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Use function and its technical debt as the foundation for modeling innovative products

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Abstract:

Aim: Conceptualization of innovative product model as the set of use functions and its application in company offer portfolio strategy determination

Design / Research methods: Analysis of product use functions formulated with the application of technical debt and customer perceived value notions, theory review and designation of new theoretic model making possible measuring the effectiveness of new technology use in product designing

Conclusions / findings: The development of a pro-innovative company needs changes in the conceptualization of management processes. This affects not only company growth characteristic but also product strategy modeling and its possible operationalization. Currently, company innovativeness is supported by the application of new technologies – those from the perspective of the company future, requires new market advantage drivers such as customer value and technical debt of new developed products. Its application in company product portfolio configuration process permits not only to develop company innovations development model but also its parameterization, on condition that the product is considered as a sum of its use functions. The proposed approach toward the company new product offer formulation enables the deciders to optimal technology choice realization and thus rationalizing the innovative technology based new product development process.

Originality / value of the article: Use function as the base for new product modeling approach thus elaboration and operationalization of new technology based company products portfolio development model with application of G. Moore curve.

Implication of the research: The elaborated model may contribute to the formalization of management tools useful for innovation process measures, providing also promising perspectives for the quantification of value creation based approach in company management.

Keywords: New technology innovation, product use functions, innovation portfolio, technical debt, customer value
JEL: O33, M11, M31

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1. Introduction

The Management of the knowledge interaction between marketing and research groups in pro-innovative organizations is an imperative to enable verification of the validity of actions undertaken by the company and to monitor innovation process efficiency. This aspect is often based on a company innovation process which is perceived as customer driven, so this process must also be adjusted to available resources and organizational potential. This indicates the real need for a decision model which optimizes both offered customer value and innovation development cost which is especially the case with complex new technology based products. Hence the need for conceptualizing the model of a new product which can be applied in qualitative and quantitative approaches to a company's new product portfolio strategy development based on the use of new technology based innovations. Commercialization of these innovations should also conform to the marketing logic of the management process and include the introduction of new value to the market in a manner which is coherent not only with regard to product policies but also to future possible technology development financing possibilities. The perspective presented needs to be developed further to become the basis for future decision model concepts, hence the goal of presented approach.

2. Product modeling based on use function configuration

Currently, the main challenge for market advantage is the fast conceptualization of a new product and its rapid propagation among customers. An innovation based approach to new product development implies the direct interaction between an emerging product concept and company realized research in technology and marketing. The pressure on shortening commercialization time requires more integrated management process models from the company helping to recognize customer preferences and thus enabling the examination of new product concepts based not only on actual user need but also on their potential evolution.

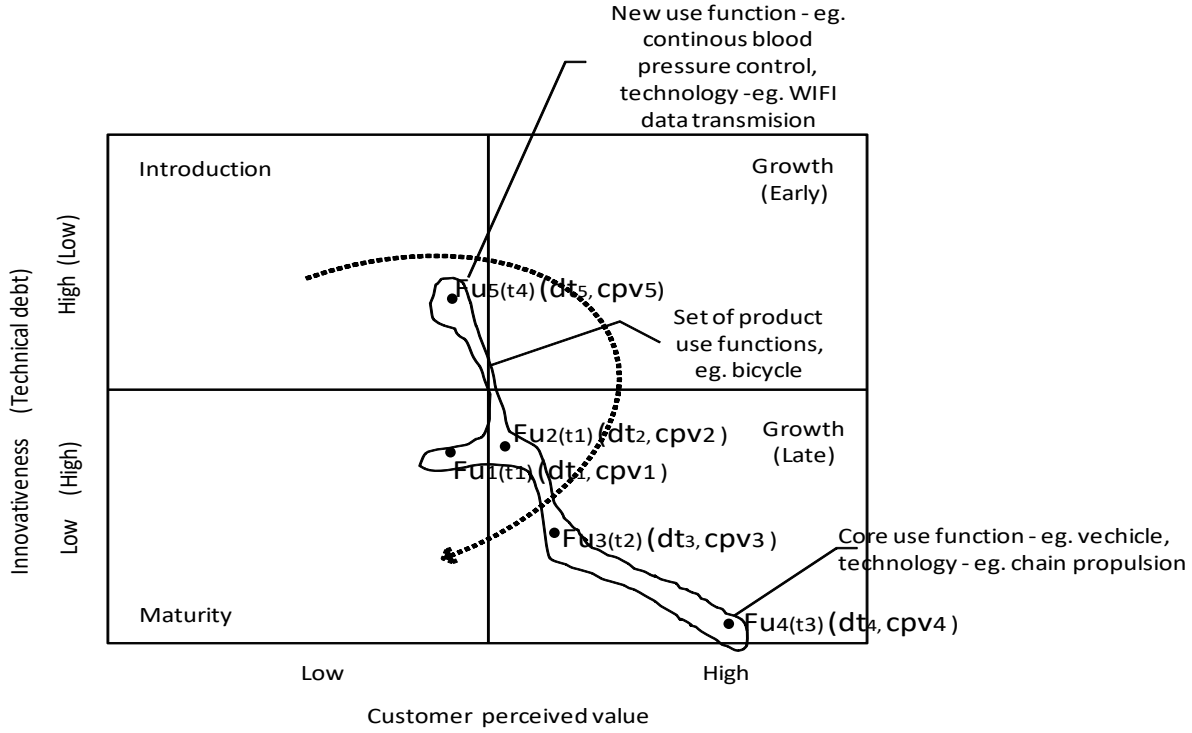
The anticipation of user needs will be crucial for the composition of a new technology portfolio even when the company outsources some of them. The importance of analyzing actual client needs becomes evident if the organization is reconfiguring to introduce innovative

products. In this situation, actual needs are only the base for the future concretion of new customer needs. Often in the case of adopting a presumption perspective on the innovation process, the challenge in the management process is to preconfigure a new use function, which may satisfy an emerging market need concept (Keinonen, Takala 2006). It is not a question of prototyping process elasticity, but rather its virtualization and thus linking the future product or offer configuration with the future potential of the company – in the sense of its credibility to insure the availability of indispensible resources including the time as an irrecoverable. In addition, it is important to make it possible for a company to configure and evaluate a multiple innovations based product portfolio and make it possible to modify product structure as new technologies are introduced. The other issue which must be taken into consideration is the possibility of integrating both radical and incremental types of innovation in the company portfolio. The nature of the customer interaction must be seen as a feedback to the company proposition – their reactions can be obtained very early at the stage of product conceptualization and will be crucial for the concretion of a competitive advantage (Sánchez-González, Herrera 2015). In most cases, the communication process is used as the base for company strategy determination and becomes an important tool of risks diminution in the market introduction process particularly if new technology based differentiation is adapted as the leading strategy.

This aspect must be also be linked to the time horizon in the sense of defining the right moment for launching a new product or for introduction of a new technology which are important from the perspective of company innovativeness. In the customer assessment of the company offer, innovativeness remains a very important constituent of the value creation process. Similarly, company potential for development is strongly associated with large numbers of new product market introductions (Schultz et al. 2013). Consequently, innovativeness, mainly in the terms of strategic elasticity, becomes important as a measure of company technology versatility and agility. Its analysis and assessment can be crucial in determining the impact of new technology uses not only on the attractiveness of offered product but also on the future company portfolio configuration as it evolves due to customer references. Particularly in the case of a high level of environment dynamics, the company has to be adept at considering multiple forms of portfolio configuration for possible new technology uses (Mul, Di Benedetto 2011). This means that innovation based advantage must be made precise in a company strategy at every hierarchical and functional level as well as through a clear vision of the proposed possible value

as perceived by the customer in new or innovative product use functions. Thus, it is possible to translate and communicate the innovativeness of a commercial offer which will reinforce the commercialization making it more comprehensive for the customer in terms of the value proposition. According to the G. Moore technology propagation curve, product value recognition, realized through effective communication with the customer is the only key factor for its market propagation (Millier 2012). Adaptation of an exponential function as the model function of product market propagation accents the speed of market introduction and changes the logic of classical new product development often presented as relying too much on quality amelioration (McNally et al. 2011). Also the suggestion that in the first stage of innovation propagation, innovativeness is the main source of value, is correct but only on condition that the innovativeness of the commercial offer is associated with the degree of unfamiliarity of the new product from the point of view of the customer, meaning that it is unrelated to the existing market offer. This can also be interpreted as decreasing the innovativeness of a new introduced product in the course of learning about the product and growing expertise in using it. A longer use time of the new product impacts customer familiarity with product feature inconveniences which leads them to request the company to ameliorate the product to satisfy the appeared needs thus, creating technical debt. The company reaction is to introduce the modification diminishing the product's technical debt. This can imply that the degree of innovativeness of a market product is reversely proportional to its technical debt formation (Highsmith 2009). The nature of technical debt is diversified but it also possible to link it to the proposed use function portfolio, the use functions development stage and their reliance on the company technology portfolio. This approach can be very important if the profitability of new technology is concerned and can serve to conceptualize often required quantitative managerial decision models of product innovation and NPD project efficacy (Artmann 2009).

Figure 1. Example of innovativeness level product use function analysis based on an s-curve holistic interpretation, where Fu (t_1, cpv_1) is the analyzed use function, derived from technology (t_1) with the value (dt_1) of asigned technical debt and described by value (v_1) of customer perceived value (cpv_1)



Source: Author's own elaboration.

The presented approach permits an analysis of the product as a set of use functions where every use function is supported by company used technology meaning that the innovativeness of a proposed use function is linked to the company technology development stage (figure 1). The concept of product modularity – often popular in production management – can be applied here as the base for modular conceptualization of innovative products. The idea of modularity can be formalized at the level of product (P) which can be defined as the sum of offered use functions – $P = \sum_i^n Fu_i(dt_i,\ cpv_j)$. Every use function is attributed with its technical debt value and its customer perceived value. As mentioned earlier, it is also possible to assume new use functions, which are possible to offer with new technology integration and which are new and valuable for the customer. The customer can also assess the attractiveness of a proposed use function by its value assignment. Basing on use function technology lifecycle stage analysis, it is possible to

propose the modification of a proposed use function configuration through continuous contact with the customer (Filipowicz 2015). Thus it is possible to envisage the new product proposition as a new use function based on new or innovative technology. In this way the proposition of an innovative product can be visualized and its customer value can be estimated. Introduced product visualization can be also applied as the base for the communication process with customer. In accordance with the customer judgment, a set of use functions can be changed or totally new and innovative products can be designed and their value perception can tested virtually. Moreover, potential customer segmentation for a new proposition can also be created. A similar proposition can be formulated at the level of the company use function portfolio to become the base for new product offers. The proposed perspective of product use function conception can be treated as the base for the future value proposition as a function of technological change. The proposed parameterization – value and technical debt – can become the base for a framework for mapping the relationship between company innovation effort and its consumer perception.

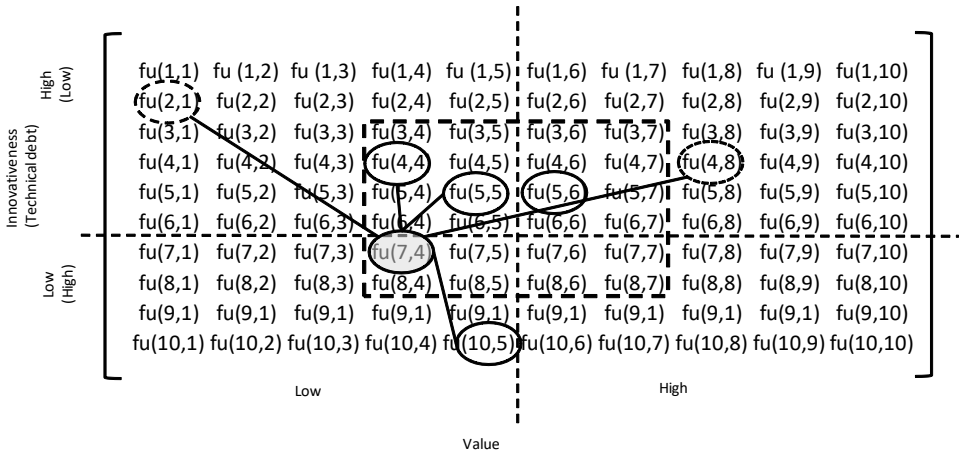
3. Managerial implications

From a managerial perspective the proposed innovation assessment concept can be used as a base for an organization's decision process. The operational dimension has already been discussed at the product level defined from the dimension of the use function and its interaction between innovativeness and customer value perception. The second important area of the proposed innovation assessment is its development and application in strategic decision process reinforcement. Hence the idea of a innovation strategy detailing tool based on the premise that the market offer of a company is directly associated with the value of offered use functions. This leads to the conclusion that strategy models based on product portfolio analysis are not multi-faceted enough to prepare a decision process and specifically to assess market risk of the introduced innovation and its impact on company funding. This issue of the innovation commercialization dilemma and its impact on a company's condition is often emphasized concretely at the moment a new technology investment decision is taken together with the realistic possibilities of monitoring and measuring this activity. For certain, the incorporation of customer opinion into the strategic decision level is justified and reasonable in preparing market actions which insure a positive response to innovative offer commercialization (Mugge, Dahl 2013). However, discontinuities can still be observed between innovation based new

product development, its integration with the actual company portfolio, company strategy and the needed resources, resulting in a less than holistic decision perspective so required at strategic level management especially in new technologies based firms. Existing and often used product portfolio strategy models should also include technology insights in the rationalization of innovation management process (Buganza et al. 2015). An outline of a future company product portfolio whilst dynamic technological changes take place should, even as an orientative indication, reinforce a company's decision confidence by including multivariate company technological innovation development scenarios (Samli 2011).

Use function based product conceptualization through its connection to development of new technologies will also help to close the gap in financial analysis with regard to not only the initial investment but also the funds needed for better market accommodation of the innovative product. This is a considerable decision dilemma for new technology based start-ups where the compromise between expansion costs and customer value proposition extension is not evident (Bhargava et al. 2013). Explaining the use function based concept requires the assumption that it is possible to define a set of use functions characterized by customer value and derived from the application of a specific technology. As a consequence, there is also the possibility of extracting from the antecedent use function, a subset Q_F which can be conceptualized with existing knowledge and technology development forecasting. All these use functions will also be described by the customer perceived value estimated through market research. Moreover, by constricting this subset, it is possible to delimit subset Q_C use functions which are associated with the actual available new technology depending on a company's own core activities and representing the company interested customer perceived value level depending in turn on the expected financial results. Extracting the last subset can thus serve as the base for a company's innovation strategy design tool (figure 2).

Figure 2. Conceptual model of innovation development strategy design tool based on use function analysis



Source: Author's own elaboration.

The presented matrix group use functions which are possible to prefigure with existing knowledge about the potential new and existing technologies and are possible to be perceived as valuable for the customer – $Q_F = \sum_{\substack{1\le i\le 10 \\ 1\le j\le 10}} Fu(t_i, cpv_j)$, in this way, Q_F represents the viable area of company choice regarding pro-innovative development. Hence, it will be appropriate to define the Q_C subset as denominating the company achievable use functions with their known value of technical debt and the actual customer perceived value – $Q_C = \sum_{\substack{3\le i\le 8 \\ 4\le j\le 7}} Fu(t_i, cpv_j)$.

The value of the maximum technical debt level is determined by the company's responsiveness to a customer need shown in accordance with the product use function evolution model (figure 2), for every use function product or whole company offer, it can be also set out in units of time or money (if tangible asset values is needed). If it is considered at the level of the portfolio offer then it derives from a company's technological debt. Thus, the application of the tenets presented above can be useful in a concrete company innovation gap evaluation. This will be the case for a new technology based use function introduction with potential technical debt bigger than the calculated maximum value. If the time dimension of technical debt is used, this means the company does not dispose of the time needed to satisfy the customer need and has to abandon the new use function introduction.

Customer perceived value as the second dimension of the proposed concept is also calculable and can be defined in the simplest way as the margin realized on a newly introduced use function as deducted from the product sales margin, but only on condition that the company uses a value based management approach. This situation is presented in the example of product level analysis (figure 2), where the new product concept P_c is considered as the sum of use functions.

Hence $P_c = \{fu(2,1), fu(4,4), fu(4,8), fu(5,5), fu(5,6), fu(7,4), fu(10,5)\}$ where:

- $fu(4,4), fu(5,5)$ are a use function at the stage of introduction built with new technologies, having low technical debt and a high degree of innovativeness, but with a low value staying unknown for the customer,
- $fu(5,6)$ is a use function at the stage of early growth, with low technical debt, very innovative for the customer with high value, generating an interesting margin for company,
- $fu(7,4)$ is a use function at the stage of maturity with high technical debt and low value, probably a core use function predetermining the main customer product purpose,
- $fu(4,8)$ is a use function at the stage of early growth, perceived as highly valuable for the customer at a sector level, but staying unexploited by the company because of patent restrictions (for example),
- $fu(10,5)$ is a use function at the maturity stage, with low customer value staying very popular but with a technical debt level which is unsupportable for the company because of time or cost dimensions,
- $fu(2,1)$ is a use function at the stage of introduction on a sector level, strongly innovative, with promising future customer value evolution but staying out of range for the company, so its acquisition would be too risky either because of the need for additional funding or because of its incompatibility with actual developed resources, thus its future technical debt would be impossible to reduce.

The presented discussion about the proposed configuration of a new product (or for a company, a new portfolio) conceived as a set of use function concludes with use functions $fu(2,1)$ and $fu(10,5)$ as having a low perspective for funding reasons but the inclusion of $fu(4,8)$ can be interesting because of increasing the customer value, despite the signalized patent acquisition costs.

The remaining use functions stay operational for the company in technical debt and

market delimitated dimensions. But it must be borne in mind that the presented description does not take into account the technical debt structure, which is too early to include at the moment of model creation. In addition it is possible that this structure will reflect use function interaction synergies or dyssynergies.

A similar situation applies to the notion of core use function linked to the company core activity and staying more recognizable for the customer. Core use function reconstitution offered by the company requires a fundamental technological change treated as a reformulation of it used technologies portfolio. Whilst it implies a fundamental change in company strategy management, its realization will be an imperative when total customer value collapses. A change of company core activities through redesign of the technology portfolio can also be analyzed with the presented use function framework and in this case a quantification of changes is possible.

Thus, rationalization of new technology development based on its acquisition source principle can be tracked. The presented analytical logic based on technology innovation customer value through assessment of product use functions can also allow the introduction of modularity seen as the tenet for production architecture organization based on the interaction between technology and its mode of usage which is the source of use function concretization. The extension of the presented model concept with a net company perspective brings to light numerous issues which can then be resolved with the idea of virtualization of new product development and also in manufacturing distributed process. The formalization of the presented concept will operationalize the notion of innovativeness, which also creates an interesting perspective on modeling the company innovation development decision process. Tying new technologies, innovations and use functions into a coherent new product concept enlarges the scope of the value management process and enables its rationalization mainly on the company strategic decision level.

4. Conclusion

The new technologies portfolio management model conceptualization presented is an attempt at formulating distinctive market advantage based on tying innovativeness, customer perceived value and use function into a coherent composition as the company strategy development driver. Placing the emphasis on maximization of customer value as a technology

innovation efficacy measure enlarges the possible market strategy choice and diversifies configuration of new company offers at every stage of the development process. The conceptualized model, based on technological life cycle, could be a promising method which is possible to be undertaken as part of a company new offer market introduction process. Its application could be a practical tool in minimizing market risk by mapping possible use function development based on customer interaction. As an area of interesting future research, incorporating the two concepts of technical debt as a measure of innovativeness and customer perceived value as a market success descriptor provides numerous directions for development of a quantitative approach in technology innovation process concretization.

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