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### Eco-design in pro-environmental activity illustrated with example of agricultural trailer loading box cover – towards a sustainable product

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With the ecological crisis in mind, manufacturers should look for such management concepts that will ensure the highest possible product quality on the one hand, and take into account pro-environmental demands throughout the entire production cycle on the other. This perspective is offered to the manufacturer by the concept of sustainable development as referred to in this publication. In the paper, a query of the literature on the ESG postulate as a concept implemented in a company producing parts and subassemblies for agricultural trailers (specializing in technical means of agricultural transport), was performed. In the further part, the strategy of sustainable production was illustrated, itself a result of pro-environmental activity, which in turn, led to the development of a sustainable product in the final phase.

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## 1. Introduction

In the last decade, social, technological and political processes have had a huge impact on the development of enterprises, which radically changed the characteristics of some markets, and thus the rules of competing. Growing competition and the high dynamics of changes in the business environment, the effects of the global energy crisis, cause numerous traditional management concepts to lose their appeal. Still, it does not mean a complete turn from previous achievements in this area. On the contrary, it is necessary to develop mechanisms that would enable enterprises to survive in such undoubtedly difficult times. It seems reasonable to put forward the concept of sustainable development and implement such solutions that, at minimal costs, will lead to above-average results<sup>1</sup>. The author's assumption is that a company should not solely care about its economic aspect. A business should bring broadly understood benefits

to all stakeholders and the environment. This is the only way for the company to ensure sustainable development and stability for itself in addition to the environment in which it is located.

Additionally, on January 31, 2023, the European Commission (EC) published public consultations on what the new product priorities should be. They are guidelines under the suggested Ecodesign for Sustainable Products Regulation (ESPR). These consultations follow the commitment made in the "Making sustainable products the norm" (COM/2022/140) communication [2].

In view of the above, enterprises should increasingly deepen and engage their competences in the development and implementation of management methods that consider the premise of permanent and sustainable development. To increase the likelihood of implementing selected ESG (E - Environmental,

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<sup>1</sup> It is a very interesting issue both from the scientific-cognitive and practical application perspectives. Each and every key decision made by the company's managers carries important pro-environmental implications. They have a direct impact on the company's market activities and the level of its functioning.

S – Social responsibility, G – Corporate governance) postulates, the company should establish appropriate conditions that adhere to the principle of effective management of the product design process.

This issue is particularly important in sectors of the economy where customers and the product tailored to their needs become a key growth factor. This is what this study is about: forming the basis for a conscious strategy for the development of a sustainable product, a strategy that consists in the systematic evaluation of a company's own resources and capabilities in the context of changing the conditions and needs of the environment. It is to provide a broader perspective of the analysis and improvement of the product on the market of agricultural technical means of transport in the context of pro-environmental challenges and to provide practical tips in this regard.

Undertaking a discussion of the respective issues, the author formulated a thesis that corresponds to the adopted objectives of the study, namely: *in view of the ecological crisis that modern enterprises are facing, market opportunities should be sought in implementing the principles of the concept of sustainable development (including ESG assumptions), especially in the sphere of production design, which has a large impact on the environment. This perspective is offered to the manufacturer by the concept of a sustainable product as referred to in this publication. The author expresses the view that it is in times of crisis that development opportunities should be sought, which can be ensured by a properly developed environmental strategy and the ability to implement it.*

As part of the work, the author intends to:

- Present the initial assumptions regarding sustainable development as a concept implemented by manufacturers of parts and technical subassemblies of means of agricultural transport.
- Suggest an eco-design concept for the product manufactured by the company.
- Present a proposal for a sustainable product, taking into account pro-environmental standards on the one hand, and reflecting high quality on the other.

The goals adopted for the implementation prompt the author to reflect upon the issue theoretically and to undertake experimental research. On the theoretical level, the author's intention is to conduct a literature review. Within the research and development layer, the author intends to reflect upon the concept of a sustainable product by implementing his own solution, taking into account pro-environmental challenges.

## 1.1 Sustainable development – assumptions for research

Sustainable development is a term that is still gaining popularity as for years it has been commonly applied in scientific literature, legal acts or strategic documents [8,9]. Although the essence of this concept seems to be quite understandable, the definition and precise interpretation of what sustainable development is gives rise to animated discussions, both among theoreticians and practitioners. The ambiguity and vagueness of the term have been reflected in its various definitions and interpretations [4].

In the literature on the issues of sustainable development (permanent development), especially in its Polish edition, it is the ecological tendency that dominates [3]. It is emphasized that special attention must be paid to the existence of mechanisms limiting the adverse effects of destructive processes for the economy, society and the natural environment, which have become apparent in recent decades. In the context of further research, the most universal and synthetic approach to sustainable development should thus be quoted, defining it as an activity that should be economically viable, ecologically sound and socially acceptable. This position simultaneously outlines the field of understanding of the term in this study.

The multithreading of issues raised in connection with the concept of sustainable development means that conducting a full query of views on sustainable development, their systematization and assessment of the current state go beyond the scope of this publication. In addition, the intention was to present that part of views which are directly related to the topic of this research, namely the ecological aspects of designing and manufacturing a sustainable product.

The motivation to undertake the research is the European Green Deal, which announced a new action plan. It concerns the circular economy and includes the policy of "sustainable products". The plan aims to support the circular design of all products based on a common methodology and principles. The priority is to reduce the use of materials and reuse them before recycling [1].

The term "eco-design", as discussed in this study, means taking into account environmental aspects when designing a product in order to improve the environmental performance of the product during its entire life cycle [5]. It regulates energy efficiency and lays down general rules for setting eco-design requirements for energy-using products.

## 2. Material and methods

### 2.1. Project data

This publication's subject of interest is enterprises that see sources of building their market position mainly in the production of sustainable products, the implementation of which offers high margins (the economic factor) on the one hand, and on the other, by minimizing the consumption of raw materials (the environmental dimension), which is based on respecting the environment, while maintaining, of course, the appropriate quality accepted by the customer (the socio-economic aspect).

Assuming the above premises as an interpretation, it seems reasonable to put forward a design concept based on skillful balancing of the price, usable quality of the product and the costs of its production, while maintaining the current group of recipients. Still, it should be remembered that each time the amount of material is reduced in the production process, apart from the possibility of obtaining a certain margin, it may also lower the quality of the final product. In view of the above, it is necessary to know the level of quality that the customer is willing to accept, as well as to specify the quality requirements, if are not met may have very undesirable consequences.

The observations referred to in the further part of the study were carried out in one of the Wielkopolska enterprises manufacturing parts and subassemblies of technical means of agricultural transport.

The essence of the production process of the examined enterprise (generalized and simplified) consists in processing the raw material into a finished product, whereby the "raw material" will be any material (object) processed and output in the form changed into a finished product, and the "finished product" will be any final product of the enterprise intended for further use in another enterprise (the production process of specific machines), or for the direct satisfaction of users' needs.

Based on the documentation analysis (design, technical, product approval), a guided, direct interview with the production manager and the main technologist, as well as a result of participant observation, the author obtained the information necessary to conduct the research. As a consequence of the project documentation analysis, information about the customer's requirements, a drawing diagram, a list of parts and materials that make up the product, production tools used in the process, project duration and quality information were obtained. The technical documentation contained detailed information on the product specifications, materials, manufacturing processes, quality control procedures and operating

instructions. Additionally, all the information needed to approve the product for use was obtained, including data on its quality.

The subject of observation and analysis was the production process of a loading box cover (Fig. 1), used as a replaceable part or subassembly in the agricultural trailer production process.

Fig. 1. Agricultural trailer loading box cover



Source: [www.fortschrittpoland.pl](http://www.fortschrittpoland.pl) [10]

The conducted observations and conclusions enabled the author to put forward the following thesis: along with an increase in the quality (in this case, measured by the thickness of the cold-rolled sheet in mm) of a particular unit of the manufactured product, the environmental costs (measured by the amount of raw material used) and the production costs rise. In other words, the higher the environmental costs, the higher the thickness of the sheet metal used in the manufacturing process. In addition, the greater the share of raw material in a given unit of the finished product, the higher the production costs resulting from the use of thicker sheet metal. In view of the above, a manufacturer wanting to fabricate a product with lower environmental costs should apply the concept of matching, consisting in maintaining an appropriate relationship between quality (market acceptance) as well as environmental and economic costs.

In the further part of the study, the author's main focus is to present the concept of a sustainable product that is a compromise between the minimum amount of material used and acceptable quality.

### 2.2 Case study

As part of the conducted research, the environmental costs were assessed, which were specified on the basis of 1 kg of raw material and its base price (manufacturing costs) used for the production of the cover for the loading box of an agricultural trailer. Detailed data are presented in Tables 1 and 2.

**Table 1.** Production costs of agricultural trailer loading box cover  
– Variant I (higher environmental costs)

A. Net raw material costs/pc.		1007.72			
Including:	Weight/pc. [kg]	Quantity/pc.	Net price in PLN of raw material/kg	Net total PLN/pc.	
Sheet metal 1815x1250x3	54.45	2	3.79	412.73	
Sheet metal 120x120x6	0.7	4	3.79	10.61	
Sheet metal 130x120x6	0.75	2	3.79	5.69	
Profile 60x30x4 – (L-24000)	123.6	1	3.86	477.10	
Shaft Fi 65 (L-500)	13	1	3.45	44.85	
Profile 50x50x5 (L-1900)	13.42	1	3.85	51.67	
Shaft Fi 30 (L-120)	0.67	2	3.79	5.08	
B. Labor costs PLN/pc.		169.00			
Including:	Cutting	Welding	Bending	Painting	Turning
	15.00	120.00	15.00	13.00	6.0
C. Other costs PLN/pc.		112.67			
D. PRODUCTION COSTS PLN/PC. (A+B+C)			1289.39		
E. SALES PRICE PLN/PC.			1670.00		
F. PROFIT (PLN/PC). (E-D)			380.61		

Source: Author's own study based on research

The production costs of one unit of an agricultural trailer loading box cover (v Variant I) constitute 1289.39 PLN. Therefore, the profit from the sale of one item oscillates around PLN 380.61. As the research shows, the sales of this subassembly in the surveyed company is at the level of 190 units per year<sup>2</sup>. Hence, the profit generated by the manufacturer is 72,315.90 PLN (the revenue from sales 317,300 PLN). The purchase of the raw material amounts to 191,466.80 PLN. The raw material consumption is 39,252.10 kg. As shown by market analyses and product safety research (in cooperation with the Łukasiewicz Research Network - Poznań Institute of Technology, Center for Agricultural and Food Technology), the product designed in this way significantly exceeds the expectations and strength needs. Paradoxically, a cover of higher quality (measured by the thickness of the sheet metal) has a negative impact on the strength of the spreading apparatus and guides

(higher load and wear of hydraulic cylinders). In this form, the total weight of the cover is 206.59 kg.

Taking into account the second production variant (Table 2) concerning a sustainable product, the manufacturer reduces the total production costs of the product unit by 260.17 PLN. The consumption of raw material per purchase decreases to 747.55 PLN, which in turn, leads to savings of the amount of 260.17 PLN. The labor costs and other costs incurred in connection with the conducted manufacturing activity converted into the unit of product did not differentiate.

The global profit (in financial terms) for the manufacturer (taking into account the sales of 190 units of the cover, the manufacturer gains an additional 49,432.3 PLN per year. Converting this into the amount of sheet metal used, the raw material is saved at the level of 49.41 kg (per unit), which gives a global savings of 9387.90 kg.

**Table 2.** Production costs of agricultural trailer loading box cover  
– Variant II (sustainable product)

A. Net raw material costs/pc.		747.55			
Including:	Weight/pc. [kg]	Quantity/pc.	Net price in PLN of raw material/kg	Net total PLN/pc.	
Sheet metal 1815x1250x2	36.3	2	3.79	275.15	
Sheet metal 120x120x5	0.57	4	3.79	8.64	
Sheet metal 130x120x5	0.62	2	3.79	4.70	
Profile 60x30x3 – (L-24000)	95.04	1	3.86	366.85	
Shaft Fi 65 (L-500)	13	1	3.45	44.85	

<sup>2</sup> Sales from 2022 were examined.

<b>A. Net raw material costs/pc.</b>	<b>747.55</b>				
<b>Including:</b>	<b>Weight/pc. [kg]</b>	<b>Quantity/pc.</b>	<b>Net price in PLN of raw material/kg</b>		<b>Net total PLN/pc.</b>
Profile 50x50x4 (L-1900)	10.98	1	3.85		42.27
Shaft Fi 30 (L-120)	0.67	2	3.79		5.08
<b>B. Labor costs PLN/pc.</b>	<b>169.00</b>				
<b>Including:</b>	<b>Cutting</b>	<b>Welding</b>	<b>Bending</b>	<b>Painting</b>	<b>Turning</b>
	15.00	120.00	15.00	13.00	6,0
<b>C. Other costs PLN/pc.</b>	<b>112.67</b>				
<b>D. PRODUCTION COSTS PLN/PC. (A+B+C)</b>					<b>1 029.22</b>
<b>E. SALES PRICE PLN/PC.</b>					<b>1550.00</b>
<b>F. PROFIT/PROFIT MARGIN PLN/PC (E-D)</b>					<b>520.78</b>

Source: Author's own study based on research

It is worth pointing out that by merely reducing the cost of the raw material (Table 3), the manufacturer achieves significant savings. In addition, the implementation of modern technological and organizational solutions implying a minimization of labor

costs is suggested. Still, the author's aim in this article was to indicate the improvement in production efficiency and the minimization of environmental costs, through product sustainability in relation to the raw material used.

**Table 3.** Comparison of discussed variants of agricultural trailer loading box cover production

<b>VARIANT I</b>		<b>VARIANT II (sustainable product)</b>	
<b>Raw material type</b>	<b>Raw material weight (kg)</b>	<b>Raw material type</b>	<b>Raw material weight (kg)</b>
Sheet metal 1815x1250x3	54.45	Sheet metal 1815x1250x2	36.3
Sheet metal 120x120x6	0.7	Sheet metal 120x120x5	0.57
Sheet metal 130x120x6	0.75	Sheet metal 130x120x5	0.62
Profile 60x30x4 – (L-24000)	123.6	Profile 60x30x3 – (L-24000)	95.04
Shaft Fi 65 (L-500)	13	Shaft Fi 65 (L-500)	13
Profile 50x50x5 (L-1900)	13.42	Profile 50x50x4 (L-1900)	10.98
Shaft Fi 30 (L-120)	0.67	Shaft Fi 30 (L-120)	0.67
<b>Total (kg)</b>	<b>206.59</b>	<b>Total (kg)</b>	<b>157.18</b>
<b>Total raw material costs (PLN)</b>	<b>699.44</b>	<b>Total raw material costs (PLN)</b>	<b>519.63</b>

Source: Author's own study based on research

To sum up, each "balancing" of a product should be based on maintaining appropriate proportions between its quality (reducing the amount of raw material will influence the global quality of the product) and the lowest possible level of raw material consumption. It is thus necessary to know about the level of quality that the customer is willing to accept on the one hand, and include the requirements resulting from strength tests on the other.

Defining quality is not easy as it means something different for each customer. In the author's opinion, the quality of the product can be considered in terms of a set (all the properties of the object related to its ability to meet the stated and expected needs) and in terms of the degree (a set of inherent properties that meet the requirements). Such an approach to quality, in the context of the cover of the loading box of the agricultural trailer, allows the strategy developed by the author to be implemented.

### 3. Conclusions

The process of transitioning a product from a traditional to a sustainable one requires the involvement of all employees at all levels of management. The manager has a special role to play here and should be

convinced of the soundness of introducing such a product variant. The role of the sales manager is also unique here, as they serve as the link between the company and the market, affecting both systems and

shaping the relationship between them<sup>3</sup>. A competent sales manager is an "informer" who, based on the data obtained from the market, initiates modern ideas and production solutions, which are in turn verified by the production staff and appropriate certification institutions.

This publication illustrates the eco-design and environmental management strategy for a specific product, which in the final phase resulted in the development of a concept of a sustainable product that takes into account the environmental dimension on the

one hand, and generates above-average profits from sales on the other. In the context of the above, the postulates resulting from the ESG strategy were considered. It was pointed out that sustainable products can bring above-average profits from sales and can be a stimulus for the development of an enterprise and contribute to a relatively rapid increase in its value, also in terms of image. Moreover, throughout the product cycle, it is worth paying attention to the possibility of using waste recycling as one of the elements of the logistics system [6, 7].

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<sup>3</sup> This seems to be noticed (and appreciated) by practitioners rather than those dealing with the subject of sales scientifically