
**AN ANALYSIS OF LOGISTIC STRUCTURE OF FARM
TRACTORS INSPECTIONS AND REPAIRS
IN THE ASPECT OF THE CALENDAR
OF AGROTECHNICAL OPERATIONS**

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Key words: logistics, logistic services, farm tractors inspections and repairs.

Abstract

In the present article we have discussed the logistic management of services and the characteristic features of these services which constitute logistic products. We have presented the results of a research along with an analysis concerning such services as pre-sale inspections, guarantee inspections and repairs, post-guarantee repairs of farm tractors. The research was carried out at the Service Department of an authorized dealer of farm tractors and machines. The cycle of the research included the years 2003-2005. The time schedules of inspections and repairs have been analyzed in the aspect of the calendar of agrotechnical operations recommended for cultivation in Poland.

**ANALIZA STRUKTURY LOGISTYCZNEJ PRZEGLĄDÓW I NAPRAW CIĄGNIKÓW
ROLNICZYCH W ASPEKTCIE KALENDARZA ZABIEGÓW AGROTECHNICZNYCH**

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Słowa kluczowe: logistyka, usługi logistyczne, przeglądy i naprawy ciągników rolniczych.

Abstrakt

W artykule przedstawiono zarządzanie logistyczne usługami i cechy charakterystyczne usług będących produktem logistycznym. Zaprezentowano wyniki badań i ich analizę dla usług: przeglądów przed sprzedażą, przeglądów gwarancyjnych, napraw gwarancyjnych i napraw pogwarancyjnych ciągników rolniczych. Badania zrealizowano w dziale serwisu autoryzowanego dystrybutora ciągników i maszyn rolniczych. Cykl badań obejmował lata 2003-2005. Wyniki badań opracowano statystycznie, wyznaczając wartość indeksów sezonowych. Rozkłady czasowe przeglądów i napraw analizowano w aspekcie kalendarza zabiegów agrotechnicznych zalecanego dla upraw w Polsce.

Introduction

The distribution of industrial products and purchaser service constitutes the organizational elements of one logistic chain. The recent years have shown that technical and technological advancement stimulates a continuous growth of customer's demands concerning the branch of industrial products. Farm tractors and machines users require from trade service companies' punctual and infallible realization of technical inspections as well as guarantee and post-guarantee repairs within the service. An important aspect that should be taken into account in the logistic management of the Service Department is the seasonality of farm vehicles and machines' use, which is a consequence of the realization of field works according to the calendar of agrotechnical operations.

Research problem

Plenty of actions in the field of distribution, which are optimized by logistic management, are targeted at achieving the level of customer service perceived as a very important element of a company's activity. The system of purchaser service should function smoothly and, at the same time, effectively in terms of generated costs. The service during the process of product use is supposed to meet the purchaser's expectations since it is the factor, which determines customers' loyalty to the brand and distributor on the long run. It should be mentioned that a company, being responsible for the product, contacts the purchaser a number of times during the whole process of exploitation. The cycles of guarantee and post-guarantee services are present throughout the whole use of the tractor (DWILIŃSKI 2006, *Teoria i praktyka...* 2004).

The goal of this paper was to provide a thorough analysis of the generic and quantitative structure of the orders realized by the authorized Service Department. Within the period of three years the following services were investigated: pre-sale inspections (P0), guarantee inspections (P1-P4), guarantee repairs (NG), post-guarantee repairs (NP) of farm tractors.

Logistic management of services

A service is a logistic product that constitutes a set of a customer's wishes and expectations. Logistic management of services is the process of planning and performing services, which includes the analysis of capabilities, needs and ways of rendering the services offered throughout the whole logistic chain, i.e. from the producer to the purchaser (CHRISTOPHER, PECK 2005, COYLE et al.

1996, *Logistyka dystrybucji*. 2005). In the recent years a dynamic growth of the service sector has been observed. Logistic management of services is a complex process due to some specific features of a service as such (CIESIELSKI 2006, KEMPNY 2001),

- lack of a possibility of storing services,
- necessity of maintaining the readiness to render services in fluctuating demand,
- high fixed costs,
- intangibility and transitoriness,
- lack of the possibility for the purchaser of judging the quality of the service before buying,
- simultaneity of production and consumption of services
- diversity of places and duration of services
- image and competence of a contractor are seen as a base of market advantage

Market requirements comprise a functional efficiency of machines, including original spare parts supply and assistance in maintaining operation efficiency and technical consultancy. Guarantee and post-guarantee services combined with the distribution are elements in the system of the quality of farm tractors and agricultural machines (PIEKARSKI 1997).

An analysis of inspection and repairs services of farm tractors in the years 2003-2005

The spot of the research was the Service Department of a commercial-servicing enterprise that runs an authorized distribution of farm tractors and machines, i.e. DEERE & COMPANY concern and ZETOR and PRONAR factories. The company has worked since the late 80s of the 20th century in the agricultural service sector on the area of the Lublin province.

Service structure in 2003

In the analysed period, the Service Department offered in general 534 services of inspections and repairs of farm tractors. The structure of the kind of the services offered is presented in a form of a pie chart (Fig. 1). Inspections and guarantee repairs were dominating in that period.

The level of the services offered is presented in a form of a histogram (Fig. 2). The analysis of inspections before the sale of the tractors confirmed maxima in March and April as well as in June and July and at the end of the year and in December. Furthermore, there was a clear relation between

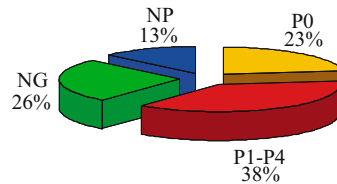


Fig. 1. The structure of the kind of inspection and repairs services of farm tractors in 2003
Source: Own study.

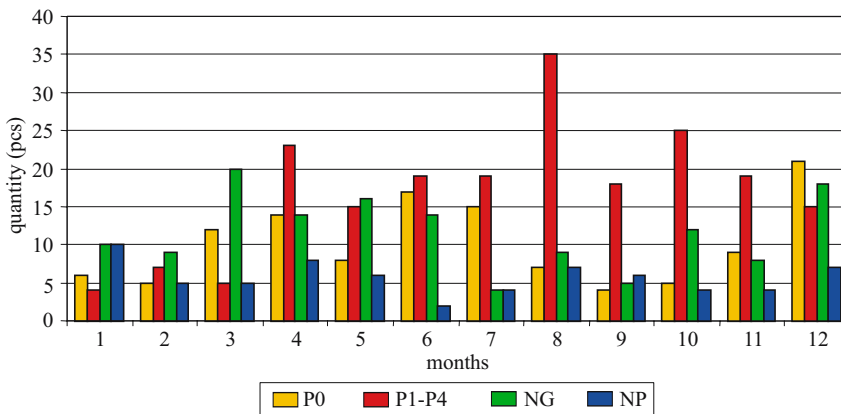


Fig. 2. The schedule of the quantity of inspection and repairs services of farm tractors in 2003
Source: Own study.

demand for technical inspections (P0) and periods of an increase in tractor sales. In a three-month presentation, there is clear demand for services in the second quarter (31.7%) and in the fourth quarter of the year (28.5%). On the other hand, the minimal number of services was realized in the first quarter and the level of the services was 18.7% for the whole year.

It results from the research that the most guarantee inspections (P1-P-4) were done in April, August and October. Moreover, there was a regularity of demand for the inspection service of a farm tractor after a defined number of moto-hours while agrotechnical operations. Maxima of the number of services coincided with the schedule of spring farm works, harvest and autumn operations (*Agrotechnika roślin uprawnych 2005, Agrotechnologia 1999*). In the periodical perspective, the highest level of inspections (P1-P-4) was observed in the third quarter (35.3%). Demand for inspections (P1-P-4) in the second and fourth quarters was at comparable levels: 28% and 28.9%. The first three months of the year had fewer services made in comparison to the summer period by 350%.

Guarantee repairs (NG) characterised with a close level of services in the first (28.1%), second (31.7%) and fourth (27.3%) quarters of 2003. But the third quarter had a fewer number of repairs (NG) to the twice lower level in comparison to other periods. Maxima of services offered appeared in March and December. The periods refer to periods of main maintenance work just before spring farm works and just after agricultural operations.

An analysis of post-guarantee repairs services (NP) has shown that the most services were offered in the first quarter and they were at the level of 29.4% of the annual number of contracts. Throughout the other analysed three-month periods, there was even demand for the services: the second quarter – 23.5%, third quarter – 25% and the fourth quarter – 22%. Generally, it resulted from the realization of the planned repairs of farm vehicles before the main season of agrotechnical operations. A high level of new farm tractors, characterizing with a low level of moto-hours, had a crucial influence on the schedule of contracts (NP).

It is worth noticing that the level of the whole package of services offered by the Service Department reached the lowest value in the first quarter of 2003. In the subsequent quarters, there was an increase by 60%, 35% and 50% in relation to the beginning of the year. Maxima of the services offered were in April, August and December. Such a time structure coincided with the periods of the biggest demand for agrotechnical operations in agriculture (*Agrotechnika roślin uprawnych* 2005, *Agrotechnologia* 1999).

Service structure in 2004

In the analysed period, the Service Department offered in general 786 services of technical inspections and repairs of farm tractors. The structure of the kind of services offered in 2004 is presented in a form of a pie chart (Fig. 3).

The level of the realised services of inspections and repairs of farm tractors in 2004 is presented in a form of a histogram (Fig. 4). The analysis of the number of the inspections made before sale (P0) has shown their highest level

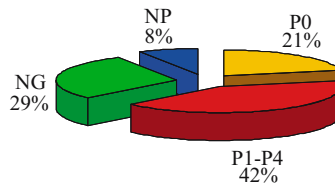


Fig. 3. The structure of the kind of services of technical inspections and repairs of farm tractors offered in 2004

Source: Own study.

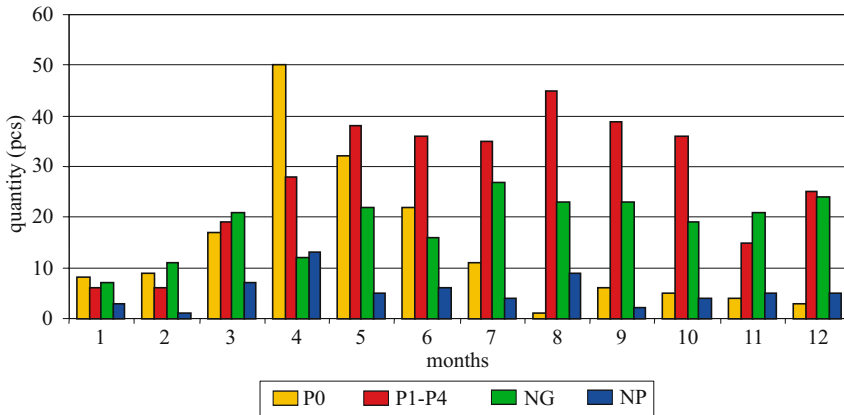


Fig. 4. The distribution of the quantity of inspections and repairs of farm tractors offered in 2004
Source: Own study.

in the second quarter of the year – 61.9% of their general number. The first half year closed with the realization of 82.1% of technical inspections throughout the entire year. The structure of the services offered by the Service Department is a precise reproduction of a dynamic increase in the sale of farm tractors in connection with the Polish access to the European Union. The second half of 2004 was a drastic decrease in inspections: in the third quarter to 10.7% and in the fourth one to 7.2%.

In the scale of the investigated year the largest number of guarantee inspections (P1-P4) were carried out in the second quarter (31.1%) and the third one (36.3%). Moreover, a high demand on guarantee inspections could be observed in October. A balanced very high level of services of this kind within seven subsequent months was a result of the number of new tractors that had been sold at the beginning of 2004. During the first four months 79% of the annual turnover was realized. After the exploitation of new tractors during agrotechnical operations in the spring and summer, they required guarantee inspections, together with the vehicles already used on the local market.

The lowest number of services rendered within guarantee repairs (NG) was observed during the first quarter of the year (17.3%), and the minimum in the scale of the year was recorded in January. This has confirmed that the level of the performed orders and agrotechnical operations within the investigated period are interrelated. The maximum demand on services (NG) occurred in the third quarter of 2004, reaching the level nearly two times higher than the minimum. The distribution of the services in the summer overlapped with a number of works connected with harvesting grain and post-harvest agrotechnical operations. What is more, the temporary increase in the number of

repairs took place in May, i.e. after the end of spring field works, as well as in December, after closing the annual calendar of agrotechnical works.

The analysis of the structure of post-guarantee repairs (NP) has confirmed that their level was minimal in the first three months (17.2%) and over a double growth of the number of these services in the second quarter (37.5%). The maximum demand on the services occurred in April, i.e. in the period of intensified agrotechnical operations. The second half of the year showed a balanced level of orders, with the temporary maximum in August during the harvest.

For the whole range of service orders, the smallest number of realized services was recorded in January and February, while in the first quarter the demand reached 14.6% per annum. A dynamic growth of demand on the services took place in March, and the maximum level was observed in April and May, which was the result of the accumulation of agrotechnical operations performed in these months. The following four months presented a balanced high level of orders due to the intensification of field works. Half of the last quarter has shown an evident decrease in the number of orders. In a three-month presentation, the second and the third quarter were dominant (35.6% and 28.6% respectively).

Service structure in 2005

In the investigated period 719 inspections and service repairs were carried out. The structure of services by category in 2005 is presented in the circular diagram (Fig. 5).

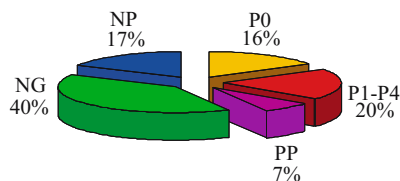


Fig. 5. The structure of the types of the inspections and repairs carried out in 2005
Source: Own study.

The distribution of the number of the rendered services, i.e. inspections and farm machines' repairs in 2005 is provided in the histogram (Fig. 6). The analysis of the level of pre-sale inspections (P0) has shown that their value was lowest in the first quarter of the year (17.4%) in relation to the annual level, with an evident minimum in January. The monthly values of inspections (P0)

reached the maximum in April, May July and November. The number of services (P0) rendered within three-month periods showed a tendency for dominance in the second (31.3%) and third quarter (26.1%), while in the last one the value was considerably lower (17.2%). The scope of the services was comparable in the first and fourth quarter of 2005. The distribution of inspections is analogous to the level of tractor sales in the investigated period.

The largest number of guarantee inspections (P1-P4) were carried out in the second quarter (29.4%) and the third one (28.7%). Temporary maxima occurred in March, April, May and September. An increased number of guarantee inspections coincided with preparing and carrying out spring agrotechnical operations and the harvest in the summer. It should be pointed out that the beginning, the middle and the end of the year was a period of the lowest number of guarantee inspections. The first quarter ended on the level of 19.6% per annum, and in the fourth quarter 22.3% were realized.

It should be mentioned that in 2005 post-guarantee inspections (PP) started being conducted due to the period of time that had passed from the beginning of service activity. Services of this type showed a similar distribution of their realization in the quarterly arrangement as guarantee inspections, and reached 22.9%, 33.3%, 25%, and 18.8% respectively.

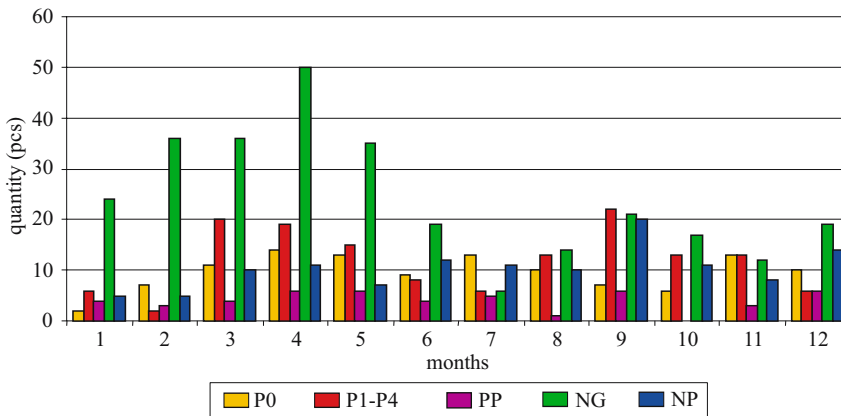


Fig. 6. The distribution of farm tractor inspections and repairs offered in 2005
Source: Own study.

Guarantee repairs (NG) reached the highest level in the first quarter (33.2%) and the second one (36%). The number of orders rendered within this period exceeded the level of repairs in the second half of the year over two times, where the number of services amounted to 14.2% in the third quarter

and 16.6% in the fourth quarter. A distinctly high demand on the services from the beginning of the year held for a few months, with a temporary maximum in April. This period coincided with the time of preparing tractors to the yearly season of agrotechnical operations and performing a number of spring field works.

The distribution of post-guarantee repairs (NP) showed the highest demand on the services in the third quarter of the year (33.1%), with the monthly maximum in September. The temporary increase in the number of repairs took place at the end of each quarter. The minimum level of services per annum fell on January and February, when the first quarter reached the number of orders of 16.2%. A balanced level of the number of repairs was recorded in the second and the fourth quarter (24.2% and 26.6% respectively).

The minimum level of the full range of services occurred in January. The first quarter was characterized by an increase in the number of realized orders, and their maximum was reached in April. June, July and August displayed a lowered demand on services at the level of 50% of the highest value in the spring. After a temporary growth in September, the number of inspections and repairs was again reduced by 30%. An increase in demand coincided with spring field works and the harvest. In a three-month presentation a dominant number of orders fell on the second quarter and amounted to 31.7% of the annual turnover. 24.3% of the services were performed in the first quarter, 23% in the second, and 21% in the last quarter per annum.

The statistical analysis of service of farm tractors

Seasonal fluctuations caused by the cyclic turn of seasons are a characteristic feature of plant production in farming. Moreover, they are the reason of the excessive growth of costs resulting from the irregularity of market processes. They may cause both not full use of companies' potential and overburdening sales and service departments in particular periods of the year.

The services, combined in the form of monthly observations, have been analyzed with regard to temporal dependence on the calendar of agrotechnical operations, which are carried out in a cyclic fashion throughout the year. The investigated processes have been studied with the use of the multiplicative model of the components of time series (ACZEL 2002).

$$Y_t = T_t \cdot S_t \cdot C_t \cdot I_t \quad (1)$$

where:

Y_t – value of the series

- T_t – trend of a series
 S_t – seasonal variations
 C_t – cyclic variations
 I_t – irregular variations

Moving average based on 12 monthly observations was used to construct seasonal indices. Those indices mirror quantitative seasonal effects in the time series of the quantity of performed services. In the graphical analysis of the influence of seasonal variations on the variables distribution the term of reference level (average level) was introduced. The reference level for seasonal indices equals 100% in all months.

Orders of service of farm tractors in the years 2003-2005

The analysis included 2039 orders of servicing and repairs of farm tractors. The value of the seasonal indices for examined services expressed in percentage is presented in Figure 7. The fact that in the examined period the beginning of the year was characterised by the lowered need for servicing should be stressed. In January the number of the carried out orders was lower than the reference level by 48.3%. As a result of seasonal variations during the following six months of the examined period, the number of carried out orders exceeded the average level. Spring months were the time of intensive agrotechnical operations. That is why they generated increased need for servicing and repairs of farm tractors. The need for servicing exceeded in March the reference level by 16.1%, in April by 60.0% and in May by 35.3%.

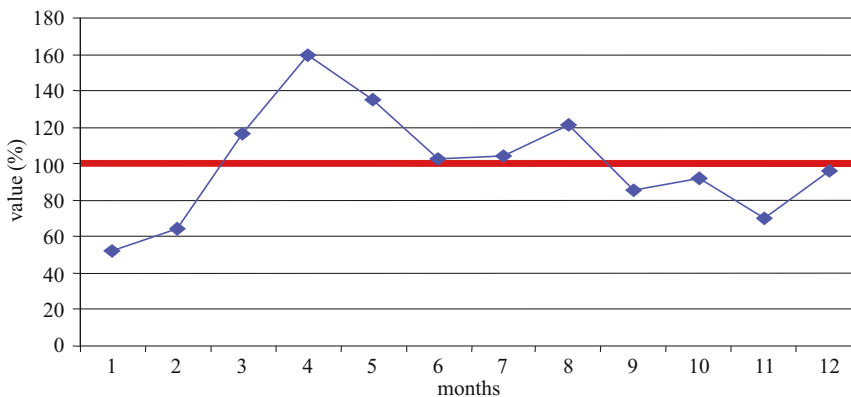


Fig. 7. Seasonal indices for servicing and repairs of farm tractors in the years 2003-2005
Source: Own study.

In the next two months the number of carried out orders was close to the average level. As a result of seasonal variations the level of the servicing and repairs in August exceeded the average monthly demand by 21.4%. In the period from September to December seasonal indices demonstrated reduction of need for the services and values lower than the reference level.

Summary

The key term in the logistic strategy of the commercial service company is providing the client with the expected service. Realization of such programme should enable the company to obtain maximum income with the low level of incurred costs. The task of developing standards of servicing before selling, servicing and guarantee and post guarantee repairs of farm tractors is complicated. Such strategy may be based on subjective feelings of logistics managers, information coming from bookmaking or researches on the needs of strategic group of purchasers. In the field of servicing the knowledge of time layout of and structure of the orders reported by the users of farm vehicles over the year is most important.

The research concerning the structure of orders of servicing and repairs of farm tractors made by the *Servicing Department* in the years 2003-2005 confirmed the occurrence of the following unique features:

- dependence of the level of service before the sale (PO) on the number of sold new tractors. The number of guarantee inspections (P1 – P4) was dependent on the intensity of field operations recommended in the agricultural calendar. The higher number of guarantee repairs (NG) could be noticed in the first half of the year and it was caused by preparation of farm tractors to the year-long season of agrotechnical operations. Also the relation of post guarantee repairs (NP) with the peak of agrotechnical operations was observed. The service of post guarantee inspections is fully payable and that is why, in most cases, they concerned removing failures, which had random character;

- the analysis of values of seasonal indices in the years 2003-2005 confirmed the dependence of the level of demand for the servicing and repairs of farm tractors on the intensity of field operations realised in accordance with the calendar of agrotechnical operations. The acquired number of the orders generated by farms in individual months proved that the highest number of orders was realised in the time of highest intensity of the field operations.

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