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USER AS A SOURCE OF THE INNOVATION BASED PRODUCT VALUE

Pawel FILIPOWICZ

AGH University of Science and Technology, Krakow; pawelfil@agh.edu.pl, ORCID: 0000-0003-2807-2295

Purpose: Development of the customer perceived value expression with the product use functions optimization model aiming particularly the case of new technology based innovations.
Design/methodology/approach: Firstly, the role of customer is presented with particular attention payed to the client role in value creation process in the case of innovation based product. Then the perceived customer value and customer value definition are described. Those formulas are used in consequence as the base for expanded theoretic value concept, which is integrating the impact of used product brand and user functions mix. Finally, the introduced notion is developed in matrix form and briefly discussed.
Findings: Extended formula of innovation based new product perceived customer value is presented in the form of the matrix notation, the possible application in the company innovation based product portfolio formation process is discussed.
Research limitations/implications: Presented approach to the customer perceived value is based on the application of technical debt concept as the measure of analyzed product innovativeness, which is sensitive data and stay difficult to collect, particularly in case of new technologies.
Practical implications: Proposed extended customer perceived value formula can be used as practical tool of new technology based innovative product, allowing to assess its market value in comparison to the existing company product cost structure. Makes possible to confront the customer product appreciation to those coming from the company interior analyzes. Hence its matrix form can serve as optimization model taking under consideration the possible market potential, impact of used brand and design and product use functions mix according to their technology life cycle.
Social implications: Developed concept can reinforce the client role in commercialization process, particularly in case technology innovation. Also its use can be an interesting tool of prosumption development, making it more unambiguous and proactive.
Originality/value: Presented extended formula of customer perceived vale can be applied as an interesting concept of research about nature the value of new technologies based innovation product also as base for practical managerial tool of optimization the new product mix during the commercialization process.

Keywords: perceived innovativeness product value, new technology, technical debt.

Category of the paper: Conceptual research paper.

1. Introduction

The customer's participation in the value creation process leads to the conceptualization of new business models, breaking with product-centrism and more focused on the customer and his or her individual needs. This approach is also related to product innovation, resulting from a strong drive for differentiation. The innovation introduced by the company develops into customer-oriented value creation and results in a concept of customer-oriented innovation. A new organizational logic resulting from the customer-oriented value creation process requires an unambiguous formalization of the individual components of the latter. This approach assumes that the company, in order to maintain its competitive position, monitors customers for changing needs and competitors for changing products. Since innovation creates its market by conceiving a discontinuity of customer perceived value, a new strategic view of innovation is required to overcome the constraint of a defined business and market (Wu, 2005). The major challenge for a company that wishes to create radically new values and develop new markets, is to make a totally new strategic perspective based on strong relationships with customers. To create customer feedback loop, it is necessary to determine specific areas of user impact on the innovative process in a given company. Hence the key research issues that should be addressed to determine the components enabling the implementation of this process and the conceptualization of the appropriate organizational logic based on innovative product value as the user functions set. The growing importance of a customer-oriented management approach is the reason for increasing the interest in the product value concept. In addition, the development of new technologies contributes to the search for reliable tools of innovative products value measure, hence the order of presented contents. Firstly, the essence of new technologies based value creation is described, particularly underlying the customer role. Secondly, selected customer value models are described with attention paid to their possible quantification. Finally, the own concept of such value model is presented, taking into account the impact of design in relation to the individual product use functions with their technical debt as an innovation measure parameter.

2. Customer-oriented approach to the new technology and its impact on product value development

M.E. Porter’s value chain applied to the innovation process has become the basis of value creation models for new technologies. For the correct application of this process, it is important to properly identify its basic and auxiliary activities. Basic activities are

directly related to the innovation model and are as follows: identification of needs, research, development (innovation), commercialization, dissemination and adaptation. Indirectly affecting the course of innovation, auxiliary activities, like competence management, research and development of technological infrastructure and knowledge management, are also needed (Porter, 1993). This division is practically a reflection of the classical approach and does not emphasize the importance of knowledge resources, including them into auxiliary activities. This is contrary to the intuitive understanding of innovation as a derivative of knowledge resources. Assuming that the concept of a knowledge-based chain reflects the essence of innovation better, it will become important to map this process to determine the way in which the value of an innovation process should be understood by its individual participants. By analyzing different types of this process, it is also possible to determine the roles of its participants in creating values at each stage of the process.

The concepts of these values are general in nature and not specific to one company only. In the proposed model of the innovation value chain, different types of value can be created by different participants. However, the accepted taxonomy of the participants needs to be clarified: the concept of the innovative knowledge producer refers to the legal or physical entity responsible for the value generated in the activities of knowledge recognition, testing, implementation and application. It is important that the innovative knowledge should provide an opportunity for the company's operations in a proven way, creating the value of potential development. According to C. Van Horne, J.M. Frayret and D. Poulin, the user of innovative knowledge can be defined as an internal or external customer (Van Horne, Frayret, Poulin, 2006). The customer’s activities include the use of new knowledge to develop a product or its new application. This also applies to prototypes. The essence of the customer's role in the value creation process is therefore closely related to the ability to identify the possibilities of implementing innovation, and thus to give it potential value. It is also important to create the right infrastructure to enable the customer to obtain value from the innovation. Customers can serve as valuable partners for company product, service or process innovations by contributing innovative ideas or engaging in collaborative development projects. They can also speed up innovation development processes, engage in a larger and more long-term oriented communication process and gain access to a wider perspective on possible modes of commercializing new technology. Adopting a user-centric approach by company management requires customer involvement. Hence, the importance of customer innovativeness, defined as the capability to create and implement innovations, throughout the operating and technical systems of the company. It is a basic determinant of the customer's demand for innovation, information, and access (Ritter, Walter, 2012).

Customer innovativeness plays a primary role in the value creation reorganization assisting companies to anticipate value proposition preparation and constituting at same time a significant source of market knowledge. Integrating customer innovativeness requires building a communication system which has to be a guarantor of communication continuity

insuring a comprehensive incorporation of customer opinions even when they are opposite to the vision of company management. Customers with a high level of innovativeness have more experience in concretization of future user functions thus predetermining the market value of innovation based new products or services (Pieper, 2019). Customer participation in the technology innovation development process helps also to maintain an adequate life cycle for this process helping to reduce the risk of overinvesting in undesirable new technology product applications (Klennera, Hüsigb, Dowling, 2013).

Therewith the economic value of technology remains an unspecified concept until its commercialization, often consisting in the creation of an appropriate business model. H. Chesbrough argues that a mediocre technology supported by a good business model may be more valuable than a good technology supported by a mediocre business model (Chesbrough, 2010). In the adopted pro-consumer perspective, it is therefore important to determine the path of monetization of the new technology, and here the perspective of the potential user cannot be overlooked. However, along with the desire to include customer interaction as the basis of the product concept or business model for a new technology, it is important to take into account the statement of E. Esposito that the customer will value the product's technical and economic parameters in a variety of ways - some will be more important to him or her, others less important (Esposito, 2004). Market success, on the other hand, will depend on the performance of various activities resulting in compliance with the existing customer preferences. This approach includes the point of view of the customer and not of the designer, which fits into the market-oriented management. Such an attitude makes it possible to avoid the isolation of the market for new technology, which is usually a significant problem for companies. Different technological parameters of the product are usually not related to each other. From such a perspective, the characteristics of the product will become a compilation of technological and economic parameters. The innovation of the product will depend on what parameter is dominant in its existing characteristics. In turn, G. Tyng-Ruu Lin and J. Lin point out that in the light of growing customer requirements, achieving the durability of the value will depend on offering it simultaneously to all stakeholders of the company (Tyng-Ruu Lin, Lin, 2006). The classic concept of value is related to the usability of the products and also depends on understanding the specifics of customer needs and the speed of their satisfaction. Real value growth, long-term growth and profitability growth occur when companies are constantly developing their products and services by offering unique benefits to a selected group of customers. Maintaining a leading position therefore requires ensuring a continuous process of value creation. This approach refers to a thorough analysis of the needs of all innovation stakeholders, their preferences, feelings and emotions.

Despite their ability to create productive innovation, some companies are failing in the market. This loss of market advantage, despite offering highly innovative products, is becoming an important area of discussion and scientific and practical research. Some companies have lost their marketing skills to commercialize their innovations. It can be assumed that these companies are unable to adapt their business models to the

changing environment. This means that in the future, competition will not only concern products and technologies, but also the business model. Unfortunately, many companies build their business model based on limited information about the environment in which they operate (e.g. the fall of Kodak, overlooking the potential of the digital photography market). According to O. Gassmann, K. Frankenberger and M. Csik, companies introduce solutions that are not adequate not so much to the current market situation, but to existing trends and potentially possible changes in the functioning of society (Gassmann, Frankenberger, Csik, 2020). Usually, in such a situation, failures are accompanied by a reaction leading to the intensification of research on the development of new technologies and new products that increase the functional aspects of the current ones. R.G. Mc Grathy noticed, that some companies can be assessed by determining the degree of uncertainty in the development of innovation initiatives in relation to core activities (Mc Grathy, 2013). Some of such innovation initiatives will be linked to the expansion of the core business in order not to lose existing customers in the future. In the case of such companies, the degree of market and technological uncertainty is low. The development of core business in such conditions will be based on activities leading to increased efficiency in order to maximize the related sales revenues, thanks to which the company achieves its goals. However, if the core activity is not competitive, the introduction of innovation initiatives should serve to strengthen it. It happens often that a company develops new activities, which in the future have a chance to become core ones. In such a case, it is important to invest in new economic platforms, the development of which will be based on an innovation process. In all the cases presented above, such platforms, maintaining close contact with potential users of new products, can also become a tool for actions to minimize the risk associated with innovation. According to H. Campos, the analysis of user reactions and behavior will not only be based on statistical data, but on new ways of creating product meaning (Campos, 2021). Previous observations show a very low awareness of the user's new needs, hence the emergence of a new role for designers – identifying new needs in terms of making corresponding meanings. Such a perspective is necessary for the effective management of the innovation process, especially in the aspect of effective commercialization of new products.

The above approach to innovation breaks with the classic link with research and development. The new approach emerges as a reaction to linking innovation and technological development too closely, at the expense of a company's development and changing its operation strategy. Strongly innovative companies do not necessarily spend the most, but effectively link their innovations with the implemented strategy. They focus the management process on innovation for which they create a strong cultural support accompanied by high knowledge and understanding of the end users. Such an extension of the concept of innovation does not negate the need for intensive financing of its development, but it is not a necessary condition. Some of such companies succeed by perfectly identifying the future needs of users to increase the likelihood of market success of the developed innovation.

3. The user role in the value creation process – chosen quantification attempts

The search for ideas to create market-effective innovative products is the first and most important reason for maintaining relations with the broadly understood community around the company. Customers and users are an important part of this community. These contacts constitute therefore the economic platforms whose important area of activity is to maintain effective communication.

These platforms are often used to group admires of a given company or brand. According to S.G. Blank, the essence of these activities is the desire to create a model, specific to a given company, of the customer development process (Blank, 2006). Its specificity includes focusing on the customer and not on the product. The model is therefore based on structuring and organizing the company's activities into customer-related ones. Those activities can be divided into four processes: finding the customer, approving the customer, shaping the customer's perception and creating a business venture as a source of value. These processes grouped in the above model are therefore a support for the product development process. Within such a perspective, a certain interpretation of a new technology allows for its application in utility functions incorporated into the new product.

Also, according to J. Redstrom, it is the new utility functions that are the consequence of such an interpretation, consisting in determining a new or different application of a new technology (Redstrom, 2006). By analysing the existing utility functions of the product, it is also possible to reinterpret them and to determine a new way of using the existing product. New technologies significantly increase the possibilities of determining utility functions and their combinations to satisfy specific needs of the customer. Then, the process of designing a new product oriented towards its user fits into the logic of prosumption. This is made possible by new technologies, used in this case as an attribute of the customer communication process and as an area of searching for innovative solutions. This approach makes it possible today to design a product according to strictly defined, individual needs of the customer based on physical and psychological profile. The product is then co-designed and co-created to meet the specific needs of a specific customer. According to S. Doustmohammadi, R. Valamanesh and E. Sandres, the factors that enable the implementation of such a product concept are e_communities and three-dimensional printing (Doustmohammadi, Valamanesh, Sandres, 2014). The current expectations of the market and of the customer are different, often unpredictable, resulting from the specificity of the needs of a particular person, and not from averaging the results of the survey. The introduction of such in-depth individualization will refer not only to the material factors characterizing the needs, but also to those present in the individual sphere of feelings and beliefs, which will therefore be important for the appropriate process of creating the value of the new product.

The emerging concept of user value includes a value that is aimed at the user who directly interacts with the product. This means a deep need for the value that motivates the user, which is important for innovations that change user behaviour. Failure to take these values into account will translate into the termination of the use of the product or service and the loss of the opportunity to take over the value of innovation. These types of dependencies apply to entire groups of users. Especially if a company wants to achieve an impact at the level of society as a whole, which is particularly important in the case of an innovation process. J.F. Figueiredo, N.C. Correia, I.S. Ruivo and J.L. Alves noticed that such a modified approach to the innovation process significantly eliminates the previous dichotomous division into the technical area and the marketing area of the innovative product (Figueiredo, Correia, Ruivo, Alves, 2015). The essence of this division was the lack of consistency between the quantitative technical description and the growing amount of qualitative data characterizing the market aspect of innovation – especially in creating value for innovative products. Design has become an exemplary personification of the innovative aspect of products based on new technologies. It is an element stimulating the innovative process. It becomes a tool for understanding unsatisfied social needs. The innovation process carried out in this way begins with defining how design and innovation can be combined, using applied art, to create new, original and ground-breaking products.

According to M. Gasparin, thanks to this approach, a new meaning develops, which becomes the reason for choosing and using a new product (Gasparin, 2018). Meaning is then understood as the sense of a product, as a perception of how a thing can be experienced. Meaning is not a permanent concept, it changes depending on the person, gaining specific experience with the use of the product. The implementation of such a concept requires that design should become a key component of the innovation process by understanding the needs of the user so as to be able to create an understandable vision of the new meaning of the product that customers do not yet know or are waiting for. The product then becomes a tool of persuasion or an argument from a rhetorical perspective. It is part of the sign system by which product users create meaning.

C. Jutant, A. Gentes, M. Bejean and C. Mivielle underlined the essence of the formulated theory, which is therefore how people give meaning to things beyond the current interpretation of the fact of their possession and beliefs resulting from their use (Jutant, Gentes, Bejean, Mivielle, 2019). The semiotics of design is an important element of giving symbolic values to things. Thus, a justification of the meaning of existing things is created through material and social interaction, cultural knowledge and communication skills. From the user's perspective, what becomes important is the symbolism attributed to radical innovation and the corresponding meaning of the new product. In the case of radical innovation and derivatives of its products, the design does not refer to the current state of affairs, but must be directed by imagination and interpretation (of the new technology). Design is not a way of initiating the process of creating a new meaning for an innovative

product, but rather a tool crowning the creation of its value. In practice, according to C. Fuchs and F.J. Golenhofen, determining the value of a product means finding an answer to the question of what maximum amount of money a person is willing to pay for satisfying his or her needs (Fuchs, Golenhofen, 2019). Value will be shaped by two factors, and meeting the customer's needs constitutes the first one. This can be done in various ways, shaping the product functionality, costs, emotions and joy, and this way offering the expected meaning. The quality and unambiguousness of the estimated customer value depends in particular on the homogeneity of customer groups. It especially depends on their values, beliefs and needs. The second factor is the amount of expense that the customer is able to incur to purchase the product meeting his or her needs. This expenditure can be measured by the equivalent of money, time, energy or human labour. Hence the following formula (1).

$$\text{Value} = \frac{\text{Need Satisfaction}}{\text{Expense}} \tag{1}$$

It is not a formula in the mathematical sense, but is intended to describe the existing relationship for the needs of the product development process. The expense will usually mean the price paid for the product. The creation of value, on the other hand, occurs when the customer's needs are met or exceeded, which is reflected in a reasonable price level. For manufacturers, the perspective of value perceived by the customer will be the most important, determining his or her willingness to pay. Depending on the standards of a given market, the manufacturer has a certain opportunity to shape the level of production costs so that it corresponds to the price expected by the customer. The producer should take into account the expected price level on the market, adapting to it in order to capture the greatest possible value. Value offered to the customer can grow by reducing costs or by more effectively meeting needs expected by the customer, and it can be defined in a new way (2).

$$\text{Value} = \frac{\text{Function}}{\text{Cost}} \tag{2}$$

The process of creating value will then mean maximizing the relationship with the customer. It should be noted that so far the most commonly used approach to increasing value has been based on minimizing costs. This approach is not enough and significantly limits the possibilities of shaping value through the development of the product user functions, increasing its customer functionality. The experience gained by the user of the product will depend on the user functions, their combinations and the meaning created thanks to them.

According to Ch. Kraft, the very concept of user experience is defined as personal experiences and impressions resulting from the use or anticipated use of a product, system or service (Kraft, 2012). Simplifying the previous definition, it can be concluded that user experience is the user's feelings resulting – perceived - from the use of a given product. These feelings can be positive or negative, extreme or balanced, so an attempt can be made to describe the change in these feelings during the use of a particular product. The subjectivity of

feeling makes it difficult to measure it. It results from the fact that the reactions of different people are different. In the same situation, the feelings of individual users may therefore be completely different. The company's goal will be to maximize the positive feelings of the user of the product. Another possibility is to minimize negative feelings, the effect of which is disproportionately stronger than positive ones.

The concept of user experience is strongly related to another concept – user expectations. It is assumed that reputable brands create high customer expectations, which in turn implies high sales margins for such products. According to Q. Liu, Q. Du, Y. Hong, Y. Fan and W. Shuang, most companies will therefore strive to induce high expectations in their customers in order to be able to satisfy them with their product (Liu, Du, Hong, Fan, Shuang, 2020). The wrong reaction to high customer expectations can cause great difficulty for the company. It is worth adding that customer expectations vary according to cultural differences and the way the product brand is perceived. The relationship between the user's experience and expectations is a very interesting issue, the understanding of which creates an opportunity for companies to develop. It should be added that there is a relationship between the user experience and the customer experience. Customer experience covers all issues related to the purchase of the product. The relationship between the user's experience and expectations is a very interesting issue, the understanding of which creates an opportunity for companies to develop. It should be added that there is a relationship between the user experience and the customer experience. Customer experience covers all issues related to the purchase of the product.

4. Design and use functions technical debt as customer perceived value modelization parameters

Analyzing the possible management application of technology, P. Asthana remarked that the primary barrier to adopting a new technology is uncertainty about its acceptability to the market because of non-existing customer experience (Asthana, 1995). Any unfamiliar technology takes time to gain acceptance in the marketplace, and the early market penetration is slow because size of buyer market is small due to undefined customer expectations. Being first on the market makes for the company the unique situation of acting without competitor’s pressure, so the capture of large market part is possible and the position of market innovator is granted. This situation allows to realize the extraordinary profits, but at same time this unique market position is very suitable for other companies. All the same, being first to market as a winning strategy is somewhat overrated. The concept fails to take into account the impact of how long it might take for the market to accept new high-technology products. For a product that had no time lag between the technology s-curve

and the marketing s-curve, first-to-market certainly could be a winning strategy but of course it very optimistic vision the inverse can also happen. The company, that is second or third to enter the market may have an advantage: it can target an already educated, receptive market and can thus spend its marketing resources on promoting its brand image. Hence, the business strategy of differentiation requires that the business have sustainable advantages that allow it to provide buyers with something uniquely valuable to them (Pearce, Robinson, 1994). A successful differentiation strategy allows the business to provide a product or service of perceived higher value to buyers at differentiation cost below the value premium to the buyers. Differentiation usually arises from one or more activities in the value chain that create a unique value important to buyers (Lopez, Noriega, Valenzuela, Serrano, 2022). The innovative company can show the importance of the innovation through its goals and these are different from one firm to another. In some firms, the innovation is in the essence of products and services; therefore, the business philosophy must demonstrate the firm´s commitment with technological innovation. But company product innovation strategy must be conceptualized not only by focusing on R&D activities, but also by linking the innovativeness of prepared conception to the company potential. In fact analyzing the actual state of organization, innovation strategy design should be associated to technical excellence which has to be measured by both capacity to deliver customer value today and create an adaptable product for tomorrow, hence the conception of lowering technical debt - improving the ability to adapt - as an integral part of the development process (Highsmith, 2009). In some cases, technology based competitive advantage is not the key company success factor because, due to rapid propagation, international competitors can easily react and offer imitation products. In this situation, some producers try to enlarge the customer value proposition which originated in the new technology and develop a complete sales solution. This then appears as the one of main reasons to assign the innovative dimension not only to product but also to complementary services in way to make the offering more adopted to satisfy market needs. This kind of commercial combination can also be very interesting for companies as it can build a strong relationship with the customer over time giving the company the possibility to develop an innovation based value proposition based on user functions development which is also linked to the technical debt dynamics (Kumar, Puneet, 2019). For this reason, it is important to setup an integrated framework focused on mechanisms creating customer value which defines also the source of technical debt. Particular attention is placed by Ph. Kruchten, R.L. Nord and I. Ozkaya on the complex nature of technical debt specifically on the connection with the technology gap which is caused by commercialization of new products (Kruchten, Nord, Ozkaya, 2012). For this reason it is possible to state that monitoring of discrete occurrences of technical debt enables a definition of the totality of technical debt incurred not only by the whole company but also by every new developed product. It is possible to make this type of definition by analyzing a company’s internal value chain model, which logics is based on the principle that innovation activities enabling

development of user functionality lead to an increase in value (Tang, Yin, Ullah, 2018). Optimization of this process will thus depend on monitoring the dynamics of technical debt creation as a result of which the optimization of the value offered to the customer will require development of an infrastructure maintaining user functions which enables limitation of defects and stabilization of the value of a product as perceived by the customer. By combining the concept of technological debt with company innovation activities, it becomes possible to define the interactions which take place within a company. Proof of this can be found in the model of technological debt creation, proposed by J. Magnusson and B. Bygstad, which is based on an assessment of ex-ante and ex-post investment decisions in the introduction of new technologies (Magnusson, Bygstad, 2014). The concept can be used as a decision tool enabling assessment of the consequences of introducing to a company an orientation on development of innovations with high returns. Monitoring the dynamics of technological debt within a company whilst research and development activities are taking place is a complementary tool in the process of assessing their future financial impact. In addition it can be applied as an element of strategic analysis which provides an assessment of the technological development of a company enabling the financing or timing requirements to be defined to develop specific domains of activity to achieve optimal new product value for the customer. Hence very interesting development possibilities for application of this concept to model technological diversification strategies especially with regard to a strategy of value creation for the customer.

Hence the most appriotate concept of customer-perceived value of a product, it was formulated by J.H. Dobbs in an original way (Dobbs, 1999). Proposed formula assumes that it is the ratio between the sum of product quality and use value, as a nominator, and price, as a denominator (1).

$$CPV = (J+U) / C \tag{1}$$

Then, the formula can be rewritten as:

$$CPV * C = (J + U) \tag{2}$$

where:
CPV – customer perceived value,
J – cost of maintaining quality,
U – product use value,
C – selling price.

A different perspective on customer-perceived value was proposed by C. Fuchs and F.J. Golenhofen. Their approach is mainly based on the importance of the product's utility (Fuchs, Golenhofen, 2019). Formula (3) is used to calculate customer value.

CV ~ F/K, which can be rewritten as:

$$CV * K \sim F \tag{3}$$

where:
CV – customer value,
F – product use functions,
K – total unit cost of production.

The above formula assumes that customer value is directly proportional to the value of the sum of product use functions, and inversely proportional to cost. Therefore, the result of CV and K multiplication is directly proportional to the value of product use functions. It means, that product use value is expressed here as the sum of its use functions, i.e. it can be assumed that U = F. Product use function is understood here as something more than the technical aspects, which are derivatives of the used technology. Hence it can be said that U means product use value. Analyzing formulas 1, 2 and 3, the difference between customer perceived value and customer value based on product use functions can be observed.

Determining customer perceived value, commercialization of innovations should be taken into account, which is also related to the optimal exploitation of the existing brand or its extension. The most common model of the innovation process focuses on the customer and ignores the issue of the design. In response to this problem, M. Mulder-Nijkamp argues that to commercialize technological innovation, the impact of the design $V_{(D)}$ and brand $V_{(B)}$ on customer perceived value should be taken into account (Mulder-Nijkamp, 2020). Then, customer perceived value would consist of three components (4):

$$CPV = V(D) + V(B) + U \tag{4}$$

where:
CPV – customer perceived value,
$V_{(D)}$ – component of the product value resulting from the design,
$V_{(B)}$ – component of the product value resulting from the brand,
U – product use value

The elements of the above sum can be expressed as the multiplication of product use value (U) by customer perceived value obtained from design D and brand B, both being proportional to U. The effect of the sum of utility functions (U) on customer perceived value (CPV) can therefore be expressed as follows (5):

$$V(D) + V(B) + U = CPV * C = CPV * (K + M) \tag{5}$$

The last part of equation (5) expresses customer perceived value according to J.H. Dobbs. Applying this expression to the equation of C. Fuchs and F.J. Golenhofen, the following relationship can be formulated (6):

$$CPV * C = V(D) + V(B) + U = CPV * (K + M) \sim J + U \quad (6)$$

where:

CPV – customer perceived value,

C – selling price,

K – total unit cost of production,

M – unit margin,

J – unit costs of maintaining quality,

U – product use value,

$V_{(D)}$ – the component of the product value resulting from the design,

$V_{(B)}$ – component of the product value resulting from the bran.

The above equations (5 and 6) define the essence of the concept of price, which is henceforth a reflection of product value and not only of cost. The value of unit margin (M), realized on the sale of the product, is then the amount reflecting customer perceived value, expressed here as CPV. Therefore, customer perceived value (CPV) may be greater than selling price (C). The greater the ratio of customer perceived value to selling price, the better are product use value (U) and company performance. At the same time, product use value (U) can be defined as the (F_U) sum of all use functions (f_u). In the case of innovative products based on new technology, the costs of maintaining quality are allocated to technical debt created by the use of new technology in order to offer a specific use function of the product. It is then possible to formulate a new form of use value based on the sum of the values of all utility functions. Then the value of a particular use function would depend on the value of technical debt $dt_{(i,i,)}$ and customer perceived value $vu_{(i,i,i,)}$ of this particular function (Filipowicz, 2019). Using matrix notation, it is possible to express formula (6) as equation (7).

$$[CPV * C] = [V(D)] + [V(B)] + [FU] \quad (7)$$

To refine equation (7), it can be expressed more precisely as (8):

$$\begin{bmatrix} cpvc_{1,1} & cpvc_{2,1} & \dots & cpvc_{1,n} \\ cpvc_{2,1} & cpvc_{2,2} & \dots & cpvc_{2,n} \\ \dots & \dots & \dots & \dots \\ cpvc_{n,1} & cpvc_{n,2} & \dots & cpvc_{n,n} \end{bmatrix} = \begin{bmatrix} vd_{1,1} & vd_{2,1} & \dots & vd_{1,n} \\ vd_{2,1} & vd_{2,2} & \dots & vd_{2,n} \\ \dots & \dots & \dots & \dots \\ vd_{n,1} & vd_{n,2} & \dots & vd_{n,n} \end{bmatrix} +$$

$$+ \begin{bmatrix} vb_{1,1} & vb_{2,1} & \dots & vb_{1,n} \\ vb_{2,1} & vb_{2,2} & \dots & vb_{2,n} \\ \dots & \dots & \dots & \dots \\ vb_{n,1} & vb_{n,2} & \dots & vb_{n,n} \end{bmatrix} + \begin{bmatrix} fu_{1,1} & fu_{2,1} & \dots & fu_{1,n} \\ fu_{2,1} & fu_{2,2} & \dots & fu_{2,n} \\ \dots & \dots & \dots & \dots \\ fu_{n,1} & fu_{n,2} & \dots & fu_{n,n} \end{bmatrix} \quad (8)$$

where:

$cpvc_{i,j}$ – customer perceived value of a given use function,

$vd_{i,j}$ – component of the value of a given use function resulting from the design,

$vb_{i,j}$ – component of the value of a given use function resulting from the brand,

$fu_{i,j}$ – component of the value of a given use function resulting from a given technology characterized by a certain technical debt. It should therefore be assumed that $fu_{i,j}$ is equal to the length of the vector representing the sum of vectors of technical debt value resulting from the application of new technology and value of a given use function $\left|\overrightarrow{fu_{\iota,\iota,}}\right| = \left|\overrightarrow{dt_{\iota,\iota,}} + \overrightarrow{vu_{\iota,\iota,}}\right|$

After adding the presented matrices, the following equation can be formulated (9).

$$\begin{bmatrix} cpvc_{1,1} & cpvc_{2,1} & \dots & cpvc_{1,n} \\ cpvc_{2,1} & cpvc_{2,2} & \dots & cpvc_{2,n} \\ \dots & \dots & \dots & \dots \\ cpvc_{n,1} & cpvc_{n,2} & \dots & cpvc_{n,n} \end{bmatrix} = \begin{bmatrix} vd_{1,1}+vb_{1,1}+fu_{1,1} & vd_{2,1}+vb_{2,1}+fu_{2,1} & \dots & vd_{1,n}+vb_{1,n}+fu_{1,n} \\ vd_{2,1}+vb_{2,1}+fu_{2,1} & vd_{2,2}+vb_{2,2}+fu_{2,2} & \dots & vd_{2,n}+vb_{2,n}+fu_{2,n} \\ \dots & \dots & \dots & \dots \\ vd_{n,1}+vb_{n,1}+fu_{n,1} & vd_{n,2}+vb_{n,2}+fu_{n,2} & \dots & vd_{n,n}+vb_{n,n}+fu_{n,n} \end{bmatrix} \quad (9)$$

Considering the above equation, it should be noted that, in practical conditions, the equal sign (=) can be replaced by a proportionality sign (~) since [CPVC] includes the assigned customer perceived values of given use functions. Those values are therefore the result of a subjective assessment affected by product design, brand and use value, which relate to the assessed use functions. It should also be added that in specific cases individual matrix values may be zero, for example when the dependencies mentioned earlier do not exist or use function does not exist. The lack of use function of the product may be the result of the introduced product concept or the lack of necessary technology, or the lack of financial resources to obtain it. The method of creating the matrix [Fu] is simple and based on taking into account the phase of the technology life cycle, which also determines the level of technological innovation (fig. 1). The product decomposition into its use functions consequently makes it possible to practically assess the effects of technological and innovative changes, which will result in product use.

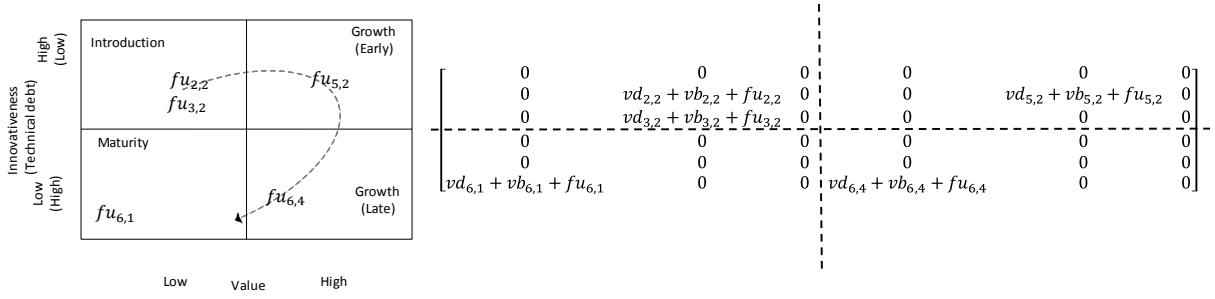

Figure 1. Principles of presenting product use as a matrix of its use functions (own elaboration).

The method of creating the matrix [Fu] is simple and based on taking into account the phase of the technology life cycle, which also determines the level of technological innovation. The product decomposition into its use functions consequently makes it possible to practically assess the effects of technological and innovative changes, which will result in product use. Analyzing equation (9), it can be stated that the relationship between matrix elements can have three forms: $cpvc_{i,i}$ is smaller than $vd_{i,i} + vb_{i,i} + fu_{i,i}$, greater or equal. When it is smaller, it means that the design, brand and technology, as components of a use function, do not translate into greater customer perceived value. Thus, when the effects of components are combined, it does not result in synergy in customer perception. When matrix element $cpvc_{i,i}$ is greater than the sum of those components, then for a given use function, the goal is achieved thanks to their synergy. This means that customer perceived value of the use function is positively affected by the efforts made by the company, and the synergy between the design, brand and technology has been achieved. This situation is the most desirable, leaving the question of whether this greater value of the use function also translates into the entire product. On the other hand, when $cpvc_{i,i}$, i.e. a matrix element expressing customer perceived value, remains equal to the sum of use function components, then there is no synergy between them. Customers behave as the company predicts, but their reaction is probably caused by the fact that their needs have been satisfied according to their vision. As said above, product decomposition into its use functions (9) enables a practical assessment of technological innovation. One of use function components is technology, with technical debt resulting from its use. Technical debt determines the level of technological innovation, also from the perspective of possible competitive imitation.

The approach presented above enables the evaluation of product perceived value through the prism of product use functions. It is therefore possible to model future customer perceived value taking into account the level of future technological innovation used to manufacture the product (Fuller, Bartl, Ernst, Muhlbacher, 2006). Conceived model can be also used as an optimization tool because by analyzing the possible distribution of the origin of customer perceived value between design, technology and usability, the structure of a new product can be rearranged according to customer perception, at the same time taking into account company capabilities. It is also possible to use this model as a budgeting tool for a new product development process, bearing in mind technical debt resulting from the use of new technology. The existing possibilities of modeling the mix of use functions allow the analysis of future changes in the product structure. Because of this, the company can try to optimize use functions according to future changes in company technological potential and according to the user's preferences. It is possible to apply the proposed approach to the general modeling of future products. It also provides an opportunity to engage the potential user in maximizing the value of current and future products.

5. Conclusions

The effectiveness of the innovative product commercialization process is crucial for a company's market competition. An important factor affecting the implementation of a new product is the way the user evaluates it, hence the need for a more thorough assessment of the customer's ideas resulting from the current use of the product for its further development. The process of searching for ideas as a source of new product applications is also gaining importance. The aforementioned concept of user experience as one of the key factors for the success of product sales can therefore be a source of innovation conceptualization. Designing a new product or service based on a new technology without defining its utility functions in line with the user's needs is inappropriate and may cause a negligible response from the market. It is up to the user to determine the effectiveness of the process of creating innovation value. It can be noted that the feelings resulting from the use of a new product may be subjective and subject to external influences. A commercial success of a new technology is conditioned by creating the right perception of the new product value. As a consequence, information about the use of the product and the experience resulting from using it should be constantly monitored and taken into account in the course of the commercialization of innovation. The proposed approach can be applied to the simulation of product new meanings in terms of maximizing customer perceived value according to future changes in company technological potential. The proposed perspective provides an opportunity to determine the specific level of technological innovation expected by the user of a given product and the possible costs to be incurred in order to obtain that innovation. It is also possible to identify the needs for the development of new use functions adapted to the phase of the technology life cycle. The presented model is an interesting concept of quantifying the customer perceived value of a new technology based product. The described possible application of the product use function technical debt provides an attractive opportunity to assess the product value, also in the future. The presented model concept is also an example of an interesting tool for use in the process of managing the innovative product development. Obviously, access to empirical data is the problematic, because of reported high sensitivity for companies. Attempts made so far were not effective, due to the companies' protection of access to used new technologies parameters, or the time-consuming data collection process. Indeed, the difficulties encountered are a challenge for the empirical verification of the proposed concept, and thus will provide material for separate research in the future.

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