RESEARCH IN LOGISTICS & PRODUCTION

TITLE PRODUCT COMPLEXITY AND ITS ATTRACTIVENESS – THE CONTEXT OF THE IMPLEMENTATION DECISION IN THE MARKET OF AGRICULTURAL MECHANIZATION

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Abstract Which criteria must a product meet so that it would be attractive from the point of view of its implementation? This article is an attempt to answer the stated question. The authors based their article on theoretical knowledge, direct interviews with managers of manufacturing plants and their own work experience. They considered it justified to present a criterion which is complexity of choice as a domain influencing its attractiveness from the point of a future manufacturer's view. On the theoretical plane, the authors want to conduct an in-depth study of literature on the concept of lean management being the determinant of the manufacturer's flexibility and, in the same time, creating an ability to match the product. On the practical plane, the authors want to prove that the product complexity is one of basic factors testifying its attractiveness because the more complex the product is, the greater is the ability to systemic "slimming" of its sub-assemblies.

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1. INTRODUCTION

A change has become the key category of the management of modern organizations. Both theorists and practitioners emphasize agreeably that flexibility as an organization's ability to react and cope with the imperative to make changes in conditions of deepening turbulent environment (According to R. Krupski, the increasing flexibility of an organization should be the answer to the increasing environment turbulence. According to the author of the paper, such point of view is another confirmation that the topic of the organization flexibility is the field within which research should be undertaken because the list of factors influencing growth of turbulence is being extended. More information: (Krupski, 2005, pp. 15 – 21).) and increasing dynamics of changes within the organization has become a desired attribute which is a condition of survival and development (Osbert, 2004, p. 51). Nowadays, it seems to be obvious that the modern organization must shape and maintain a proper level of the ability to change that is to have determined potential of changeability which ensures its flexibility. In the view of the above, the implementation adjustment, that is the ability to implement products ensuring superior profitability, was considered a condition for the organization's operation in this study by reference to both duration and development.

In the view of the above, the question is: "Which criteria must a product meet so that it would be attractive from the point of view of its implementation?" This article is an attempt to answer the stated question. The authors based their article on theoretical knowledge, direct interviews with managers of manufacturing plants and their own work experience. They considered it justified to present a set of criteria in which the complexity of choice is a domain influencing its attractiveness from the point of a future manufacturer's view.

In the view of such goal, the authors incline to theoretical reflexion and undertaking empirical research. On the theoretical plane, the authors want to conduct an in-depth study of literature on the paradigm of lean management determining the manufacturer's flexibility and, at the same time, creating an ability to match the product especially that, as authors assume, lean management is a condition for taking a lead in terms of costs, which evinces in higher profitability. On the practical plane, the authors want to prove that product complexity is one of the basic factors testifying its attractiveness, especially taking the implementation decision into consideration. In the view of the above, the authors assumed that the more complex the product is, the greater is the ability to deepen the production depth of manufacturing its particular sub-assemblies, which evinces in a greater ability to "slim" the complex product in terms of its production costs.

During solving particular research problems, the authors base on works of the field of economic sciences, including literature on management sciences and technical sciences, especially in the field of production engineering (In accordance with the Production Engineering Committee of the Polish Academy of Sciences, the production engineering is a concept covering aspects of planning, designing, implementation and management of the production systems, logistics systems as well as the protection of their functioning. See: http://www.kip.pan.pl). The undertaken research indicates that there are a great number of unsolved questions, in relation to both theory and practice of management, which require further investigation. In this study, the pragmatic approach prevails. Thus, following any rules of research workshop, presentation of discussed issues from the point of view of business practice was considered justified. These directions of activity make this study useful from the point of view of a market participant, especially the market of agricultural mechanization participant.

2. LEAN MANAGEMENT AS AN INHERENT FEATURE OF A FLEXIBLE ORGANIZATION

Conditions of the market economy and ongoing changes in the social and economic system of the country resulted in the transformation on the labour market. Information, employees, materials, products, and capital move around the world in the increasing numbers and with increasing speed. The global, intense competition may pose a threat to the domestic manufacturers, if they are not enough fast to adopt to the market, and they do not cheaply manufacture products of high quality. It may result in the transfer of capital and production to the regions and countries, where the labour costs will be lower and they will be able to obtain greater profits. Globalization is thus a struggle for a job, and a standard of living (http://www.kip.pan.pl).

In the view of the above, as P. Grajewski notices (2012, p. 11), a modern organization intrinsically operates in conditions of much greater variability than in the past. This view seems to be confirmed by S. Trzcieliński, H. Włodarkiewicz-Klimek and Krystian Pawłowski (2013, p. 5), according to whom, a model of the lean company is a basic model applied in enterprises with high technological and organizational culture, specialized in the industry, and thus oriented on the use of long-life opportunities. According to the authors, in terms of increasing variability of the environment, a cycle of opportunities shortens, and although the concepts, methods and lean tools may or even must be implemented, a need for such concepts and methods, which allow for use of the short-life opportunities, is created. A model of the flexible company meets the needs of the company's (In this paper, it was accepted that the agility and flexibility of an organization will be treated as synonyms, assuming in accordance with S. Trzcieliński that the opportunity is a fundamental idea in the concept of the agile and flexible company. Cf.: (Trzcieliński, 2011, p. 43). According to the authors of this paper, the agility and flexibility are a source of the company's success, as M. Sajdak emphasizes, and according to which the dynamic nature of the environment dictates the need for the company's adaptation to changes, using sudden opportunities as well as anticipating adverse events. In accordance with: (Nogalski & Niewiadomski, 2014, p. 225).) demand, which according to S. Trzcieliński (2011, p. 6) uses the opportunities emerging in the environment. This view seems to be confirmed by P. Golińska (2012, p. 26), noting that the variability and unpredictability of the modern economic environment, progressive individualization of consumer attitudes, and shortening of the product's life cycles resulted in the development of forms of organization of modern manufacturing systems, namely an agile manufacturing process.

According to R. Krupski (Krupski, 2014, p. 55), the recognition of opportunities in the company strategy is on one hand a theoretical proposition primarily contained within simple rules, as well as the business practice, as numerous empirical studies confirm. In the view of the above, as the authors of this publication notice, the lean management is a kind of management method creating the

work culture within the organization, which makes that all participants of the organization are interested in the continuing reduction of costs, raising the level of quality, and shortening the time period for completion for the customers' needs, in order to meet their expectations in the changing environment conditions (Trzcieliński, Włodarkiewicz-Klimek & Pawłowski, 2013, p. 14).

The lean management is a process of achieving such efficiency which makes the company more flexible, lean, practiced, and trained. The "lean" company builds its organization and manages the process, so that a customer actually pays for its production, and not for the functioning of such, e.g. a vast organizational structure, storages, means of transport or excessively complex administrative tasks, etc. Thus, lean manufacturing is slim, supple and flexible production which achieves outstanding success. According to T. Kocha, lean manufacturing is a concept which is defined as "slim", consuming less resources – less human effort, less equipment, less time and space, at the same time, striving for supplying the customer with the exact product that he or she expects. In contrast, J. Lipecki believes that the main goal of lean management is the simultaneous achievement of a high level of the economic efficiency, quality and flexibility. The complexity of the related activities makes that the chain of various enterprises, aimed at "slimming the organization", should never end or close (Niewiadomski & Pawlak, 2012, pp. 67-68).

A concept of the lean company is focused on the elimination of all forms of waste, thanks to which the efficiency measures improve because the company uses less resources to achieve the same objective. It is mostly used in the companies with high production potential, giving them considerable autonomy in the achievement of objectives. Lean production/manufacturing/enterprise can be regarded as a philosophy of the company management, organization of the company or a system of the management concepts and methods (Trzcieliński, 2011, p. 26 et seq.).

In conclusion, it is worth noting that lean as the organization of the lean company manifests in the application of the above mentioned rules not only in manufacturing, but also in the design of the product, its technology, supply chain, relations with customers and sale. All these activities require harmonizing, creating a lean company. The organization of such a company is characterized by a transfer of possibly the biggest amount of tasks to the employees, who add value to the product during the tasks' execution, and equip a company in the detection of defects, their causes and their removal.

3. MARKET ADJUSTMENT AND IMPLEMENTATION ADJUSTMENT

A high quality product or its "slim" version? It is often not an easy choice. It is worth emphasizing that the choice made by the company, whether its product should be of low or high quality, is a matter of the marketing strategy. The manu-

facturer may offer a lower quality but cheaper product or a product of higher quality mostly generating lower margins. In the first case, the manufacturer produces and sells a lot and cheap, hoping to achieve high profits as a result of the appearance of the effect of experience (A theory of the effect of experience is that the total unit cost of the product is reduced by a fixed percentage each time when the cumulated value of production doubles.). In the second case, the production is sometimes lower. The path that should be created and chosen. The "slim" high-margin products providing the above-average profits from sale may be and certainly are a stimulus to the development of a company and affect the relatively rapid growth of its value.

The essence of management, which involves putting the customer at the centre of the companies' activity, is to develop, in the strategic horizon, the offer adjusted to his or her needs and expectations. A basic strategy is therefore the product strategy which sets the direction of the next strategies. The manufactured product should be planned in a way that provides a customer with the greatest value, maximizing his or her satisfaction, which should be reflected in the size of profits that the manufacturer should obtain from its implementation.

Due to even greater care of a customer and flexibility in dealing with him or her, the lean management - what is the most important - introduces to the organization a systemic approach to respond to the market changes and unpredictability. Additionally, trying to be ahead of time, it assumes the necessity of formation of virtual corporations.

According to D. Głowacka-Fertsch and M. Fertsch, an area of the lean application relates to manufacturing standard products, adjusted to market needs, and being produced in optimized processes of designing and manufacturing with the use of specialized equipment. It is worth mentioning that the production system is often based on the "lean" concept, it is organized in accordance with Just-in-Time (JIT is simply defined as a constant flow of material "towed" through the successive phases of the manufacturing process. In this system, things that are produced and transported are only these which are needed, and only when they are needed, and also in the necessary amount (Golińska, 2012, p. 61).) but with the use of flexible automation and robotics (Głowacka-Fertsch & Fertsch, 2004, p. 16). Due to the publishing requirements, within the framework of this paper, the issues connected with the product adjustment was treated very briefly, and will be brought up separately within the framework of the other authors' publications.

The above analyses are confirmed by I. Rutkowski (2006, p. 7), who assumes that the operation of industrial companies in the global economy makes it reasonable to consider the possible sources of the effectiveness of strategies as well as the new product development process, and the success of new products on the market as a key condition for the success of the organization.

At this point, the authors found it reasonable to present a set of criteria related to the attractiveness of the product from the point of view of manufacturers operating in the sector of agricultural mechanization. The research executed by B. Nogalski and P. Niewiadomski, referred to in this part of the paper, was conducted with-

in the framework of the meetings during the International Agricultural Exhibition-Fair AGROTECH, held in Kielce from 7 to 9 March 2014. They led the authors to undertake the direction research in the presented scope, which in turn resulted in this publication.

Direct interviews with managers responsible for the implementation activities have shown that the product complexity, in addition to five other criteria, makes the attractiveness of the product, in the context of the decision on its implementation. The research, referred to in this paper, was presented in a very simplified manner (individual criteria were given no rank), because it is not the aim of this paper to prioritize but only to draw attention to the fact that the product complexity is crucial from the point of view of the manufacturer, a place in the adopted research model (Fig. 1). The above facts justify the advisability of the subject matter taken by the authors.

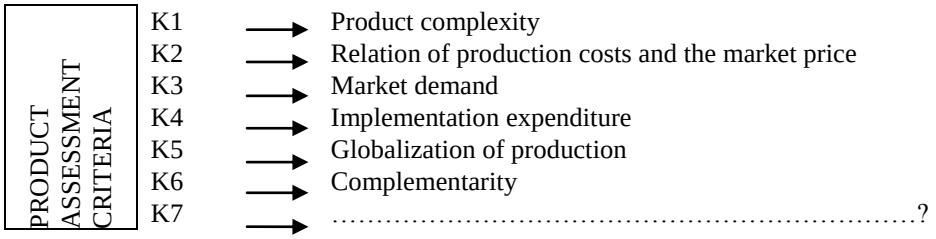

Fig. 1 The criteria for assessment of the product in terms of its implementation attractiveness. Source: the research model according to Nogalski and Niewiadomski

4. PRODUCT COMPLEXITY AS A DETERMINANT OF ITS IMPLEMENTATION ATTRACTIVENESS

4.1. Subject and entity of research

As noted by M. Lisiński (Lisiński, 2014, p. 135), the scientific knowledge related to each scientific discipline (including management or engineering production science) develops not only through the creation and development of new concepts, claims or theories, but also because of changes in the methods of solving emerging problems. Taking into account the above indications, the authors of this paper found it reasonable to use the research method which constitutes a case study, what will make it possible to analyse and assess the phenomena occurring in the practical implementation activities of the manufacturing companies. Such an action is to confront the adopted reasoning of the researchers with the proceedings of the actual participants of events and processes.

The research was conducted in one of the plants manufacturing sub-assemblies as well as spare parts dedicated for agricultural machinery. The entity referred to is located in the Wielkopolska province. The company employs 34 people, including 28 production workers. As a result of the experimental research, based on the analysis of project documentation as well as on the basis of the guided interview, the authors obtained the information which are essential for the performance of the conducted research. The obtained information made it possible to illustrate what is the relationship between the product complexity and the possibility of "slimming" the production costs.

The subject of research constitutes purposely selected sub-assemblies and spare parts for the implied agricultural trailers.

4.2. The "lean" management of the sub-assembly in the context of a complex product – a case study

In this part of the paper, a complex product, in the form of a transmission for a spreading unit of the tipping agricultural trailer, was subjected to the research (Fig. 2).

Fig. 2 Conveyor drive transmission – a complex product subjected to research. Source: the FORTSCHRITT company advertising materials

The purpose of the analysis was to show the correlation between the amount of sub-assemblies constituting a given complex product and the possibility of its slimming as a whole in terms of manufacturing costs. The authors assumed that the more sub-assemblies constituting a given complex product, the more possibilities in terms of the cost reduction for the manufacturer. In other words, each reduction of manufacturing a given sub-assembly has a significant impact on reducing the production costs of the complex product. In order to confirm the adopted assumption, the authors intend to present practical solutions in this regard. Due to the publishing requirements, related to the volume of text, in this paper, a "slimming" methodology of the production costs of the selected sub-assembly's gear (drive shaft – shafts are part of devices or machines which support the rotating parts in an axis. Shafts carry the load twisting them, thus their strength is of course important – Fig. 3), while the influence of "slimming" of each sub-assembly, constituting the complex product, was comprehensively illustrated in the context of costs.

Fig. 3 Gear shaft – a sub-assembly subjected to "slimming". Source: FORTSCHRITT company advertising materials

In the context of the conducted research, the analysis of the resource used in production of gear shafts was performed. The research has shown that the steel of C45 grade is necessary to manufacture the shaft. According to the standard, it is carbon steel intended for moderately loaded machine parts and more resistant to abrasion: crankshafts, axles, spindles and gears. Under the resource supply in the examined plant, steel of 50HS grade, the torsional strength of which (strength tests showed the excessive strength but also the purchase price is much higher) (Spring steel - steel used in the manufacture of suspension springs, springs and torsion bars. The steel yield strength of this grade is at a level of 1180 [MPa] and the limit of short-term strength is 1320 [MPa]), was used to manufacture a shaft. In the case of the supply of resource of C45 grade, the cost of buying one kilogram of steel is PLN 2.56, while in the case of resource of 50HS grade amounts to PLN 2.30 per kilogram. Detailed data is included in Table 1.

Table 1 Analysis of the production costs of the gear shaft No. 0200213840 – the applied resource and the "lean" resource, Own development based on research

Gear shaft **Product name**		**0200213840** **Catalogue number**			
Resource		Dimension [mm]	Weight [kg]	Costs of resource [PLN]	Total [PLN]
W I	Rolled rod Grade: C45 Cross-section 52 mm	L-640	10.69	2.30	24.59
W II	Rolled rod Genre: 50HS Cross-section:52 mm	L-640	10.69	4.10	43.83
Labour costs [PLN]				8.50	
CKP [PLN]		Variant I		Variant II	
		34.09		52.33	

In the context of the above, under the supply in the first variant (C45 steel), the manufacturer achieves a saving of PLN 18.24, taking into account one piece of the analysed sub-assembly. The analysis of the construction drawing of the gear has shown that the application of two shafts is essential to its production, which produces a saving in the amount of PLN 36.48.

Similar analyses in the context of "slimming" costs were applied in the case of the other sub-assemblies constituting the gear. Unfortunately, as it was earlier mentioned, due to the publishing requirements, in the further part of the paper, the authors presented only their reflection in the context of the complex product. Detailed data is included in Table 2.

Table 2 Analysis of the production costs of the gear – holistic management of the "lean" product, Own development based on research

Component name	Quan-tity [pcs.]	Production/ purchase price [PLN]	Production/ purchase costs [PLN]	Production / purchase price[PLN]	Production/ purchase costs [PLN]	Balance "slimming the costs [PLN]
A	B	C	D=B*C	E	F=B*E	G=D-F
Left housing 0200213430	1	158.00	158.00	142.20	142.20	15.80
Right housing 0200213430	1	158.00	158.00	142.20	142.20	15.80
Middle housing 0200212960	1	150.80	150.80	135.72	135.72	15.08
Long shaft 0200213840	2	52.33	104.66	34.09	68.18	36.48
Shaft 0200213100	3	16.86	50.58	15.62	46.86	3.72
Connec. Sleeve 0200213270	1	7.59	7.59	7.02	7.02	0.57
Circle Z-18 0200131180	1	77.00	77.00	70.00	70.00	7.00
Circle Z-19 0200131420	1	77.00	77.00	70.00	70.00	7.00
Circle Z-16 0200131671	2	66.00	132.00	60.00	120.00	12.00
Circle Z-20 0200131751	2	66.00	132.00	60.00	120.00	12.00
Bearing 6308	5	13.00	65.00	12.00	60.00	5.00
Bearing 6309	5	13.00	65.00	12.00	60.00	5.00
Cover	4	1.61	6.44	1.47	5.88	0.56
Sealant 40*90*10	4	1.21	4.84	1.10	4.40	0.44
Sealant 40*72*10	1	1.10	1.10	1.00	1.00	0.10
Screw M10*25	4	0.50	2.00	0.45	1.80	0.20
Washer Fi 10	4	0.03	0.12	0.02	0.08	0.04
Screw M8*15	24	0.23	5.52	0.20	4.80	0.72
Screw M8*30	12	0.28	3.36	0.25	3.00	0.36
Spring wash. Fi 8	12	0.04	0.48	0.03	0.36	0.12
Flat wash. Fi 8	24	0.05	1.20	0.04	0.96	0.24
Protection W-90	4	1.21	4.84	1.10	4.40	0.44
Protection Z-40	5	0.44	2.20	0.40	2.00	0.20
Protection Z-42	5	0.46	2.30	0.41	2.05	0.25
Plug DIN-910 M16*1,5	6	1.60	9.60	1.45	8.70	0.90
Pin M16*70	4	2.75	11.0	2.50	10.00	1.00
Costs of resource [PLN]			1232.63		1091.61	Σ
Labour costs [PLN]			16.00		16.00	141,02[PLN]
TOTAL [PLN]			1248.63		1107.61	

In the context of this research, the authors demonstrated that any reduction of the purchase or given sub-assembly production costs (At the same time, it is assumed that the higher the production depth of manufacturing of a given sub-assembly is, the lower is the cost of its "obtaining". In the context of the above, the manufacturer should strive to manufacture the highest number of sub-assemblies within the framework of own technological resources.) reflects on "slimming" of the complex product's manufacturing costs. In the analysed case, the production costs of one piece of the complex product was reduced by PLN 141.02. In the context of the above, it is assumed that at the market price of the gear, the manufacturer generates additional profit in the indicated amount.

3. CONCLUSION

Due to the high saturation of the market and rapidly changing environment, it is important to know what should be produced, how to produce and to whom this product should be sold. Therefore, it becomes essential to take – on the basis of available information – quick and effective decisions based on knowledge (Nogalski & Niewiadomski, 2013, p. 664).

According to K. Grzybowska (2012, p. 52), a key to achieve the flexibility and improve the speed of actions' performance is the effective coordination, especially that the globalization of markets, products, technology, legal regulations or organizational culture require a different approach to the problem of business management, formulation of their objectives and action strategies as well as the rules and criteria of the assessment of the effects of their activities (Jaki, 2014, p. 5). Accordingly to the above, the development of management concepts and methods must follow the variability of conditions, in which companies operate (Trzcieliński, Włodarkiewicz-Klimek & Pawłowski, 2013, p. 5).

In this paper, the implementation adjustment, that is the ability to implement products ensuring superior profitability, was considered a condition for the organization’s operation in this study by reference to both duration and development. In the view of the above, the question appeared: “Which criteria should a product meet so that it would be attractive from the point of view of its implementation?”

The above question resulted in undertaking research based on theoretical knowledge, direct interviews with managers of manufacturing plants and their own work experience. Moreover, the criterion, which is complexity of choice as a domain influencing its attractiveness from the implementation point of view, was presented.

It has been shown on the practical plane that the product complexity is one of the basic factors testifying its attractiveness, because the more complex the product is, the greater is the ability to the systemic "slim" of its particular sub-assemblies.

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BIOGRAPHICAL NOTES

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