FACTORS INFLUENCING SPARE PARTS MANAGEMENT IN THE AUTOMOTIVE INDUSTRY

N. Pawlowska-Kalinowska, A. Stachowiak
Faculty of Engineering Management, Poznan University of Technology, 11 Strzelecka Str., Poznan, Poland

Abstract
Thoroughly prepared, worked out and implemented tools as well as methods of spare parts management can influence companies’ success against the competitors. Under the term success following actions are hidden: cost reduction including logistics and transportation costs as well as the increase of companies’ profits. In this paper data from the analyzed case studies have been broadened by the theoretical issues described in the literature of the subject. Basing on chosen case studies a schedule of four main factors influencing spare parts management has been prepared. These are spare parts, spares suppliers, competitive companies and customers. In this paper particular factors which influence the process of spare parts management have been presented. The note of their individual features which are crucial to support an effective functioning of a company in the environment of the spare parts management has been taken.

Keywords:
Spare parts, suppliers, competitors, customers.

1 INTRODUCTION
Service of vehicles as well as spare parts availability are becoming more and more important elements of aftermarket processes in automotive companies. The companies try to cater for the customers’ needs and develop aftermarket in their structures. The availability of spare parts for both maintenance and accidental repairs is a factor which is nowadays more and more often taken into consideration by the customers during the vehicle’s choice process. Their expectations relative to long-time spares availability as well as service activities are high. For the automotive companies spare parts sale generates measurable gains because of spares demand during many years of vehicles’ usage [1]. Spare parts management processes on a level which satisfies customers causes challenges for the automotive companies and requires decision making regarding several participants of the supply chain. The paper’s aim is to present different factors which shall be taken into consideration while designing an effective spare parts management system. In the paper spare parts logistics characteristics in the companies has been presented including its aims. Spare parts management methods presented in the literature have been described taking into consideration different approaches presented by the scientists. Moreover, main factors influencing spare parts management process in the company have been depicted. Roles of spares, suppliers, competitors and customers have been presented taking into consideration their influence on an effective spare parts management process.

2 SPARE PARTS MANAGEMENT METHODS - LITERATURE OVERVIEW
A universal system of spare parts management has not been created yet, only individual models of spares provisioning created for particular companies in their specific environments have been presented in the literature [2]. Different approaches have been published around the world. First group of methods base on the use of common known solutions dedicated to production processes. These are among other things classical methods basing on safety stock and its influence on stock replenishment. The most often characterized approaches in the literature are two basic systems based on the reorder point or periodic review. As these approaches are insufficient in the real companies’ lives caused by different reasons such as minimal order quantities, high transportation costs by small orders or delivery cycles to achieve planned results in form of appropriate stock levels particular modifications and other approaches need to be implemented. Different solutions of supply reduction are developed e.g. JIT Just in Time, ECR Efficient Customer Response, VMI Vendor Managed Inventory and other [3]. These approaches can be successfully implemented for inventory management to support production processes. However, in the spare parts management processes the previous mentioned stock replenishment methods are insufficient in the long run. There are several reasons which cause the use of traditional method of stock replenishment may increase stocks and block company’s assets for a long time.

In the spare parts provisioning environment several methods have been created which focus on parts individual features. These are parts division according to different parameters, use of mathematical calculations and solutions to optimize stocks in the companies as well as implementation of complicated solutions basing on sophisticated calculation methods. All the methods have one thing in common – they are not universal but only created for particular environment’s conditions. Several examples of them are presented in this paragraph.

2.1 Parts categorization and grouping
Several researchers lean towards parts grouping but their approaches differ from each other by parameters taken into analysis. First method presented in this paper is parts division into following groups:

- key parts (with only a few possible suppliers, mostly made-to-order parts with long lead times);
- industry specific parts (similar to key parts but are easier to manufacture, their lead times are considerably shorter);
- commercial parts (parts available in several sources, characterized by short lead times).

By taking into consideration price and demand of spares a categorization matrix is created which helps the companies to manage the spares demand. It is mentioned that the final categorization should be case-dependent and
does not fit to all the companies but as a general tool can be used under different conditions [4].

Another approach of spare parts grouping is the use of Criticality VED and ABC Classification matrix [5]. The ABC classification is designed for the parts division according to their value added to the company (A – the highest value, C – the least value). This division is a characteristic reflection of the Pareto principle, where the smallest group creates the highest value added and the largest group represents the lowest value added for the company. Additionally the VED classification allows the parts division regarding their criticality to the product functionality. It is categorized in terms of V - vital E - essential and D - desirable (see Table 1).

<table>
<thead>
<tr>
<th>Classification and Criticality</th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vital (V)</td>
<td>A-V</td>
<td>B-V</td>
<td>C-V</td>
</tr>
<tr>
<td>Essential (E)</td>
<td>A-E</td>
<td>B-E</td>
<td>C-E</td>
</tr>
<tr>
<td>Desirable (D)</td>
<td>A-D</td>
<td>B-D</td>
<td>C-D</td>
</tr>
</tbody>
</table>

Table 1. Parts grouping based on Criticality and ABC Classification.

For forecasting and supply planning each company needs to decide which parts are critical for them and how they should be classified – if they should be paid a lot of attention or not especially [6].

2.2 Mathematical models for spare parts management

Second group of spare parts management approaches are mathematical models used for this purpose. In the literature of the subject several techniques are presented. As the first example the Croston model is presented. It is an approach for intermittent-demand forecasting. It involves separate simple exponential smoothing forecasts of the demand size and the time between demands. According to the literature overview, different modifications have been implemented to the Croston model to optimize its use in the spare parts stock management [7].

Another example of mathematical approaches in the spares management is the Poisson model based on the Poisson distribution. It forecasts the probability of a rare event. When applied to the spare parts forecasting problem, it provides an estimate of the probability of consumption for a fixed value of spare parts. The main problem in this approach is to define the expected probability of consumption for different values of spare parts [8].

The third example of methods supporting spare parts management is the Multi-Echelon Technique for Recoverable Item Control METRIC. This method was designed for military industry, in which the demand for particular parts or assemblies occurred in different facilities supported by one central warehouse. The mathematical model was created for two-echelon structure which consisted of lots of parts. The two echelons were built by the central warehouse and local warehouses. The aim of this method is establishing of appropriate stock levels in all the warehouses in all echelons in order to minimize number of expected lack of parts taking into consideration system constraints at the same time [8]. This method has been developed by several researchers to different modifications, e.g. MOD-METRIC including Bill of Materials at the two levels in the two-echelon structure, or VARI-METRIC which assumes that the average number of parts to be repaired equals their variances. Other METRIC modifications are available in the literature [9].

2.3 Complex methods of spare parts management

The third group of spares provisioning methods includes approaches characterized by a high level of complexity. Examples of these techniques are neural networks and their modification in form of enhanced fuzzy neural networks (EFNN) used for forecasting of spare parts demand. The EFNN is a five-layer hybrid neural network. It is able to self-organize its activation function based on genetic algorithms in the learning process. The case study presented in the literature shows the reason of implementation of spare parts management methods at a high level of complexity. In real life, traditional forecasting methods and fuzzy neural networks which satisfy the demand for spare parts with significantly larger stock costs will never be applied in the industry [10].

Different approaches presented in this chapter are only chosen examples which shall visualize how many different methods have been developed and may be used in particular environments. The difference in their complexities influences their implementation possibility in different structures. It may happen that some companies are not ready to use methods at a higher level of complexity but firstly they can still choose a method which can support their stock replenishment processes.

3 SPARE PARTS LOGISTICS IN A COMPANY

Spare parts logistics of the manufacturer contains the market-oriented planning, design, realization, and control of the spare parts supply and distribution, along with associated information flows within a firm and between the firm and its network partners. Spare parts logistics aims a demand-driven and cost-minimal provision of the required spare parts for the defective or preventive maintenance of primary products to ensure an optimal level of product’s availability or reliability [2]. As the demand of spare parts is characterized by stochastic demand, random supply, high inventory and transportation cost [11] and affected by following factors such as intensity of product use, wear behavior, failure rates or type of maintenance, manufacturers can achieve a competitive advantage if their spare parts strategy is designed for the specific environment in the company. A careful selection of an appropriate spare parts management method is crucial because of among other things changes in the primary product markets (competitive pressure, technical equalization of products), rising cost awareness (low capital lockup), high customers’ expectations (high level of available parts), competition in the market (spares imitations, many market actors) [2]. Important elements for a successful spare parts stock replenishment are the assurance of the highest possible spares availability level by the lowest possible stocks, customer loyalty kept by the number of activities and process development preventing the competitors’ takeovers on the spares market. An important role for spare parts market plays the cooperation between the company and the suppliers which influences the company’s effectiveness. Suppliers’ reliability, certain delivery dates, competitive prices and payment conditions are elements influencing company’s success. As in the spare parts inventory management lots of factors are random it is crucial that the managers are ready for changes and new solutions which do not represent standard approaches. Parallel to the material flow information flow need to be led at a high level. It requires cooperation and trust between all cooperation partners.
4 FACTORS INFLUENCING SPARE PARTS MANAGEMENT EFFECTIVENESS

There are four main factors influencing spare parts management processes in the automotive: spare parts, spare parts suppliers, competitors and customers. In this unit these four factors are characterized.

4.1 Spare parts

Spare parts in the automotive can be divided into different groups according to different criteria chosen. One of the classifications basing on the parts individual features is following:

- maintenance parts – filters, wipers, oils and grease;
- consumables – batteries, exhaust system elements, brake pads, brake discs;
- drive system elements;
- tires;
- accidental parts – bumpers, glasses, mirrors etc.;
- accessories – audio-video devices mounted in the vehicle [12].

Another classification is created by legal rules. According to the European law spare parts are divided into following groups:

- OE – Original Equipment parts – signed with the car producer’s brand (e.g. VW, Ford etc.).
- OEM – Original Equipment Manufacturer – signed with the parts producer’s brand (e.g. Bosch, DAF, Konvexta, etc.).
- OE Replacement Parts (Aftermarket Replacement) are produced by the companies which are not OEM.
- Other spare parts are not classified in any of group mentioned [13, 14].

The definition of original spare parts says that they are the parts characterized by the same quality as the parts used for the first assembly, produced under production standards which have been established by the vehicles’ producer for the components and spare parts for the particular vehicle. It is presumed that the spare parts are original when their producer certifies that they have been produced in accordance with the specifications and standards established by the vehicle’s producer. Moreover it needs to be certified that their quality is the same as the quality of the parts for the first assembly. According to this every parts producer who delivers parts for first assembly is allowed to call them original even if they are sold in own packages and signed with the own brand as well the part number. Also other part producers if they know the production technology which is required by the vehicles producers are allowed to call such parts original parts. The evaluation of the parts originality is left to the vehicles producers the only thing which need to be taken into consideration by calling the parts original parts is that such certificates can be claimed by both the customers as well the vehicles producers if the statement is inconsistent with the truth. This rule enables different producers to introduce their products (spare part replacements) to the market. To ensure the spare parts sales from own sources companies force the customers to buy original parts during the warranty period. Use of parts replacements may cause warranty loss for the whole vehicle. To keep the warranty conditions customers decide to buy original parts which are of the highest quality which are often more expensive than the OE replacement parts.

The character of spare parts and its classification into different group causes different approaches during spare parts management system. To achieve a satisfactory customer service level and by keeping the lowest possible stocks it is important to take into consideration factors which influence spares’ behavior during the primary product life cycle:

- cost of the part;
- delivery time;
- parts rotation;
- material which it is made of due to obsolescence (rubber, chemical substances etc.);
- parts dimensions influencing warehouse space;
- storage costs.

All the features of spare parts need to be taken into consideration while ordering process. If the part is crucial for vehicle’s functioning and its delivery time is very long sometimes it is better to keep it on stock to provide the parts availability and fulfill customers’ expectations. To find a golden mean decisions need to be taken which spare parts inventory method(s) shall be implemented. An important thing is to take into consideration company’s specific environmental features.

4.2 Spare parts suppliers

An important factor taking part in the spare parts provisioning are suppliers. There are two suppliers groups regarding the type of parts delivered to the market. The first group delivers parts to the market which are the same parts as the primary products but they are spare parts. They can differ from the primary products by quality, method of production or price. This group of suppliers can deliver components to more complex sub-assemblies which are replaced in the sub-assemblies mentioned before. An example of such parts are cooling hoses in air conditioning – they do not need to be ordered by the vehicle producers but direct by the air conditioning producers to the first assembly. It is obvious that the vehicles’ producers are not the producers of particular aggregates in the vehicle. This way of parts purchase and participants of the process are presented in the Figure 1.

Figure 1. Participants of spare parts purchase process of A/C components.

The second group of parts suppliers consists of producers delivering components to the first assembly. The priority of spare parts deliveries to the market is not as important for them as the production to the vehicles which can cause difficulties in their purchase. An important element in the cooperation between the suppliers and companies is the information flow. Companies introduce different tools to improve this process, e.g. sharing demand forecast with the suppliers to meet customers’ needs, creating appropriate stock levels as well as planning market oriented production processes [15].

All the parameters influencing cooperation between companies and their suppliers can be formed in suppliers’ evaluation lists. Different approaches of suppliers’ evaluation strategies have been published. From the described criteria a picture of a reliable supplier occurs. Four main criteria are taken into consideration: price, delivery date, quality and additional features. A detailed analysis of these criteria is presented in the Table 2 [16].
Suppliers’ evaluation criteria presented in the Table 2 are universal. As it is impossible to compare the price values it is suggested to implement an indicator of price level compared with the competitors’ prices as the price of a particular supplier to the arithmetic mean price in the market of the supplier.

As the list is not the only one valid other criteria can be added to it. As an example flexibility is used. Flexibility on the market is required to react fast on the market demand – the suppliers need to be ready to change the production smoothly from one product to another [17]. As by the plan of spare parts stocks, cooperation with the suppliers shall be tailor-made for the particular companies’ conditions. Individual needs and features shall be taken into consideration.

### 4.3 Competitors in the spare parts management

Another factor which plays an important role in the spare parts management processes are the competitors in the market.

For many years spare parts provisioning was a rentable business for the vehicles producers. The companies distributed spares in the aftermarket almost in a monopolistic way. The situation changed when other companies discovered the potential in the spare parts market first of all in the field of consumable parts. The companies which had previously delivered parts without any pressure started to meet growing competitors.

Nowadays spare parts are delivered to the market by primary product producers, suppliers connected to the primary product producers and independent parts producers or distributors. The first two groups can be connected by cooperation agreements and work in the way to complement each other. An example of such cooperation is an authorized maintenance center which ensures repairs with parts mounted in the first assemblies. They are in charge of keeping the functionality of the vehicles during the warranty period. Parts mounted by them are original parts accepted by the vehicles producers to maintenance and accidental repairs and do not influence any aftersales conditions. After the warranty period the third group of spare parts market participants starts to play an important role. They are pure competitors. The main business field for these companies is the spare parts market. Working on a mass scale they are able to decrease the margin level to gain the market and customers’ loyalty. The parts brought to the market by the companies from the third group do not need to be original parts. They only need to have the same function as the parts mounted in the vehicles. If a company brings to the market a part replacement which is cheaper than the original component lots of customers decide to save money and buy the cheaper product. In the automotive this solution is often met by the post warranty vehicles. This trend is observed by different types of parts however it is most visible by the consumables which need to be replaced regularly during the product life cycle. The independent workshops compete with the brand service stations to increase their service volume first of all with price. Their service as well parts prices are lower, additionally their time of repairs is relative short. The quality of such repairs is at a very high level so it is not possible to say that with the lower price the lower quality level is offered. This trend is visible in the European market. The value of the European automotive market is calculated at the level of ca. 120 billion € per year whereas 82 billion € is related to the parts, tires and accessories production. In Europe there are ca. 490 thousand workshops, 370 thousand of them are independent service centers. 46 thousand spares sellers cooperate with them [18]. The vehicles’ owners are also aware of the safety in the traffic and they take care of their vehicles. Additional aspect which influences the increase of spares sellers in the market is the technical development of the vehicles. In vehicles there are also parts which are not classified as spare parts and cannot be purchased in the distribution channels. These are components which should not break as well as frame elements. The correct repair of them shall be provided by the authorized facilities which are able to conduct such repairs due to the vehicles producers’ instructions. Customers are not able to repair the vehicles by themselves and they visit often and often the service centers to have their vehicles repaired.

The market power of the competitors depends on different factors. These are among others the market characteristics. Some markets follow only one factor which is the price, on the other hand the quality is also important. It is not said that the part replacements are not as good as the original parts but taking into consideration their role in the vehicle, some customers decide to pay more to feel safer in the vehicle by the use of original components. The awareness that the competitors play an important role in the spare parts market helps to create an effective spare parts management system.

### 5 CUSTOMER – THE ENDUSER OF THE PRIMARY PRODUCT

Vehicles buyers are also the customers of spare parts. To fulfill their expectations – to provide spare parts under competitive conditions companies implement different solutions. It is important to learn who the customers are and what their wishes are. Focusing on the customers satisfaction refers to the level of cognitive or affective evaluation in purchasing and using a product or service. Customers feel satisfied when their demands are met. Consequently, they continue to buy and use the same product or service. When a customer feels satisfied, it could be the result of emotional response based on his/her experience of the purchase and use of the product or service or the cognitive evaluation between the level of
expectation and the actual experience [19]. In the automotive customer-oriented approach plays more and more important role. The customer-oriented design ensures the possibility of deeper understanding of customer’s needs and requirements. Vehicle sales is dependent on producing vehicles which are designed and engineered for what the customer and user needs, not just on what is the most technologically advanced, represents the next step forwards in the highly competitive global automotive industry [20]. Customers using vehicles, driving cars wish them to be never-failing and if a fault occurs they wish to have it fixed as fast as possible. To understand customers’ needs a number of analyses have been published. One of the approaches focusing on customers’ needs understanding and satisfaction is relationship marketing. It is understood as creating, keeping and enriching relations with the customers in the way that the goals of both sides are achieved by mutual exchange and keeping promises. Relationship marketing does not focus on a single sale but on keeping a permanent bond with the customer. Its goal is to enrich customer’s loyalty. All the employees, not only those who are in contact with the customer shall take care of his/her satisfaction. The main reasons of the relationship marketing’s creation are higher and higher customers’ requirements as well as excessive operational costs of the companies. Customers wish to get offers which are prepared for their individual demands and they require higher and higher service quality as well as caring customer service [21]. Loyal customers are wealth for the company among others because winning of new customers decreases profits from the relation. Constant increase of offered products and services quality is necessary because the majority of the customers do not accept products of average quality. To learn their moods customer’s satisfaction analysis should become a prior activity in a company. A satisfied customer builds stronger longstanding relations with the company and these lead to regular incomes. Their summary in time can be described as customer relation profitability. Figure 2 presents the relation between quality and company’s profitability [22].

High service quality
↓
Increase of customer’s satisfaction level
↓
Higher customer’s loyalty toward the company
↓
Long-lasting relation customer-company
↓
Increase of company’s profitability

Figure 2 Relation between the quality and company’s profitability.

The company’s relation with the customers plays the crucial role in the company’s success. It needs to be developed to increase the satisfaction level and to create long-lasting bonds which are connected with the company’s profits.

6 CONCLUSIONS

Spare parts management differs from the stock management for the production processes because of different factors. These factors are individual features of spare parts and the environmental conditions. That is why the stock replenishment methods successfully implemented in the production processes do not achieve the same results in the spares management. Characteristic features of spare parts such as random demand, long delivery dates and relative high price levels of some parts make stock replenishment process difficult. The process starts to be more complicated when other boundary conditions such as the lowest possible cost of stocks kept are taken into consideration. To achieve the goals and to be successful in the market the companies need to look at the spare parts management processes in a global way. On the one hand a correct chosen and a tailor-made stock replenishment method plays an important role. On the other hand the recognition of the environment as well as individual features of its participants are crucial for being successful in this field. From the company’s point of view success is understood as the customer’s loyalty, strong position in the market and finally the increase of revenues year by year by the lowest possible stocks levels in the warehouse(s).

The company’s success is influenced by the factors described in this paper. These are spare parts, suppliers, competitors and customers. Although spare parts are not active participants of the whole spares management process, their quantity and quality influence the customers’ contentment. This is the reason why they are also mentioned as one of the factors playing role in the analyzed process. The second factor influencing the company’s success is related with the suppliers. A successful cooperation with them plays a role in the quality and punctuality of the deliveries which determine the customers’ satisfaction of parts availability. The development of this cooperation is crucial for both the suppliers as well as the company providing spares to the end customers. The third factor analyzed in this paper includes competitors. The knowledge about them, about their structure, goals as well as ambitions plays an important role in the strategy building and helps to react to competitors’ behaviors. Finally the customers’ needs shall be met and to achieve it the knowledge about them needs to be developed.

The goal of the paper has been the presentation of crucial factors influencing the spare parts management processes in a company. In the paper theoretical approaches have been joined with the solutions implemented in the companies described in the literature of the subject.

7 REFERENCES


