

BOŻENA GAJDZIK

Integrative approach to marketing of product and technology lifecycles in innovative and sustainable manufacturing enterprise

1. Introduction

In recent years the value of innovations management of all the functions occurring in enterprises is underlined. The essence of this matter is introduction of novelties into business practice. The actions which are considered innovations are the introductions of new products or new technologies, finding new sources of resources and new organisation of enterprise functioning (J. Schumpeter, 1960).

There is dependence between the product lifecycle and technology lifecycle in the enterprise. The management of cycles is an interactive process, in which the enterprises interact with clients of products, the suppliers of modern technologies and service companies or other entities in the surrounding.

The aim of this publication is to design a model of product lifecycle and technology lifecycle management in the aspect of innovativeness for manufacturing enterprises tend towards sustainable development. In the economy based on enterprise knowledge, in order to develop systematically and in a stable way, the enterprises must learn how to broaden

PhD. Eng. Bożena Gajdzik
Silesian University of Technology
Department of Management
and Computer Science

the scale and range of business activity by introduction of new products and technologies faster than competition. Enterprises should base their strategies on development of modern products and new or modernised technological solutions. In developed countries the customers expect products with highly innovative qualities. The confrontation of the customer expectations with the enterprise possibilities allows for identification of strong and weak points in the interactive model of innovations. The publication was based on literature study and describe method of enterprises' functions in sustainable development of economy.

2. Interactive model of innovations in sustainable business

The connections between the introduction of innovative changes in products and changes in manufacturing technologies and the needs and expectations of the customers are the key elements of Interactive innovation model. The impulses for product modification or introduction of new products are the technological changes and new customer needs. Process of product innovation is a sequence of particular actions, which take place in the following areas: research and development (R&D), production and marketing. In each of the areas are projected and realized activities connected with particular phases of product lifecycle. First phase is a period of high costs and low sales of products. Such situation causes losses or small profit for the enterprise. The risk of new product introduction on the market is a big risk, because the product is unknown to the customer (creation of needs). It is necessary to invest a lot in product marketing (elaborated promotional campaign). In the second phase the dynamics of the sales is big and of progressive type. The company has big expenses on the production (preparation for mass production). The number of customers increase and distribution cost rises. Risk is still high, first competitors appear. Signals that the market is glutted with a product appear in the third phase. Dynamics of sales growth has decreasing character, the enterprise profit also decreases. The sales reaches maximum, market stabilises. Producers lower the price of the product in order to gain additional customers. In the last phase (fourth) the sale drops. Cost of unit manufacturing increases, as a result the profit drops and even a loss may appear. Executives in the enterprise begin actions connected with withdrawal of the product from the market or its modification (Gierszewska G., Romanowska M. 2003, p. 191-200, Kotler Ph. 1994, p. 328). The length of product lifecycle is different for various products and may last from a few to a several dozen of years. With the development of the post-industrial society the lifecycles of products are gradually becoming shorter. Each enterprise does their best to

lengthen the product lifecycle because it causes lower cost of its development and better profitability.

The access to new technological solutions in an enterprise has a key influence on the introduction of product innovations. The notion of manufacturing technology should be understood as the way of creation of a product based on the best available technique adjusted to a given branch and at the same time reducing the negative influence on the environment BAT – Best Available Technique. The environment plays an important role in strategies of product innovations. Enterprises which accept the assumptions of sustainable development realise the dynamic model of environment protection (first of all they prevent the negative

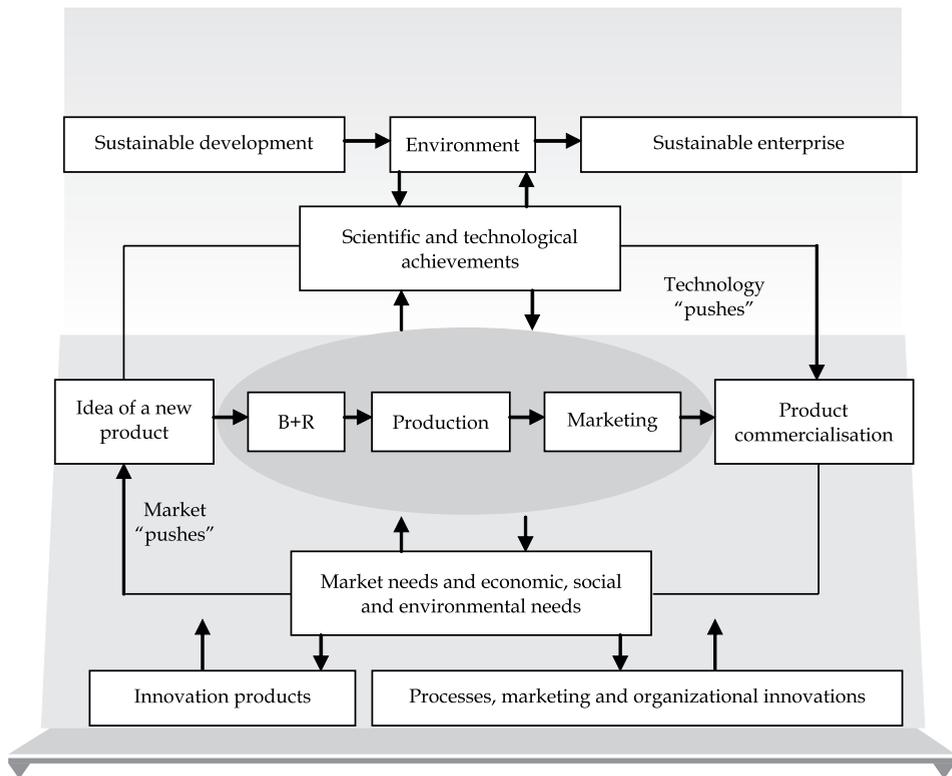


Figure. 1. Interactive innovation model in sustainable enterprise

Source: a part of figure was realized on the base of: Brdulak J. 2005, p. 66

influence of products and technologies on the environment). In the interactive model of innovation in the triad of the key assumptions there are: the market, the environment and the enterprise. In the triad one goes from the assumptions of sustainable development concept, for which the basis is an ecological product, through the best accessible technology one reaches the sustainable enterprise (Grudzewski W., Hejduk I., Sankowska A., Wańtuchowicz M. 2010, p.116). For this model the innovation in the understanding of P.F. Druckera (2005, p. 116) was applied and in it he introduced the division of innovation into two kinds: innovation in the area of product and services and innovation in different abilities and actions (process, marketing, organisational)¹, allowing the enterprises for the product and service to reach the customer and, at the same time, (definition extended by the author of the publication) provide the sustainable development of the enterprise.

3. Interaction product lifecycle with technology lifecycle

Lifecycle of a product is in a nutshell the whole history of its manufacturing and application. It begins from natural resources and other production materials, lasts during all stages of manufacturing and application of the product and finishes in the form, in which the product or its elements come back to manufacturing processes (internal or external recycling). Such system of product lifecycle may be presented in a form of a dependence loop: environment – consumption- environment. This cycle is referred to as LCA (Life Cycle Assessment). It allows for a comparison and assessment of inputs and outputs of a manufacturing system and its potential influence on the environment in the full cycle of existence (Górzyński J. 2007, s. 179-185). A simplified cycle structure is presented in fig. 2.

Table 1. Ecological aspects product and technology lifecycles analyses

Phases of ecological lifecycle of a product	Type of technology	
	Old-fashioned technology	Modern technology
Output of resources, access to materials and intermediate products	<ul style="list-style-type: none"> • limited access to resources, intermediate products, materials • natural resources dominate (primary) 	<ul style="list-style-type: none"> • easier access to resources, intermediate products and materials • artificial resources dominate (processed)

1 OECD/Eurostat, 2005.

Manufacturing of products	<ul style="list-style-type: none"> • high level of pollution emission to atmosphere, water, land, • static model of environment protection (second waste management) 	<ul style="list-style-type: none"> • low level of pollution emission to atmosphere, water, land, • low use of resources • dynamic model of environment protection (based on minimising procedure and prevention of waste formation)
Consumption of energy and other media	<ul style="list-style-type: none"> • high consumption of energy, water and other reserves (high level of energy-consumption and material-consumption of the applied product manufacturing technology) 	<ul style="list-style-type: none"> • low consumption of energy, water and other reserves (designing the product in reference to energy efficiency and aware consumption by the client may minimise the negative influence).
Consumption after use – of side-products	<ul style="list-style-type: none"> • small recycling and reuse possibilities of side-products use 	<ul style="list-style-type: none"> • big recycling and reuse possibilities (the product can be easily fixed or recycled).

Source: Gajdzik B., Wyciślik A., Wieczorek T., 2011, p. 10-34

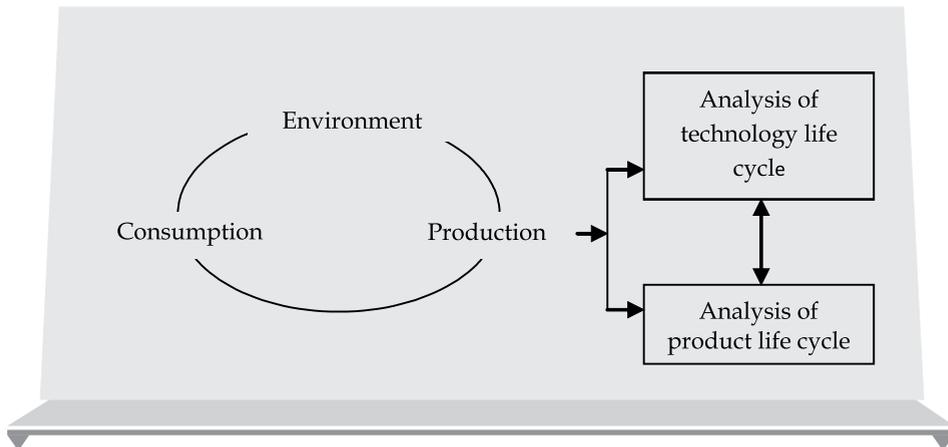


Figure 2. Cycle of environment-production-consumption

Source: own study

In the cycle: environment –production– consumption a multi-level use of all the waste is assumed, which as a result gives zero waste and zero emission. Some

products influence the environment to a highest degree during the production and some during use or utilisation. Before a product is put on the market rigorous tests are conducted concerning its influence on the environment in the whole time of use. The total analysis starts from the moment of output of resources and accompanies the environmental aspects of production, distribution (including packaging), use and utilisation of the product. Of course, for various products the biggest influence on the environment occurs in different stages of their lifecycle. For example, the metallurgical products significantly influence the environment mainly in the process of production (metallurgical slag and open-hearth slag, gas emissions into the air, mainly of carbon dioxide). That is why the decrease of negative effect on the environment is mainly focused on the decrease of harmful effect of those processes, which influence the environment to a greatest extent. Process innovations most often need the application of modern technological solutions (BAT) (Górzyński J., 2007, p. 180-185, Gajdzik B., 2010, p. 289-314). There is a dependence between the lifecycle of a product and the technology which enables the enterprises to introduce innovations quite fluently. In table 1 the environmental aspects are presented in full ecological product lifecycle, taking into account two types of technology, which are the old-fashioned one (decline phase of technology lifecycle) and the modern one (fully active phase of the technology).

The choice of tools for the product lifecycle management is subjected to, among other factors, the technological situation of the enterprise. Technology lifecycle analysis is a tool used to test the competitive abilities of an enterprise in terms of technology. From the point of view of market value there are four types of technologies (Gierszewska G., Romanowska M., 2003, s. 191-200):

1. Experimental technologies (new), with a small range of application, but promising that in the future they will become key technologies; also very well protected against the competition.
2. Key technologies (developing) which are the basis of competitiveness of the products, their mastering is a key to success, they are highly protected.
3. Basic technologies (mature) widely applied in the sector, available and of small or weakening competitive value.
4. Decline technologies (outdated) – gradually withdrawn from the enterprises due to their economic and technical unprofitable aspects.

In table 2 the types of products and technologies were presented together, taking into consideration all the phases of the lifecycle.

**Table 2. Types of products and technologies
in each of the phases of their lifecycles**

Lifecycle phase	Introduction	Growth	Maturity	Decline
Type of technology (according to market value of a technology)	New (experimental)	Key (developing)	Basic (mature)	Declining (old-fashioned)
Types of products (marked according to BCG matrix)	New (problem children)	Developing (stars)	Mature (cash cows)	Old (dogs)

Source: on the base of analyse BCG; Gajdzik B., Wyciślik A., Wieczorek T., 2011, p. 10-34

The following stages should be mentioned in the product life cycle:

1. Idea and concept formulation (thinking up),
2. Designing a new product (project and planning system),
3. Realisation (manufacturing of a new product based on new or modernised technology),
4. Re-use (internal and external recycling).

Formulation of the concept of a new product (thinking up) requires a deep analysis of the customer needs and market situation. Therefore, the first stage begins from customers, on the basis of their knowledge, by formulation of their needs, preferences, likes and the end of product's life occurs in case of the user when product is fully exploited and after re-use after real consumption. During the planning stage a directed scientific research is necessary. Enterprises may use the intellectual potential of their own workers employed in units dealing with research and development (R&D) or buy ready-made solutions – know-how (licences and patents) (Gajdzik B., 2010, p. 289-314).

A stage of detailed designing of a product occurs together with designing technological modernisations (purchase of new machines, devices, additional service back-up). Manufacturing of the products is more and more automated (*high technology*) and that is why in the analysis the IT computer systems existing in an enterprise are presented together with conceivable possibilities of purchase of new solutions. Technology transfer in innovative economy is realised according to the assumptions of open innovation model (*open innovation*) (Santarek K. (red.), Bagiński J., Buczacki A., Sobczak D., Szerenos A., 2008, p. 30). The characteristics of the open model is based on the exchange of the knowledge and experience between the enterprise and the environment, as well as the participation of the external organisations in the R&D works which is bigger than the amount of

work performed internally within an enterprise. Time pressure and the cost of research and development works cause that the enterprises decide to use services of highly specialised units. In the “open” model the supply on the market with the broadly understood services connected with research and development, services connected with service of technology, counselling computer and design rises steadily. The key factor of development of the “open” model is globalisation of the markets of products and technologies. Global competition forces the enterprises to introduce quick changes, which favour being open to co-operation with the surrounding in terms of gaining innovations. About 45% innovation in enterprises are from environment (Linder J.C., Jarvenpaa S., Davenport T.H. 2003, p. 43).

The most important stage of product management is the realisation of the designed innovations. This stage requires an efficient service back-up (maintenance service) and other back-up systems. In the second stage there is a need of co-operation of three systems, which are technology – set of devices and machines needed for production; production capability – for creation of innovative products and service system; and maintenance – necessary for the proper course of production process and reliability of the applied technologies. Manufacturing system is based on the analysis of product lifecycle, whereas technological and service system on the analysis of technology lifecycle. Particular lifecycles have different characteristic features in each phase, the duration of them is different but their simultaneous analysis enables to determine the mutual influences between them. Such approach allows to test the market age of each product of a given enterprise and each technology used in it. The result of such analysis is the rational planning of the range of production and the costs connected with the introduction and creation of new products and technologies.

Taking into account the concept of cost in the interaction with the expectations of the purchasers the term of “value innovation” or otherwise “valuable innovation” appears in the reference books. Graphic representation is presented in fig. 3.

The notion of value is understood very broadly. Particular disciplines of knowledge expose different criteria of building value. The definition of value for the customer from the point of view of economy is: “the feature of the object towards which that object is considered more or less needed, borrowed, respected or important” (Gajdzik B., 2011, p. 203-210; Dobiegała-Korona B., Doligalski T. 2010, p. 26-27). In this theory the value means full and continuous meeting the needs of recipients on the competitive market by achievement of

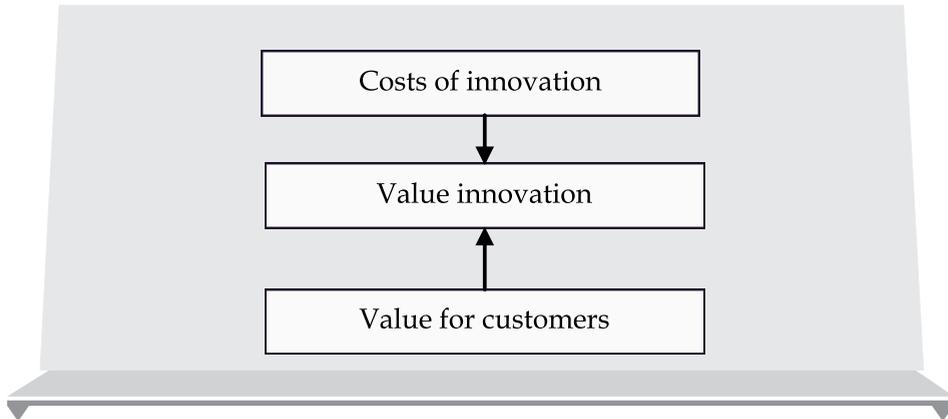


Figure. 3. Value innovation

Source: Kim W.C., Mauborgne R., 2007

the best position in the assessment of customers, who purchase the product at a given price (Dobiegała-Korona B., Doligalski T. 2010). In management branch the meaning of value is the maintenance and gaining the customers in order to reach the higher levels of profitability by efficient and effective actions the enterprise (Czakon W. 2005, p. 24 by: Player S., Lacerna R., 1999, p.4). In the finance branch the notion of value is associated with, the so called, fundamental value, marked on the basis of the valuation of the elements of assets (the possessions of the enterprise) and with the assumption that such price can be paid by investors on free and competitive market (Bodie Z., Merton R.C. 2003, p. 284). In the finance branch the notion of value is associated with the value of the enterprise assessed with the use of various methods, that is accounting (the value of assets), liquidation (market value of the enterprise less financial commitments), reconstruction (the company is worth as much as it would cost to build it from the beginning), stock valuation (the valuation of joint-stock companies), current cash flow (costs and income from particular activities) (Bodie Z., Merton R.C. 2003, p. 284). In the branch of finance, the customers are perceived as the elements of assets who have influence of the value of the enterprise. In marketing the precursor of the value definition is Ph. Kotler, who defined this notion as the difference between the predicted price of all the benefits which the customer may get when buying a product and the amount of input which must be used in order to consume those benefits. The examples of input are: financial expenses, time

input, risk connected with offer choice, the costs of purchase. The benefits are: the quality of the product, the satisfaction of the customer, form of the product, functionality, the accessibility of the offer, additional benefits, for example discounts and special prices (Kotler Ph., 1998, p. 466). In logistics, value means, first of all, the features of logistic product which are factors connected with time, cost and quality of logistic services served. Logistics combines the marketing actions, financial actions and operational actions in the network of functional and organisational connections of the enterprises which serve the customer on the market (Mokrzyszczak H. 1998, p. 133-134). Together with the development of sustainable development concept a term of sustainability value appeared. The basis for its creation is the balance between the technological-economical aims and ecological and social aims in the enterprises. Modern customers, more and more often pay attention to the kind of the used packaging, possibilities of recycling, the influence of the product on the environment, way of utilisation etc. Customers look for healthy products, ones which are safe and ecological. The concept of value is constantly modified and besides the material features connected with the purchased product, the non-material features become also its basis like aesthetics (finding and creating beauty), ethics (searching and creation of the good), reputation of the company (goodwill) *Dobiegała-Korona B.* 2007). In table 3, the modern determinants of product value in the eyes of customers are presented. It should be pointed out here that the list is open, because the notion of value is complex, and, as the experts in the field of value concept claim, it is highly subjective.

One of the components of product value is its ecological aspects. Customers after consumption of the market products are interested in less product waste. According to new payment (communal waste management) customers and local organizations tend towards reduce communal waste. Moreover producers have to produce goods that after customers' consumption have to decrease communal waste.

On the basis of old technology the enterprise is not able to produce modern and ecological products. The decline phase affects also the market products. A product is withdrawn from use and a phase of its re-use of the whole product or a part of it follows. In life cycle management this phase is significant and includes the issues of eco designing, environmental balance and striving at the zero waste production. Phase four of the lifecycle model of a product - reuse - is based on internal and external recycling. If enterprises realise recycling they need to have technology which enables the second use (reuse) of the product leftovers. Manufacturing enterprises expand their machinery and commission

their recycling to other companies specialising in that matter (outsourcing of waste).

A lifecycle of a product and technology is a technique of strategic analysis, enabling the application of the portfolio methods, the analysis of key factors of success, the test of money flow as well as strong and weak sides of the enterprise. On the basis of enterprise assessment results a decision is made to introduce product and technology innovations. Particular technological and product innovations are followed by organisational and managerial innovations like benchmarking, time management TBM, Just-in-Time concept, philosophy of Kaizen, Kanban, *Total Productivity Maintenance*, *Lean Production*, FMEA, 5S. The application of those modern solutions in the area of management of an enterprise leads the company towards the status of a WCM company that is to *World Class Manufacturing*.

Table 3. Basic determinants of product value in the eyes of customers

Categories of value	Benefits for the customer
Value of function	Adjustment of the product to individual needs and expectations of the customer, in which there are: operational functions of a product (usefulness of a product), the easiness of maintenance, the safety of use etc.
Value of form	The possibility for a customer to choose the shape, size, style, accessories, sort, etc.
Value of price	Discounts and special offers (referring to amount or seasonal), promotional prices, combined offers, special offers, sale in instalments with low interest rate, etc.
Value of time	Availability of the offer in time convenient for a customer, the possibility to order products by means of websites of the producers, electronic service of calculations, production of items <i>Just in Time</i> , short period of order execution etc.
Value of place	Delivery of products to places convenient for the customers (transport organised on the cost of the producers and the traders).
Value of possession	Diversity of the purchase forms, for example: paid in cash, in instalments, on credit, leasing etc.
Value of communication	Professional consulting and advice, availability of information concerning the offer, the conditions of use of a product, forms of purchase etc. Communication of the 21st century is the information service available 24/7 and active (mutual) information flow.
Value of education	Customer is initially trained on the use of the product: there are shows and demonstrations of the product.

Value of experiences	These are the sensations of customers connected with purchase, use and recycling of the product.
Aesthetic values	It is the accordance of a product with the current trends in fashion, the aesthetics of the workmanship, the right colours, the form etc.
Value of brand	The reputation of the company and the product, the share of the company in the market, the familiarity with the brand, the extent of acceptance, the position of the brand on the market, time of brand existence on the market(tradition), the capital of the brand, etc.
Ethical values	Aspirations of the customers to purchase products which take part in programs of SR - <i>Social Responsibility</i> .
Value of innovation	Customer purchases a product which is the latest technological innovation.
Ecological values	Availability of purchase centres of products which no longer serve their function, the cost of recycling, the safety of waste management, lower use of energy, fuel, reduction of pollution etc.
Service values	Additional service offered to customers, such as overhauls, conservation, insurance, installation, starting, renovations, transport, repair service, etc.
Value of trust	The customer's assessment of the company based on the satisfaction level in reference to the purchased product. Companies with regular clients offer them loyalty programs, additional sets, sets of free services etc.

Source: own research, extension based on Dobiegła-Korona B. (2007), Gajdzik B. (2011), s. 203-210

4. Conclusion

Innovativeness of the product lifecycle is subjected to the lifecycles of technologies. In market economy the new, competitive products and services appear quite quickly and the creation of innovation is often based on the idea of an open market where the innovativeness is co-created also outside the enterprise and not only within the developed infrastructure B+R (the rule of costs reduction). The notion of technology and innovation is understood very broadly in modern economy, and their interpretation is subject to category of value for the customer. Relationships which occur between the product life cycle and technology influence the sustainable development of the company and particular stages of such development because enterprises on the industrial and customers markets are the basic element of sustainable chain between economy and ecology. Other institutions and organisations (higher in organizational economy) are responsible

for establishing law and principles for particular activities in economy. Producers and customers bear the high expenses of sustainable development. These groups have direct interest in reduce of waste.

The summary is presented in table 4, on the basis of chosen criteria, with features of subject lifecycles which are the company, the technology and the product.

Table 4. Lifecycles of company, technology and product – chosen comparative criteria

Criterion	Duration
Lifecycle of a company	Diverse depending on a company (Japanese Hotel Hoshi exists for 718 years, ArcelorMittal Poland has been functioning on the Polish market since 2007)
Technology lifecycle	Average (together with the development of science and technology the duration of particular phases of technology lifecycle shortens, in the past a given phase of increase and maturity lasted up to 10-15 years, now it is 3-5 years)
Product lifecycle	Relatively short (huge changes in needs and expectations of the customers)
Criterion	Competitiveness of particular phases of the cycle
Lifecycle of a company	The strongest in the increase and maturity phase (in the birth phase there are huge capital needs, costs, so called fixed appear independently from the size of operated market)
Technology lifecycle	In the phase of introduction and growth (admiration of the innovativeness of technology occurs in two first phases of the lifecycle)
Product lifecycle	In the phase of introduction and growth (customers are interested in purchase of new product, rapid growth of income from sales of products for companies)
Criterion	Innovativeness
Lifecycle of a company	Product innovations, technological innovations and other (organisational-managerial) decide on the level of innovativeness in a company
Technology lifecycle	Technological innovations enable to introduce the product innovations
Product lifecycle	Product innovations are subjected to the needs of the market (creation of demand)
Criterion	Influence of conditions on the changes in a cycle

Lifecycle of a company	Influence of external factors (mainly market related) and internal factors
Technology life cycle	External factors (technology transfer) and internal factors (possibilities of a company, including the possibilities within B+R)
Product lifecycle	Market factors prevail, first and foremost the needs and expectations of the customers

Source: on the base of: Górzyński J. (2007), *Podstawy analizy środowiskowej wyrobów i obiektów*, Wyd. Naukowo- Techniczne, 2007 Warszawa; Gierszewska G., Romanowska M. (2003), *Analiza strategiczna przedsiębiorstwa*, PWE Warszawa

Presented dependencies of product lifecycle and technology lifecycle enable the formulation of the following conclusions:

- cycles management is an interactive process, in which the enterprises interact with the surrounding,
- innovations in enterprise management are understood very broadly as innovations of value,
- category of value for the buyer is subject to constant modifications,
- implemented innovation in manufacturing enterprises help them to realize the principles of sustainable development, new products and technologies should reduce negative influence on environment and use less environmental resources.

Summary

Integrative approach to marketing of product and technology lifecycles in innovative and sustainable manufacturing enterprise

Management of product lifecycle and technology lifecycle should occur in integrated way. Innovative technology achieved in own B+R point or from the surrounding of the enterprise creates conditions to implement new product solutions. The introduction of a new product and new technology must take place in a synchronised way and should take into account the value for the buyer. Moreover, it should not be forgotten that the relationship between the product, technology and the environment is essential in an attempt to reach a state of a sustainable enterprise.

Key words: *product lifecycle, technology lifecycle, innovation, sustainable business.*

Streszczenie

Spojrzenie integracyjne na zarządzanie cyklami życia produktu i technologii w innowacyjnym i zrównoważonym przedsiębiorstwie produkcyjnym

Zarządzanie cyklami życia produktu i technologii powinno przebiegać w sposób zintegrowany. Innowacyjna technologia, pozytywnie oceniana w własnym ośrodku B+R lub z otoczenia przedsiębiorstwa, warunkuje wdrażanie nowych rozwiązań produktowych. Wdrażanie nowego produktu i technologii musi przebiegać w sposób zsynchronizowany z uwzględnieniem wartości dla nabywcy. Ponadto należy pamiętać o relacjach produktu i technologii z środowiskiem dążąc do osiągnięcia stanu zrównoważonego przedsiębiorstwa.

Słowa

kluczowe: *cykl życia produktu, cykl życia technologii, innowacje, zrównoważony biznes.*

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