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THE MEANING OF ECO-DESIGN PROCESSES FOR LOGISTICS MANAGEMENT OF DEFECTIVE PRODUCTS

ZNACZENIE PROCESÓW PROJEKTOWANIA EKOLOGICZNEGO DLA ZARZĄDZANIA LOGISTYCZNEGO PRODUKTAMI NIEPEŁNOWARTOŚCIOWYMI

Abstract: Modern market economy is adapted to the ever increasing demands of customers. Therefore, in logistics flows appear more often and in larger quantities defective products – returns, that need to be properly managed. Fulfilment of this requirement is by the concept of logistics management of defective products. Another advantage is the ability to re-use these products or their components. And here helps the eco-design concept. By this concept, it is possible to reuse the materials used before. The paper presents the basic principles of ecological design (eco-design) processes and their importance for the logistics management of defective products.

Key words: eco-design, logistics, logistics management, defective products, returns

Streszczenie: Współczesna gospodarka rynkowa dostosowywana jest do wciąż rosnących wymagań klientów. Dlatego też w przepływach logistycznych coraz częściej i w większych ilościach pojawiają się produkty niepełnowartościowe – zwroty, które muszą zostać odpowiednio zagospodarowane. Spełnieniu tego wymagania służy koncepcja zarządzania logistycznego produktami niepełnowartościowymi. Dodatkowym atutem jest możliwość ponownego wykorzystania tych produktów lub ich komponentów. A tu naprzeciw wychodzi koncepcja projektowania ekologicznego. Dzięki niej właśnie możliwe jest wielokrotne korzystanie z wykorzystanych już raz materiałów. Artykuł prezentuje podstawowe założenia procesów projektowania ekologicznego, oraz ich znaczenie dla zarzadzania logistycznego produktami niepełnowartościowymi.

Słowa kluczowe: projektowanie ekologiczne, logistyka, zarządzanie logistyką, produkty niepełnowartościowe, zwroty

Introduction

For several years, in the global economy there is observed an increased trend associated with the use of an ecological approach in production processes. It is a reflection of the need to realization the priorities of sustainable development, including mainly the priority of the environment protection from harmful substances and activities. Whereas at first the knowledge of a limited number of certain (most of) raw materials, and secondly to avoid unnecessary burden on the environment with production residues, both in the form of waste and used products, there starts to begin apply more and more attention to the design of products in an environmentally friendly manner. Initially, these efforts have focused exclusively on the use of appropriate materials and components, or non-waste production methods. Nowadays, the design of environmentally friendly products has become a much more complex process, which creates not only the environmentally friendly products, but also that the way of their production is environmentally friendly. This complexity caused that the ecological design of products permanently is inscribed to contemporary trends in production.

Eco-design of products relays mostly to the fact that the companies that use this type of processes have in mind not only the eco-friendly selection of raw materials and ecological production, but also to the use of the product by the end user in the way that is not harmful to the environment.

At the same time, eco-design can be very effectively combined with the concept of logistics management of defective products. With this combination we gain a more complete picture of the possibilities to protect the environment and implementation of sustainable development priorities. Since logistics management of defective products is closely related to the management of product returns that arise in different places in the supply chain, product life cycle, and especially its end - when they become defective prod-

ucts, is a very important point. If the product is designed ecologically, processes of logistics management of defective products will be much more efficient and effective, because the products or their components can be reused.

1. The need of natural environment protection

Natural environment is being degraded year by year and the reason for such state can be found in industrial development and operation of businesses variety. It is the first time that human race has seen a global crisis, encompassing both developing and developed countries, caused by human attitude towards the environment. The symptoms which heralded this crisis has been long obvious – demographic explosion, insufficient integration of extremely developed technologies with environmental demands, land overuse, unplanned development of urban areas, decrease in free areas and increased risk of extinction of various animal and vegetation life forms. Undoubtedly, if this process is continued, future life on Earth might be endangered. Thus, it is extremely essential to consider the problems of threats to the environment and to take necessary measures in order to prevent them[1]. Due to this fact, it is more and more popular to combine management science with environmental protection with the practice of business operation in order to use and protect it more reasonably.

For this very reason, in the seventies of past century, a socially-economic concept was conceived, according to which the aim of environmental protection is to satisfy material and esthetical needs, health and life protection and protection of interests of future generations. Apart from this concept, another eco-development concept also appeared, i.e. integration of the environment with social and economic development.

Fundamental goal of eco-development is to ensure such a scale of intervention in the natural environment that its condition is not deteriorated and nature-relating basis of functioning of social and economic systems as well as satisfying of human physical and psychical needs are guaranteed through proper adjustment of human relation to the natural environment. Eco-development is a method of business operation through use of environmental potential and society organization, which ensures dynamic development of production processes, continuity in use of natural resources as well as improvement and maintenance of high quality of life[2]. Main principle of eco-development is unambiguous determination that an obligation of environmental protection cannot be treated as being in conflict with economy's interests but it becomes an element of proper management and all activities which infringe this obligation are illegal.

It has been known for many years that biggest damage to the environment is brought by the industry and that is why the measures have been taken to influence the companies through legal system with environmental protection economic instruments. The economic instruments include the measures to affect finance in companies and other economic

[1] R. Paczuski, *Prawo ochrony środowiska*, Oficyna Wydawnicza „Branta", Bydgoszcz 1996.
[2] S. Kozłowski, *Ekorozwój. Wyzwanie XXI wieku*, PWN, Warszawa 2000.

entities, which make environmental protection profitable. They might be a means of economic pressure to some companies, while to others they might be a form to reward preventive measures that are taken. In each case they have essential importance to financial result in a company, forming cost-benefit relationships in production efficiency account or through reduction in profits as a result of penalty fees.

From this point of view of environmental issues, ecological policies of organizations are derived. Environmental protection have long been treated as one of the elements in economic policies. Initially, it was termed 'economic policy for environmental protection. After some time, however, it was observed that ecologic policy also shows strong relationships with social policies and the domain of management.

Yet, it is important to the process of eco-development to consider a principle of prevention against pollution and other emissions to the environment during any activity and at any stage of manufacturing processes. A variety of preventive measures can be applied here, including: avoiding pollution during technological processes, application of recirculation or installing protection equipment which prevents pollution.

Another important element connected with protection of natural environment against negative impact of industrial activity is ecological management. It is impossible to manage companies without considering a very important, from the social standpoint, aspect such us pollution and degradation of natural environment. More intensive environmental pollution negatively impacts human health and ability to work, shortens average life expectancy, morbidity and death rate as a result of ecologic stress connected with exposure to the devastated environment; there are also changes in interpersonal relations, social cost of development are rising while competitiveness on foreign markets is on the decrease[3]. Responsibility for such a condition of the environment is obviously taken by companies, which are its main users. Thus, taking care of its quality must become one of the most important issues of managing them and planning their development. It must appear in all areas of operation: research and development, production and marketing – thus both during the process of goal setting and their realization.

Modern management is based on systematic approach, whose starting point is an assumption that a company and nature make up a closed system. In relation to the company, this means output in the form of ecological product, experience of the staff and financial means. In each production cycle there is, however, some waste, which in the analysed system is brought back to the production cycle and processed into other products, feedstock for another cycle or it is subject to utilization or neutralization.

2. The concept of logistics management of defective products

One of the answers not only for growing technical and technological innovations needs in economy and customer requirements, but also for the problem of growing environmental pollution causing the conflict between economy and ecology, might be the

[3] J. Penc, *Strategie zarządzania*, AW „Placet", Warszawa 1997.

concept of logistics management of defective products. It can take the role of tool recreating and restoring the economic and ecological balance[4].

Logistics management of defective products concept in the global scale has been already existing for some time, and during this time it was evolving in very intensive manner. At first, there were some small information in the literature, not directly about logistics management of defective products, but about returns and reverse channels[5]. Then some authors has used the term of "*reverse distribution*" instead of "*logistics management of defective products*" but with the equivalent meaning[6]. And after, in the literature was noticeable the great highlight of logistics management of defective products growing importance[7]. There were also mentioned main drivers for logistics management of defective products activities such as law acts in form of directives and legislations, better consumer awareness, or companies social responsibility towards natural environment by which further research focused on reverse logistics in terms of waste management, recycling as recovery of materials, remanufacturing for reuse products or parts[8].

3. Review on logistics management of defective products definitions

The most common and wide within its scope definition of logistics management of defective products is the one made by Council of Logistics Management – "*the term often used in relation to the role of logistics in recycling, waste management and hazardous materials management*"; and in a broader sense it applies to "*all aspects of logistics activities undertaken to reduce the use of raw materials, recycling, substitution, reuse of materials and their management*"[9]. This definition formula strongly emphasizes aspects of the recovery and reuse of waste as an action built in logistics management of defective products. This

[4] M. Starostka-Patyk, M. Zawada, Al. Pabian, M. Szajt, *Reverse logistics barriers in Polish enterprises*, "International Journal of Services and Operations Management" 2014, vol. 19, no. 2, p. 250-264.

[5] D.K. Beckley, W.B. Logan, *The retail salesperson at work*, Gregg publishing, New York 1948; J.P. Giultinian, N.G. Nwokoye, *Developing distribution channels and systems in the emerging recycling industries*, "International Journal of Physical Distribution" 1975, vol. 6, no. 1, pp. 28-38; S.H. Terry, *The retailer`s manual*, Jennings Brothers, Newark 1869, reprinted by B. Earl Puckett Fund for Retail Education, Guinn, New York 1967.

[6] P.R. Murphy, R.F. Poist, *Management of logistical retromovements: an empirical analysis of literature suggestions*, "Transportation research forum" 1989, pp. 177-184; J. Barry, G. Girard, C. Perras, *Logistics planning shifts into reverse*, "Journal of European Business" 1993, vol. 5, no. 1, pp. 34-38; C.R. Carter, L.M. Ellram, *Reverse logistics: A review of the literature and framework for future investigation*, "Journal of Business Logistics" 1998, vol. 19, no. 1, pp. 85-102; V. Jayaraman, R.A. Patterson, E. Rolland, *The design of reverse distribution networks: Models and solution procedures*, "European Journal of Operational Research" 2003, vol. 150, no. 1, pp. 128-149.

[7] H. Baumgarten, C. Kornak, *Trends in der Logistik in der 90er Jahren. Basis fur Unternehmensstrategien*, Technische Universitat Berlin, Berlin 1990; M. de Brito, *Managing reverse logistics or reversing logistics management?*, ERIM PhD Series Research in Management (35), Erasmus University Rotterdam, Rotterdam 2003; R. Guitini, *Introduction to reverse logistics*, "Total Quality Environmental Management" 1996, vol. 3, no. 3; S. New, *The scope of supply chain research*, "Supply Chain Management: An International Journal" 1997, vol. 2 no. 1, pp. 15-22; D. Rogers, R. Tibben-Lembke, *An overview of reverse logistics practices*, "Journal of Business Logistics" 2001, vol. 22.

[8] D. Rogers, R. Tibben-Lembke, *An overview of reverse logistics practices*, "Journal of Business Logistics" 2001, vol. 22; H. Dyckhoff, R. Lackes, J. Reese, *Supply chain management and reverse logistics*, Springer, Berlin 2003; S.D.P. Flapper, T. Jensen, *Logistic Planning and Control of Rework*, "International Journal of Production Research" 2002, no 6.

[9] Council of Supply Chain Management, http://cscmp.org/

definition is general and broad, and constructed with a point of reference to the waste management[10].

At the same time there was also often used a different definition of logistics management of defective products associated with the direction of goods movement in the distribution channel. Logistics management of defective products has been set out in it as a "flow of goods from the customer toward the producer in the distribution channel"[11]. A few years later has been sustained the concept of definition associated with the efforts to protect the natural environment through the appropriate use of materials and waste management. According to this definition the logistics management of defective products is "a process where companies can effectively impact on the natural environment through recycling, reuse, and reducing the amount of used materials"[12].

At the end of the nineties the literature presented another definition which also emphasized the objective of logistics management of defective products, as well as its internal processes. This definition specifies the logistics management of defective products as "the process of planning, implementing and controlling the effectiveness, costs and raw material flows, storage in the production process and finished products, and also related information from point of consumption to the point of the original foundation in order to recover the value or properly disposal"[13].

In a later period of time the following definition has been created by the European Working Group on Reverse Logistics: logistics management of defective products is "the process of planning, implementing and controlling the flow of raw materials, processes of storage in production and finished products, from the point of manufacturing, distribution and consumption to the point of recovery and proper disposal"[14]. This concept of logistics management of defective products keeps the essence of logistics, as well as the definition quoted above. There is a difference between the point of origin and the point of manufacture, which gives a margin for the flow of returned products not used at all or some other that may go to another reverse point than the original, so they will be incorporated into other logistics chain.

Modern approach to logistics management of defective products presents the Council of Logistics Management and is characterizing it by the second time as "the process of planning, implementing and controlling the effectiveness, cost efficiency of raw materials flows, processes involving the stocks and finished products accumulation and related information starting with the consumption and ending with the point of value recovery

[10] R.J. Kopicky, M.J. Berg, L. Legg, V. Dasappa, C. Maggioni, *Reuse and recycling: reverse logistics opportunities*, Council of Logistics Management, Oak Brook, IL 1993.
[11] T.L. Pohlen, T. Farris, *Reverse logistics in plastics recycling*, "International Journal of Physical Distribution & Logistics Management" 1992, vol. 22, no. 7, pp. 35-47.
[12] C.R. Carter, L. M. Ellram, *Reverse logistics: A review of the literature and framework for future investigation*, "International Journal of Business Logistics" 1998, vol. 19, no. 1, pp. 85-102.
[13] D.S. Rogers, R.S. Tibben-Lembke, *Going Backwards: reverse logistics trends and practices*, Reverse Logistics Executive Council, Pittsburgh 1999.
[14] R. Dekker, K. Inderfurth, L. van Wassenhove, M. Fleischmann, *Quantitative Approaches for reverse logistics*, Springer-Verlag, Berlin 2003.

or the correct action"[15]. In other words, logistics management of defective products is the process of moving products from their typical final destination in purpose to gain the value or proper operation. This concept of logistics management of defective products is a combination of logistics management skills and activities aimed at reducing and proper placement of waste. In the so-formulated concept also features a "reverse distribution process by which it is possible to meet one of the main tasks of logistics management of defective products, which is collecting and sorting waste with a recoverable value"[16].

Another definition of logistics management of defective products defines it as "a process of planning, implementation and control, efficient and beneficial because of the cost stream of raw materials, components or finished products and information, from the point of consumption to the point of production, in order to recover certain values of the products or their proper disposal"[17].

Describing in a concise manner the logistics management of defective products, while fully giving the nature of this discipline it is necessary to cite the conclusion that logistics management of defective products is "a way of maximizing the value of waste"[18]. Under this definition the waste can be applied to the products present in the flow of logistics management of defective products, which in most cases are treated as defective or waste products.

Definitions of logistics management of defective products have particularly important attribute to the formation the links between the sphere of utilization and spheres of production and consumption. Such an approach sets the new tasks for logistics in recycling processes that rely on "appropriate collection and segregation of raw materials and production materials due to their ability to continue the recovery and recycling processes"[19].

This allows to link the logistics management of defective products with ecology and sustainable development[20].

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[15] Council of Supply Chain Management, http://cscmp.org/

[16] R. Dekker, J. Bloemhof-Ruwaard, M. Fleischmann, E.A. van der Laan, J. van Nunen, L. Van Wassenhove, *Operational research in reversed logistics: some recent contributions*, "International Journal of Logistics: Research and Applications" 1998, no 1(2); H.R. Krikke, *Recovery strategies and reverse logistic network design*. [in] J. Sarkis, *Greener Manufacturing and Operation*, Clarke University, USA, 2001.

[17] D.S. Rogers, R.S. Tibben-Lembke, *Going Backwards: reverse logistics trends and practices*, Reverse Logistics Executive Council, Pittsburgh 1999.

[18] J. Sarkis, *Greener manufacturing and operations. From design to delivery and back*, Greenleaf Publishing, Sheffield, UK 2001.

[19] U. Kleineidam, A.J.D. Lambert, J. Banens, J.J. Kok, R.J.J. van Heijningen, *Modelling of product recycling chains*, [in] I. Troch, F. Breitenecker, *ARGESIM Report No 15*, Proceedings of 3rd Mathmod Congress on Mathematical Modeling, Vienna 2000; K. Inderfurth, S.D.P. Lambert, A.J.D. Rappig, C.P. Voutsinas, *Production Planning for Product Recovery Management*, FEMM working paper 8/2002, University of Magdeburg, Germany 2002.

[20] P. Georgiadis, D. Vlachos, *The effect of ecological awareness and reverse channel capacity on the behaviour of product recovery networks*, Working paper. Aristotle University of Thessaloniki 2001; A.J.D. Lambert, F.A. Boons, *Eco-industrial parks*, "Technovation" 2002, no 22(8); A.J.D. Lambert, M.H. Jansen, M.A.M. Splinter, *Environmental information systems based on enterprise resource planning*. "Integrated Manufacturing Systems: The International Journal of Manufacturing Technology Management" 2000, special issue: the 3rd International Symposium on Logistics, no. 11(2).

4. Management of defective products

Logistics management of defective products in brief refers to managing products that flow backwards in the supply chain, so to the reverse movement of materials[21]. All returns, which often in definitions are mentioned with the name of waste, basically can be classified as defective products[22]. Often such products are also called as end-of-life products. This does not imply that materials are necessarily ending up at their original manufacturers, but refers to the collection of product returns, disassembly and disposal aspects of logistics management of defective products, regardless of their final destination. Companies involved in the reverse supply chain do not have to be identical with the manufacturers of the original product, but can also include new auxiliary channel members[23]. While the broad definitions of logistics management of defective products include any kind of product returns, other definitions narrow down the scope of the concept to those activities that ensure sustainable, or environmentally friendly, recovery of products and materials.

Returns flows can be divided into three groups by return reason, point in the supply chain: manufacturing returns (e.g. raw material surplus, quality-control returns and production leftovers); distribution returns (product recalls, B2B commercial returns, stock adjustments and distribution items) and market returns (e.g. B2C commercial/reimbursement returns, end-of-use). Returns flows can be divided into five main categories: end-of-use returns, commercial returns, warranty returns, production scrap and by products and packaging[24].

Irrespective of the kind of return, returning product is the defective product. There must be always some activities taken by to give back the proper value to the product, or to take back some value from the product.

In case of defective products eco-design is a very useful tool. It allows for maximizing the value of defective product in a various way.

Management of defective products effectively meets the external pressures on business, coming out from: social pressure, government regulations, market requirements, influence of suppliers, pressure from trade unions, competition (as an argument), customer pressure.

And in the same time enterprises that lead the business with defective products management principles and eco-design, get some additional profits in the form of: cost reduction, innovations, improvement of products, motivation, improvement of brand image, responsibility status.

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[21] T.J. Goldsby, T.P. Stank, *World class logistics performance and environmentally responsible logistics practices*, "Journal of Business Logistics" 2000, 21 (2).

[22] D. Rogers, D. Lambert, K. Croxton, S. Garcia-Dastugue, *The Returns Management Process*, "The International Journal of Logistics Management" 2002, vol. 13, no. 2.

[23] M. Huge Brodin, *Logistics Systems for Recycling - on the Influence of Products, Structures, Relationships and Power*, Linköping Institute of Technology, Dissertation No. 53, 2002.

[24] M. de Brito, R. Dekker, *Reverse Logistics- a Framework*, Econometric Institute Report EI 2002-38, 2002.

5. Main principles and background for eco-design

The first mentions of the environmental component integration with product development emerged in the literature as early as the seventies. The whole purpose of these actions was to reduce the amount of solid waste generated by industry and society, and the fact that they are irretrievably lost its value ending in landfills. Attempts to re-use the waste were associated with the development of approach oriented on materials circulation in logistics flows. Products and services were recognized as ecologic when their production, use, and later recovery at the end stage of a product's life, recycling and other management required a minimum amount of materials and energy, as well as generated the least amount of waste (solid, liquid and gas).

Eco-design includes the material and energy balance for a better assessment of the resources necessary to the development of a product and to an evaluation of the impacts on the various ecosystems.

In the literature often are used other terms for eco-design such as ecological design, sustainable design, responsible design, but all of them gain to design products respecting the principles of sustainable development.

Eco-design is seen as an approach that takes into account environmental impacts in product design and development. These impacts refer to the whole product lifecycle, from the mar material supply to the production, distribution and use.

The eco-design concept includes environmental criteria concerning the consumption of raw materials, water and energy, the emission of pollutants into water and air, as well as waste production. So it is a major aspect of the prevention and reduction at the source of environmental impacts. However, eco-design allows for the innovations and creativity of industrialists, as it states as a new opportunity for differentiation and for a future competitiveness factor. Designers can choose and combine solutions because it is a multicriteria approach.

The general idea of eco-design is to avoid or minimize the impacts of product life cycle on natural environment, human health and natural resources. Main categories of these impacts are presented on Figure 1.

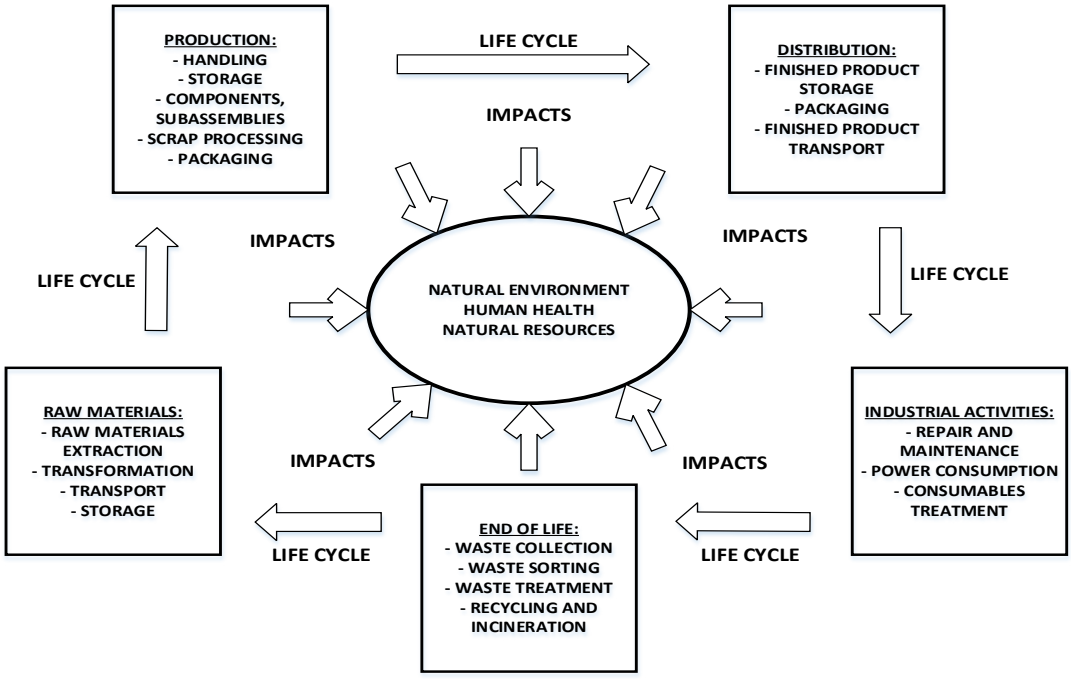

Figure 1. Product life cycle and impacts on natural environment, human health and natural resources cause by its main stages
Source: Own elaboration based on : D. Ait-Kadi, M. Chouinard, S. Marcotte, D. Riopel, *Sustainable reverse logistics network. Engineering and Management*. John Wiley & Sons, 2012, p. 97.

The main impacts on a product life cycle that should be reduced during the process of eco-design are[25]:

- Consumption of renewable or non-renewable materials (use of recycled materials instead of materials taken from nature);
- Energy consumption (for example electric and electronic equipment put in a standby mode to consume less energy);
- Greenhouse effect;
- Atmospheric acidification;
- Formation of photochemical oxidizers;
- Water pollution;
- Soil pollution;
- Transport;
- Waste;
- Effort necessary to carry out the work;
- The impacts that are not taken into account.

[25] D. Ait-Kadi, M. Chouinard, S. Marcotte, D. Riopel, *Sustainable reverse logistics network. Engineering and Management*, John Wiley & Sons, 2012.

Depending on how many environmental impacts are taken into account during eco-design process through design the product life cycle, it is more or less complex and complicated.

6. Eco-design as a tool of defective products management

Considering the fact that the products may appear in flows as both defective products during their life cycle, as well as products after life cycle completion, it is extremely important to design the product ecologically. This is due to the eco-design that possibilities of product re-use increase, in whole or in part, or only materials, what at first allows the obtaining of value, and secondly these products do not burden the environment or in the form of waste, or in the form of necessity to produce new products using natural resources. Thus, the eco-design minimizes the environmental burden.

When making decisions about eco-design and environmental friendly production there should be taken into account a number of different criteria. Given the variety of production processes is not always possible to meet all environmental criteria. The better is fitting to ecology assumptions, the more environmentally friendly is the product, and the greater is the possibility of reuse.

For eco-design we can distinguish 12 main categories that are used to determine the environmental performance of production and the product itself[26]:

1. Production of raw materials:

a) The use of unique materials: which may not be used in production and does not exist in product, may be used in a moderate range;

b) The use of renewable materials: all production and product is based on renewable resources, just certain elements are based on them;

2. Product design:

a) The life of the project: which may be timeless, contemporary, seasonal and short-term;

b) Taking into account the needs and requirements of consumers: products aimed at reducing the need for excessively burdensome environmental products, not taking into account the needs of customers, compatible with a variety of needs;

c) Differentiation of materials: product designed with a single material, small differences in materials associated with the function, high diversity of materials related to the function;

d) Plan of consumption linkages resources with other products: link with more than two products, link with two products, lack of linkages material;

e) The modular structure of the product: modular structure used, partly modular structure, the complex structure;

3. Production:

[26] Based on: W. Adamczyk, *Ekologia wyrobów*, Polskie Wydawnictwo Ekonomiczne, Warszawa 2004; B. Ciecińska, W. Zielecki, *Ekologiczna ocena cyklu życia produktów modułowych*, „Technologia i Automatyzacja Montażu" 2009, nr 3.

a) Management approach: long-term planning without Just in Time implemented, intermediate storage in distribution centres, implemented system Just in Time;

b) Water consumption: water-saving production using the closed water circuits, water-saving production, large water consumption;

c) Energy consumption: energy efficient production utilizing energy recovery, energy-saving production, high energy consumption;

d) Generation of waste: waste-free production, low-waste production where the waste can be recycled, high-waste production where the waste cannot be recycled or only in small amount;

4. Marketing:

a) Chosen suppliers: regional, cross-regional, global;

5. Distribution:

a) The used means of transport: avoided empty runs, empty runs in exceptional cases, the problem is considered as negligible;

b) Used vehicles: minimum emissions of toxic substances, measured emissions and fuel consumption, lack of action on any reduction;

6. Sales:

a) Returnable packaging: used in daily practice, possible to use, not to be used;

b) Environmentally friendly packaging: product does not require packaging, reusable packaging, packaging design improvement;

7. Usage / utilization:

a) Reliability of product: longer than the typical, typical, shorter than typical;

b) The warranty period: more than 5 years, less than 5 years, less than 1 year;

8. Dismantling and waste generation:

a) Susceptibility to dismantle due to the structure: hierarchical structure, there is no relationship, a complex structure;

b) Standardization of components: all parts of standardized and reusable, partial standardization, the lack of components standardization;

c) Hazardous waste: not created, produced in small quantities and controlled, production of significant amount of hazardous waste;

9. Waste collection:

a) Marking materials: all harmful ingredients are labelled, marked the certain substances, harmful substances are not marked;

10. Repairs:

a) Maintainability: easily remedied, remedied with an acceptable level of spending on repairs, impossible for repair;

b) The number and variety of components: small, appropriate to the function, significant;

11. Recycling:

a) The use of recycled materials: 70-100% of materials recyclable, recovery possible at the level of 30-70%, the recovery of materials only up to 30%;

b) Sustainability of the product: product in 100% renewable, renewable are some of the components, the completely new product is needed;

12. Waste disposal:

a) The use of toxic materials: not being used, partially present, a substantial amount is used in the product.

The above mentioned criteria can be modified depending on the specific companies that will use them. Modifications may also be subject to the possibility given to each criterion.

The main objective of the creation of such a classification is the possibility of individual adjustment, the findings of their abilities for each criterion and select the scoring for the evaluation of each criterion. Companies themselves are formed by setting the score limit for which the product and production are environmentally friendly.

Summary and conclusion

The paper presents the general idea of eco-design, and the possibility of its use for processes of logistics management of defective products.

It is obvious that eco-design is very fruitful solution for logistics management of defective products. The flows of returns and defective products are quite extensive, so they must be properly managed. But the companies should get the benefits for such management. So the possibility of re-use some products and/or their components allow to gain the additional value. If the products, before manufacturing, will be designed in the way that allows for further use the materials and components, it will be easy to manage them, when they return. This is the main reason that the modern companies should use eco-design. Additional profit is to be environmentally friendly. This helps to fulfil the priority of sustainable development.

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