Analysis of seasonal character of the demand for post-warranty service repairs of agricultural tractors

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Abstract: Analysis of seasonal character of the demand for post-warranty service repairs of agricultural tractors. The problem of variable demand for agricultural vehicles in the distribution chain is presented. There are presented the logistic issues in realization of spare part purchase orders in repairs of agricultural tractors. The results of investigations and their analysis on post-warranty repairs of John Deere tractors are discussed. The investigations were carried out in 2003–2005 in the Service Department of the authorized dealer of John Deere tractors. The obtained results were elaborated statistically and the seasonal indices values were calculated. The post-warranty repair time distributions were analyzed with respect to the schedule of agro-technical operations recommended for the crops in Poland.

Key words: logistics, service, agricultural tractor repairs.

INTRODUCTION

The automotive industry manufacturing agricultural vehicles, as the branch producing durable goods of a high unitary value, is significantly susceptible to seasonal demand fluctuations. Changes in the food producers’ demand within the year apply to a range of products and services offered by the distribution chain [Juścinski and Piekarski 2008a]. The service-commercial enterprises, which meet the problem of seasonal character of demand for the products and spare parts, use a series of marketing and logistic actions in order to decrease differences between particular months [Coyle et al. 2003; Ballou 2004; Blanchard 2004, Juścinski and Szczepanik 2008]. The above problem is particularly important in the field of services, which are performed in Service Department and their quality determines significantly the customers’ satisfaction. This results from the nature of contacts, which are repeated many times during the entire process of agricultural tractor utilization. However, it should be emphasize that with respect to a specific character of services, including their immateriality, inability to make the service reserves and variability of their site and period, the structure of service orders realized by the enterprise should be monitored as a time function [Kempny 2001; Ciesielski 2003; Juścinski and Piekarski 2008b; Juścinski and Piekarski 2008c].

RESEARCH PROBLEM

To ensure high availability of repair services at the variable demand, there are applied various logistic solutions, especially in the field of spare parts availability. A
wide range of tractor models offered with various equipment and constructional variants makes impossible storing of the spare part sets, which would fully satisfy the needs of repair realization [Mentzer et al. 2001; Skrobacki and Ekielski 2006]. A model for purchase order creation in the response of current demand of customers was assumed. Generation of collective orders in real time in connection with outsourcing in transport services allowed for prompt delivery within 24 hours. The application of distribution system with the use of national logistic center enabled to maintain the reduced stock on hand.

The object of carried out investigations was the authorized dealer service for agricultural vehicles and machines, making repairs on the sold tractors. The carried out analysis aimed at determination of quantitative distribution of agricultural tractors’ post-warranty repairs realized in 2003–2005, with respect to agro-technical operations recommended for Poland.

ANALYSIS OF POST-WARRANTY REPAIRS OF AGRICULTURAL TRACTORS

The carried out investigations included the collective orders for spare part purchase, which were sent from the enterprise to the logistic center. Obtaining of ordered spare parts allowed for realization of post-warranty repairs of John Deere tractors ordered by the customers. The services were performed by the employees of service department on the site of authorized service station. The enterprise investigated during three years has been making repairs on agricultural tractors in middle-east Poland.

POST-WARRANTY REPAIRS IN 2003–2005

In 2003 there were made in total 298 collective orders for spare part purchase, needed to perform the equivalent number of post-warranty repairs submitted by customers. The histogram (Fig. 1) presents the number of post-warranty repairs of John Deere tractors realized in 2003.

The analysis of quarterly demand for the spare parts showed that the least demand occurred in the first quarter, while the monthly minimum for the entire investigated period was found for Febru-ary. The share of service sale during first three months amounted to 7.7% of the annual turnover. In the second quarter the demand was increased and service realization amounted to 19.8% of the annual turnover. The highest demand for spare parts in post-warranty repairs was found in the third quarter, when 53% of annual turnover was realized. In July and August the highest number of orders was performed, while in the fourth quarter 19.5% of the annual demand for services was realized, and a decreasing trend in the subsequent months was recorded.

In 2004 there were made in total 387 collective orders for spare part purchase, needed to perform the equivalent number of post-warranty repairs submitted by customers to the service department. The histogram (Fig. 1) presents the number of post-warranty repairs of John Deere tractors realized in the investigated period.

Assessment of the demand for post-warranty repairs in particular periods of the year showed that the least share of services performed occurred in the first quarter (10.3% of annual turnover). The least number of orders was realized in
January and February 2004. The highest service activity was recorded in the third quarter, when the share performed services amounted to 46% of the annual demand and the demand peak occurred in August. In the second and fourth quarters there were realized comparable amounts of orders equal to 21.5% and 22.2% of annual turnover, respectively. However, an increasing trend was found in the number of repairs realized in the second quarter, while a decreasing trend in the last one.

In order to perform repairs ordered by the users in 2005, 594 collective orders for spare parts’ purchase were made. The histogram (Fig. 1) presents the number of repairs realized in John Deere tractors in 2005.

The least demand for post-warranty repairs occurred in the first quarter and amounted to 13.3% of the annual turnover, while the minimal number of purchase orders in the entire investigated period was found in January and February. A significant increase in services occurred in April (in the period of performing the spring field operations). A substantial number of services was maintained during second quarter, with a slight decreasing trend during entire second quarter, which ended with the share of 27.8% of annual demand. The maximal demand occurred in the third quarter (41.1%), while the highest number of orders was found in August. The end of 2005 confirmed a distinct decrease in demand for service repairs of the previous years. In the fourth quarter the share of performed services amounted to 17.8% of annual turnover, with a local minimum in December.

COMPARABLE CHARACTERISTIC OF POST-WARRANTY REPAIRS IN 2003–2005

The analysis of repair demand distribution in the investigated period included in total 1279 collective orders, prepared according to customers’ orders. During
three years there occurred an increase in the number of realized orders. Comparison between subsequent annual periods pointed out at an increase in the number of orders in 2004 by 30% when related to 2003, and by 53% in 2005 when related to 2004. The aggregate distribution of post-warranty repairs in John Deere tractors is presented in Figure 2.

Distribution of post-warranty repairs’ structure in particular investigated years is similar. Although the demand increased in subsequent years, the shares of orders in particular quarters were similar. In each of investigated periods, the least demand for spare parts occurred in the first quarter. In the initial period of spring field operations (in the second quarter – the time of cereal sowing and planting of root crops) the service demand increased twice. The highest number of collective orders for the spare parts was realized in the third quarter, which was characterized by a dynamic increase in demand and by the highest number of orders in August. This is period of intense field operations in cereal harvesting and post-harvest cultivation. In the last quarter the number of collective orders for spare parts decreased and a decreasing trend in the turnover was found for subsequent months.

STATISTICAL ANALYSIS OF POST-WARRANTY REPAIRS IN 2003–2005

The analysis of post-warranty repairs made in John Deere proved their periodic character and seasonal changes. In application of statistical methods in investigations on periodic fluctuations in economic processes it is assumed that the shape of time series is influenced by: trend, seasonal fluctuations, cyclic fluctuations and random fluctuations. With respect to occurrence of the mentioned factors, the analysis of investigated phenomena was carried out basing on a multiplicative model for time series components, which can be presented in the form of equation [Aczel 2002; Pułaska-Turyna 2005; Sobczyk 2006]:

![FIGURE 2. Aggregate distribution of post-warranty repairs in John Deere tractors in 2003–2005](image-url)
Analysis of seasonal character of the demand

\[ Y_t = T_t \cdot S_t \cdot C_t \cdot I_t \]  \hspace{1cm} (1)

where:
- \( Y_t \) – value of series,
- \( T_t \) – trend of series,
- \( S_t \) – seasonal fluctuations,
- \( C_t \) – cyclic fluctuations,
- \( I_t \) – random fluctuations.

The seasonal fluctuations and random fluctuations can be isolated by application of moving average according to dependence:

\[ \frac{Y_t}{MA} = \frac{T_t \cdot S_t \cdot C_t \cdot I_t}{T_t \cdot C_t} = S_t \cdot I_t \]  \hspace{1cm} (2)

Standardization of raw seasonality indices can be obtained by calculation:

\[ S_i = \frac{\bar{w}_i \cdot d}{\sum_{i=1}^{d} \bar{w}_i} \cdot 100\% \]  \hspace{1cm} (3)

where:
- \( S_i \) – seasonal index for i-sub-period (month),
- \( \bar{w}_i \) – arithmetic mean of coefficient values in subsequent months,
- \( d \) – number of months in a year.

The seasonal indices value describes the quantitative seasonal effects in a time series for the amount of post-warranty repairs. In the analysis of the effect of seasonal fluctuations on distribution of services offered there was used a reference level concept (average level), which for seasonal indices in particular months amounted to 100% [Aczel 2002; Starzyńska 2005].

The value of seasonal indices (expressed in percent) for post-warranty repairs of agricultural tractors in 2003–2005 is presented in Figure 3.

In the first quarter the demand for services decreased as a result of seasonal fluctuations. In January and February the seasonal indices were lower than the reference level by 62.8 and 67.1%, respectively. A gradual increase in service demand caused, that in the second quarter the values of indices were comparable with the reference level equal to 100%.

As a result of seasonal changes, the highest service demand occurred in the third quarter. This period was characterized by

FIGURE 3. Seasonal indices for the level of post-warranty repairs in John Deere tractors in 2003–2005
Source: Own study.
a high dynamic of service demand, and in July and August it reached 83.9 and 146.9% above the reference level, respectively. In the last three months of the year there occurred a constant decreasing trend and a decrease in service demand to the value of 50% of the average level.

SUMMARY

Knowledge of post-warranty repairs distribution serves in optimization of created schedules for repairing of tractor break-downs submitted. It is important to use rationally the service staff and to shorten to a minimum the time of agricultural vehicles’ standstills, especially during execution of basic and special field operations [Kaczmarczyk 2005; Banasiak 1999].

Basing on carried out investigations on quantitative distribution of post-warranty repairs as a function of time, one can formulate the following conclusions:

1. The quantitative histogram of 2003 shows a significant increase in realized post-warranty repairs in July and August. The demand in this period was generated by the increased number of operation hours in harvesting of cereals and oil crops. In 2004 the quantitative histogram presents the highest repair demand for agricultural vehicles in the third quarter. The local minimum is concurrent with harvesting of cereals, oil crops and execution of post-harvest cultivation. In 2005 the histogram proves the increased demand for repairing of tractor break-downs during spring field operations executed in April and harvesting in August. Knowledge of demand distribution in tractor post-warranty repairs allows for application of logistic tools in the form of season-variable stock level of the selected spare part group for realization of the increased number of orders in particular agro-technical periods.

2. Characteristic feature of all the investigated years is a very small number of orders for post-warranty repairs in January, February and December, therefore, when no field agro-technical operations are performed.

3. Analysis of seasonal indices of post-warranty repairs’ number proved that seasonal fluctuations significantly influenced the demand in the period of cereal harvesting and post-harvest agro-technical operations. They caused a very high periodic increase in the sale of investigated spare part range for the need of repairs realized by the Service Department.

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