

# QUANTITATIVE ANALYSIS OF RAW MATERIAL USED IN MANUFACTURING PROCESS OF PARTS AND SUB-ASSEMBLIES OF AGRICULTURAL MACHINERY IN THE ASPECT OF LEANING THE ORGANIZATION

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**Abstract** The main goal of this publication is the attempt to answer the question: what is the leading type of raw material used in the manufacturing process of spare parts for agricultural machinery of the type selected. Such action in the conviction of authors will determine which of these areas the savings should be searched for, especially in the context of a lean - implying flexibility of the organization - management. In the context of the implementation of the predetermined basic goal, according to the authors, it is necessary to carry out a series of indirect actions, among which the following were distinguished: Analysis of the literature on management of lean organization, which implicitly allows to verify the accuracy and soundness of the research presented in the publication, Determining what type of raw material is the most commonly used in the production of a tested part of the, which will allow for the development of lean cost strategies within it. In the research the conceptual model thesis was adopted, namely: Type of raw materials used in the manufacture of selected spare parts implies a strategy for the cost leaning within it. This article is part of a preliminary study in the analysis and selection of raw materials in the context of lean management.

**Paper type: Research Paper**

**Published online:** 30 April 2016

Vol. 6, No. 2, pp. 129-139

**DOI:** 10.21008/j.2083-4950.2016.6.2.3

ISSN 2083-4942 (Print)

ISSN 2083-4950 (Online)

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**Keywords:** *Lean Management*

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## 1. INTRODUCTION

The fundamental, universal and dominant feature of contemporary management conditions (as well as all other spheres of socio – economic development) is a rapidly growing uncertainty which is according to E. Niedzielski (Niedzielski, 2013) the consequence of universality, scope and depth of the changes and their temporal density and often abrupt character. In the context of the above, it is noted that adaptation to the environment is a prerequisite for the success of the company. The key to this is the harmony between the strengths and weaknesses of the organization and the opportunities and threats present in the environment. According to B. Nogalskiego (Nogalski, 2004) use and implementation of new trends in business management emerging in the world in the form of changes in Polish companies, gives them a great opportunity in terms of competitive advantage, and in the perspective of a chance for survival and development. Company operating under certain conditions shaped by the environment must take into account constraints in its business, especially those having their source in the expectations of customers and market challenges by its competitors. This means that it must adapt the structure and level of resources at its disposal to these requirements, including, and perhaps especially considering manufacturing technology, which largely determines its flexibility.

According to W.M. Grudzewski and I.K. Hejduk the company to develop effectively and dynamically needs not only change but also innovation: new products, new technologies, new systems of production and management organizations (Grudzewski & Hejduk, 2008). The consequence of applying this concept to the company is the crucial role of development or modification of material procurement processes<sup>i</sup> that lead to increased implementation efficiency. The main task of the procurement logistics is to provide the company with supplies of all the materials necessary to carry out continuous and rhythmical business. Hence, the mission of the procurement logistics is securing all material requirements at minimal logistics cost of realization of market supplies (Nogalski & Niewiadomski, 2013).

In the context of the above, according to the authors, purchase of materials is essential to do business for any industrial enterprise, and the decisions in the

procurement area due to the significant share of the total cost of materials, should be taken very carefully. This claim was a prerequisite for carrying the research presented in this publication.

Thus, the main goal of this publication was outlined as an attempt to answer the question: what is the leading type of raw material used in the manufacturing process of spare parts for agricultural machinery of the type selected. In the context of the implementation of the predetermined basic goal, according to the authors, it is necessary to carry out a series of indirect actions, among which the following were distinguished:

- Analysis of literature on management of lean organization, which implicitly allows to verify the accuracy and soundness of the research,
- Determining what type of raw material is most commonly used in the production of the part, which will allow for the development of cost leaning strategies within it.

The conceptual model thesis was adopted for the research, namely: Type of raw materials used in the manufacture of selected spare parts implies a strategy for the lean cost within it.

The research presented refers to the manufacturing sector within agricultural mechanization. The market of agricultural machinery manufacturers – or more precisely plants producing machinery parts and components implied for agriculture - were currently in crisis<sup>ii</sup>, which most clear manifestation are the processes of losing financial liquidity. Regardless of the extent to which it is possible to stop the processes of loss of liquidity by individual manufacturers, economic forecasts present a recession in the whole machinery sector. Accordingly, the authors suggest that the feature that will allow for development, in the admittedly difficult times, is production of spare parts taking into account the constant monitoring of the supply of raw material set for continuous optimization towards the lean – implying flexibility – organization.

## **2. LEANNESS AS A DETERMINANT OF CONTEMPORARY ORGANIZATION**

More and more companies appreciate the way of business management, in which the reference point is the "leaness". A method for managing consistent with this concept in a flexible and continuous manner responds to the challenges of variability of demand, increased customer demands, and thus gives the opportunity for further development, which according to the authors, is a desirable feature of any organization.

Lean Management is a management methodology that creates a certain kind of work culture in the organization. It stresses the fact that all persons associated with the organization are interested in continuing the reduction of costs,

shortening delivery cycle, and improving the quality (Pawlowski, Pawlowski & Trzecieliński, 2010).

Leaning management is achieving such efficiency that makes the company more flexible, lean, practiced and trained. "Lean" enterprise builds its organization and manages the process so that the customer actually paid for its production, and not for the operation of such as immense organizational structure, storage, transport or excessively complex administrative work, etc. So Lean Manufacturing is lean, elastic and flexible production, which achieves the above-average success. Lean Manufacturing by T. Koch is a concept which is defined as the lean process consuming fewer resources - less human effort, less equipment, less time and space, while striving to supply the customer exactly what he or she expects (Koch, Kornicki, Sobczyk & Oleksy, 2003). On the other hand, J. Lipecki believes that the main aim of lean management is the simultaneous achievement of a high degree of economic efficiency, quality and flexibility (Lipecki, 1998). The complexity of related activities makes the chain of a variety of projects, aimed at "leaning organization" never ending or closed (Niewiadomski & Pawlak, 2012).

The concept of Lean enterprise is focused on elimination of all forms of waste, resulting in improved efficiency of action because the company uses less resources to achieve the same goal. It is the most commonly used in companies with high production potential, giving them considerable autonomy in achievement of objectives. Lean production / manufacturing / enterprise may be treated as a philosophy of business management, business organization or system of concepts and management methods (Trzecieliński, 2011).

On the other hand, J. Czerska states that lean concept should be understood as a set of activities affecting the reduction of actions that do not add value to the product and enabling achievement of the results that identify the company as lean. Hence, lean is a concept of action, leading to the reduction of operating costs by minimizing the involvement of the means of production in the manufacturing process, as well as through the so-called current enterprise behavior directly adapted to the changing requirements of the environment (Czerska, 2001).

In conclusion, it is worth noting that lean as the company's organization manifests itself using the above-mentioned principles not only in manufacturing but also in terms of product design, its technology, supply chain, customer relations and sales. All of these activities require harmonization and creating a lean enterprise. The organization of such an enterprise is characterized by passing the largest possible number of tasks to staff, who in their execution add value to the product and equip the company with a system to detect defects, their causes and their removal.

### **3. RAW MATERIAL IN PRODUCTION PROCESS OF SPARE PARTS FOR AGRICULTURAL MACHINERY – QUALITATIVE ASSESSMENT**

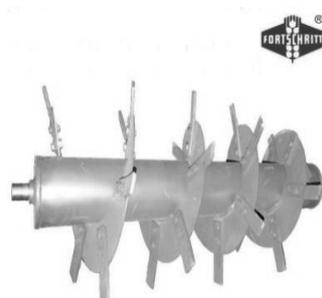
The main activity of the production company is manufacturing process, which relies on processing raw material into the finished product; in the specific industrial enterprise resource will be any material processed and outgoing modified as a finished product<sup>iii</sup>.

Development of science and technology, located rebound in production processes and in the technical equipment of production workshops, contributes not only to the growth of quantitative and qualitative manufactured products, to enrich their product range, but also to the use of increasingly diverse and economically efficient processes that make from raw materials produced in the organization of finished products (Zymonik, Hamrol, & Grudowski, 2013). This development, in turn, results in significant change in the processes of auxiliary and complementary nature in relation to processes directly related to the production of products.

When determining the resources the decision maker must be aware of the fact that the smooth functioning of an organization requires possession and use of various raw materials, which are to be transformed in certain goods. According to the authors it is the raw material - and more specifically the possibility of obtaining it and transforming it according to the specifications adopted for an effective use of the occasion. According to the authors, the longer the time horizon, the more the issues concerning the acquisition and use of raw materials in the corporate strategy<sup>iv</sup>.

Issues concerning the efficiency and rationality of procurement management, despite widespread interest among researchers, are still not sufficiently described and specified; according to the authors of this paper, there are some issues unresolved. In the literature it is characterized mainly in the ideological area and although there is a description of the possible use of the tools, it shows the need to develop a methodology of procurement management and the development of the product portfolio in practical applications. For every company that wants to be innovative and function successfully in an ever-changing economic space must effectively create and use specific procedures.

When designing a tool for assessing the cost of production of the product, the authors assume that on the analytical processing layer, tools and technologies used should meet the needs of different user groups, including both people independently developing reports and analyzes, as well as for people using already data already prepared. The application, which the authors use for tests carried out further in this document is a simple analytical tool; It is based on the widely used Excel, which ensures the technical possibility of its implementation and operation, without incurring high costs. The remainder of this paper, is presentation of the use of such a tool on the example of a particular product, which was a screw cylinder (Fig. 1) for spreading adapter of a specialist agricultural trailer.



**Fig. 1** Transmission of spreading adapter - the product analyzed; Source: internal materials of Fortschritt company

Developing the tool and related calculation procedures, it was essential to determine the type and quantity of raw material, the use of which implies the execution of the product. Such action was necessary, especially in the context of determining the costs associated with its production.

The research presented was conducted in one of the companies located near Poznan involved in the production of parts for agricultural machinery. The plant analyzed is located in Wrzesnia. The company employs 34 people, including 28 production workers (turners, milling machine operators, locksmiths, welders). Based on the analysis of documentation (material card, technological schemes, assembly documentation) and based on the interview with the main technologist responsible for implementing processes and as a result of participant observation, the authors obtained the information necessary to carry out research. As obtained by direct interviews, analysis and monitoring, the information allowed the development of a tool shown in the Figure 1.

**Fig. 2** Calculation – data transformation; Source: Own work

1	2	3	4	5	6
Part number:	Part:			Use:	
<b>204027810</b>	<b>Screw cylinder</b>			<b>FORTSCHRITT T-088</b>	
Type of raw material	Dimensions [mm]	Weight [kg]	Quantity [szt.]	Price of the material [PLN]	Sum [PLN]
Tube 159x4	1360	*	1	39,5	53,72
Plate #8	160*160	1,6384	2	2,19	7,18
Plate #4	420*420	5,6448	4	2,19	49,45
Shaft #52	L-90	1,5	1	2,3	3,45
Plate #5	100*100	0,4	2	2,19	1,75
				<b>SUM [PLN]</b>	<b>115,55</b>

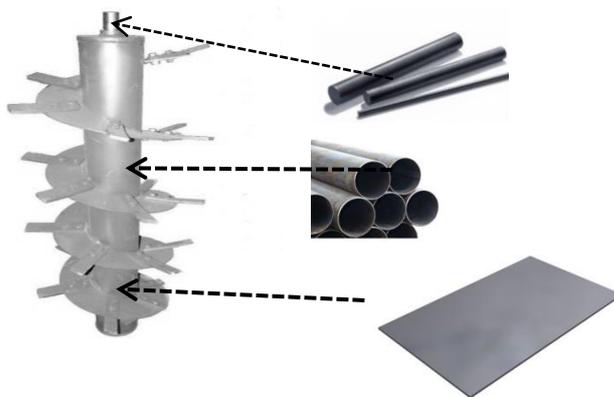
Manufacturing process of the screw cylinder is implied with purchasing of the three types of raw material namely (Fig. 1):

- tube of the dimensions: 159x4<sup>v</sup>,
- hot rolled sheet<sup>vi</sup>,
- steel rod – type 45<sup>vii</sup>

As each of the above-mentioned raw materials is characterized by a different specifics in terms of costing it was indispensable to develop procedures to obtain information for each individual.

Detailed analysis of the BOM of the screw cylinder showed that its production requires the use of 1360 mm of the tube of the following dimensions: 159x4 mm (Fig. 2). In this case calculation procedure of raw material is very simple, because the purchase price relates to 1m (in the present case the price of 1 m oscillates at 39.50), hence 1,36 m<sup>viii</sup> x 39,50 gives the value of 53,72 PLN. The calculation for metal plates and tubes used in the manufacturing process of the product is quite different.

**Fig. 3** Manufacturing process of screw cylinder – Raw material specification. Source: Own work



According to analyzes conducted by the authors of this research to produce a single piece of a cylinder 4 pieces of plate of dimensions of 4x420x420 have to be used. Taking into account the optimization of material use, it was found that the pieces should be trimmed of metal sheet of dimensions of 4x1250x2500 mm<sup>ix</sup>. According to the accepted standards in the field of trade in steel materials the unit which is valid for the purchases - sales transactions is kg<sup>x</sup>. In the context of the above, it was essential to introduce a procedure allowing to determine the weight of the plate of the size of 4x420x420 mm. The calculation scheme is presented below.

1 m<sup>2</sup> of plate 1 mm thick --- 8 kg  
 1 m<sup>2</sup> (1000 mm x 1000 mm) of plate 4 mm thick --- 32 kg (4x8 kg)

$$\begin{aligned} & \text{thus} \\ & 0,42 \times 0,42^{\text{xi}} \times 32 \text{ kg} = 5,6448 \text{ kg} \\ & 5,64 \text{ kg} \times 2,19 \text{ PLN/kg} = 49,45 \text{ PLN}^{\text{xii}} \end{aligned}$$

A similar situation was observed in the case of determining a cost estimate in relation to the steel rod. According to the bill of materials for a single piece of cylinder 90 mm of a steel rod of 45 type and diameter of 52 mm was used. Similar to the previous case of the plate, the unit used for transaction and calculation of this raw material is kg. The calculation procedure is presented below.

$$\begin{aligned} & 1 \text{ m tube diameter 52 --- } 16,7 \text{ kg} \\ & \text{thus} \\ & 0,09 \text{ m tube diameter 52 --- } 1,503 \text{ kg} \\ & 1,5 \text{ kg} \times 2,30 \text{ PLN/kg --- } 3,45 \text{ PLN}^{\text{xiii}} \end{aligned}$$

In the context of received calculations it was considered appropriate to determine what is the percentage of a given raw material costs<sup>xiv</sup> in the total cost of obtaining them in relation to the specific implementation. These are presented in the Table 1.

**Table 1** Raw material in manufacturing process – qualitative classification; source: Own work

Type of raw material	Cost [PLN]	% share
PLATE	58,38	50,52
STEEL ROD	3,45	2,98
TUBE	53,72	46,50
SUM [PLN]	115,55	100

In context of the above, it should be emphasized that, in the production process of the screw cylinder lead material is the plate (50.52%) and the tube (46.50%). The share of steel rod is small (only 2.98%). This gives confidence that the savings in the manufacturing of that product should be sought in the area of purchasing and optimizing the use of the two leading groups of the raw material identified in the particular process.

### 3. CONCLUSION

The complex nature of flexibility is closely related to the multitude of factors (contextual variables) which determine it, determine its scope and intensity of its manifestations and effects (Osbert - Pocięcha, 2011), hence the prospect of an implementation is particularly interesting because the most important

determinants of new product development are the main levers of long-term success of the company. Consequently, an implementation area of research should focus on mechanisms and factors which determine the activities of the company, build competitive advantage, and thus its success. Hence, a new paradigm of flexible company is adapted, which assumes that factors of key importance for implementation processes are the following: productive resources as materials determining the specific implementation possibilities.

The main aim of this publication was an attempt to answer the question what is the leading type of raw material used in the manufacturing process of spare parts for agricultural machinery. The authors believe that such action would allow to identify which of these areas should be the source of savings, especially in the context of a lean – implying flexibility of the organization – management. In the context of the main research goal it was identified that it is appropriate to monitor individually each item that is part of the product range provided by the manufacturer. In this sense, the type of raw material used in the production of selected spare parts implies a strategy for the cost leaning within it.

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## BIOGRAPHICAL NOTES

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<sup>i</sup> The process is usually associated with transformation, which is subject to an object, and which occur according to established routines or procedures. An example of such a process can be understood processing cereal grains in bread. See (Trzcieliński, Adamczyk & Pawłowski, 2013). In praxeological terms process is defined as "a twist or permutation of events, extending in the time, taken as a whole due to some highlighted features. See: (Pszczółowski, 1978).

<sup>ii</sup> The crisis category is understood by authors more broadly than that the approach adopted in some economics textbooks. See: (Kozminski, 2012). It is about the co-existence of economic, political, social and intellectual phenomena, more specifically: a) a clear slowdown in the growth of agricultural mechanization (the end of payments from EU) sector b) contradiction of market expectations, c) the instability of demand resulting from a lack of understanding and co-operation between manufacturers, d) the lack of a clear, dominant policy concept concerning subsidies for farmers and the institutional structure to implement it. See: (Nogalski & Niewiadomski, 2014).

<sup>iii</sup> The finished product is every final product for further processing or use in any other enterprise, or to directly meet the needs of consumers.

<sup>iv</sup> Strategies of organizations operating in turbulent environments should be flexible. According to R. Krupski the basic category of flexible strategies are occasions, and preparation of the organization for their identification and use can and should be the subject of strategic planning. See: [www.rafalkrupski.pl/strategia.html](http://www.rafalkrupski.pl/strategia.html) (access date: 08.06.2015).

<sup>v</sup> The structural element having a cross section generally in the shape of a ring and a large length (for the case analyzed to perform a single piece of the product there is a tube of length of 1360 mm used). Tubes are used as conduits for conducting liquids and gases, or as components for mechanical engineering and other technical equipment and building structures.

<sup>vi</sup> Steel article, the thickness of which is considerably smaller than the length and width. Sheet thickness lies in the range of tenths of a millimeter to tens of millimeters. Plates can be smooth or have a surface structured. Plates are delivered in the form of flat sheets or strip coiled in circles.

<sup>vii</sup> Production of metallurgical industry, whose transverse dimensions are much smaller than its length. The ratio of transverse dimension to the length is in the range of from 0.001 to 0.35. Rods mostly have a high stiffness, for the purpose of deformation, considerable power and specialized equipment is used. The rods are made by rolling or dragging. Rods are used to fabricate by machining or for use as structural elements. The rods of circular cross-section, the ratio of transverse to the length dimension much smaller than 0.001 are called wires. Steel meeting quality standards PN45 are structural steels for machine parts and equipment of average load, with increased resistance to abrasion, among others, in engineering, for example shafts, axles, spindles, shafts and gears, piston, rings; elements of agricultural machinery and tools.

<sup>viii</sup> The amount of material needed to produce one piece of the product.

<sup>ix</sup> Optimization is based on the existing commercial size of a sheet, ie. 4x1000x2000 mm, 4x1250x2500 mm and 4x1500x3000 mm.

<sup>x</sup> In the present case the purchase price of one kg of metal fluctuates at the level of 2.19 PLN. The price agreed with the vendor on 2.07.2015.

<sup>xi</sup> Dimension determined by the production process.

<sup>xii</sup> The cost of buying sheets per one piece of manufactured product.

<sup>xiii</sup> The cost of purchasing steel rod per one piece of the manufactured product.

<sup>xiv</sup> Split into sheet, rod steel, pipes, profiles and cast iron or steel.

