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# FUNCTIONALITY ANALYSIS OF THE SOFTWARE SUPPORTING THE PRODUCTION OF SPARE PARTS USED IN THE COMPLAINT REPAIR: A CASE STUDY

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**Purpose:** The main purpose of this paper was to present the possibility of using IT systems in a production company for managing complaints and the manufacture of spare parts.
**Design/methodology/approach:** The paper presents the legal regulations in force in Poland in the field of complaints under warranty and guarantee. It discusses the rules of the complaint procedure in consumer sales and characterizes product complaints. It also presents the definition of a spare part and its classification and discusses the activities related to the management of pare part availability.
**Findings:** This paper discusses an example of the implementation of an IT system supporting the company's production activities. The author assesses the usefulness of this tool in the implementation of activities related to the production of dedicated spare parts and comprehensive handling of complaints. The functionality of the software is analysed and the conditions and requirements related to the complaint procedure in consumer sales are presented. In addition, the limitations of data exchange and additional expectations of the users of the IT system, which may be the direction of its development, are described.
**Research limitations/implications:** The author has pointed out that an extremely important issue in the complaint procedure is keeping the deadlines both in terms of the feedback that should be given to the consumer and the completion of the contracted production work. Verification of the compatibility of the used spare part with the repaired device is also required. It is vital as the components used are often subject to technological improvement.
**Practical implications:** The paper shows that the method of managing spare part availability affects the handling of complaints. It is also a platform for interference in the course of production processes of new products.
**Originality/value:** Undoubtedly, the original contribution of the paper to the literature on the subject is the assessment of the suitability of the selected software supporting production activities used in the improvement of the complaint management system.

**Keywords:** Industry 4.0, spare parts, after-sales services, knowledge management.

**Category of the paper:** Research paper, Case study.

## 1. Introduction

Even the most thoughtful purchases are not able to ensure satisfaction and trouble-free use of the purchased product. The initiation of complaint procedures is often necessary. A complaint notification is a dissatisfaction expressed by a consumer, most often resulting from a quality non-compliance of the purchased goods or services. It is carried out to repair a defective product, replace it or receive compensation in the form of a reduced price or a refund. The consumer sends it to the seller or the manufacturer, making a claim under the warranty or guarantee.

From the manufacturer's point of view, it is important to identify the source of the defect and take corrective actions to remove the reported non-compliance. The repair of the sold goods based on quality reservations is a particularly difficult issue for non-standard goods, made to order or in accordance with the specification provided by the customer. It results from the necessity of the seller to respond to the notification in a statutory manner within fourteen days from the date of its receipt. Warranty claims may be subject to other rules because they are handled under contractual conditions imposed by the guarantor. Usually, the provisions of the guarantee agreement extend the period of the guarantor's response to the defect reported by the consumer and prolong the deadline for the remedy which will restore the required parameters of the product. The need to replace or repair non-standard components that were used in the construction of the product complained about is often associated with the need to launch dedicated production. This is highly challenging, which is why guarantee claims are a more preferred form of customer service for the manufacturer than a warranty.

In the area under consideration, IT tools supporting production and complaint management systems are extremely useful. The former enable efficient coordination of production activities, including, apart from serial production of new products, also unit production of spare parts. It is not always possible to use the available stocks of semi-finished products. Unfortunately, the necessity to meet the deadlines in the complaint handling process forces service and guarantee repairs to be processed urgently, which significantly affects the previously planned course of production activities. The tools that support the implementation of the described production activities are most often the production modules of ERP (Enterprise Resource Planning) systems, but also the following systems: MES (Manufacturing Execution System), SCADA (Supervisory Control and Data Acquisition), HMI (Human Machine Interface), EDI (Electronic Data Interchange), WMS (Warehouse Management System), or SCM (Supply Chain Management) and TMS (Transportation Management System).

The second group is complaint management systems. The most frequently configured tools. These include CSS (Customer Service) or CRM (Customer Relationship Management) systems. Their functionality makes it possible to record and process claims, manage the circulation of documents and carry out statistical analysis of the data collected in them.

There are many different systems of the listed classes on the market. They are dedicated to selected industries or enterprises of specific industries. Universal tools that are subject to broadly understood parameterization are less often. In the sector of large production companies, however, solutions based on one IT system are most often preferred. This is due to the need to maintain the efficiency of not only separate IT tools, but also to design and supervise the work of mechanisms that integrate these systems. The construction of these mechanisms requires the specification of the frequency of communication between the systems, the direction and scope of data synchronization, and the definition of rules ensuring the security and confidentiality of the information sent. However, it is an indispensable element, because it affects the continuity of the business processes of the enterprise, and thus keeping the timely implementation of previously planned tasks (Milewska, 2020). The way of construction and the effectiveness of operation of various integration mechanisms is described in the literature. The connection between the CRM and ERP systems describes, among others Ruivo (Ruivo et al., 2014), while the integration of the CRM and WMS systems is presented by Khan (Khan et al., 2012).

In this article, however, the task of evaluating the operation of an IT system was undertaken, the functionality of which supports two areas of the company's business activity. The first one covers manufacturing activities. It represents both the production of new products, as well as undertaking tasks related to the production of spare parts and the repair of advertised products. The second area covered by the research is the handling of complaints. As part of the research, the possibility of keeping the deadliness in the consumer service process and the manufacturer's response to the need to produce non-standard spare parts, the use of which is necessary in repair or service activities, will be verified.

## 2. Legal Basis For Complaints

From 25 December 2014, the handling of complaints under the warranty is carried out in Poland based on the provisions of the Consumer Rights Act of 30 May 2014 (Journal of Laws 2014, item 827). It implements the provisions of Directive 2011/83/EU of the European Parliament and of the Council of 25 October 2011 on consumer rights (Directive 2011/83/EU), which requires the harmonization of consumer issues in the European Union. This Directive amended (Journal of Laws 2002.141.1176) and repealed (Journal of Laws 2004.54.535) the statutory provisions previously in force in Poland.

Pursuant to the aforementioned Act (Journal of Laws 2014 item 827), the buyer should contact the seller regarding the identified physical defect of consumer goods consisting in non-compliance of the product with the contract (Articles 560-561). In their declaration, the customer may submit a request for a price reduction or withdrawal from the sales contract, unless the seller immediately and without undue inconvenience to the customer replaces the

defective product with a non-defective one or removes the defect. The customer may also request replacement of the product or removal of the defect found. These rights are of an equivalent nature, which means that the customer can immediately use either the first or the second option.

The declaration of non-compliance of the goods with the contract should be understood as the obligation to provide information about the undesirable quality of the goods (Article 556 and section 3 of Article 557) (Journal of Laws 2014 item 827). The buyer does not have to explain the reasons for this quality. The description of goods can be graphic. In order to respond to the consumer's complaint and remove the defect, the customer may be asked to deliver the product to the address indicated by the seller. If, due to the type of non-compliance or the method of installation, the delivery of the goods is difficult or impossible, the customer is obliged to make the product available at the place of its use. The seller's failure to respond within fourteen days from the date of receipt of the request shall be deemed as the acceptance of the complaint. The refund to the consumer should take place immediately, as requested by the customer.

The regulations (Journal of Laws 2014 item 827) do not impose any special requirements regarding the complaint procedure. However, according to the Act on counteracting unfair market practices of 23 August 2007 (Article 6(4)(4)) (Journal of Laws 2007.171.1206), consumers should be able to familiarize themselves with the seller's procedure for handling complaints before concluding the sales contract. This applies in particular to situations where the complaint handling procedure deviates from the standards that can reasonably be expected from the trader in their relations with consumers, in accordance with fair market practices or the general principle of good faith in the scope of their business (Article 7(4)(d) related to Article 2(h)) (Directive 2005/29/EC). The complaint handling procedure may in no case contain provisions that are inconsistent with the Consumer Rights Act (Journal of Laws 2014 item 827). It may, however, contain provisions more favourable than the act provides or issues not specified by law. Most often, it determines the place and form of submitting complaints, regulates the method of describing the non-compliance, determines the method of product delivery as well as the form and scope of communication with the buyer.

Complaints under the warranty are not uniform in nature and their diversity affects the manner in which claims are handled. Taking into account the method of recording goods rotation in the company and the rules of complaint procedure in consumer sales, complaints are classified into value and material ones. Value complaints result from accounting errors in the sales documents. They mainly concern: prices, the method of calculating the discount or the margin. Submitting a value complaint usually results in reducing the amount to be paid by the disputable amount. The settlement is adjusted with a correcting invoice. Material complaints concern qualitative reservations about or quantitative non-compliance of the delivered goods. Identified apparent defects of the goods may be removed by repairing the sold goods or by providing compensation in the form of replacing the product with a defect-free one or making a refund.

Handling guarantee claims is a separate issue. Guarantee is a voluntary obligation of the manufacturer of the equipment or the provider of a given service (Kirkizoğlu and Karaer, 2022; Sundina et al., 2010; Zhu et al., 2022). It does not exclude, limit or suspend the consumer's rights under the warranty. The guarantor undertakes to provide solutions that meet certain parameters for a clearly defined period of time. In this way, they declare their readiness to undertake the obligations connected with the restoration of the required operating parameters of the sold product. In the guarantee agreement they also specify the guarantee claim procedure, i.e. the method of removing the defect, e.g. by repairing or replacing a component, as well as the processing time and the deadline for claim satisfaction. It should be noted that relatively often the guarantee also imposes obligations on the customer. In order to meet the terms of a guarantee agreement, the consumer should perform the inspections or maintenance procedures recommended by the manufacturer, often periodically. They can be quite challenging not only financially, but also in terms of organisation, because they require timely performance of certain actions.

## 3. Management Of Spare Part Availability

According to the standard DIN 24 420, spare parts are defined as elements (also called parts), groups of elements (also called assemblies and subassemblies) or complete products that are used to replace damaged, worn or defective parts, assemblies or products (DIN 24420-1, 1976). They must be unambiguously assigned to one or more machines or devices and should not be used on their own. American Production and Inventory Control Society has defined the concept of a spare part as a module, component and element that is used without any additional modification to replace original parts (APICS, 2004).

Taking into account the intended use of spare parts, the following classification is applied (Biedermann, 2008):

- replacement of damaged or missing parts,
- replacement of worn parts which, due to their design or the materials used, cannot be repaired.

Spare parts are characterized by high variability of demand (Rahimi-Ghahroodi et al., 2019), therefore they are divided into two groups:

- parts that require constant replenishment of stock,
- and parts for which keeping stocks is economically unviable.

Although inventories freeze capital, they are essential in many cases. The determinant of maintaining an inventory of selected spare parts is to conduct factor analysis (Kennedy et al., 2002; Van Kooten and Tan, 2009). The basic criterion for these activities is the classification of parts as elements subject to wear and tear. The selection of the method of replenishing the

stock of spare parts requires the determination of the statistical distribution of material flow. The level of inventory should be determined, among others, on the basis of (Kolińska and Doliński, 2013):

- the degree of component wear,
- the frequency of its releases,
- the number of machines/devices in which it was installed,
- the frequency of component failure,
- the significance of the device used for ensuring continuity of customer processes.

Unfortunately, the classic inventory control models are not always effective (Christopher, 1996; Niemczyk, 2010; Sarjusz-Wolski, 2000; Sleptchenko et al., 2018). Manufacturers keep expanding the range of their offer and commonly use the practice of replacing the original components with other that have a lower risk of damage. These activities may change the management method of spare part availability (Durao et al., 2017; Shi, 2019).

It should be noted, however, that the factor having a significant impact on maintaining spare parts stocks is not only the need for efficient implementation of service activities, but also the manufacturer's continuous processing of complaints (Sabaei et al., 2015). According to the guidelines of the Act (Journal of Laws 2014.827), the completion of remedy proceedings should take place within the set deadline. Otherwise, a refund to the consumer may be required. This means that handling complaints under the warranty, but also under the guarantee, requires, apart from organizing repair and logistics activities, also the production of spare parts that will replace previously damaged or worn components. It is obvious that time is a critical factor in these proceedings. The production of spare parts that are not in stock should be extremely efficient. Their production technology is of great importance. Long normative duration of the operation, commissioning work to external contractors or the need to change the resources of the machine park are just some of the reasons that may hinder or even prevent timely implementation of the planned tasks. It should be emphasised that from the perspective of the Act, but also the guarantee agreement, timeliness is of key importance for the course of the entire process. It requires the integration of manufacturing activities with logistics services. In both cases, the delivery of spare parts to the place of repair or replacement may take place both at the authorized service point and directly at the customer's premises, if due to the method of installation or the type of non-compliance, the delivery of the equipment is difficult or even impossible (Journal of Laws 2014.827). As it has been shown above, the manufacturer's reaction to the confirmed quality non-compliance of the sold product will not always result in the immediate launch of unit production for the missing components. Economic viability may force them to take alternative solutions and persuade them to maintain a stock of spare parts, which are necessary for immediate remedial actions in guarantee and after-sales service (Rao, 2011).

## 4. Example Of Use Of IT System

Currently, the foundation of production process management and material flow control in the company and the basic condition for the integration of business activities is the implementation of IT systems supporting the acquisition, processing and transmission of information. Obtaining an efficient control system is associated with the creation of an implementation that reflects the significant factors determining the production capacity of the enterprise as well as limitations and disruptions occurring in the course of manufacturing processes. Most often, the model is obtained through parametrization of the process, but also technology, and the integration of data that is obtained from various sources. This means that individual functional areas of IT tools used are adapted to the size and structure of the business entity and the way it is organized. It should be noted that this adjustment is not a one-off activity, but a cyclical action of various scope, which not only takes into account the dynamics of internal changes in the organization, but also the impact of environmental factors. System flexibility understood in this way is recognized, among others, by the declaration of the alternative use of production resources in the course of the company's production activities.

An example of an IT system that comprehensively supports the company in terms of both production management and complaint notification management is a tool called IPOsystem™. It is designed by UiBS Teamwork Sp. z o.o., which supports discrete unit production, but also small batch production. It was implemented at the Polish manufacturer of highly specialized machines, where this research was conducted. The implementation is based on Microsoft SQL Server. The data it collects describes the workflow and material flow. Task allocation is performed autonomously. Instructions to perform a technological operation are issued with a terminal located in the hall and connected by network to the server. Through the RFID identifier, the terminal recognizes the person performing the task and enables them to confirm the completion of work or to receive another instruction. Alternately issuing instructions and receiving completion reports is a solution that systematically provides up-to-date information on the current status of work. In addition to continuous recording of the start and end time of each technological operation, IPOsystem™ enables registering on the terminal the number of semi-finished products leaving the workstation and the number of shortages, for which the previously adopted classification of the causes of non-compliance is used.

The basic document of IPOsystem™ that enables the registration of the course of production activities and auxiliary processes is the work order. It enables the collection, processing and sharing of data that describe the technology used in production or the manner of taking other activities supporting basic processes. The order class determines the way the process is handled in the system. It forces the introduction of some data, determines the urgency of its implementation and specifies the stages of undertaken actions. Order class is selected at the stage of defining the order (when a new document is created). One of the many classes available

in IPOsystem™ is a complaint order. It is used to register and process complaints, which signal the consumer's dissatisfaction with the product used. They can represent the circulation of documents necessary to decide whether the complaint is justified, be used in planning and recording corrective actions or correspond to the production of non-standard spare parts that are used in after-sales customer service. In the described implementation, they are used in each of the abovementioned areas. They are a record of work carried out both at the customer's premises, i.e. outside the company, and internally.

Whenever a complaint notification is accepted by the examined company, a work order is created in IPOsystem™. The complaint processing procedure is implemented in accordance with a predefined scenario. It has been saved in IPOsystem™ as a template and constitutes a pattern of operation, which may be changed. Converting a template into a work order is most often performed by users through a context menu (Figure 1).

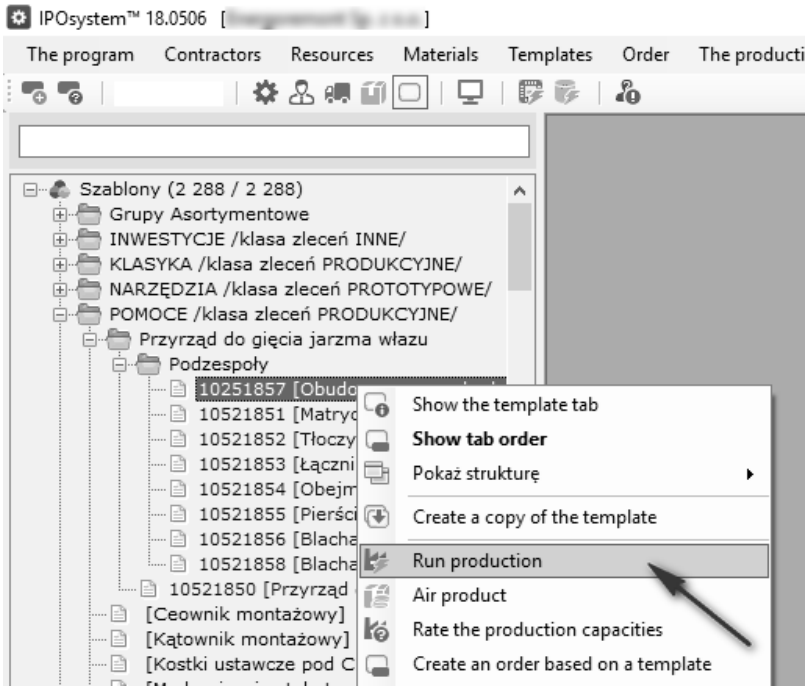



**Figure 1.** Creating a work order on the basis of a predefined template. Source: Own elaboration.

The complaint procedure includes accepting the product suspected of being dysfunctional, performing diagnostic tests showing the current operating parameters of the device and issuing an opinion or expert opinion on the legitimacy of consumer dissatisfaction with the reported non-compliance of the quality with the manufacturer's declaration. An alternative place for the performance of the abovementioned activities are external authorized service centres. If this stage ends with a positive opinion, i.e. with the acceptance of the customer's claims, repair activities are carried out as part of the continuation of the complaint procedure, or production activities are undertaken, resulting in the production of spare parts used in the faulty product. The implementation of these tasks is reflected in IPOsystem™. As part of the technological preparation of production, the technology of the complaint order is created and entered in the

IT system. The declaration of the method of execution is built through the selection, parameterization and prioritization of technological operations as well as the allocation of the material structure. The technology representing repair activities most often does not have precisely defined normative execution times. They are supplemented after the completion of the task and constitute the basis for estimating the costs incurred to remedy the product.

In the production of spare parts, data describing already completed production orders is extremely useful (Figure 2). It provides a summary of planned production activities with their completion reports. This means that the functionality of IPOsystem™ enables not only determining the effectiveness of the actions taken, but also the human and machine resources involved in these activities, and defining precisely the time of execution of each technological operation and the use of direct-production materials.

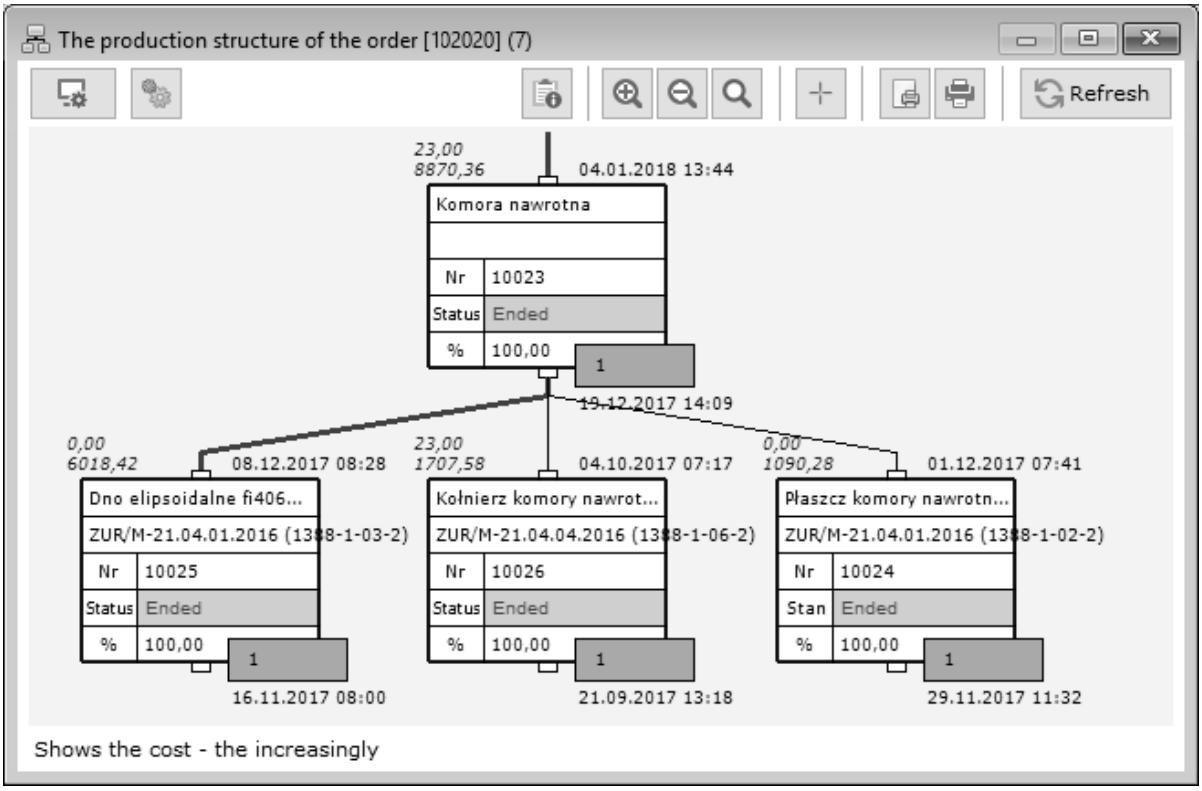


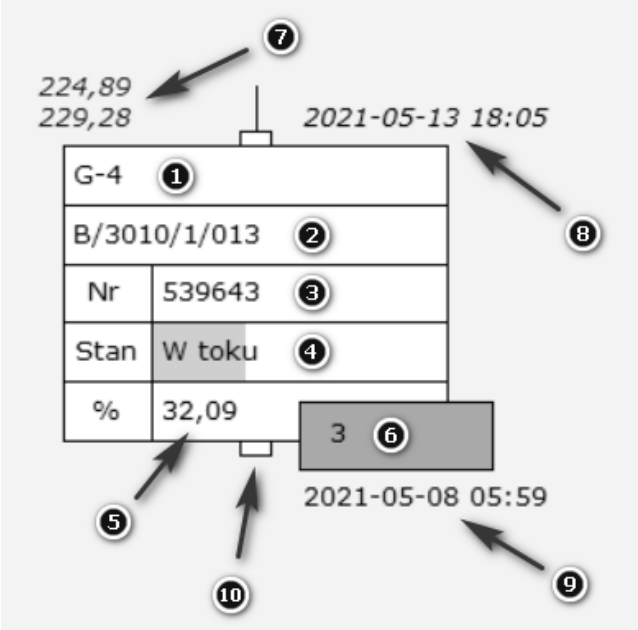

**Figure 2.** Diagram of a multi-level technological structure of a completed production order. Source: Own elaboration.

Using the product genealogy stored in IPOsystem™, it is possible to keep track of the production process, supervise the workload of individual resources, react to undesirable disturbances in the course of production activities and create multidimensional statistical analyses showing the efficiency and effectiveness of selected areas of the company's business activity. For this purpose, data summaries in tabular form and graphical forms of presentation, such as diagrams (Figure 3) or charts, are used.

It should be noted that most of the windows opened in IPOsystem™ are interactive. It means that the system simultaneously receives information provided by the user and immediately responds to it in terms of widely understood functionality. Mutual interaction of the user and

the system takes place on various levels. Although the response of the system to each of them is a continuously generated plan of production activities, each time it adopts a different form of communication. The operational level includes the ongoing recording of events, initiated by direct-production employees. It is performed through terminals located in the production hall, and the plan is communicated in the form of operator's instructions.

On the tactical level, information is exchanged through supervision. It is the user's reaction to disruptions occurring in the course of production, but also an adaptive activity, within which the investments made are reflected in the operation of the system. It is made by correcting the list of production resources, changing their quantity or the distribution of hourly working time and many other values that define the production capacity of the enterprise. It is implemented by the executive team at standard workstations, who receive feedback, among others, on the degree of use of resources or the scale and type of commissioned or implemented cooperation services.




**Key:**
1 Order name.
2 Execution drawing number.
3 Order number.
4 Order status name (the bar shows % of execution).
5 Percentage of execution.
6 Material quantity and requirements.
7 Unit manufacturing cost*: planned/real.
8 Work completion date*.
9 Work commencement date.
10 Control point marker.
* Values representing the planned nature of the activities are written in italics.

**Figure 3.** Graphic visualization of a fragment of a production order. Source: Own elaboration

On the other hand, the strategic level is created by communication in the area of demand, which is expressed by the quantity, quality and type of the manufactured products. Activities in this area include defining and launching orders, for which production technology and material structure are specified. The interactivity of the system is particularly important here from the point of view of processing complaints. Employees are constantly struggling with the pressure of time, because they are obliged to keep the deadlines for initiated proceedings. The functionality of IPOsystem™ helps them by suggesting possible actions, quick transfer of user activity between related workspaces and graphical presentation of data, whose colours additionally interpret the displayed record. Of course, the invaluable information provided by IPOsystem™ is the planned completion date, determined on the basis of the order technology and concurrent production. An example of the area of occurrence of this functionality is a window showing the production structure in the form of an interactive diagram. There, it is possible to use the 'Drag & Drop' mechanism and the context menu for which the location of the mouse cursor dynamically changes the availability of individual commands. Selecting any part of the technology enables its quick copying or transfer to another order. The implementation of this task is illustrated in Figure 4.

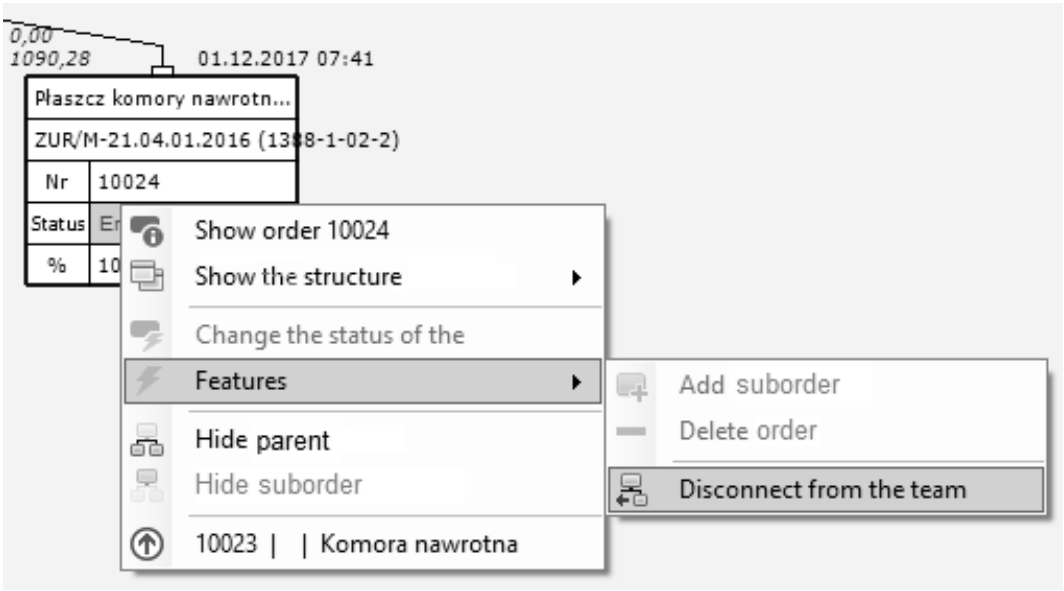



**Figure 4.** Disconnecting an assembly for further use. Source: Own elaboration.

In complaint notifications, however, it is important to search for the production technology of the damaged component in advance in order to be able to recreate it in the order under which the spare part will be manufactured. However, in time the components used are subject to technological improvement. Of course, it is a producer's reaction to previously made design or execution errors, or a response to the changing expectations of users. Then, the condition of adjustment is not only meeting the required assembly tolerances and compliance in terms of aesthetics, but also the range of functions performed by the element. The new engineering version of the spare part should effectively and reliably fulfil all functional tasks assigned to it,

therefore, final verification of its compatibility with the repaired device is required. It should be remembered that the use of non-standardized components in the solutions sold is associated with a high risk of starting the production of a single spare part, dedicated to the complaint procedure, and often entails higher production costs.

## 5. Summary

The complaint management system plays an important role in the process of improving the products and services provided. It is a valuable source of information on the ways of using products as well as the needs and expectations of consumers. Understanding them is the key to gaining a competitive advantage in the market. However, since effective business activity is also impacted by the efficient flow of information, the functionality of the IT tools used in the company is of great importance. Due to the undertaken remedial actions and the production of spare parts, the functionality of IT systems of production companies should cover both the area of processing complaints and support production activities. Having regard to the above, the author of this paper has attempted to assess the efficiency of a system named IPOsystem™, whose functionality covers both these areas. The possibility of starting document circulation procedures and producer response to demand for non-standard spare parts, the use of which is necessary in repair or service activities, has been analysed. The conducted research has shown the usefulness of IPOsystem™ in the implementation of tasks related to the comprehensive processing of complaints and the discreet production of dedicated spare parts. The usefulness of production technology templates as well as document flow scenarios has been confirmed. The mechanisms of searching for historical data have been verified, which enable determining the genealogy of the faulty products. Moreover, the possibility of starting and tracking the production of spare parts undertaken in connection with the planned repair of the faulty products was investigated. It should be noted that the interface of the IPOsystem™ system is highly intuitive and flexible. The configuration options enable the application to be adjusted to the user's requirements, and the multi-threaded system operation enables simultaneous editing of many documents.

At the same time, the research carried out showed the limits of IPOsystem™ with regard to analysing with the use of the data collected in it. Although most system windows have built-in reports, they offer little possibility of modification. Only in a few places where they built in the form of multi-level aggregation of data or enable comparative analysis. Importantly, it should be noted that IPOsystem™ does not offer tools that would allow the user to create reports on their own. However, since the data from IPOsystem™ is exported into standard recording formats, the search for correlation between selected data areas can be performed in an external environment. In the analysed company, summaries prepared in this way are used to indicate the most favourable conditions for conducting business activity.

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## References

1. APICS (2004). *APICS Dictionary*. Falls Church: American Production and Inventory Control Society, Inc.
2. Biedermann, H. (2008). *Ersatzteilmanagement: Effiziente Ersatzteillogistik für Industrieunternehmen*. Berlin-Heidelberg: Springer Verlag, DOI: 10.1007/978-3-540-68205-9.
3. Christopher, M. (1996). *Strategia zarządzania dystrybucją*. Praktyka logistyki Biznesu. Warszawa: Placet.
4. DIN 24420-1 (1976). *Lists of Spare Parts: General*. Berlin: DIN Deutsches Institut Für Normung E.V. Beuth,.
5. Directive 2005/29/EC of 11 May 2005 concerning unfair business-to-consumer comercial practices in the internal market and amending Council Directive 84/450/EEC, Directives 97/7/EC, 98/27/EC and 2002/65/EC of the European Parliament and of the Council and Regulation (EC) No 2006/2004 of the European Parliament and of the Council ('Unfair Commercial Practices Directive') (Official Journal of the European Union, L 149/22, 11.6.2005).
6. Directive 2011/83/UE of 25 October 2011 on consumer rights, amending Council Directive 93/13/EEC and Directive 1999/44/EC of the European Parliament and of the Council and repealing Council Directive 85/577/EEC and Directive 97/7/EC of the European Parliament and of the Council (Official Journal of the European Union, L 304/64, 22.11.2011).
7. Durao, L.F.C.S., Christ, A., Zancul, E., Anderl, R. & Schutzer, K. (2017). Additive manufacturing scenarios for distributed production of spare parts. *International Journal Of Advanced Manufacturing Technology*, *93(1-4),* pp. 869-880, DOI: 10.1007/s00170-017-0555-z.
8. Dz.U. 2014.827. Ustawa z dnia 30 maja 2014 r. *o prawach konsumenta* (Dz.U. 2014, poz. 827 ze zm.).
9. Dz.U.2002.141.1176. Ustawa z dnia 27 lipca 2002 r. *o szczególnych warunkach sprzedaży konsumenckiej oraz zmianie Kodeksu cywilnego* (Dz.U. 2002, nr 141, poz. 1176 z póź. zm.).

10. Dz.U.2004.54.535. Ustawa z dnia 11 marca 2004 r. *o podatku od towarów i usług* (Dz.U. 2004, nr 54, poz. 535 z póź. zm.).
11. Dz.U.2007.171.1206. Ustawa z dnia 23 sierpnia 2007 r. *o przeciwdziałaniu nieuczciwym praktykom rynkowym* (Dz.U. 2007 nr 171 poz. 1206).
12. Kennedy, W.J., Patterson, J.W., Fredendall, L.D. (2002). An overview of recent literature on spare parts inventories. *International Journal of Production Economics*, 76(2), pp. 201-215, DOI: 10.1016/S0925-5273(01)00174-8.
13. Khan, A., Ehsan, N., Mirza, E., Sarwar, S.Z. (2012). Integration between Customer Relationship Management (CRM) and Data Warehousing. *Procedia Technology*, *1*, pp. 239-249. DOI: 10.1016/j.protcy.2012.02.050.
14. Kirkizoğlu, Z. and Karaer, Ö. (2022). After-sales service and warranty decisions of a durable goods manufacturer. *Omega, 113*, 102719. DOI: 10.1016/j.omega.2022.102719.
15. Kolińska, K., Doliński, D. (2013). Assessment of criticality of spare parts using the method of multi-criteria decision making. In: M. Erechtchoukova, P. Khaiter, P. Golińska P. (Eds.), *Sustainability Appraisal: Quantitative Methods and Mathematical Techniques for Environmental Performance Evaluation* (pp. 243-254). EcoProduction. Berlin-Heidelberg: Springer Verlag, DOI: 10.1007/978-3-642-32081-1_11.
16. Milewska, E. (2020). Integration of IT systems supporting production management. *Zeszyty Naukowe Politechniki Śląskiej. Organizacja i Zarządzanie*, *148*, pp. 497-509. DOI:10.29119/1641-3466.2020.148.36.
17. Niemczyk, A. (2010). *Zarządzanie magazynem*. Poznań: Wyższa Szkoła Logistyki.
18. Rahimi-Ghahroodi, S., Al Hanbali, A., Vliegen, I.M.H. & Cohen, M. (2019). Joint optimization of spare parts inventory and service engineers staffing with full backlogging. *International Journal of Production Economics*, DOI: 10.1016/j.ijpe.2019.02.007.
19. Rao, B.M. (2011). A decision support model for warranty servicing of repairable items. *Computers and Operations Research*, *38(1),* pp. 112-130. DOI:10.1016/j.cor.2010.04.005.
20. Ruivo, P., Mestre, A., Johansson, B., Oliveira, T. (2014). Defining the ERP and CRM Integrative Value. *Procedia Technology*, *16*, pp. 704-709. DOI: 10.1016/ j.protcy.2014.10.019.
21. Sabaei, D., Erkoyuncu, J. & Roy, R. (2015). Positioning of Spare Part Contracts in the Servitisation Process. *Procedia CIRP*, *38*, pp. 106-111, DOI: 10.1016/j.procir.2015.08.035.
22. Sarjusz-Wolski, Z. (2000). *Sterowanie zapasami w przedsiębiorstwie*. Warszawa: PWE.
23. Shi, Z. (2019). Optimal remanufacturing and acquisition decisions in warranty service considering part obsolescence. *Computers and Industrial Engineering*, *135*, pp. 766-779. DOI: 10.1016/j.cie.2019.06.019.
24. Sleptchenko, A., Al Hanbali, A. & Zijm, H. (2018). Joint planning of service engineers and spare parts. *European Journal of Operational Research*, *271(1),* pp. 97-108, DOI: 10.1016/j.ejor.2018.05.014.

25. Sundina, E., Rönnbäck, A.Ö., Sakao, T. (2010). From component to system solution supplier: Strategic warranty management as a key to efficient integrated product/service engineering. *CIRP Journal of Manufacturing Science and Technology*, *2(3),* pp. 183-191. DOI: 10.1016/j.cirpj.2010.04.007.
26. Van Kooten, J. & Tan, T. (2009). The final order problem for repairable spare parts under condemnation. *Journal Of The Operational Research Society*, *60(10),* pp. 1449-1461, DOI: 10.1057/jors.2008.111.
27. Zhu, Y., Xia, T., Chen, Z., Zheng, M., Pan, E., Xi, L. (2022). Joint optimization of price, warranty and service investment for capital-intensive equipment considering maintenance capacity limits. *Computers & Industrial Engineering*, *169*, 108152. DOI: 10.1016/ j.cie.2022.108152.