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THE APPLICATION OF VIDEO MONITORING IN THE CONTROL OF ORDER PICKING

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Abstract
The automotive industry was one of the first to implement the "just-in-time" approach on a massive scale. Such an approach required a very effective ordering of goods as well as monitoring of deliveries, and The consequence of such actions was a significant reduction in production costs. Missing components, in transit to an assembly line, cause stoppages in production which result in high financial losses in the form of contractual penalties. The onus is on the supplier to prove that he is not at fault himself, in order to have the complaint annulled. One of the methods used in the Production Plant under discussion is video monitoring of the order-picking process. The idea itself and its implementation were discussed with a rationalisation team, under ISO/TS 16949: 2009. The authors of the project were employees directly involved in the process The goal was quite relevant to them since these same employees, were getting internal complaints for deficiencies in their collective packaging; this was then being reflected in the size of their bonuses Such a visual demonstration of accuracy in completing the process resulted in the withdrawal of complaints, leading to the elimination of the financial losses which had been occasioned by production line stoppages. The study period covers a period of 5 years, from January 2010 to December 2015. Analysis of the data collected allowed conclusions to be arrived at, regarding fairness and the measurable benefits to be had when using this method.

1. Introduction

Henry Ford once said: *"Any customer can have a car painted any colour that he wants so long as it's black"* [4]. Mass production in the automotive industry has evolved from serial to multi-variant mainly due to an increased demand for product individualisation. In recent years, the number of car models and their equipment has been forced up by the growing market demand as well as the soaring competition among car manufacturers [8]. Due to the large number of variants production had to become more flexible to ensure that the delivery of sub-assemblies in collective packaging went directly to the production line, according to the configuration specification of the car [2, 5]. The greatest challenges are as follows:

- the short deadline for the fulfilment of orders,
- the need to synchronise many processes,
- maintaining the lowest possible costs,
- the use of non-standard solutions.

The automotive industry was one of the first to implement the *"just-in-time"* approach on a massive scale. This required a more effective ordering of goods and the monitoring of deliveries. At the same time, however, this gave rise to a significant reduction in production costs. The application of this strategy minimised the inventory levels in car manufacturing. In the Polish publications dealing with this material order picking is defined as the separation of homogeneous loading units, stored in a warehouse, from sets of unitary or collective packaging and subsequently combining these packages into loading units in accordance with the recipients' orders [3]. Therefore, it is most expedient and reasonable to take action in order to reduce the number of errors by detecting them as soon as possible. Problems with the quality control arise in every production facility. Regardless of what we produce and for whom, we need to continuously monitor the quality of our products. The more complex the product, especially where there are multiple parts or modules, the more complicated the quality control becomes. In addition, it should be noted that production deadlines, employee fatigue and the resultant slipshod compliance with job instructions may all affect the quality from both the supplier's and the customer's perspectives. The article analyses the problem later on by discussing the use of monitoring treated both as a tool for those employees engaged in quality control and as a remedy for the improvement of order picking.

2. Characteristics of the process

Market expectations *vis-à-vis* the finished product are constantly growing. In the pursuit of the most competitive relation between prices and quality, manufacturing companies are focussing on procuring processes and on production from sub-suppliers at reduced cost on account of the unstable level of orders. This is meaningful for the employment levels at a time when the number of orders is in decline [1]. One such process which could improve efficiency – *and consequently, could offer a cheaper product* – is the installation of production and assembly modules for assembling the finished product. Order picking as a part of the manufacturing process of a car wiring harness requires a individualised specification. Therefore, the car wiring harness must be either wholly manufactured beforehand or purchased as separate sub-assemblies which make up its component parts. On average, a single order may consist from 20 to 50 elements, depending on the car model and the way it is to be fitted out. The problem of inaccurate order picking causes stoppages and customer complaints along the production line. In order to analyse the cause of the error at the sub-supplier's past – *and in order to prove accuracy of procedure* – a monitoring system showing the individual stages was installed.

The implementation of video systems for quality control within a plant brings the following positive results:

- a reduction in the number of customer complaints,
- automation of the quality control process,
- full supervision of the order picking process from any location,
- fewer errors,
- increase in production,
- 100% certainty of the inspections carried out,
- the ability to easily provide documentation of the results of the monitoring.

It can thus be determined whether a given module, *the absence of which was the reason for the complaint,* was actually picked in the first place. Such a visual demonstration of the accuracy of the process results in the complaint being handled speedily, which then leads to the elimination of financial losses on account of production line stoppages. It also positively affects employee morale since no-one is penalised by the loss of bonuses as a result of such complaints. For most people, the word "*monitoring*" conjures up the idea of cameras recording images. This, however, is only one of its possible uses when supervising employees' work. Employers often utilise computer programmes *which includes the use of scanners* to observe and record the activities of employees. It is also possible to record telephone conversations when a company telephone is being used. In company cars, GPS devices are installed to monitor whether the employee is using the car for private purposes. Therefore, technology allows an employer to ensure the protection of company property, as well as provide the opportunity to check employees' working time and their engagement in the duties performed. In accordance with the judgment of the European Court of Human Rights of April 3, 2007, the use of workplace monitoring should be proportionate to the purpose for which it is intended and should interfere with employees' lives as little as possible [7]. When installing such cameras, several rules should be borne in mind:

- cameras must not be installed in places such as locker rooms or toilets where the person being monitored may reasonably expect privacy,
- persons who may possibly be subject to monitoring should be given prior notification, such as *"monitored object/monitored area"* and a pictogram,
- records should be securely stored [6].

3. Monitoring

The idea was conceived and submitted by the rationalisation team in accordance with **ISO/TS 16949:2009**. The authors of the project were employees directly involved in the process. The objective was crucial to these employees since they were on the receiving end of internal complaints for deficiencies in their collective packaging; this was then reflected in the size of their bonuses. The first stage was to create a layout for the erection of camera mounting points, the work area, the wiring, the location of the label printer and the image recorder.

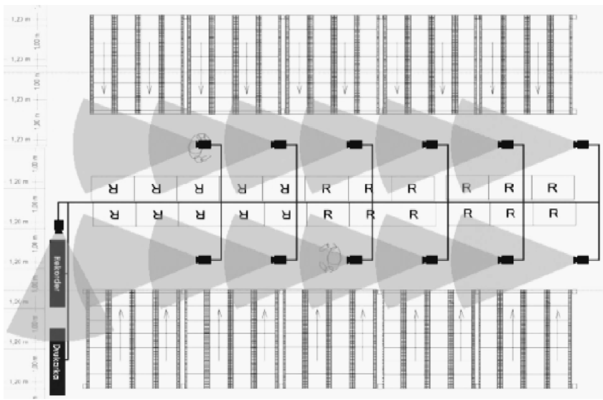

Fig. 1. An overview of the order picking area [own study].

A set was prepared and adapted for the external monitoring of the enterprise's needs. The second stage involved the installation of 13 cameras working in HD resolution, the scope of view and registration of which included the work area of the order picker in accordance with the assumptions from the first stage. The purpose of the registration was to record the exact point at which the individual modules were inserted into the packaging. Additionally – *and for better orientation in the initial stage of the implementation* – horizontal markings were made to assist the monitoring team to recognise the stage of the process. The monitoring set was launched at the beginning of November 2011. The total cost including the assembly by the maintenance team was PLN 21000. A set of cameras registered the work area 24 hours per day. The camera above the printer recorded the order number and the time when the process was completed. This allows the correct packaging, *for which a complaint has been made*, to be searched for in amongst the recorded material. At the beginning of the process, the scanner indicates the number of each successive container which contains the modules included in the order on the display.

Fig. 2. Sample frames from a video image. In the upper right corner of a video image, the date and time are recorded, and in the lower left corner – the number of the recording camera. On the floor, horizontal markings are visible [source: monitoring material, the author's own research].

Operation time for camera 2 is 3 seconds and for camera 7 is 2 seconds. By knowing the time that the process was completed, based on the printout of the report summary which includes the date and time the quality control employee is able to search for the collective packaging under dispute in the recorded material. In addition, the accuracy of the label being scanned by the order picker, while working according to the rules applicable, can be checked.

Fig. 3. The final list of automotive components picked, including the order number along with the date and time of its completion [source: monitoring material; the author's own research].

4. Data analysis

The study period covers 5 years from January 2010 to December 2015. The line field **"Issued"** shows a monthly breakdown of the number of complaints *for a module found to be missing in the collective packaging*, as having being unpacked by the client's employees during the production process. The column field **"After verification"** includes the number of complaints from December 2011 – *q.v. the cell marked in yellow* which remained after analysing the video material which had registered the shortage but which *actually* was an error on the part of the order picking employee. Other complaints were cancelled and redirected to other departments at the customer's premises. In the period prior to the installation of the monitoring system, the subcontractor had always been forced to accept such complaints on the basis that: *"The customer is always right"*.

Table 1. List of the total number of complaints along with the number of complaints that remained after analysing the video material in individual months. The grey field marks the month in which the monitoring process was implemented [source: Author's own research].

Year	Number of complaints	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Average
2010	After verification	80	52	63	59	52	71	63	82	62	44	80	58	64
	Issued	82	54	65	62	55	73	66	84	65	57	82	60	67
2011	After verification	60	53	52	55	52	66	61	59	53	56	58	21	54
	Issued	64	58	56	59	53	68	65	61	58	59	61	48	59
2012	After verification	16	10	13	12	9	3	3	4	3	2	1	1	6
	Issued	61	57	59	62	52	50	41	32	28	24	15	12	41
2013	After verification	3	2	1	4	0	4	0	5	2	2	1	0	2
	Issued	12	10	9	13	13	11	8	9	7	8	9	5	10
2014	After verification	3	1	0	1	2	2	1	0	0	3	3	2	2
	Issued	6	5	7	5	6	5	6	8	7	8	4	6	6
2015	After verification	2	0	2	0	1	1	1	2	0	4	0	3	1
	Issued	6	9	6	5	6	4	5	4	3	7	4	5	5

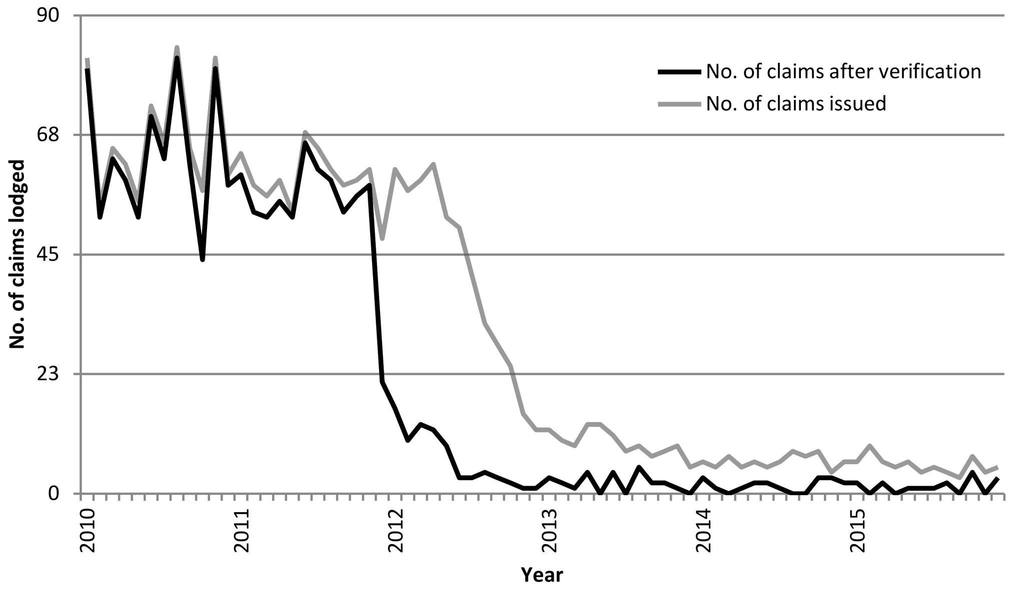

Fig. 4. An overview graph for Table 1. The black line illustrates the point at which the monitoring process was implemented [source: own study].

The large number of complaints received in 2010 was the result of the implementation of a new production line at the plant. At the beginning of 2011, doubts were being raised regarding the accuracy of the process. Random checks of collective packaging confirmed the opinion of the quality control department that it would have been necessary to look outside the plant for the causes of deficiencies. The installation of the monitoring, however, in November 2011, resulted in a significant reduction in the number of complaints from the sub-supplier. The above chart shows the number of complaints that were issued and the number remaining after the analysis of the video material.

5. Time analysis

According to the customer's demand for multiple packaging, one 50-person production line generates 100 units of finished product *per eight-hour* shift. After subtracting a half-an-hour break for employees, the total production time is seven hours and thirty minutes. By dividing the time allocated for work by the number of harnesses that must be produced on a given day, the (cycle) tact time (TT) can be obtained, i.e. the rate at which production should proceed

$$\mathrm{TT} = \frac{\text{Working time available per shift [s]}}{\text{Level of receipient's orders per shift [pcs]}}, \quad (1)$$

$$\mathrm{TT} = \frac{27000 \text{ s}}{100 \text{ pcs}} = 270 \text{ s/pc}.$$

The cycle time for the data given is 270 seconds. This means that every four and a half minutes one harness should leave the production line. In the plant where the collective packaging was delivered directly to the production line, further to the *"just-in-time"* principle, a 50-person team of employees generated a stoppage of 270 minutes as assessed at the end of the shift; this was caused by omitting one production cycle (tact). It is worth noting that stoppage minutes are just one cost element.

The remaining time is generated by activities such as taking the incomplete electric harness off the line and putting it aside and then sorting out, *both at the customer's and inside the plant*, the shortage of modules in other cars for assembly as well as the urgent delivery of missing elements to the production plant and also the quality control training and procedures resulting from complaints.

The highest number of complaints received occurred at the beginning of 2012 as a result of a correctly chosen method for proving the accuracy of the order picking process. The last column in Table 1 shows the average number of complaints issued for individual months, along with the number of complaints which were not accepted after analysis of the video material. Had the 2010 and 2011 trends continued, the plant would have received 708 complaints annually, which would be 191160 minutes of stoppage. In the years following the introduction of the analysis of the system, 36 complaints were generated annually, on average, which translates into 9720 minutes of stoppage.

The data in Table 2 quantifiably illustrates the application of the monitoring system in the discussion regarding the control of the order picking process and in terms of the legitimacy of *end-customer* complaints. Cost analysis determines measurable values only and does not show the reasons for their occurrence. Depending on the level of development, the complexity of the processes and, the resources involved in the production process, one minute of stoppage throughout the entire production plant has a different material dimension; even a short period of downtime may cause the supplier's bankruptcy if such costs were to be enforced.

Table 2. Compilation of the average number of complaints and minutes per year.

Average number of complaints	708 pcs	191160 minutes
Average number of complaints issued after the introduction of the monitoring system	36 pcs	9720 minutes
Difference	672 pcs	181440 minutes

6. Summary

The logistics of production in today's very dynamic business environment is as important as the logistics of the final product. *"Just-in-time"* deliveries have become a requirement for large manufacturing companies demanding prompt delivery from their suppliers. Accuracy, in the case of high-quality requirements, is often of the greatest importance for plants' business operations. The process of monitoring modules at the order picking stage reduced the number of complaints from 80 per month to almost zero. At the same time, it allowed the search area to be extended when looking for reasons for shortages in the following modules:

- in transportation from the sub-supplier to the customer by lorry,
- in the transport route from the unloading ramp to the front of the production line,
- in the availability of people to pick collective packaging,
- in the behaviour of production employees in the event of a module failure on the production line.

The recording and storage of monitoring should be carried out in compliance with the provisions on the protection of personal data. The above article does not deliberately draw unambiguous conclusions regarding the reasons for the shortage of modules, despite their presence in the video material.

Materials and archive data developed by the present author.

References

[1] Bokhoven M., *Lean Manufacturing – praktyczny przewodnik od wiedzy do rezultatów*, Lean Visio, Wrocław, 2011.

[2] Creutznachera T., Bergerb U., Leprattic R., Lampartera S., *The transformable factory: Adapting automotive production capacities*, 48th CIRP Conference on Manufacturing Systems, CIRP CMS, 2015.

[3] Fijałkowski J., *Technologia magazynowania*, Oficyna wydawnicza Politechniki Warszawskiej, Warszawa, 2005.

[4] Ford H., *My life and work*, [reprint], Cosimo Classics, New York, 2007.

[5] Kübera Ch., Westkämperb E., Kellerc B., Jacobid H.F., *Planning method for the design of flexible as well as economic assembly and logistics processes in the automotive industry*, 48th CIRP Conference on Manufacturing Systems, CIRP CMS, 2015.

[6] Lazarowicz A., https://poradnikprzedsiebiorcy.pl/-monitoring-w-miejscu-pracy-i-nagrywanie-rozmow-sluzbowych-a-brak-regulacji-prawnych-w-tej-kwestii, Warszawa, 2016.

[7] Wyrok WSA w Warszawie – II SA/Wa 453/12.

[8] http://www.pzpm.org.pl/Rynek-motoryzacyjny/Produkcja-pojazdow-samochodowych-w-Polsce/Produkcja-pojazdow-samochodowych-w-Polsce-wedlug-danych-GUS-2000-2016.