

## APPLICATION OF SPARE PARTS MANAGEMENT METHODS IN THE COMPANIES IN THE CZECH REPUBLIC

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### Abstract

The concern about proper management of spare parts in nowadays corporate environment is a great demand and strategy for many global companies in many types of business, especially because they are expensive, require much storage space in their plants and represent a big portion of their financial results. Some unanswered key questions enhance this discussion: which are the influences and how spread is this concern of spare parts management in companies all over the world today? This paper presents an overview of quantitative and qualitative research regarding the usage of spare parts management methods in Czech Republic companies. Many types of analysis comparing multiple aspects of the companies (size, type of business, used methods, demand patterns) and some statistics are also presented.

### Keywords

Spare parts; Logistics; TPM; Inventory management; TQM.

### Introduction

The level of service quality in industry is measured, among other things, by the time at which the technician is able to arrive at the customer's place with a spare part after the customer has reported an error or a defect on the machine. Manufacturers are forced to comply with delivery times to their customers and within the shortest possible downtime of production equipment it is necessary to have at least certain types of spare parts in stock. Spare parts are expensive and the purchase of individual components is associated with high depreciation and other costs associated with their obsolescence. For this reason, enterprises are forced to keep spare parts stock levels at the lowest possible level.

### 1 Spare Parts Inventory Control

Spare parts logistics has become an important aspect of supply chain management. The size of the spare parts market has greatly increased in the last decade, according to estimation, reached \$150 trillion worldwide and annually increases by five to nine percent [1]. Companies have started to benchmark their costs for logistics operations with the best organizations in their class. The demand for logistics providers and their services has increased in this area. More and more companies realize the strategic value of a well-built logistics service, especially in the context of ensuring spare parts availability and faster response times to their customers.

The inventory of spare parts can be generally controlled by mathematical models. These methods usually focus on cost optimization of inventories and setting the required level of

inventory of spare parts which is necessary to the smooth running of production. An effort to find a compromise among them led to the classification of inventory items by their economic value. While using information systems, complex modelling is feasible without major problems. However, the selection of input parameters, such as the allocation of control variables, purchasing decisions and individual management strategies for various types of items, still needs to be set straight. For this reason, the classification of items is an important aspect. Most authors focus on specific areas of spare parts logistics; therefore, it is useful to examine the different factors that affect the level of service, and to propose a framework that provides a holistic view.

Within the management of spare parts inventories, numerous methods have been developed. Management of spare parts is often considered a special case of a general model of inventory management thanks to its special features, such as low and sporadic demand [2]. Their goals, however, are identical: to achieve the desired level of service with minimal cost. Professional literature mentions so called multilevel systems of spare parts management [3]. One of the first works in this field was Sherbrook's METRIC model. Other related works that live in multi-level storage systems to budgetary considerations, are by the authors Muckstadt and Thomas (1980) [4] and Hausman and Erkip (1994) [5].

K. Ficoń in [6], on the other hand, analyzes the logistics of supplies and characterizes management system of spare parts and components such as material stocks, also distinguishes between raw materials and semi-finished products. The author points out that some components of the machine can be made directly at the point of production so that an organization can flexibly meet their own needs. This statement can be successfully supported by using 3D printing technologies. Another aspect of safety and reliability should be considered within the spare parts management.

Generally, the requirements for spare parts can be the result of the following factors [7]:

- replacement of parts which reached the technical or warranty lifetime
- exchange due to the limit of the technical conditions, e.g. a device does not meet the parameters required for operation during the technical inspection,
- damage of the workpiece during application (damage discovered during the operation, during regular maintenance)
- damage of the workpiece during storage (loss of quality), e.g. replacement of the parts recommended by the manufacturer or an authorized person in the technical documentation with respect to the warranty period.

Another classification of spare parts inventory is divided according to their availability in the market and sales volume [8]:

- key components are only available from a few vendors and only made to order, causing long delivery times. Therefore, manufacture and repair should be planned in advance, because there is a high likelihood of shortages of parts in the required time;
- industrially produced parts, which have similar characteristics as key components, but produced in large volumes, greatly reduce the risk of lack of spare parts and provide a larger number of suppliers of these items. They are made in accordance with the technical documentation of customers, but they have a universal character, and their lead time is significantly shorter than those of key components;
- parts of the counter are universal, so it is possible to use them in all industries. These include small items such as light bulbs, screws, etc., which are readily available and the delivery time is very short.

On the other hand, with regard to the type of production requirements for spare parts, it is possible to divide [9]:

- individual parts such as gaskets, screws, filters, etc.
- components assembled from various parts by the supplier which are ready for installation.

Different characteristics of this inventory items requires a different management strategy than the conventional inventory [10]. At the same time, it is also necessary to take into account the following special conditions of storage [11]:

- Delivery time requirement associated with scheduled maintenance. The event (part replacement) is especially difficult to be predicted if there is no information about the previous failures, for example due to the absence of regular inspection or in case of brand new facilities. The only way to avoid unexpected shutdowns is to constantly monitor the device status and scheduled repairs and replacements.
- Maintenance strategy determines the demand for spare parts inventory. One of the approaches is an emergency recovery of the device or replacing the defective part. A larger number of storage units enable to cover a sudden increase in demand. Lower number of storage units increases the probability of sudden supply and thus the increase of the costs.
- Costs incurred by a deficit of spare parts are the costs of downtimes and production loss.
- The purchase of partial components is more desirable than the purchase of the entire device. This is coupled with the fact that the purchase and the cost of repairing the equipment are usually higher than the cost of replacement parts. Disorder parts are usually dependent on each other, which means that the failure of one element may be the result of the dysfunction of the second one. This can represent a serious problem, especially when the relationship of the components is unknown.
- In the case of obsolete equipment at the end of the life cycle, the acquisition of spare parts is difficult. Prevention is the acquisition of a sufficient number of spare parts in advance. It is also a source of excessive capital freezing. Moreover, it is difficult to replace the component which has been discontinued. As already mentioned, by definition spare parts inventory control differs from the control of traditional warehouse inventory. In order to control the necessary spare parts effectively, lifecycle tools need to be monitored carefully and these parts should be continuously ordered and stored at a certain level. Optimum pool is then determined by a more complicated manner than by standard inventory. However, the goal is the same; to minimize the risk of losses resulting from downtime and maintenance costs and to eliminate unnecessary costs of holding inventory in the warehouse.

## **2 Methods and Techniques of Inventory Management of Spare Parts**

In the previous chapter, various kinds of spare parts were outlined including their possible typologies reported in professional literature. Regarding the methods and techniques of inventory management, most notably mentioned is ABC analysis, which is the classification based on the distribution of individual inventory items by the cash value of sales or other criteria. In practice, however, many situations require more accurate classification than just by using one of the criteria. The traditional approach has been extended by the inclusion of other classification criteria. Flores and Whybark (1989) [12] and Cohen and Ernst (1988) [13] also introduced a clustering method, which multiplies the effect of individual criteria. This approach takes into account also other criteria than solely production factors. For example, Fuller et al. (1993) [14] used the criteria in relation to sales volume, order size, the coordination and requirements for shipping and handling. De Leeuw (1996) [15] uses the

properties of individual products, processes and markets and accordingly adjusts the individual criteria. Van der Veecken and Rutten (1998) [30] determined the profile of the customer's order by three attributes: according to basic data about the customer, the number of deliveries and by product attributes (its value and size).

The literature research shows focus on further categorization to improve the internal management of spare parts inventory, for example by Braglia et al. (2004) [16]. There are also studies that combine both aspects, demand and purchasing policies depending on demand. Vaughan (2003) [17] studied the strategy orders in case of accidental failure. Specific studies concerning the categorization of spare parts depending on the strategy of supplying and purchasing portfolios were conducted by Caniels and Gelderman (2005) [18] or Kraljic (1983) [19]. Categorization according to the type of demand for spare parts has been studied by Kobbacy and Liang (1999) [20] but also by Kalchschmidt et al. [21] who examined the impact on the demand for spare parts in times of uncertain demand. Lee (2002) [22] created a work which combines the uncertainty in supply and demand for spare parts and accordingly suggests a strategy for reducing these uncertainties. The concept of integrating demand and supply chains is discussed in the work of D. Walters (2006) [23].

In deciding on a strategy for inventory management, it is important to have a balanced view of both its efficiency and effectiveness. As reported by Jouni et al. [8], it is necessary to connect the analysis of customer's needs with management strategies, so that spare parts and the aggregate demand for a particular product will add to the characteristics of individual customers.

### **3 New Trends in Inventory Management of Spare Parts**

In the previous chapters various methods of inventory control were presented. According to Jouni et al. [8], for classifying the parts it is particularly helpful to focus on characteristics other than price and volume demand. This led the scientists to propose the above-mentioned multidimensional models designed specifically for the management of spare parts inventory. Duchessi et al. [26] use a two-dimensional system combining criteria such as the cost of spare parts inventory and the risk of shortages. D. Petrović and R. Petrović [27] designed an expert model for deciding a strategy for managing these stocks. This model is based on a heuristic method of making and use of the following characteristics: availability of the required system cost, weight and volume of parts, parts availability in the market and the effectiveness of the repair. Gajpal et al. [28] developed a critical analysis of the spare parts management using the method of analytical hierarchy process (AHP).

In addition, the current literature shows that the results concerning optimization of parts inventory mainly focus on the following four aspects:

1. optimization of the classification of the spare parts;
2. optimization of the forecasts methods for ordering spare parts;
3. optimization of strategies for inventory management of spare parts;
4. development of information systems for inventory management of spare parts.

### **4 Research Methodology**

For the quantitative research, a questionnaire survey was used as a method of data collection. The pilot survey was performed on a sample of 126 enterprises from different regions of the Czech Republic in order to examine trends and levels of spare parts management. Disproportionate stratified selection was used with the same size of subgroups, where the sorting character was the size of the company and the sector. For the statistical processing of data, the descriptive statistics and the methods of statistical analysis was used. A quantitative

analysis rating the survey shows the distribution of opinions in the total number of responses. It is not an in-depth survey but a statistical presentation of the respondents' answers.

## **5 Results and Discussion**

Initially, the survey intended to map the corporate scenario of spare parts and inventory concern over Czech companies and originally contained 26 different questions, in which only 23 were considered for discussion. Right after its submission, 126 complete answers over Czech Republic's corporate environment could be gathered for further analysis. Some demographic data results are shown. Regarding a company's first business, the majority is automotive, representing more than 30% of total results, followed by mechanical engineering with 15% and services companies, with 10% of total respondents.

Changing the focus to the type of production, most companies are customized, representing more than 41% of all answers, followed by Serial, with more than 27% and then mass production, with 14.29%.

Most companies adopt a single shift system, and the three-shift and continuous production.

It was also noticed that the majority of Czech companies do concern about spare parts and inventory management, represented by 59.52% of total respondents.

Question number 4 presents a scenario of outsourcing usage over enterprises, where most answers reveal that a small part of their inventories is outsourced, which shows that they prefer to manage their stocks inside doors.

When it comes to the methods of inventory management, the answers vary. However, ABC curve is still the most often used method, representing 18.25% of all answers, followed by qualified estimate based on historical data, which represents 17.45% of total respondents.

Regarding the variability of consumption of spare parts, the answers were quite close. Most respondents stated that spare parts were commonly available (37.30%) and 30.16% answered that they were specially ordered; or both cases can happen, also with 30.16%. In another perspective, not very often their equipment and machinery outage due to the lack of spare parts, shown by 63.49% of all answers, and none of them with 21.43%. The minority of them (15.08%) actually feel the impact of a lack of spare parts, which proves to be a gap and an opportunity for implementation and usage of methods for spare parts management.

Additionally, most of the companies plan maintenance, representing 76.19% of all answers, which also shows an opportunity mentioned in the previous paragraph. 67.45% adopt preventive maintenance, which is very important and directly associated with the consumption of spare parts and, at the same time, avoiding production downtimes, followed by 26.19% of companies which only take actions after the failure happens (corrective maintenance) and the minority, shown by 6.35%, do predictive analysis over their machinery.

When it comes to the connection and relationship of maintenance within companies' other key departments, as purchasing, procurement, logistics and production planning, the answers show that the companies mostly share information over many departments, some of them exemplified previously, with 34.92% of all answers, followed by purchasing, represented by 20.63% of all answers, followed by production planning, with 11.11%, then controlling (also known as procurement), with 7.94% of all answers, and further logistics, represented by 7.14% of them, and after that accounting and warehouses, with 4.76% and 3.94% of all answers, respectively.

As far as the usage of evidence for planning and inventory of spare parts is concerned, most companies use records, represented by 54.76% of all answers, followed by the usage of

barcodes system, 16.67% and the other 28.57% vary between maintenance plans, ERP's such as Microsoft® SAP®, OHP permanent marker and others.

To the authors great surprise, when the discussion was related to the usage of ERP software for inventory management over Czech companies, the majority of them answered that they do not use ERP's, represented by 36.51% of all answers. The second place goes to Microsoft® SAP®, with proves to be the most used ERP over Czech companies, shown in 21.43% of all answers, followed by custom systems, represented by 3.17% of total population.

The other part of the survey presents the aging scenario of machinery inside Czech companies, where most of them have middle-age equipment, between 5 and 10 years old, represented by 36.51% of all answers, followed by ones older than 10 years, which require more attention, predictive maintenance and proper management of associated spare parts, otherwise these will cause many production downtimes and/or delays on delivering their products. They are represented by 23.02% of all answers. 21.43% represent figures between 3-5 years old (21.43%), then between 1-3 years old (16.67%) follow, and the minority have newer equipment less than 1 year old (2.38%).

It's very important to mention that the key factors prior to spare parts buying are also considered by most Czech companies, such as the lead time of suppliers, spare parts costs, criticality in the production process, replacement time and stock size. As expected, the lead time of suppliers and the cost are the most important factors, represented by 49.21% of all answers, followed by cost, as 44.44%. Regarding this analysis, it was noticed that multiple factors analysis are combined prior to spare parts buying, which is clear taking into account that management departments should rank and weight their importance inside their buying matrix.

When it comes to who is in charge of this whole process, the data show that maintenance, purchasing and production are responsible for inventory management of spare parts, represented by 33.33%, 32.54% and 22.22% of all answers, respectively. The remaining 11.90% show varied answers. From this data, it is possible to conclude and confirm that these 3 departments are the ones that deal with spare parts on a daily basis and it doesn't mean that they deal alone. In fact, trading information between their management systems is deeply connected in order to handle their inventories of spare parts properly.

Regarding suppliers of spare parts, most companies have single and multisource suppliers, depending on the type, cost and criticality of them. Level on majority of percentage with 43.65% each are both and single, followed by multi-sourcing with 12.70%.

Additionally, and also very importantly, the discussion comes to how companies deal with outdated or inefficient inventories of spare parts. Most of them have the policy of selling with a below market price, represented by 32.54% of all answers. Closely to this come companies that prefer scrap or discard these parts, shown by 30.95% of all answers. There are also the ones that provide exchange business with other plants, with 13.49% of responses. 5.56% prefer to keep spare parts in stock. The remaining 17.46% answers vary between not having any inefficient/outdated spare parts, didn't answer to this question, purchase on demand, define the usage of spare parts in another contract, do not have any stocks, or are not applicable to any of the options mentioned above.

Another key discussion is related to quality management. As expected, most of the companies use Quality management, represented by 58.73% of all answers. These include ISO9001 standards, 6 Sigma, non-conformities tracking and other quality management tools. The minority but also a very representative percentage of 41.27% shows the companies that do not use quality management. A key question remains unanswered: How do they evaluate

inefficient or outdated spare parts? Do they concern about their impact over the cost control and their annual financial results?

The last question analyzed in the survey is related to the size of companies according to the number of employees. Most of them are medium-sized, having between 50 and 250 employees (26.19%), small companies (between 10 and 50) (22.22%), large ones (between 250 and 1,000) as 21.43%, micro (below 10), as 16.67% and finally enterprises, with over 1,000 employees, representing 13.49%.

## Conclusion

This article intended to discuss and present data obtained by a survey regarding diverse aspects and scenarios inside corporate environment in the Czech Republic, focused on the usage and concern regarding spare parts and inventory management, connected with their size, business type, quality management, maintenance types, usage of ERP's and software for SP management, variability of consumption and many other aspects. All gathered information clearly confirms that spare parts management still needs to be deeply viewed and taken care of, as it can cause serious problems and negative financial impacts on companies' results. All data collected lead to further and combined analysis of these aspects and many other conclusions and diagnostics are possible.

Effective inventory management of spare parts is a challenge for many industrial companies that seek to maximize the use of their machinery and equipment. Determination of the optimal level of inventory of spare parts, which meets the requirements for their timely availability in repair and maintenance and balancing the costs of storage for enterprises, is a key concern. As in the case of other types of inventory, the main objective is minimizing the sum of direct and indirect costs.

Individual classifications of spare parts mentioned in this paper have their limits, which enable their usefulness in difficult situations. Another important limitation is that the boundaries between different types of spare parts can be very thin. Also very similar types of spare parts located near the border may become subject to different management strategies inventory. To overcome these limitations, statistical clustering analysis can be used. Other methods of techniques that can be used to solve complex problems in the area of inventory management of spare parts are not a part of this article but it is an interesting topic for further research.

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## VYUŽITÍ METOD PRO ŘÍZENÍ ZÁSOB NÁHRADNÍCH DÍLŮ V PODNICÍCH V ČESKÉ REPUBLICĚ

Řízení zásob náhradních dílů je v současné době v podnikovém prostředí velké téma a výběr strategie v tomto směru je pro mnoho globálních společností výzvou, a to zejména proto, že tyto zásoby představují vysoké skladovací náklady a tím jsou zátěží na celkových finančních výsledcích. Tento příspěvek se snaží nalézt odpovědi na některé nezodpovězené klíčové otázky: jaké jsou vlivy a jakými metodami se řídí zásoby náhradních dílů ve firmách? Tento příspěvek představuje dílčí výsledky kvantitativního a kvalitativního výzkumu prezentující používání metod řízení náhradních dílů podniky v České republice. Výsledky analýzy se zaměřují na porovnání několika aspektů (velikost, typ podnikání, použité metody, vzory poptávky) a prezentují je z pohledu deskriptivní statistiky.

## EINSATZ VON METHODEN FÜR DIE VERWALTUNG VON INVENTARERSATZTEILEN IN UNTERNEHMEN IN TSCHECHIEN

Die ordnungsgemäße Verwaltung von Ersatzteilen ist in der heutigen Unternehmensumgebung ein großes Thema und die Wahl der Strategie ist für viele globale Unternehmen in vielen Arten von Unternehmen eine große Herausforderung, vor allem, weil sie viel Geld und Speicherplatz in ihre Werke investieren. Dies ist eine Belastung für ihre finanziellen Ergebnisse. Einige unbeantwortete Schlüsselfragen steigern diese Diskussion noch: Was für Einflüsse gibt es und wie verbreitet ist das Anliegen des Ersatzteilmanagements in Unternehmen auf der ganzen Welt? Dieser Beitrag bietet einen Überblick über quantitative und qualitative Untersuchungen zur Verwendung von Ersatzteilmanagementmethoden in Unternehmen der Tschechischen Republik. Viele Arten von Analysen, die verschiedene Aspekte der Unternehmen vergleichen (Größe, Art des Unternehmens, verwendete Methoden, Nachfragemuster), und einige Statistiken werden ebenfalls vorgestellt.

## WYKORZYSTANIE METOD ZARZĄDZANIA ZAPASAMI CZĘŚCI ZAMIENNYCH W PRZEDSIĘBIORSTWACH W REPUBLICIE CZESKIEJ

Zarządzanie zapasami części zamiennych jest na dzień dzisiejszy w środowisku biznesowym bardzo omawianym zagadnieniem i wybór strategii w tym zakresie jest dla wielu globalnych spółek wyzwaniem. W szczególności dlatego, że zapasy te oznaczają duże koszty magazynowania, a tym samym znaczne obciążenie ogólnego wyniku finansowego. W niniejszym opracowaniu podjęto próbę znalezienia odpowiedzi na niektóre pozostające bez odpowiedzi kluczowe pytania: jakie są oddziaływania i jakie metody stosowane są do zarządzania zapasami części zamiennych w firmach? W niniejszym artykule przedstawiono cząstkowe wyniki badań ilościowych i jakościowych pokazujące stosowanie metod zarządzania zapasami części zamiennych w przedsiębiorstwach w Republice Czeskiej. Wyniki analizy skupiono na porównaniu kilku aspektów (wielkość, typ działalności gospodarczej, stosowane metody, wzorce popytu) pokazując je z punktu widzenia statystyki deskryptywnej.