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Modeling Market Value of Product Based on New Technologies – Preliminary Tool Concept

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Abstract. Changes in the way market advantage is achieved and the emphasis on value creation that has been introduced by technological change are forcing companies to seek new and effective management tools when it comes to innovative activities; hence, the discussion and presentation of the conceptualization of such a decision-making model. Its basic premise is to take the technology life cycle as a determinant of the market diffusion of a product based on the use of new technologies. Consequently, a decision matrix is developed – one dimension of which is innovation measured by the dynamics of technical debt and the other by customer-perceived value. The product as an analytical object is considered as the sum of the utility functions while allowing for each utility function to originate from the use of a different technology (which is in an adequate phase of its life cycle). After presenting the theoretical model, an example of an analysis of a fictitious product is given, which is a device for cooling and printing food substances. The presented analysis example shows the practical possibilities of using the developed decision-making tool in the areas of the technological and marketing activities of the enterprise and, in particular, the design of new products or new utility functions.

Keywords: product conceptualization, perceived value, innovation, technical debt, new technology

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JEL Classification: C53

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1. INTRODUCTION

Understanding the customer impact on a company's product-value-strategy-formation process means also perceiving the relationship between product innovativeness and its customer. Understanding the positive impact of this relationship on the commercialization of innovation should provide reason for developing a new insight that cements a new technology-based conceptualization of new product model tools. Innovative customers have more experience in change adoption in product development, and they lead the innovation process by predetermining a company's value creation. Innovation-based strategies pose a challenge for the creation of new markets based on innovation- and differentiation-based products or services and can help deciders develop new innovative products in an unconventional ways. At the same time, developing and introducing strongly differentiated products can result in a certain risk of commercialization failure that is directly related to the unrecognition of the value by the customer. This phenomenon highlights the significance of client involvement in new technology commercial usage, which can form the basis of new management that evaluates the potential value that is attributable by the new users to an analyzed innovation. Hence, the presentation of such a decision model is given, which allows for a visualization of the level of innovation of a new product based on its utility functions and a presentation of the resulting relevant customer-perceived values.

2. CONCEPTUAL BASIS OF MODEL AND ITS PARAMETRIZATION

Technological innovation implementation implies changes in a company's strategic thinking –particularly at the level of fundamental market-behavior models. In the case of the new technology's company sector, the model often used is the technology Foster s-curve (Foster, 1986). This curve shows the progress of a new technology as the source of the R&D future development. The first stage of this development is very slow, which reflects the very weak diffusion of the concept being developed. Furthermore, exceeding a certain level of knowledge resources results in a significant increase in the diffusions of developed solutions; this increase is exponential. After this, stagnation can be observed – this is the state of the maturity of the developed technology. An observation of the theoretical course of the curve allows us to conclude that the performance of the proposed solution decreases following the inflection point of the function; this point is characteristic of the described phenomenon of technological development (Fig. 1). According to Asthana (1995), it is also possible to use this curve to describe certain principles of technology management. He stated that the primary barrier to the adaptation of a new technology is unfamiliarity by the wider user base, which translates into uncertainty of acceptance by the market. The described new-technology-diffusion function is currently finding numerous applications and interpretations; according to Sood and Tellis (2005), this supports the need for some standardization of this model. As part of a holistic view of this model, one can propose a view of it based on defining the curve as a life-cycle model that is based on three phases. The first phase is the introduction, at which time a new technological standard is put into use; its propagation is slow because it remains unknown, and, although new, it does not attract users. Another possible interpretation of this state of affairs is that there are too few practical applications of new technological standards, resulting in a small number of new products that are based on technological innovation.

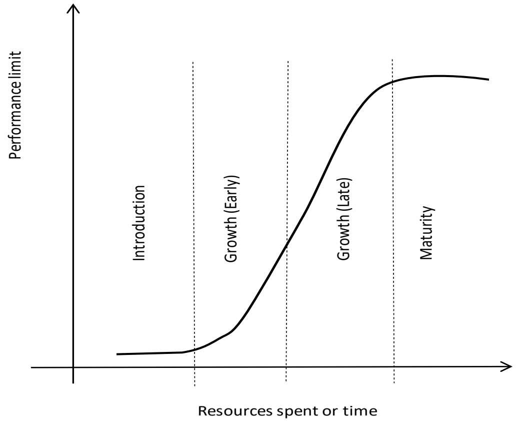

Fig. 1. *Technology s-curve*
Source: based on Bowden (2004)

The second stage is the (early and late) growth stage; a rapid propagation of the innovative technology (Filipowicz, 2015). This is the phase of the dominant standard emergence, which determines the specifics of market-dominating-product standards and consumer preferences. This progress leads to increased product sales based on the use of the new technology, which increases revenues and profits and offers further support for research and performance amelioration. The third stage is the maturity phase of slow technology diffusion and then market saturation. This maturation stage is due to a reduction of innovation activities because of low-cost imitations, competitive offers, and a growing lack of customer interest. Pearce and Robinson (1994) highlighted that, in a dynamic market, even a small or relatively weak business is often able to find an interesting market niche.

Thus, innovation-strategy formulation should be associated with technical performance, which can be measured both by the capacity to deliver customer value and the creation of an adaptable product for tomorrow. According to Highsmith (2009), the idea of exposing technical debt – improving the ability to adapt – is an important part of the innovation process. It appears that the use of technical debt could be proposed as the new technology-based product-innovativeness measure. The aforementioned exponential growth in the diffusion of new technology implementations is, in such a situation, a reflection of the increase in the value to the customer of the new implementations of the developed solution. An important issue for the effectiveness of the innovation process is the understanding that the increase in the value of the innovation as perceived by the user is the result of a compromise between the cost of its production and the value for the customer. This implies the need for the continuous optimization of value for the customer, which may translate in specific cases into a decrease in the value that is acquired by the company (Chen & Quester, 2009). This process results in the growing importance of the concept of the value-management process, which emphasizes the importance of the contribution of customer-perceived value to shareholder-value maximization (Porter, 1985). Therefore, customer-perceived value (CPV) can be defined as the ratio between the level of customer satisfaction and the perceived value of a product as well as satisfaction with the price that was paid for this product. A company thus creates added value for the customer when its products or services hold greater value to the customer than those that its competitors have offered under similar market conditions. CPV can be measured by surveying customer opinions or be calculated as the ratio of a company's performance relative to its utilities and quality (Blut et al., 2024). The deep individualization of this approach (suggested by the authors) can become a key factor in the effectiveness of the commercialization of new technologies. The often-indicated strong relationship between customer participation in the development of the innovation process and the parallel development of commercialization is expected to contribute to the significant reduction in the risk of the market failure of the venture (Ritter & Walter, 2012). Hence, the suggested connection of technology development with the conceptualization of customer value results in a contradiction with respect to the classic linear-innovation process. In effect, this leads to the possible identification of a certain congruence between the value that is perceived by the customer and the level of the innovation of the technology of a given enterprise. This congruence results in the possibility of determining the level of the innovation of the proposed technology and its perceived value, which in turn determines the level of financing that is needed for its development (Radford & Sridhar, 2005). The concept was confirmed by Cunningham (1993), and it results in the practices of enterprises with great importance being placed on the timeliness of the operations in the areas of the developed technologies. Thus, the increasing emphasis on maximizing customer value leads to an increase in the number of utility functions of an offered product. This results in the need for changes in the management and organization of an enterprise that applies such a concept (Nord et al., 2012).

3. PRESENTATION OF CONCEIVED MODEL

A competitive advantage based on new technology is not always a key factor in a company's success; this is due to the too-rapid diffusion of this technology and low-cost international imitation. Under such conditions, some companies attempt to expand the value proposition based on technological innovation and develop various commercial proposals; this is the main reason for giving innovative importance to not only the development of a new product but also the creation of complementary elements of a commercial offer (including new services) to meet market expectations. This is why the importance of the previously mentioned descriptive parameter – customer-perceived value – is so important. When analyzing the possibility of expanding an offer, it may be important to identify the set of utility functions of an innovative product that are available on the market during a given time period (Ho et al., 2014). The identified set of utility functions will, thus, form the basis of the developed product strategies based on the use of the new technology. An important factor that shapes these strategies for developing attrition functions will be the use of their evaluations by potential users, which can become part of a standard innovation development. Such an approach to product development based on a new technology can be a very effective dimension for assessing market opportunities for new applications of the technology that is being developed; therefore, this is crucial when it comes to the dynamics of diffusion of especially radically innovative products or innovations. It is important in this context to consider the organizational dimension of such an approach to the diffusion of innovations; i.e., the need to take the formation of customer value into account in the process of financially evaluating a new technology (Ho, 2011).

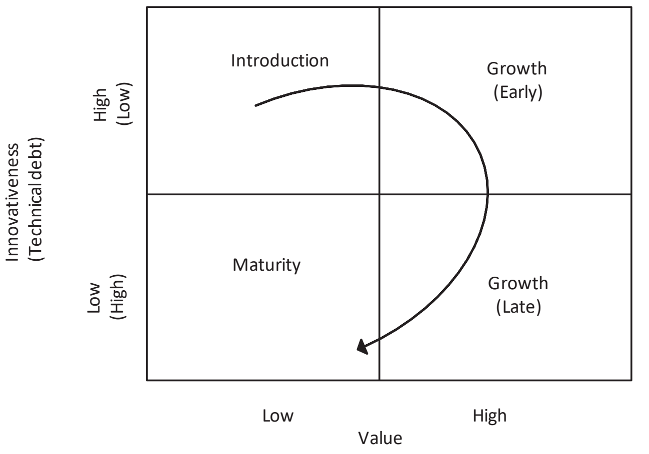

Fig. 2. *Presented tool based on technology life-cycle model*
Source: Tool-concept proposition based on s-curve holistic interpretation (Filipowicz, 2014)

The easiest way to understand the issues that were described above will be to use the developed tool (Fig. 2). The application of this model requires estimating the values of the levels of innovation and customer value that are associated with each product based on a collection of empirical data (or rather with the utility function that is offered). This tool is a very important decision factor for determining the involvement of potential users in the development of a new technology that forms the basis of the innovative products that are offered. The main purpose of its application is to anticipate the optimal value of the innovative technology that is used in the new product; this, in turn, allows the company to conduct an effective cost policy and is the basis for co-production. As a consequence, there is a further need to concretize and operationalize the presented concept.

The relevance of analyzing the current needs of customers, therefore, becomes indisputable only if the organization intends to reconfigure in order to introduce technologically innovative products; it is then important to take the fact that today's customer needs are only a base for future customer needs into account. Hence, it becomes very important when adopting a prosumption-based perspective of the innovation process to be able to anticipate that the desired new utility functions are what will then guide the development of the new technologies needed by the company (which can be sources for creating new markets) (Keinonen & Takala, 2006). At the operational and strategic levels, it therefore becomes important for the enterprise to be able to configure and evaluate new product portfolios based on innovations and the resulting need for a possible change in the structure of the designed products, thus allowing it to take the possibility of implementing the new technologies that have been developed or acquired by the organization into account. Other things to be taken into account are the possibility of analyzing the level of effectiveness of the integration of all types of innovations into the portfolio of the owned products or technologies. (Fuchs & Golenhofen, 2019); hence, the high relevance of the nature of the interactions that take place with the customers or users (who henceforth constitute the desired feedback for the company). The earlier that the nature of the reaction of one's potential customers is known (even at the level of product ideation), the greater the importance of these comments for constructing a market advantage (Sánchez-González & Herrera, 2015). When a company's offerings are subjected to customer evaluations, innovation is usually identified as an important component of the value-creation process. Accordingly, the development potential of a company is considered to be dependent on the number of new products that are introduced to the market (Schultz et al., 2013). This becomes relatively important in the case of a very dynamic environment when companies are looking for different forms of configurations of their existing portfolios of derogatory products that take the new technologies into account (Mul & Di Benedetto, 2011). The ability to analyze current customer preferences is becoming increasingly important – especially when a company wants to commercialize innovative products. In such a situation, the currently declared needs are only the basis for sealing their new forms in the future. Then, it becomes necessary to apply the prosumption approach to the course of the innovation process to search even at the strategic level of the organization – for new technological innovation based utility functions possible to incorporate in the product according the potential user wants – one that is expected by the emerging market (Keinonen & Takala, 2006). This need to analyze current customer needs becomes clear when a company recomposes its offerings to commercialize innovative products. Hence, it follows that interactions with customers are a source of feedback; it is important to develop them as early as possible at the conceptual stage of designing a new product; after all, these interactions will be an important factor in the process of shaping the company's market advantage (Sánchez-González & Herrera, 2015). According to Moore (1965), the technology propagation curve (which describes the value of an innovative product due to the effective communication with the customer) is the primary factor in the effectiveness of technological innovation diffusion (Millier, 2011). The adoption of the exponential function as a model function for the diffusion of technological innovation highlights the importance of the speed of a product's launch and, thus, replaces the classical understanding of product development (which focuses primarily on its quality) (McNally et al., 2014).

In addition, the assumption that the first phase of innovation diffusion is the most significant source of acquired value is true when the innovativeness of a proposed commercial offer is the same as the lack of familiarity with the new product, thus signifying its originality and lack of any references. This can also mean that the decline in the innovativeness of a newly introduced product occurs as the user becomes familiar with it and knowledge of it increases. The longer a product is used, the more the user's knowledge of its flaws and shortcomings grows; this, in turn, promotes interactions with the company and the reporting of needed modifications to better meet customer needs (which is the main reason for creating technical debt). The changes that are made by the enterprise reduce the value of this debt; this leads to the conclusion that the level of innovation of a market product is inversely proportional to its technical debt. This approach becomes very important when, for strategic or financial reasons, a company wants to determine the market value of the technologies that it introduces or uses (Artmann, 2009).

The role of customers in the innovation process is already widely recognized and often used to maximize the values of products. The fact of being a leader in a new market provides a unique opportunity for creating an autonomous pricing policy that fits into the strategy of value creation – as long as one's customers perceive the uniqueness of the proposed innovation in satisfying their needs (Kumar & Phrommathed, 2005). Commercialization based on innovation represents a unique opportunity for a company to create a new market and its further development if the product is modified. Hence, the great interest in applying customer relationship management as a kind of connection between the customer and the enterprise mainly serves the development of any valuable commercial applications of the introduced technologies (Huang & Wang, 2013). These new applications become a potential source of new utility functions or even new product meanings; this approach gives even more weight to the roles of customers and their experiences of using new utility functions, and it allows for redefining product utility as the sum of the utility functions (Eversheim, 2009). Thus, linking customer value to the process of developing new technologies becomes a key factor in the market success of new products and is essential if a company is thinking about growth; it also influences the decision-making rationalization of the led NPD, reducing risk and conditioning the consumer acceptance of market applications of the new technologies.

In some situations, the configuration of utility functions – the new technologies that are used – can change the application of the product and lead to the emergence of new users. Then, the principle according to which more complex and extensive modularity translates into a higher level of individualization and differentiation, which can translate into an increase in interest (Jensen et al., 2014). This approach to value creation through utility function analysis provides new opportunities for optimizing product policy – even at the level of the structure of a single product; this significantly reduces the risk of failure during the first stages of NPD. It becomes evident that the possibility of different product applications in the value-creation process is based on different ways of perceiving them by reflecting customer preferences for new products. The integration of the customer's optics in the process of designing a product's utility functions should be implemented with an understanding of not only the hedonistic approach but also as a compromise of both (Verhagen et al., 2010). The implementation of these assumptions should cover all phases of the life cycle and implies a balance between the development of the utility functions and the suggested way in which they are perceived by the user (depending on the situation being once hedonistic and once utilitarian). In addition, the process of utility-function development represents an opportunity for the enterprise to optimize the value offered in a manner that is consistent with the degree of the mastery of the technology that is used (Ha & Park, 2013). The use of such an application makes the enterprise ready to perceive the commercial offer not only as a wide selection of products but rather as an offered collection of utility functions. The described hedonic/utilitarian dualism can then serve as a tool for the value-creation-mapping process and become a starting point for the conceptualization of a new product (particularly, when it comes to designing the core functions of the product) (Pieper, 2019). Such an approach is, therefore, in line with the essence of the innovation process and the reason why it will be beneficial to use customer-designed functional characteristics and increase the market-utility value or create links between product performance and user comfort that are new in nature (Townsend et al., 2013).

Hence appears the proposal of the concept of functional value in relation to the possible uses of the product, which can be defined as the accumulation of the utility functions that represent benefits for the customer (Fig. 3). The assumption that the customer is at the center of the value-creation process also allows the customer to be involved in the product-design process by creating the configurations of the utility functions of the offered device that are most interesting to him/her (Liu et al., 2020). An opportunity that is formulated in this manner is also attractive from the perspective of innovation product development (IPD) and can provide an attractive basis for organizations to conceptualize the structures of their products based on possible user perceptions (Moon et al., 2015). Therefore, an in-depth understanding of customer preferences for the value of product applications can significantly reduce the risk of market failure and should be treated as a starting point for a company's future product and innovation portfolio. Another dimension of such a perception of innovation-product development is the ability to understand and gain the customer's perception of product innovation through different compositions of the possible applications of the designed device (Tang et al., 2018).

Therefore, it will be very helpful when designing a product to know the utility functions that are desired by users and, thus, determine the market values that are used and know how much the company is able to respond to these needs given the level of investment being made or the potential to develop technological capabilities (Kumar & Puneet, 2019). The presented perspective on the development of innovative products provides an opportunity to present the company's offer as a set of offered use functions, which allows it to present a map of product functions that are offered or developed based on new technologies. In this case, a set of use functions is represented by fu(t,v), where t is the technology that is applied to obtain the use function, and v is the customer-perceived value of the use function. When fu(t,v) = 0, this means that a specific use function does not exist or has yet to be invented (Fig. 3). The possibility of writing down the product structure in this way results in the ability to analyze use functions in terms of the company's current production capabilities as well as any projected changes in user preferences or possible technological changes. In extreme situations, conducting an analysis can be used to develop completely new production processes or a new formulation of the value offered to the customer. The ability to design the structures of new products based on the map of utility functions greatly supports the decision-making process of the enterprise, which can also provide the basis for cost optimization for the entire product family or the basis for outsourcing (Fan et al., 2015).

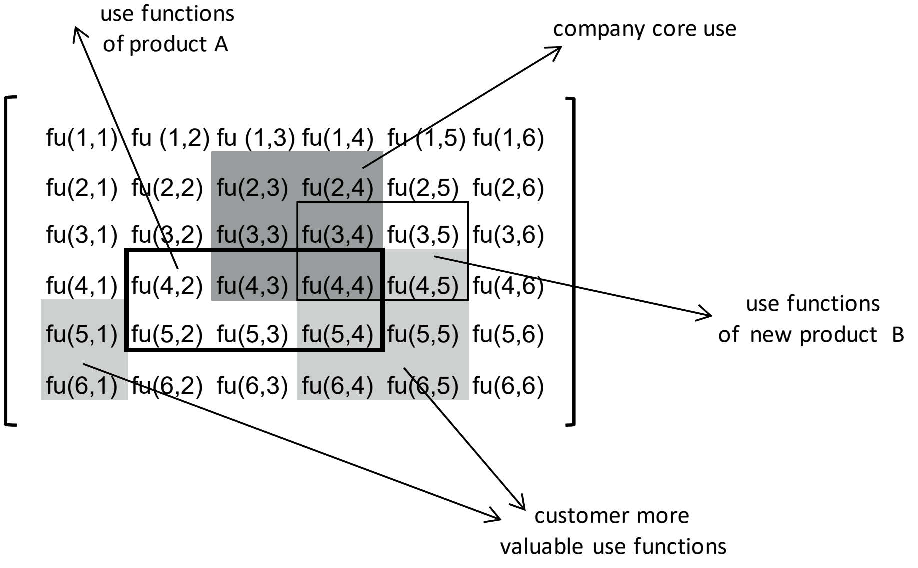

Fig. 3. *Utility functions offered by enterprise and distribution of their customer preference – analytical matrix*
Source: (Filipowicz, 2019)

4. APPLICATION EXAMPLES AND DISCUSSION

At the beginning of commercialization, an innovative product based on the use of a new technology is characterized by a low value of technical debt; when the customer does not know the product's capabilities and limitations well, any new utility functions often remain unknown to him/her. Due to the limited availability of this product and its uniqueness, its value is perceived as being high. Its utility functions are unique, hardly available – simply rare. Due to its new mix of utility functions, an innovative product often has a completely new meaning, which translates into a high innovative market value. The assumption that a highly innovative product's technical debt is low or equal to zero is derived directly from the assumptions of Jim Highsmith. As the product becomes more and more diffuse, its innovativeness decreases; this translates into an increase in the value of its technical debt, as more and more users or customers get to know product's properties and applications. This affects the wider area of the proposed modifications and improvements. The concept of the product then becomes more and more widely imitated, which translates into a decrease in its perceived value. A distinctly unique meaningfulness becomes standard, and its adaptations become more and more frequent; this is the result of imitation by other companies. Thus, these phenomena contribute to an increase in a product's technical debt or a decrease in its innovation (and its value on the market). In such a view, product innovation is a reflection of the low degree of the diffusion of the new meaningfulness and, thus, the high value of its perception. To illustrate the model, the example of an enterprise that produces household appliances is presented below. The company is considering the launch of a product that is a refrigerator with the ability to 3D print organic food – "Frizprint." The device's concept is based on the utility functions that are presented in Table 1. As a result, each utility function will be characterized by two variables – the value of its technical debt (describing the level of technological innovation), and its value (reflecting the market attractiveness); this allows for an estimation of the market price of a product that offers this type of utility. The presented perspective provides an opportunity to draw analogous conclusions that cover the entirety of the designed product. Based on the presented assumptions, the listed device functions can, therefore, be divided into core and innovative. Core functions are those functions that are sub-activities of the core business in the sense of organization theory and the resource-based view of the firm and are derived from the past utility functions of an innovative nature that have spread and are now standard activities of the company. These are characterized by a low level of innovation and, therefore, high technical debt and low perceived value for the customer. However, they represent basic utility functions in the proposed new product's concept, thus building a positive brand image of the manufacturer at all times (Mulder-Nijkamp, 2020). The innovative functions of a device are functions whose inclusion in the product concept is based on the application of new technologies; these functions have zero technical debt and high value for the user. The innovative functions of a designed product represent its technological innovation; for the potential user, they represent high value and are often the reason for buying this device. They are the ones that create a "not-seen-before" effect. The core functions of a given device are currently implemented based on in-house technologies or externally sourced technologies on an out-sourcing basis, remaining perfectly mastered in the production process of the enterprise. On the other hand, the innovative functions are based on completely new technologies, the application of which is the result of the carried out innovation process, and the implementation is reflected in zero or very low levels of technological debt. Such a value of the technological debt of a given innovative utility function can be interpreted as a current barrier against imitation by other companies. Another situation is possible when a given utility function is innovative and characterized by a zero level of technical debt of new use of externally acquired technology; this is due to the lack of organizational competence to enable its own innovation process for a given technological innovation.

Table 1. *Classification of presented product utility functions according to innovativeness and customer-perceived value: CUF – core utility function; IUF – innovative utility function*

No.	Utility function	Description	Innovation category	CPV
1	F(u1)	Cooling of food products	CUF	LOW
2	F(u2)	Freezing of food products	CUF	LOW
3	F(u3)	Decontamination of contents	CUF	LOW
4	F(u4)	3-D printer suitable for printing organic substances	IUF	HIGH
5	F(u5)	Storage of food substances for printing	IUF	LOW
6	F(u6)	Control to synthesize food products according to preset recipes	IUF	HIGH
7	F(u7)	Weight of stored products and printed products	CUF	LOW
8	F(u8)	Grinding of food ingredients feeding printer	IUF	HIGH
9	F(u9)	Information about quantity and status of food resources, composition, caloric value	CUF	HIGH
10	F(u10)	Internal and external temperature measurement	CUF	LOW
11	F(u11)	Reading of barcodes enabling acquisition of information on expiration dates	CUf	HIGH
12	F(u12)	Wi-fi communication of measuring and control device with user's phone	CUF	HIGH
13	F(u13)	Optical interface – touchscreen with information about stored, printed products	CUF	HIGH
14	F(u14)	Digital notice board (via e_communicator)	CUF	HIGH

The customer's perceived value of a given utility function is determined by the degree to which he/she perceives its attractiveness as compared to other products that are known to him/her or his/her own needs or expectations that are caused by his/her lifestyle or level of perceived utility satisfaction, with the product offering the utility function in question. Value is determined by the customer or user outside the company; this is often the result of an intensive process of communication with the customer or the result of the presumption process being carried out. The above-described utility functions of the designed device are placed in a matrix according to the value of their technical debts and perceived values by the customer. Under real conditions, both coordinates have their specific values expressed in monetary units. The function outline that is presented here provides a tool to help interpret the characteristics of the designed product. The matrix shows the distribution of utility functions according to the values of their technical debts and their customer-perceived values. Thus, the chart reflects the state of the product as is perceived by each utility function as well as according to the phase of the technology life cycle (as assumed in the model described above). Three functions are in the introduction phase; that is, brand new technologies have been used to make them available to users. For the purposes of the example, it is assumed that they are being developed based on internal funding sources. Three more are in the early-growth phase, and another three are in the late-development phase. These last six utility functions are highly perceived by customers. There are five functions in the maturity phase, except that all of them are core functions or functions that are related to the endogenous development of the company (whose main business is the production of home appliances and, therefore, its own refrigerator production). In the late-growth and maturity phases there are eight utility functions with low innovation potentials that, therefore, remain easy to imitate. The number of utility functions in the introduction and early-development phases may indicate a very cautious initiative of the enterprise in question to gain a market leadership position in the area of refrigeration and food-substance 3D-printing equipment.

There is some concern, however, from the perspective of the life-cycle phases of the used technologies regarding the very concept of such a designed appliance based on the assumption of a combo; that is, a multifunctional product (Fig. 4). The core functions are rather perceived by customers as being not very innovative; this is not a problem in the case of the refrigeration equipment, but their value in relation to the designed equipment definitely has a rather low perceived value on average, which may indicate a high level of competitiveness in the sector. It should also be taken into account that it is the sum of the perceived values of the utility functions (that is, the quantity) that can affect the price of the product. On the other hand, the sizes of the technical debts of the individual utility functions will similarly determine the subsequent needs for financing research and development activities in order to adapt the product to the possible increase in the customer's adaptation needs. The increase in these needs will grow with the increase in the technical debt, indicating a decrease in the innovativeness of the function or product and resulting from the increasing knowledge of the customers as to the possible utility of the product or its utility functions.

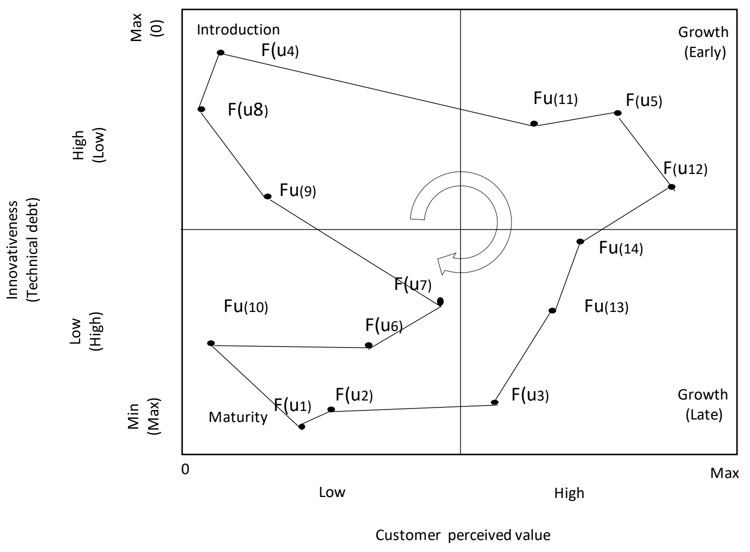

Fig. 4. *Mapping of innovative product-utility functions – case of fictitious product "Frizprint"*

Thus, the presented tool provides an opportunity to analyze the distribution of the individual utility functions in relation to the levels of the innovation of the used technologies, which effectively allows for determining the degree of the differentiation of a given product; in the case of mapping a greater number of derived products, there is the possibility of determining the levels of the differentiations of the entire range of products or product offerings. The example that is presented here refers to the conceptualization of an innovative product as the first step in the commercialization process. It is easy to imagine simulating products for the future by taking past feasible technologies into account.

On the other hand, a given enterprise's existing skills in the use of available technologies will enable the design of future utility functions and the study of the customer reactions to the new product utility mix. As a consequence of such simulations, an enterprise can profile not only current but also future customer needs so that the values of their innovative products are optimal for the enterprise at a given moment (as well as in future periods). Therefore, this tool can be used to evaluate the current range of products and to design future ones.

Undoubtedly, any further development of the presented model should focus on the possibility of using it to design new product meaningfulness through the use of innovative technologies as bases for new utility functions, which will be a very interesting tool for the conceptualization and design of new products – especially those that are based on the use of new technologies. Another direction of urgency is the full verification of the model based on real data that is derived from enterprises. Due to the high sensitivity of data that is related to the use of new technologies (and especially in relation to the value of technical debt), it is not easy to disclose this data in a publication. Another problem that occurs is the lack of data on the technical debt of a product; this applies mainly to companies outside the IT industry. Determining its value in relation to the utility function of the product and the technology that is used is very difficult and labor-intensive; it also requires a surveyed company to recognize the structure of its direct costs. Additionally, this data is treated by companies as being very sensitive – especially in the cases of innovative technologies. When it comes to measuring the value of a product as perceived by the customer, it is possible to visualize the innovative product or use computer graphics thanks to the use of artificial intelligence. Acquiring this data does not seem to be difficult; however, it may be more complicated to study the perceived values of new meaningful innovative products.

The designed tool can be used for visualizations in the case of a comparative analysis of a designed product with a competitive product on the basis of benchmarking of offered utility functions. Thanks to the results of such an analysis, it is possible to identify gaps in the range of utility functions that are offered and, therefore, potential directions for the development of the underlying technology. Based on such an analysis, it is also possible to determine potential directions of out-sourcing when it comes to the desired technologies. It is also possible to identify potential directions of out-sourcing in terms of the desired technologies, the possible increase in the value offered, and the possible directions of the development of marketing communications with potential customers. It is possible to use the model to present the company's entire portfolio, including all of the products that are offered as well as their functionalities while taking their levels of innovation or perceived value into account. In the case of perceived value, it is possible to visualize each product, the entire portfolio, and all of the utility functions that are offered and, thus, the technological level of the product offering.

Thanks to this, we also have the possibility of forecasting the financial results to be achieved in time as well as the financial outlays that are needed for this and the time that is required to implement any technological changes.

Another important direction of the possible use of the designed matrix is a detailed analysis of manufacturing capabilities and, therefore, the technological potential of the company in the field of their designed products in relation to the needs that are declared by the customer. In fact, it is possible to create a map of a product that is desired by the customer (or simply invented by him/her). This would make it possible to carry out an analysis of the potential deviations between the company's current technical capabilities and those that are expected by the customer at the level of the desirable utility functions and the product's transferable value (which is, of course, linked to the shaping of the prices of the designed or manufactured products and their changes in the future). The change in the level of the technical debt that accompanies an analysis of customer needs therefore makes it possible to predict specific technological needs or simply determine changes over time in the need for new technologies as well as in the view of changing customer needs.

Taking the life-cycle phase of the various functions of the products into account, this gives an indication of the dynamics of the development time of the various technologies that are already used by the company and allows for the identifications of specific new technologies in terms of their uses for the development of existing functions (or even the creations of concepts for new functions and their testing by potential users) by using the presented tool as a basis for the simulation and drilling of new innovative products or the development of existing ones. On the basis of technical predictions, the model allows one to determine the technical changes in any offered products in the future, which allows one to better adapt production offers to future needs or market requirements.

The suggested possibility of using matrix calculus allows for a complete mathematical notation of the model of the designed product, which can provide a basis for time-based optimization, while changes in the technical debt of the technology determine the prospects for changes in its utility functions. Not without significance is the fact that the mathematical notation also makes it possible to determine the new meaningfulness of products based on new technologies. A simultaneous analysis of a company's entire product portfolio on the basis of the proposed method creates the possibility of simulating changes in its technological and production potential depending on changes in the market characteristics or the emergence of completely new technologies. The identified problem of quantifying the presented model is the development of a complete mathematical notation using matrix calculus, which allows for the presentation of all possible changes in the evolution of the individual utility functions of the analyzed product.

The presented concept of the tool refers to the logic of portfolio-analysis methods (in particular, to the BCG matrix), which is a determinant all of the time – not only of those activities at the operational level in the marketing area. An extension of this method is the adoption of the technology life-cycle model as a determinant of product development, which is a significant modification in the sense of current business conditions. Also, the introduction of the parameterization of the matrix based on the technical debt and the perceived value of a product is a very important modification that corresponds to the current dynamics of the market processes. The use of technical debt in relation to the technology that is used as the basis of the utility function is an interesting approach to such an ambiguous issue of the level of innovation of the designed product. In particular, it refers to the assumptions of agile management and reflects the problems of IT product development. The second parameter, which is an important novelty, is the use of the value that is perceived by the customer; in particular, for the evaluation of the product utility function in this case and, therefore, the interchangeability of the estimeted value of the new product. An important issue to be developed in the model is to take the impact of the industrial design on the value of the product into account as well as the interactions that occur between it and the various utility functions of the product. It becomes an important research problem in this situation to analyze and periodically characterize the relationship between product design and its innovativeness – especially in terms of the use of new technologies. The conceptualization of the decision-making tool is an attractive proposition in the area of decisions at the operational level, enabling not only the effective designs of innovative products but also giving the possibility of assessing their potential values. In addition, it provides a wide range of possibilities to assess its evolution over time and provides an interesting tool for assessing the technological potential of the company's production processes.

Consistently based on the preparation of a matrix and taking the entire portfolio of the products or all of the functionalities that are offered by the company into account, it provides the possibility of a strategic assessment of the current technological potential of the company – especially in terms of its market value and level of innovativeness.

5. CONCLUSION

Companies that launch innovative products should have a strictly defined target clientele, which they can achieve by developing interactive communications with the customers or users; such linkages result in minimizing the risks of commercialization of innovations, and such a role can be played by the presented and described tool, which streamlines the process of developing innovative products thanks to the very possible visualization of the designed product and the possibility of assessing the levels of innovation and customer-perceived values that are attributed to its utility functions. The presented possibilities are to be used in empowering the decision-making process at the operational level with regard to the commercialized product and at the strategic level through the possible analysis of the entire portfolio of all of the offered utility functions that come from the technologies that are used. An important feature of the presented model is its possible full quantification; thus, it is possible to carry out a quantitative analysis of the designed product with regard to its level of innovation, the customer value proposition, and the value that is perceived by the customer. This is so important because a quantitative description that is based on these parameters is interesting from the perspective of marketing activities. Regarding the use of the concept of technical debt as a measurement of the level of an innovation, it is worth noting the importance of this approach, which sanctions the innovation of the technology that is used in terms of its perception by the organization. It is interesting to look at this issue in terms of commercialization decisions. The described approach facilitates the implementation of the technology innovation process; thus, firms should provide the best-possible solutions for the individual customer. To assess this, a standard evaluation tool is needed that highlights any changes in the value perception for innovative technology implementation, thus helping a company to observe and analyze changes in user behaviors. In addition, the model provides the opportunity to take the projected future segmentation of the market into account and, thus, offers an overview of different concepts for new products and even the definition of new usability. This translates into the possible conceptualization of new utility functions based on any new technologies under development – even at the beginning of an innovation process that is already underway. The role of the customer then becomes anticipating the new product's meaning.

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