structure of Milk run

In the supply, we have to take into account the preparation times of the milk run. We see all the tasks and their duration time in the table 2.

Table 2. Time structure [1]

THE TASK			
	One box	First group	Second group
Time of loading boxes in the warehouse	00:01:30	00:26:00	1:37:30
Time to unload full boxes at the workplace	00:00:12	00:10:24	00:26:00
Time to load empty boxes at the workplace	00:00:07	00:06:04	00:15:10
	1 meter	Variant 1	Variant 2
Transport time	-	00:02:56:00	00:02:24:00
Worker's walking time	00:00:01:12	00:06:50:00	00:11:48:00

The short cycle should have a maximum value of 30 minutes and the long cycle a maximum of 150 minutes to make all the tasks and also return to its place.

- Short cycle, first variant = 26 minutes and 14 seconds
- Short cycle, second variant = 30 minutes and 40 seconds.

- Long cycle, first variant = 50 minutes and 56 seconds.
- Long cycle, second variant = 55 minutes and 22 seconds.

From the results, we see that the first variant is more advantageous, due to the time saved.

2.5 Technical means

The milk-run train consists of a tractor, and we have two types of carts available. We suggest that the type of tractor in which worker stands is used to shorten the time of entry and exit of the operator. The tractor must also be adapted for use in the interior and exterior if, for example, it needs to go outside the hall to take out waste or help with the loading of goods coming from the supplier. We will need two types of trolleys, a pallet trolley and a box trolley Figure 4.

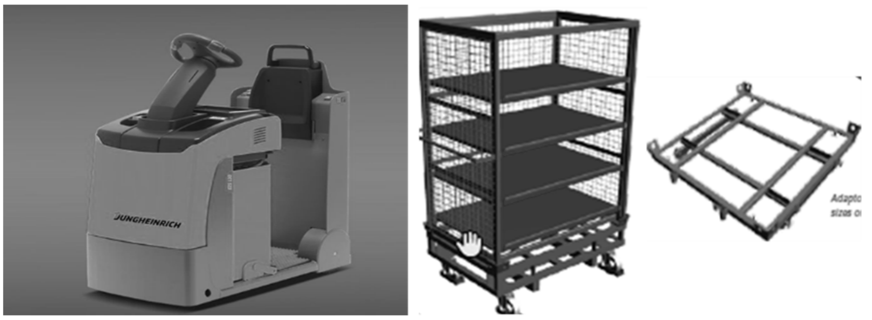

Figure 4. Technical means [1]

3. Economic evaluation of the proposed solution

After the introduction of the supply system, we expect an increase in productivity, which is associated with the elimination of downtime, such as waiting for material or transport of material. The expected change in productivity is at least 10%; revenues would be € 40,000 higher table 3. The minimum return on investment would, therefore last two and a half years, depending mainly on the increase in worker productivity.

$$\text{Minimum return on investment}=\frac{Costs}{Revenues}=\frac{175000+1900}{31200+40000}=2{,}5\ year \tag{2}$$

Table 3. Economic evaluation [1]

	Input costs (€)		Savings per year (€)
Technical means	175 000	Salary	31 200
Skeners	1 900	Revenues	40 000
Sum	176 900	Sum	71 200

4. Conclusion

The article deals with the supply plan of specific components. There is a variant solution of roads and stops, the time structure of both parts group, oversizing the train set. The result is an efficient distribution solution through a supply system.
However, we are currently in the fourth industrial revolution, so we can also talk about the Milk run 4.0 system. The main difference between the classic Milk run system and Milk run 4.0 is that we can digitise every step of the supply in real-time and Milk run is more autonomous and agile. By the aplication of system we achive folowing results productivity increase by 10% and revenues is €40,000.

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REFERENCES

1. BURGANOVA N.: Návrh logistického systému vo výrobe: diplomová práca. Žilinská univerzita v Žiline, 2020.
2. MALINDŽÁK, D., TAKALA, J.: Projektovanie logistických systémov (teória a prax). Košice : EXPRES PUBLIC s.r.o., 2005. 226 s. ISBN 88-8073-282-5.
3. KRAJČOVIČ, M.: Priemyselná logistika. Žilina. 2004. ISBN: 80-8070-226-8.
4. BUBENÍK P., KADUCH P.: Vzdelávanie modelovacích techník prostredníctvom e-learningu In: InvEnt 2006 [elektronický zdroj]: moderné trendy v oblasti priemyselného inžinierstva: medzinárodná konferencia doktorandov, Strečno, 18.-19.5.2006: zborník referátov. - V Žiline: Žilinská univerzita, 2006. - ISBN 80-969391-1-4. - S. 160-165. - Požiadavky na systém: Windows 95 a vyššie; CD-ROM mechanika.
5. EMMETT, S.: Riadenie zásob. 2008. ISBN: 978-80-251-1828-3.
6. HARRIS. R., HARRIS. CH., WILSON. E., Making material flow 2008. ISBN:978-80-89333-11-0.