RFID helps to increase customers' satisfaction

Introduction

There are many tools and techniques aimed at improvement of resource management systems in a company. Among them, one is exceptionally famous in the world of industry, that is Lean Management which come from Toyota management system created by Taichi Ohno. The key concept in Lean Management is elimination of any type of wastes in a company, including eliminating defects in a product and mistakes during its production process or during completing and packing customers’ orders.

Companies which offer a narrow range of products produced on a massive scale find eliminating mistakes during completing and packing operations relatively easy to control. On the other hand, in the case of companies which realize complex orders counted in hundreds and produce many different kinds of elements (of which some do not differ significantly from one another), dealing with the problem of instability during completing and packing an order is a much greater challenge.

In the case of production process of bus seats, customer’s order is almost always an individual and dedicated list of items adjusted to a specific model of a vehicle. It generates an additional problem – not only are ordered elements diversified but also orders themselves are very often modified to fit a specific vehicle and thus rarely repeat. As a consequence, it often happens that customers file a complaint due to errors in delivered orders. Problems that are most frequently reported to the company concern the insufficient number of some elements and delivering a batch of mistaken products instead of products conforming the order.

The problems were one of the reasons for modernisation of identification system in the company through implementation of a system based on bar codes. Despite many advantages, the system has one undeniable disadvantage (at least from the perspective of the operation discussed), as it requires an optical contact between a label attached to an element and a scanner. In the case of large orders, many elements are packed on a pallet and their arrangement makes the access to an individual element difficult. As a consequence, elements had to be scanned individually, which turned out to be not only a time-consuming process but also a process involving a human factor and thus non-error-free.

Achievements of the contemporary technique encouraged the company to go further and implement RFID technology into completing and packing operations whose aim was to control the state and correctness of these operations in an easy and fast way.

Literature review

With no doubt, companies are interested in as short time needed for realization of an order as possible. As a result, tools which might help to reduce the time and eliminate problems occurring during this cycle (including completing and packing) have been being searched [2].

RFID technology, as many other modern solutions, has its roots in the military. It was used for the first time by British army to identify planes of Allies during World War II [1]. Later, the technology was esteemed by many non-military branches of the industry, including [9]:

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RFID technology is based on cooperation of 4 elements. The first one is an antenna which emits an electro-magnetic field. The field ‘finds’ an RFID tag attached to an element in the range of the antenna. The tag is activated by the field and starts emitting its own electro-magnetic field which carries data included in the tag. The information reaches the antenna which then sends it to a reader. The reader decodes the information and send it to the computer system where it is available for a user in a desirable format.

Among most important advantages of RFID technology, the following are given:
- Possibility to read many tags at the same time
- Possibility to modify data included in a tag at any moment
- Elimination of the need for optical contact between a tagged product and a reader
- Possibility to attach a tag inside an element
- Possibility to adjust a tag to harsh conditions of a production process, e.g.: extreme temperatures

However, for several dozen years implementation of RFID technology was limited by high costs of the whole system. However, last years have brought some decrease in prices of devices required to the implementation. As a result, more and more companies decide to introduce this technology to improve some of their operations or a whole production system. One of the most important encouragements are impressing results of the technology in reducing costs and time consumption of some operations and other benefits that result from its use, including: time reduction for some operations, inventory reduction or increase in quality of order realization or correctness of inventory control.

Apart from many profits resulting from implementation of RFID, there are many concerns that still discourage entrepreneurs from partial or global implementation of the technology into their logistic processes. For instance, there is a myth that has been going around people interested in this technology for many years. It says that implementation of RFID into processes involving liquid or metal products is ineffective because of technical problems concerning reflection and jamming the signal between a tag and an antenna. However, [4] and [8] assure that even in these groups of materials, a suitable modification of tags enables the signal to go round between the devices. Moreover, another encouragement is included in [5] and says that most of problems that appeared in companies which implemented or tested RFID were not a result of technical problems with signal but had roots in external factors.

With no doubt, costs of implementation of RFID technology is its huge disadvantage. It is even more worrying as it often happens that implementation of the system entails costs of further investments aimed at technological integration of the system with the company’s infrastructure and organization of processes that it conducts. Implementation of RFID often requires a need for a global reorganization of logistic processes in a company. Another aspect concerning costs which restricts RFID introduction into companies is a high price of an individual RFID tag. As a consequence, implementation of RFID is limited to those branches of the industry where the value of a product can justify the cost of a tag.

Finally, there are three groups of factors that restrain RFID technology included in [1]:
- Technical barriers
- Organizational barriers
- Barriers in management system

It is also worth to emphasise that in literature RFID technology is examined mainly from the perspective of profits which result directly from its functioning in a company, including mainly reduction in time of operations involved in a production system or logistic processes. On the other hand, the aim of this article
is to show that RFID brings not only direct benefits counted by time and effectiveness but also indirect benefits which result from retaining customers and keeping them satisfied with products and services. It is obvious that repetition of the same problems with the realization of orders may cause loss of a customer. It is an important aspect, as according to [10] costs of losing a customer usually exceed costs of retaining them and costs of attracting new clients are often much higher than retaining them [11].

**Applied research method**

The study was based on actual experiment and concerned an analysis of a specific case from the industry. The subject of the analysis was the company which produces bus seats and elements necessary to assemble them in a vehicle. The company commands a very good opinion and is continuously trying to improve its production system by implementation of innovative or improved products, but also though development of production processes. It meets the aims included in their quality politics and commitments to customers.

The experiment was based on the analysis of complaints filed by customers and isolation of those which had roots in instability during completing and packing. Then stations on which the operations are realized were equipped with RFID readers integrated with the computer system in the company. What is more, shelves in the warehouse of final products were equipped with a set of displays and diodes whose task was to inform a worker which product should be taken to a packing station. The information was introduced into the computer system by scanning a code on an order checking list. Another task of RFID was to confirm that all elements that are on a pallet conform the order both in the aspect of a number and in the aspect of type of elements. Only then does a worker get a green light which lets him send the pallet.

The experiment was preceded by monitoring the production process and interviewing workers of such departments as: supply, warehouse and production. The interviews were aimed at obtaining information concerning the most sensitive points in the production process.

**Results**

The diagrams illustrate problem with complaints in the company over the course of a few years. Diagram 2 presents an overall number of complaints that were filed and their relation to those complaints which were caused by errors during completing and packing products. The diagram shows results from the period 2009–2013, i.e. period preceding implementation of RFID into the warehouse of final products and packing stations.

![Diagram 1: Number of complaints resulting from errors during completing and packing products in relation to the overall number of complaints](image)

**Rys. 1.** Diagram 1. The number of complaints resulting from errors during completing and packing products in relation to the overall number of complainants.
Diagram 2 presents the number of complaints resulting from errors during completing and packing products including mistakes in delivered types of elements or an incorrect number of products between 2009 – 2013. RFID technology was implemented in November 2013 so the data represent results obtained after introducing this improvement.

**Fig. 2.** Diagram 2. The number of complaints resulting from errors during completing and packing products including mistakes in delivered types of elements or an incorrect number of products between 2009 – 2013

**Discussion**

Implementation of RFID technology almost completely reduced the risk of errors in completing an order and packing products. In 2014, i.e. a year following the implementation, the number of filed complaints was 1. It is necessary to emphasise that probably the complaint was not the result of an error in the system, but it was caused by an unexperienced worker’s mistake who attached two RFID tags to some elements which resulted in the too little number of products delivered to the customer despite no mistake detected by the system.

The analysis of complaints filed to Quality Management Department before implementing RFID showed that errors during completing and packing products were the reason for 32-44% of the overall number of complaints reported by unsatisfied customers. In other words, more than one third of complaints was caused by errors during the final operations.

Introduction of the identification system based on bar codes resulted in significant reduction in the number of complaints filed to the company. The difference between 2012 and 2013 was 24 which was about 27% of the overall number of complaints in 2012. However, the elongated time of the operations together with negative remarks reported by workers encouraged the company to look for a solution that would join the advantages of system based on bar codes and simultaneously would eliminate its imperfections, such as: difficulties in scanning some products or the need for scanning each product individually. Thus, the company turned to RFID. What is more, as diagram 2 presents, RFID technology gave better results in decreasing the number of complaints rooted in final operations and consequently increasing customers’ satisfaction. Thus, RFID turned out to be more effective than the system of bar codes.

**Conclusions**

The analysis confirms the hypothesis that implementation of RFID almost completely eliminates the risk of errors in final operations of a production process, i.e. completing an order and packing products. How-
ever, individual cases of errors while working with this technology suggest that reliable and effective train-
ings for workers, which increase their consciousness, play a significant role in this technology in the cases
when the human factor may be one of the aspect determining the final effect. What is more, an automatic
application of RFID tags may also be taken into consideration as one of possible solutions which could
eliminate the human factor from the system.

Taking into consideration reduction in the number of complaints, RFID technology turns out to be more
effective than identification system based on bar codes. The difference does not come from the systems
themselves whose bases are similar and work properly. It may be a consequence of problems which may
occur (and often do) because of mistakes made by workers who manually scan all elements included in a
given order. RFID eliminates the human factor on this particular stage of the process and simultaneously
reduces the risk of errors in these operations.

Abstract

In this work, the influence of implementing RFID (Radio-Frequency IDentification) technology on cus-
tomers’ satisfaction was analysed. Customers’ satisfaction was represented by a number of complaints. The
emphasis was put on complaints based on problems resulting from improper realisation of completing and
packing an order.

The analysis was based on actual test concerning a specific case from the industry, i. e. implementing
RFID technology in a warehouse and on packing stations of a company which produces bus seats and
elements necessary for their assembling in a vehicle. The reason for choosing such a company was the
specificity of such processes as completing an order and packing. These processes are complicated because
of their volume, high complexity and little repeatability of customers’ orders.

The analysis showed that RFID causes decrease in the number of customers’ complaints concerning
problems with either a sort/type or the number of elements delivered. The influence was seen both in the
comparison to the initial state and to the state after implementing bar codes as a system of identification
and control.

The results suggest that RFID technology is a perfect tool for both increasing customers’ satisfaction and
improving production processes not only in companies with mass production but also in companies that
realize medium series production. It is necessary to emphasise that although RFID eliminates problems
during completing and packing, an important role is played by trainings and experience of workers who
realize preceding processes.

RFID POMAGA PODNIEŚĆ POZIOM SATYSFAKCJI KLIENTA FIRMY PRODUKCYJNEJ

Streszczenie

W pracy dokonano analizy wpływu jaki ma wprowadzenie technologii RFID (Identyfikacji Radiowej)
a poziom satysfakcji klienta wyrażany przez liczbę reklamacji zgłaszanych przez klientów. Skupiono się
na reklamacjach, których podstawą jest powstanie błędów wynikających z nieprawidłowo przeprowadzanej
operacji kompletnowania zamówienia w magazynie i jego późniejszego pakowania. W analizie posłużono
się wynikami z rzeczywistego eksperymentu dotyczącego konkretnego przypadku ze świata przemysłu,
a mianowicie wprowadzenia RFID w magazynie wyrobów gotowych oraz na stanowiskach pakowania
w firmie produkującej fotele autobusowe oraz elementy służące do ich zamontowania w pojazdach komu-
nikacji zbiorowej. Wybór przedsiębiorstwa o takim profilu działalności wynikał ze specyfiki samego pro-
cesu kompletnowania i pakowania zamówienia, które w tej firmie jest działaniem skomplikowanym
ze względu na wielkość, stopień skomplikowania oraz małą powtarzalność zamówień składanych przez
klientów. Przeprowadzona analiza wykazała znaczący wpływ wdrożenia technologii RFID na poziom za-
dowolenia klientów wyrażony przez spadek liczby reklamacji zgłaszanych do firmy z uwagi na nieprawidłowości w liczbie lub rodzaju asortymentu dostarczonego do klienta. Spadek ten zaobserwowano w porównaniu zarówno ze stanem przed wprowadzeniem jakichkolwiek usprawnień, jak również z zastosowaniem systemu identyfikacji i kontroli przy pomocy kodów kreskowych. Otrzymane wyniki sugerują, że technologia RFID stanowi doskonale narzędzie doskonalenia procesu produkcyjnego także w firmach produkującym średnioseryjnym jaką jest firma będąca podmiotem, w którym przeprowadzona została analiza. Należy przy tym podkreślić, że o ile RFID eliminuje możliwość postawania błędów na poziomie operacji kompletowania i pakowania zamówienia wynikających z błędów pracowników, o tyle ogromną rolę w poprawnym funkcjonowaniu systemu identyfikacji i kontroli opartego na technologii RFID odgrywają szkolenia i doświadczenie pracowników realizujących procesy poprzedzające te operacje.

**Słowa kluczowe:** RFID, reklamacje, błędy w zamówieniu, poziom zadowolenia klienta

**References**


