MAXIMISING THE RFID BENEFITS AT THE TYRE DISTRIBUTION CENTRE

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Abstract:

In recent years the applications of radio frequency identification technology (RFID) in warehousing have gained a great amount of attention as it is a challenging and dynamic environment. Analysing a receiving operation of third party logistic (3PL) operator running a tyre distribution centre, this paper presents a case study of RFID application in the warehouse. The receiving process is enhanced with the RFID technology, which provides contactless identification, less manual data entry errors, instant stock management. Moreover, these benefits could be maximised by the proposed use of the RFID generated data in accounting of costs and services, which is a novel application of the RFID technology.

Keywords:

RFID, warehouse, distribution centre

1. INTRODUCTION

A warehouse is an essential component linking the partners in the supply chain. Current business environment requires warehouses to gain competitive advantage through increased operational efficiencies and reduced operational costs. To achieve this aim many industry leaders have recognised the positive impact of radio frequency identification (RFID) technology on their business processes. However, it appears that the use of the RFID generated data is not fully utilised.

This case study paper provides an analysis of receiving operation in the third party logistic company (3PL) that is later enhanced with the RFID technology in order to achieve operational efficiencies. Furthermore, the use of the RFID generated data in cost accounting is proposed as the novel application of this technology.

The paper is organised as follows: the role of warehouses in the supply chain and application of the RFID in tyre industry is discussed in Section 2. Presentation of receiving operation at the 3PL company and proposed improvements with the use of RFID technology is found in Section 3. Proposition of maximising achieved benefits with use of RFID data is outlined in Section 4 and followed by concluding Section 5.

2. WAREHOUSE OPERATIONS AND THE RFID

Warehouses are essential part of the supply chain, with the major role of meeting the changing market conditions and uncertainties of production and demand fluctuations. They also allow taking advantage of transportation and production economies. Introduction of just-

in-time and lean philosophy brought new challenges for the warehouse systems. Tight inventory control, rapid response and greater variety of products are in demand. Implementation of information technologies (IT) helped at least partially to alleviate these problems, further extended by warehouse management systems (WMS) and aided by barcode and the RFID technology.

2.1. The use of RFID in the tyre industry

The application of RFID in the tyre industry is described in both academic literature and industry news. RFID Journal reports that trials for the use of RFID technology in the tyre industry started after US Congress passed the TREAD (Transportation, Recall, Enhancement and Documentation) Act in the year 2000. It mandates that car tyres made after 2004 are closely tracked so they can be easily recalled if they are faulty. In 2003 Michelin, one of leading brands of the tyre industry, reported trials with the RFID technology. Using the RFID chips embedded within the tyres was challenging due to the rubber characteristics, which blocks radio signals, however with specially designed antenna the read distance reached 60cm, which met the American industry standard [1].

Alternatively to embedding the RFID tags in the tyres, special RFID labels can be used, which can be stuck onto tyre surface. Such labels were used by Goodyear, as this leading manufacturer was required to comply with the RFID mandates of its customers [2]. Michelin developed special cloth-type label with embedded RFID tag in order to alleviate problems with labels application to tyre surface, which rejects most of the typical labels. The label was tested with tyres of different manufacturers for surface application and the RFID reading performance. Tests showed that placing these special RFID labels on sidewalls of tyres can provide very accurate readability [3]. Tyres with embedded RFID tags were used by Goodyear to keep track of tyres leased to NASCAR racing teams. Tag contained unique tyre ID, which was linked to the inventory database containing details about each driver and vehicle [4]. Similar solution is used during the British Touring Car Championship (BTCC), where data about tyres from embedded RFID tags is collected without stopping the vehicles. Such data is used for maintenance purposes, ensuring that equal type of tyres is used by opponents, and it can be also passed to sport enthusiasts and media. Using embedded RFID tags eliminates human error of scanning tyres and speeds up maintenance operation during the course of the race [5].

The RFID technology is also used during tyre manufacturing process. Finnish company Nokian Tyres uses RFID tags as well as barcodes to manage the tyre assembly area and distribution of treaded rubber on reels. The problem company faced was getting the right materials to the right assembly line without delays and backlogs. The problem of materials shortage was causing many disruptions to the operation. Solution included the RFID interrogators identifying reel's RFID tag number [6].

Reference [7] presents utilisation of UHF RFID tags in monitoring the history of a single tyre. In order to overcome the tag reading difficulties caused by rubber properties special antenna designs are proposed. Designs make it viable to use RFID for operations. The use of RFID in tracking tyres in order to improve operational efficiency is described in [8]. The application of RFID is said to alleviate problems of the tyre industry, which are tracking individual tyres for quality and recall purposes, product identification during manual operations as well as avoiding the counterfeit products. Other specific use of the RFID system at tyre re-treading company is presented in [9] where cost effectiveness of data collection with the RFID is evaluated. Study concluded that RFID technology is able to reduce operating time and increase productivity.

As the industrial reports and academic research show the RFID technology can provide meaningful benefits to the tyre industry. Offering the individual identification of tyres and thus enabling close tracking with ability to recall fault items from the market. The next section shows the application of the RFID technology in the receiving process at the tyres distribution centre.

3. RECEIVING PROCESS AT THE TYRE DISTRIBUTION CENTRE

In this section the case study of receiving process at the tyre distribution centre is presented. It is later enhanced with the use of RFID. The distribution centre is run by 3PL operator on behalf of their client and deals only with the passenger tyres. In order to indicate the business name an acronym TDC is used. A diagram of receiving process at TDC is presented in Figure 2.

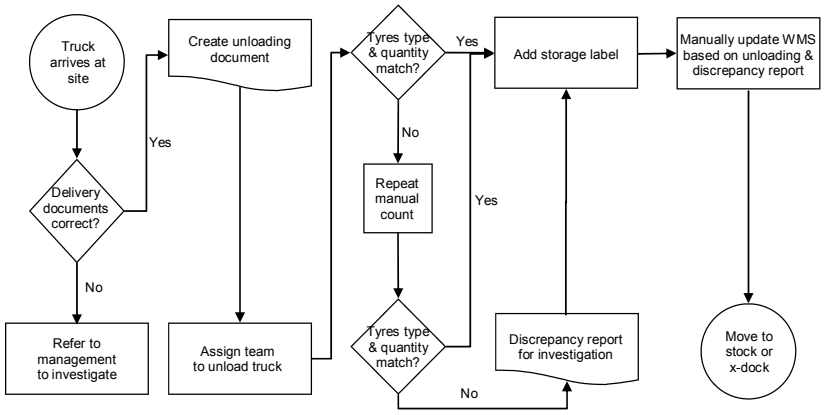

Figure 2: Receiving process at the TDC.

Receiving process was chosen as it has a critical significance for the whole warehouse operation. Admitting cargo in incorrect quantity or type causes disruptions to the further operations and results in poor performance as well as low customer's satisfaction.

The receiving process at the TDC starts with creating the 'Daily Inbound Delivery Schedule', a chronological list of inbound deliveries with references to delivery and container numbers, in line with warehouse requirements and restrictions. It is based on information received from the suppliers on advanced shipping notes (ASN). This schedule is updated throughout the day. It is a basis for shift manager to plan work schedule and the security gatehouse to allow trailers onto the TDC premises.

When the trailer arrives at the TDC gate, the security allocates it to the unloading bay. After the trailer is parked at the assigned bay, the driver presents the documents at the 'Operations Office' and goes to designated rest area following health and safety regulations. Documentation is checked and the delivery details are entered to WMS. If the documentation from the driver matches the schedule from ASN unloading document, barcode labels for pallets are created and trailer can be unloaded. Conversely, if problem occurs it is investigated by the management.

Trailers with tyres are unloaded by a team of 3 people. One person is in the trailer unloading the tyres one by one and rolls them to the two team members who catch them and put into the stillages/pallets. Prior to the unloading, the team receives the unloading document, so type and quantity of tyres is known. Tyres for passenger vehicles look very similar. The

unloading team members check tyre type based on the printed sticker with the tyre type code or make judgement on based on their experience with the product.

When the stillage is full, the tyre type and quantity is checked again against the unloading document, if everything matches, the stillage is labelled and ready for putaway. When stillage is not full, it is checked that the quantity is matching the unloading document, then label is attached and stillage can be put-away. Unloading continues until all tyres are unloaded from the trailer onto stillages. In case of differences to the scheduled quantities the notes are made on unloading document and new labels for stillages are printed.

Unloading team returns the unloading document to 'Operation Office' where WMS is updated manually. The list of discrepancies is generated and is passed for investigation.

In order to ensure that the process is realised correctly following manual controls are in place. Visual check is performed to verify that only the right tyres, type and quantity, are accepted according to the documentation. Prior to attaching inbound storage label to the pallet, the tyres are once again checked for correct type and quantity and then transferred to the correct location.

Manual count errors, not recognising tyre type and manual data entry errors are a serious issue and cause a lot of disruptions when they go undetected. The next section shows how the RFID technology can aid warehouse operation at the TDC and make it less prone to errors and more efficient.

3.1. Enhancing the TDC receiving process with the RFID

It is possible to identify tyres with the RFID technology either by reading information from tags embedded in them or labels attached to their surface. Embedding the tag inside the tyre is gives more options for further use, for example post sale services, as opposed to the label, which only brings the benefits of contactless identification until it is removed at the point of sale. For the purpose of this analysis it is presumed that the tyres are embedded with the RFID tags.

In order to facilitate the benefits of the RFID technology, the warehouse needs to be equipped with the hardware and existing WMS must be able to operate on the RFID data. Looking at the example of the TDC warehouse following RFID hardware is envisaged for receiving operation. The system of choice is UHF Gen2 RFID, as this is most popular system used in the supply chains due to its standardisation. The tyres have a UHF tyre tag embedded in them, with a specialised antenna allowing signal to pass through rubber surface. As the tyres are unloaded one by one from the trailer and rolled towards stillages the information about them is read by antennas set up on both sides of the unloading bay area. Alternatively tyres could be unloaded onto a conveyor belt equipped with the RFID reading devices. Tyres IDs can be checked with the handheld RFID device. Stillages and pallets are tagged as well to indicate their locations. The configuration of RFID equipment for further operations includes the readers on forklifts and tagged bin locations in the storage areas. In addition, the trailers might be tagged with an active tag, providing identification about the load.

The flow of the operation in the TDC equipped with the RFID technology is following. The vehicle with tyres arrives at the bay. Vehicle tag is identified and delivery is documentation is created. As tyres are moved one by one from the truck, their unique numbers are marked in the system as delivered. When the unloading is complete information about type and number of tyres is known. Tags on the stillages are coded by worker with a mobile RFID device about the type of tyres and their quantities. In case of discrepancies workers are

alerted and the discrepancy report is created. After unloading is completed the WMS becomes automatically updated with the data regarding the delivery.

The use of RFID technology brings certain benefits, which are persistent in singular steps of each operation. The foremost benefit of RFID is instant identification. At the TDC warehouse system becomes aware of the truck and its content as it approaches the reading range of the bay. Then each of the unloaded tyres is identified and recognised by the system, completing the scheduled delivery. Such level of identification helps to alleviate errors of miswritten documents or mistyped data into the WMS system.

The knowledge of items, which come to storage enables the business to use the information in order to become more efficient and dynamic. When the tyres are delivered and their individual codes are recognised in the system, the data about their destination can be collated from WMS. This enables making use of the temporary storage, which is the area of the warehouse where items can be stored for a short periods of time without putting them to the main storage area. The use of temporary storage can save time and costs of material handling movements. For example, when the tyres arrive, are identified individually with RFID, system recognises that these tyres are going to be despatched with the next delivery to customer. Instead of putting them to main storage, tyres are already prepared for the delivery. This saves time and cost of material handling for storage and order picking.

Moreover, the individual identification of received items can help in a situation where a part is critical for a customer, a special delivery is supposed to pass through the warehouse and be immediately despatched to the customer. It happens that due to the untrained or careless staff such effort is compromised by putting the special delivery to stock, without giving it a priority it requires. It is treated as a normal delivery. With RFID recognition of individual codes, manager can be alerted by the system about the situation and instruct staff about the priority treatment for this delivery.

The 3PL companies are often penalised or rewarded with bonus depending on their performance. In case of the TDC the 3PL company must meet over 99.5% OTIF mark (OTIF = On Time In Full), which means right quantity and right type delivered to the end customer on agreed delivery time. When during the receiving incorrect tyres are admitted to stock, it affects the total TDC performance. If the RFID is used and the benefits of identification and increased efficiency are realised the company can gain the advantage of fulfilling the contract agreements and avoid the penalties, but receive the bonuses, ensuring good relationship with the pleased customer.

Dishonest end customers can be a serious problem. The issue is that some of the end customers order tyres then use the possibility of resigning from the purchase few days after the delivery was made. The tyres that are returned to the warehouse are not the same ones, which were ordered in the first place. In order to gain from transaction customers swap tyres and return their old stock. Embedding RFID tag within the tyre would help to identify the tyre and ensure that only the tyres, which were recently purchased are returned. The collecting driver could check tyre identification with the handheld RFID device. This would result in the decrease of malicious orders and save time, which is spent now on investigating such issue.

The example of applying the RFID technology in receiving process of the TDC business showed that benefits of contactless identification of delivered items, avoidance of errors during manual data entry and instant quantity checks are realised. Additionally the reduced material handling, better space utilisation and asset management can be achieved. However the list of benefits of RFID technology to enterprises remained unchanged over the years. They are based on three questions, which the RFID answers “What am I?” – identifying the object; “Where am I?” – identifying the location; “How am I?” – answered in case of RFID tags with environment sensors [10].

The need exists to show that the RFID technology can bring more substantial benefits beyond what is currently proven and widely accepted within the academic and industrial world. In order to extend use and application of the RFID, new advantages of using this technology should be shown and recognised. This is examined in the next section.

4. USE OF RFID DATA IN ACCOUNTING WAREHOUSE COSTS

The market of 3PL operators is very competitive, with contracts often won on the basis of the lowest price. It was shown in the example of the tyre distribution centre that the RFID technology can help to alleviate problems faced during the operations. In addition to streamlined warehouse operation it is proposed to use the RFID generated data in such a way, which gives the 3PL company an ability to offer a customer a fair pricing for the world-class services. Fair pricing is understood here as accurate costing of services, which leaves enough margin for the 3PL and offers a competitive, contract winning, price to the customer.

The example of the TDC business shown that the RFID technology gives possibility to carry out improvements in the warehouse operation, stock identification, material handling, tracking of equipment, locations and personnel as well as managing exceptions. In order to extend these benefits it is proposed in this section to use the RFID data for accounting purposes, helping the company to better understand and calculate costs and expenses of the warehouse operations. This is a new area for application of the RFID technology within the warehouse environment.

4.1. Warehouse cost elements in example of TDC

There are several types of costs incurred in the warehouse, which are related to its direct operations, labour force, handling equipment and other handling expenses. The careful examination of this costs can provide saving for the company, and it is aimed to show that the RFID technology can be used in accounting of these costs.

Direct handling expense is considered to be all those costs associated with moving product into or out of the warehouse. The primary components are labour, material handling equipment (MHE), supplies, and other items related to operations. A wide range of warehousing activities from unloading vehicles to handling product returns is included in the category of handling expense. Warehouse direct costs by activity are shown in Table 1.

Receiving	Put-away	Storage	Picking	Despatching
- unloading inbound vehicles - palletising & sorting - use of MHE - labour	- moving goods to storage - use of MHE - labour	- inventory control - cycle counts - space - storage system - stock moves	- use of MHE - picker routing - labour	- checking orders - sorting to routes - loading vehicle - labour - use of MHE

Table 1: Warehouse direct costs by activity

Direct handling operations can be tracked with the RFID technology, which provides the necessary identification and time stamps for placing the events within the time frame. The time stamps are the basis for the RFID time-driven activity based costing, presented in the Section 4.2.

Expenses related to warehouse labour include payment to employees – warehouse workers, forklift operators, casual and part-time labour. They include regular wages, bonuses and

overtime. With the RFID system in place a company can identify its workers by the RFID tag embedded in their identification, time spent on activities can be measured. This can be a source of information for warehouse operation improvements and the grounds for salary calculations.

Handling equipment costs include the expenses for the forklifts and other material handling equipment, including the cost of fuel, maintenance, rental fees etc. With increased optimisation of the warehouse activities, thanks to making the use of RFID data, costs savings can be made as less material handling equipment might be necessary.

Additional warehouse costs include expenses on pallets and supplies, demurrage costs, recouping warehouse damage and other costs. As well as costs incurred during value added activities, like: repacking, case breaking, re-labelling.

4.2. The RFID time-driven activity based costing

In order to keep the incurring costs of operation under control the 3PL companies have the cost accounting systems in place. This enables the business to know costs of running their business and helps to set up pricing for the services. The method proposed in [11] uses the activity-based costing (ABC) method to calculate activity costs in a distribution warehouse. In the ABC method costs of resources are assigned to activities and these are assigned to cost objects. The ABC model for logistic costs is an effective tool for estimating enterprise's cost efficiency and showing where improvements could be made. However, the ABC methodology has issues with scalability, granularity and coordination between multiple sites. The extended ABC model was proposed in [12], it uses a time-driven approach in order to resolve these problems. Time-driven ABC (TDABC) requires only two parameters: the cost per time unit of supplying resource capacity and the unit times of consumption of resource capacity by products, services and customers. It is recognised that in conjunction with the capabilities of the RFID identification it is possible to extend this method. The RFID generated data, which comes from continues reads of tagged objects in the warehouse, can be used with TDABC providing necessary granularity for cost calculation. The RFID data has the time stamps and individual identification, which aids this methodology. It is possible to constantly review the costs, as the RFID data is continuously being collected during the warehouse operations. The novel use of RFID is proposed, as it is used not only to wirelessly identify objects and bringing benefit of nearly full visibility, but also this technology can be applied now to the area of cost measurements. This will help warehouse managers to have a greater insight into the running costs of the 3PL business, giving them the possibilities of setting the price at the fair level, in order to benefit their company and the customer.

Within the TDC business the application of the RFID technology provided better identification of tyres, cut amount of manual handling and decreased amount of manual data entry. The receiving and consecutive operations could be streamlined and executed with greater confidence, which comes from correct stock levels. These benefits can be extended with the use of TDABC for cost calculating based on the collected RFID data. When tyres, workers and manual handling equipment is tagged with the RFID chips information on their individual identity, movements between locations and the time between are known. This forms a basis for using the TDABC methodology.

The link between 3PL business, which uses the RFID technology, the pricing of the warehouse services and calculation of the costs based on the RFID data in order to give the customer the competitive and fair price is going to be explored further. It is envisaged that the more extensive use of RFID data can bring more benefits to the businesses beyond simple wireless identification.

5. CONCLUSION

This paper analysed the receiving operation at the tyre distribution centre operated by 3PL company. It was shown that application of the RFID technology is able to enhance the receiving operation, ensuring that tyres of correct type and quantity are admitted into stock. Moreover, benefits of dynamic temporary storage, decrease of manual handling and less manual data entry errors were envisaged. The use of RFID technology can also enable this particular business to solve problem of dishonest customers who take advantage of company return policies. Additionally, it was explained that the RFID technology can not only bring these benefits, but the use of RFID generated data can be extended to accounting of costs and services within Time-driven Activity Based Costing framework. The further research on the RFID technology should focus on providing new areas where analysing the real-time information about objects and events can bring improvements of businesses decisions. With the future progress of research on new benefits of the RFID the vision of ubiquitous identification systems becomes nearer.

6. REFERENCES

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