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A Quantitative Model for Using Open Innovation in Mobile Service Development

by

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A Quantitative Model for Using Open Innovation in Mobile Service Development

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Abstract: The potential of mobile service innovations to create valuable economic impact makes their development desirable for companies. To develop and launch successful mobile services, the integration of customers in the idea generation process bears high potential. However, such Open Innovation activities usually demand for investments, whereas the precise relation between the money invested and the generated economic effect is still indistinct. The objective of this paper is to replace the black box between investments in Open Innovation and the thereby generated profits through formal-deductive analysis. For this purpose, we analyze the effect chain between Open Innovation and economic profit by adapting the model of Kano and putting special emphasis on the specifics of mobile services. Building on that, we develop a quantitative formal model to determine the optimal investment amount in Open Innovation activities for mobile services. The model's utility is illustrated with an example based on real-world data.

Keywords: Open Innovation, mobile services, customer satisfaction, Kano model, decision model

1 Introduction

According to recent studies, the market for mobile services via mobile apps will grow to €115 billion globally and €32 billion in the European Union by 2020 [35]. The study's results point out that mobile service innovation can generate valuable economic impact for companies. Simultaneously, competition is expected to grow dramatically leaving some industries behind if they are not able to offer innovative mobile services that create customer satisfaction and consequently profits. For developing and launching successful mobile services, customer integration in the idea generation process bears high potential, as one prior risk of new service development results from the narrow range between inventing a sought-after service on the one hand and creating something that does not meet the market needs at all on the other hand [29]. Regarding the mass of mobile services, the speed of technological advancements, and an average failure rate of 35-60 % of new products in the consumer markets, companies need a quick development of mobile services that meet the customers' expectations [2], [28]. One possibility for customer integration is Open Innovation (OI), a management paradigm according to which companies use the purposive inflow of knowledge to accelerate innovation [7]. Various companies from different industries apply OI activities to integrate customers in the development of mobile services as shown by HTC's "Tomorrow Talks", Google's "2012 Apps Developer Challenge" or Hilti's "2013 Mobile App Competition". However, though some companies have developed methods for the economic analysis of activities and decisions regarding innovation and technological collaboration [8], only in very few cases, "[…] financial analyses are used to support decision-making concerning innovations and technological collaboration" [25]. Hence, the precise relation between OI activities and economic profit is indistinct and well-founded economic decisions regarding OI are missing. We approach this research gap by developing a formal-mathematical model that is based on the relations between OI, customer expectations and customer satisfaction of mobile services. The focus on mobile services is useful since mobile services are characterized by e.g., high customer product knowledge and quick and easy development and update possibilities with continual feedback opportunitnies for the users making them a very appealing object for OI activities. We derive important aspects of the well-recognized work of Kano et al. [22] who laid a strong foundation for research on customer satisfaction. The objective of this paper is to replace the black box between investments in OI activities and the generated economic profit by analyzing the effect chain between the two in section 3. In section 4, we formalize the whole effect chain putting special emphasis on the specifics of mobile services. We aim at determining the optimal investment amount in OI activities for mobile service development and illustrate our findings with an example on the basis of real-world data from an industry project.

2 Relevant Literature

Integrating customers in the creation and design of new services is part of research discourses since the early 1980s. Von Hippel [41] quite early presented the lead user concept as users can provide more accurate data on future needs. Other authors emphasize the customers' contribution to the concept, design, performance testing or validation in the development of new products and services [15], [23], [26]. The effectiveness and benefits in form of more customer-oriented products that meet expectations more precisely is stressed by various past and recent research papers and studies [2], [3], [11]. Next to the benefits, also risks associated with customer integration in innovation processes are examined [9]. Turning away from internal and isolated idea creation in the beginning was called "Open Innovation" by Chesbrough [7]. "New information and communication technologies (ICT) have reduced the perceived distances between the actors of the innovation process […]" [12] and so allowed for a broader integration of customers. OI experienced a vital exchange in research as well as in practice in the last decade and is expected to increase further over the next few years [13], [20]. Though literature is rich of qualitative case-study research and OI best practices in different industries, different kinds of users or different stages of the innovation process, research aiming at the economic valuation of investments in OI activities is virtually non-existent. The analysis of van de Vrande et al. [40] who examined a broad range of OI publications within the last decade show a lack of formal-methodological approaches that aim at an economic valuation. The rising impact of mobile devices and the dramatically increasing market for mobile services and products requires innovative services that serve the customer's mobility needs. Bouwman et al. [4] for that stress the importance and relevance of OI approaches for mobile service models as companies in this area often lack experience and best practices. Hence, integrating customers in the innovation process within an OI approach seems to be promising for mobile service development [4], [38]. However, experience from past open or traditional innovation approaches have to be adapted with regard to mobile services as the speed of technological advances regarding mobile devices and hence the possibilities of mobile services do not fit in regular innovation processes. Yet, literature still lacks contributions that provide methods for determining the right amount on how much to invest in mobile service OI activities and how the effect chain between OI and customer satisfaction works. As one of the few papers, Platzer [37] extended the classic Technology Acceptance Model and developed a taxonomy that enables user integration in terms of an OI approach for automated classification of user reviews. This enables a learning environment within mobile app development during the innovation process to increase the probability to develop mobile apps that meet the customers' needs. In the very early stage of mobile services, Aalto et al. [1] described the prototypical implementation of an OI approach for the development and testing of mobile applications. Based on our literature review and the finding that "[…] future research has to continue to broaden the scope of open innovation research to exploit its full potential" [40], we find a research gap regarding OI approaches in the innovation process of mobile services in general. Additionally, research lacks well-founded economic analysis and formal-methodological models that aim at the determination of the optimal investment amount in OI activities for mobile services in particular.

3 OI and the Kano Model for Customer Satisfaction

In order to increase revenue generated through mobile services, companies increasingly open up their innovation process. However, as stated above, the precise relation between OI investments and thereby generated revenue is still indistinct leading to a lack of well-founded economic decisions regarding investments in OI activities.

Fig. 1. Black box between investments in OI activities and thereby generated revenue

As we will show in the following, simply assuming that higher investments in OI activities will always increase the revenues of mobile services neglects important aspects of OI. In the following, we firstly analyze the direct effect of OI activities on the over-fulfillment of customer expectations in sub-section 3.1. In sub-section 3.2, we analyze the relation between the over-fulfillment of customer expectations and customer satisfaction using the Kano model. On that basis, we can analyze the idiosyncratic relationship between investments in OI activities for innovative mobile services and customer satisfaction in sub-section 3.3. In chapter 4, we develop a formal model to determine the precise relation between investments in OI activities and revenue under consideration of all mentioned elements of the effect chain. Figure 1 illustrates our analysis process and points out the major contribution of our approach.

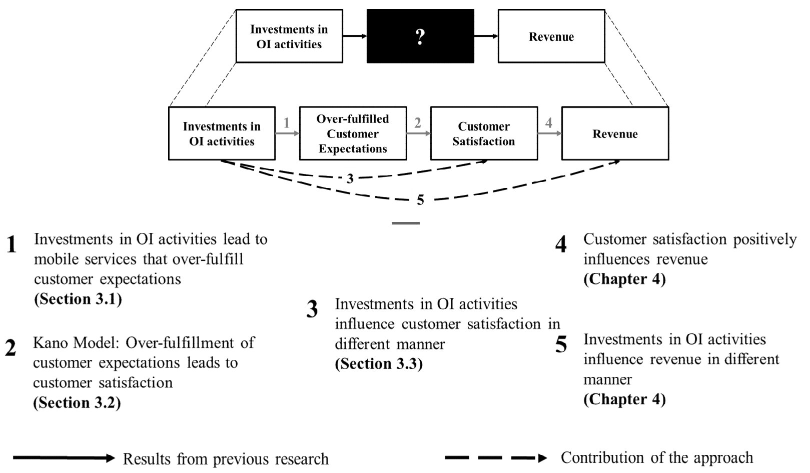

Fig. 2. Effect chain between OI investments and revenues

3.1 OI Activities and Over-fulfillment of Customer Expectations

Initially, literature states that the integration of customers in the innovation process reduces the risk of developing mobile services which do not meet customer needs [38]. This is due to the fact that integrating the customer allows for a much deeper level of individualization especially regarding mobile services [38] since mobile services by nature require individualization and are very familiar to today’s customers. For that, companies need to integrate customers early, significantly and along the whole innovation process regarding new products like mobile services [30], [38]. Consequently, we are in line with Enkel et al. [9], Bruce and Biemans [5], and Kohli and Jaworski [24] when we conclude that investments in OI activities positively influence the possibility to create auspicious mobile services that lead to over-fulfillment of customer expectations.

3.2 Over-fulfillment of Customer Expectations and Customer Satisfaction

Meeting or even over-fulfilling customer expectations is not a direct driver of quantifiable financial results. For that, we have to take a closer look on customer satisfaction which directly leads to financial impacts for the company [6], [14], [21], [33]. In order to determine customer satisfaction [34], the confirmation/disconfirmation paradigm is a widely spread and well acknowledged method. In case a considered service over-fulfills customer expectations, it is above a customer's so called confirmation level and thus generates customer satisfaction and vice versa. The Kano model [22] distinguishes three different kinds of attributes of a product or service, which determine customer satisfaction through the respective over-fulfillment of customer expectations.

Must-be attributes are considered fundamental and natural by the customer. Under-fulfillment of must-be attributes leads to customer dissatisfaction. However, over-fulfilled expectations of must-be attributes will not increase customer satisfaction as must-be attributes are perceived only implicitly. Must-be attributes of mobile services e.g. are implicit expectations regarding availability and stability.

One-dimensional attributes generate dissatisfaction or satisfaction depending on the extent of a service's over- or under-fulfillment of expectations. Over- /under-fulfilling expectations towards a one-dimensional attribute leads to a proportional increase / decrease of customer satisfaction. Customers are aware of one-dimensional attributes and explicitly demand them. Application speed or productivity increases are examples for a mobile service's one-dimensional attributes.

Attractive attributes are service features that are not expected by customers. Over-fulfillment of customer expectations by developing services that include attractive attributes leads to a disproportional increase of customer satisfaction. With regard to mobile services, attractive attributes e.g. are unique and breakthrough solutions to problems, customers were not even aware of in advance [6]. Figure 1 illustrates the determinants of customer satisfaction following Kano et al. [22].

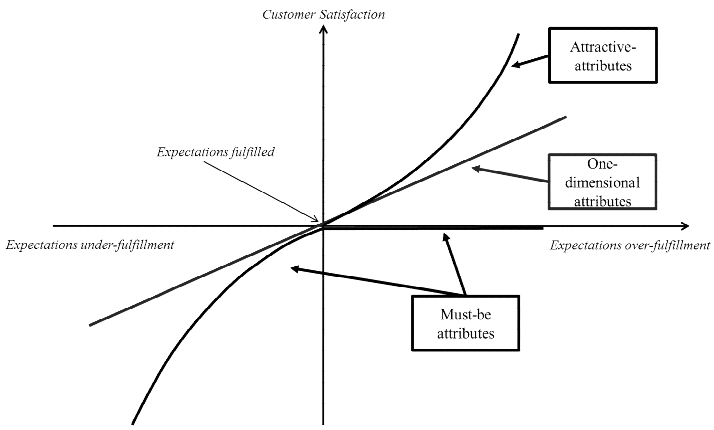

Fig. 3. Determinants of customer satisfaction following the Kano model

In Figure 1, the influence of must-be attributes on customer satisfaction is illustrated as a monotonically increasing, concave function in the section of expectations under-fulfillment. Above the confirmation level, must-be attributes do not contribute to customer satisfaction, resulting in a linear, non-increasing or decreasing function. The influence of one-dimensional attributes to customer satisfaction is consequently directly proportional. Finally, the high contribution of attractive attributes is illustrated as a monotonically increasing, convex function in the section of expectation over-fulfillment. As customers do not expect attractive attributes, they are not defined for the case of under-fulfillment.

3.3 Effects of Investments in OI Activities on Customer Satisfaction

We in the following will discuss idiosyncrasies of OI activities on customer satisfaction when applied in mobile service development.

OI investments and the attributes of customer satisfaction of the Kano model. According to Peppers and Rogers [36] exploiting the customer's knowledge through integration in the innovation process can be a key success driver for increasing customer satisfaction. As such OI activities aim at the generation of innovative and completely new mobile services, we argue that OI activities in the first place produce attractive attributes of services and do not produce must-be or one-dimensional attributes. Regarding must-be attributes, this is due to the fact that customers perceive must-be attributes only implicitly whereas mobile service innovations can assumed to be perceived explicitly. One-dimensional attributes make existing functions quicker, cheaper or at higher quality and are explicitly demanded by customers, i.e. they are neither generated by OI activities in the first place. Consequently, OI activities in the first place only produce attractive attributes which, in case of over-fulfillment, are surprising for the customer and hence lead to customer satisfaction. Increased customer satisfaction through attractive attributes then directly links OI activities to customer loyalty, long-term competitive advantage and thus financial impact [17], [31]. However, OI activities produce customer satisfaction through attractive attributes only in the first place and not constantly. In case of mobile service development, conducting several OI activities is not likely to reveal always more innovations, but can create one-dimensional or even only must-be attributes.

The subsiding impact of mobile service OI activities on customer satisfaction. As illustrated in the previous section, investments in OI activities positively influence customer satisfaction by leading to services with attractive-attributes that over-fulfill customer expectations. Consequently, one could assume that the execution of all OI activities available always makes good economic sense. Yet, mobile services show some idiosyncrasies that speak against this assumption and that are to consider when applying OI activities. Though technological developments as web-based social collaboration methods today allow for customer integration at reasonable costs for infrastructure – transaction costs, consultancy, legal expenses, software tools etc. still state for significant investment payouts linked with OI activities in the early and middle phases of mobile service development [19], [38]. Furthermore, the positive contribution of OI to customer satisfaction usually slows down throughout its use [6]: Product features identified through OI activities that initially created unexpected excitement later on are considered as normal by the customer [19]. These product features increasingly lose their positive influence on customer satisfaction and, as a consequence, their status as a service's attractive attribute. In this vein, a mobile service's attractive attributes can become one-dimensional attributes and one-dimensional attributes can become must-be attributes [6] as implied above. The extent of this negative effect depends on the amount of customers, which experience true excitement by surprising mobile service features on the one hand and the amount of customers, which already have expected the mobile service innovation on the other hand. Regarding OI activities, all customers involved in the service development process are likely to belong to the second group. Customers that took part in the idea generation process are likely to know and expect innovative product features already before the mobile service is on the market. If features that were discussed in the innovation process or submitted by the customers are not implemented or only to a limited extent, this is likely to lead to disappointment of customers who took part in the OI activity. The positive influence of OI activities on customer satisfaction will then be solely determined by the degree to which the explicitly raised expectations will be fulfilled (through one-dimensional or basic attributes). All other customers will be delighted by the innovations through excitement attributes. Beyond that, it is also conceivable that over a certain threshold, OI activities do not generate additional customer satisfaction at all or even negatively influence customer satisfaction. Customers contacted repeatedly and on versatile marketing channels by companies executing large scale OI activities can react with rejection which causes decreasing customer satisfaction [9], [27]. The former positive influence of creating a fashion around an OI activity can then turn the OI activities into a transient fad which only attracts bandwagon behavior instead of thorough collaboration with breakthrough ideas for new mobile services. This subsiding effect of OI is especially important for our consideration, since mobile service customers are significantly more online and usually well connected to each other via their mobile device (e.g. by social networks). The consequently tend to spread negative experiences with innovative services and rejection with high frequency, extremely fast and with a potentially huge dispersive character.

4 Model

In this section, we introduce a formal-deductive mathematical model that aims at optimizing the investment amount in OI activities regarding the trade-off between the up- and downsides of OI activities in mobile service development mentioned above. Though determining the optimal amount of OI activities seems suitable to a broad range of products beyond mobile services, it seems particularly useful for mobile service development due to the following idiosyncrasies: *First*, mobile services by nature are services where customers are eager to engage in since their utility directly is perceived by the customer. *Second*, due to the vast number and variety of mobile services, the ease of installation and low costs, customers have a broad knowledge on various mobile services making them very capable in providing feedback and suggestions. *Third*, the development and update of mobile services on average is easy, quick and requires much less resources than traditional product or software innovation. This allows for a broad range of experience in a short period of time and the application of a standardized evaluation and development approach without being subject to heavy changes in the company's market environment. The applied Kano model and its formal description by Buhl et al. [6] build the methodological basis for our work. After describing the research methodology used, we introduce the mathematical optimization model and illustrate its practical utility with an example based on real world data.

4.1 Research Methodology

According to the research framework of Meredith et al. [32], research activities have to fit in an iterative cycle of description, explanation and testing. Our contribution shall correspond to the first two phases, the description and explanation of an observable economic fact. Since some new research insights cannot always be derived from observations in practice, a formal-deductive approach can be used. Testing the discovered insights according to its prognosis robustness shall be subject to future empirical research. For that, our approach aims at providing a basis for deriving hypothesis for empiricism. As a first step towards this direction, we will use a simplified practical example on the basis of real world data to illustrate our model's utility.

4.2 Setting and Assumptions

We consider a company which aims on integrating customers in the idea generation process for a mobile service. For this purpose, different OI activities for active customer integration like mobile idea communities, mobile service prototypes, mobile app idea competitions, lead user workshops etc. are available to the company [43]. As our model's scope is the optimal investment amount in OI activities, we do not focus on single OI activities with different principles of operation, but on the optimal investment amount $I^{*}>0$ to be spent on a sum of OI activities with the objective to maximize the company's profit. We aim at formalizing the impact of OI activities on customer satisfaction and hence, the company's revenue. As we use a formal-deductive mathematical approach, we refer to Hevner et al. [18], who stated that in order to "[…] be mathematically rigorous, important parts of the problem may be abstracted". This consequently implicates assumptions that we state in the following.

A1: Taken alone, all available OI activities are equal regarding their positive impact on the over-fulfillment of customer expectations and the therefore necessary payout. OI activities are divisible and can be executed separately and independently.

Though we can find weak evidence in literature [43] for this simplifying assumption A1, we can state that our model's results are also valid for scenarios where OI activities have differing impact. In this case, the company would conduct the OI activities in descending order sorted by the ratio "impact on the over-fulfillment of customer expectations/payouts". As a result of assumption A1, the investment amount in OI activities has a positive linear influence on the over-fulfillment of customer expectations. Consequently, we substitute the qualitative determinant of customer satisfaction (*over-fulfillment of customer expectations*) of the Kano model by a quantitative measurable determinant (*investments in OI activities*) and focus on the specific impact of OI on customer satisfaction. Considering not a single OI activity taken alone, but several OI activities, we have to account for the Kano model and the subsiding effect of OI activities. In this vein, we can model the relationship between OI activities and customer satisfaction, which is stated in assumption A2:

A2: Investments in OI activities influence customer satisfaction in different manner (i.e. changing between convex and concave sections). To model the different impact of OI activities on customer satisfaction, we arrange Kano's attributes of customer satisfaction in descending order (i.e. attractive attributes → one-dimensional attributes → must-be attributes) and extend it by rejection through customers with regard to the respective amount of money invested.

Figure 4 illustrates the influence of the investment amount in OI activities I on customer satisfaction as a curve $cs(I)$. Due to the different positive as well as negative impacts of OI activities on customer satisfaction, the function on the one hand inherits a convex section where OI activities lead to attractive attributes (section 1). The function in section 2 shows a proportional progress, when OI activities only produce one-dimensional attributes and concave progress in section 3, when OI activities only produce must-be attributes due to too much customer integration [6]. The negative effect of OI activities is illustrated in section 4 where additional OI activities even lead to a decreasing progress due to rejection of the customers.

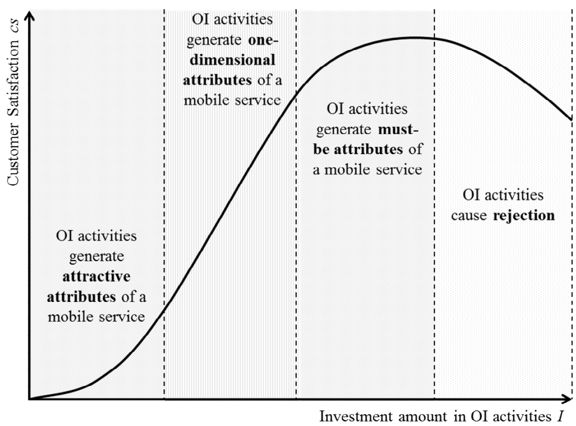

Fig. 4. The different effects of OI on customer satisfaction

To model all described positive and negative effects of OI, we need a formal description for cs(l). One possible function to model the curve shape pictured in Figure 4 adequately is the so called classic earnings function from production theory [42]. This function which originally aims at mathematical relations of partial factor variation is a scientifically acknowledged way to accurately describe the relation between an input factor (here: the investment amount in OI activities l) and earnings (here: customer satisfaction cs). In its general form, the function is transferable to other application fields than production theory. By using the classic earnings function, we can consider all aforementioned effects of OI. We state assumption A3.

A3: The effect of the investment amount in OI activities l on customer satisfaction cs follows a classic earnings function in the following form:

$$cs\ (l) = - a * l^3 + b * l^2 + c * l + cs_0 \quad \text{with } a\ ,\ b\ ,\ c > 0 \tag{1}$$

The parameter $cs_0>0$ thereby guarantees that a company not investing in OI activities in mobile service development at all will end up at a basic but positive customer satisfaction level. The parameters a, b, and c are necessary to model the changing course gradient and curvature progression of the customer satisfaction curve as seen in Figure 4. In order to reach a decision model with economic parameters, we have to consider that investing in OI activities influences customer satisfaction and, eventually, the financial performance of the company [16], [33]. Since we do not focus on the monetary valuation of customer satisfaction, we state the simplifying assumption A4.

A4: A company's revenue originating from mobile services r (cs(l)) for a considered period of time equals the customer satisfaction achieved by investing in OI activities multiplied by the conversion factor $d > 0$. Other influences are neglected.

Assuming a linear correlation between customer satisfaction and a companies revenue from mobile service innovations by all means is simplifying matter. Nevertheless, we refer to the work of Mittal et al [33] who state that "[…] the assosication between customer satisfaction and long-term financial performance is positive […]". They emphasize this correlation to be stronger in case companies are able to simultaneously increase customer satisfaction *and* decrease costs at the same time. As OI activities through enhanced innovation processes and more customer oriented products increase customer satisfaction and also partly support cost reduction (at least in the long-term), they indirectly are able to contribute (weakly) to both goals as shown by Faems et al. [10]. Thus, we can state this simplifying assumption without distorting reality and our model's results too much. In case a company's revenue stands in other than a linear relation to customer satisfaction, e.g. convex, concave, relations, the model could easily be tailored to such other relations by adapting the factor d to be a function of cs (l). However, empirically examining the association between customer satisfaction through OI activities is still due to further research.We incorporate this simplifying correlation by formalizing the company's revenue by $r\ (cs(l)) = cs(l) * d$. In order to come to a decision model, we state our last assumption A5.

A5: The company's major objective is to maximize its profit P(l). For reasons of simplicity, all parameters are assumed to be deterministic and the time value of money is neglected.

Neglecting the time value of money is simplifying matters but reasonable due to the short time periods of innovation processes and market penetration with mobile services. On the basis of these assumptions and the presented profit function we are able to determine the optimal investment amount in OI activities in sub-section 4.3.

4.3 Determining the Optimal Investment Amount

The company evaluates the economic utility of OI activities on the basis of the profit function, which is thereby also the function to be optimized:P(l)= r(cs(l)) - l
By including the revenue function and the classic earnings function in the profit function P(l), we can derive the final objective function for investments in OI:

$$\max!P(l)\ r(\ cs\ (l))\ -\ l = cs\ (l) * d - l = (-\ a * l^3 + b * l^2 + c * l + cs_0\ ) * d - l \quad (2)$$

In order to determine the optimal investment amount in OI activities, we maximize the objective function by setting the first derivative of P(l) equal to zero.

$$\frac{\partial P(I)}{\partial I} = -3 \cdot a \cdot d \cdot I^2 + 2 \cdot b \cdot d \cdot I + c \cdot d - 1 = 0 \quad (3)$$

By solving this term for l, we get two candidates $\check{I}_1$, $\check{I}_2$ for the maximization of the objective function. Under the given assumptions it is easy to show that only

$$\check{I}_1 = \frac{bd+\sqrt{-3ad+b^2d^2+3acd^2}}{3ad} \quad \text{implies} \quad \frac{\partial^2 P(\check{I}_1)}{\partial^2 \check{I}_1} = 2 \cdot b \cdot d - 6 \cdot a \cdot d \cdot I < 0$$

and therefore $\check{I}_1$ remains as the only candidate. Given that $\check{I}_1$ is in the assumed domain $(\check{I}_1 > 0)$ and $P(\check{I}_1) > 0$, $\check{I}_1 = I^*$, which is the optimal investment amount in OI activities maximizing the company's profit under the given assumptions. In case $P(\check{I}_1) < 0$, $l^* = 0$. Consequently, it is reasonable to raise the investment amount up to l^*. Investments in OI activities with $l < l^*$ do not maximize the company value. Thus, an increase of the investment amount in OI activities leads to an increased over-fulfillment of customer expectations and, hence, customer satisfaction. In contrast, the positive effects of investments in OI activities with $l > l^*$ in fact still exceed the initial payouts. However, the subsiding effect of OI activities on customer satisfaction leads to disproportionally high capital expenditures and to less additional customer satisfaction.

5 Practical Example with Real-World Data Basis

We demonstrate our model's practical utility with the data of a large manufacturing company of a current industry (research-in-progress) project in the context of mobile app innovations. The company is developing several mobile apps for its customers and sales representatives. The company has already performed OI activites and now wants to decide on the investment amount to be spent on an OI activity for its next mobile app projects. With regard to the company's experience with OI, the company has tracked occurred payouts of five already completed OI activities from the past mobile app projects. With the help of the user statistics of the already implemented mobile apps emerged from the OI activities, the company is able to estimate values for productivity increase, realized cross selling potential, brand value and revenue increase and other benefits of two mobile service innovations. Moreover, the company can use a quantitative estimation method to estimate the financial benefits of the ideas generated by the three other OI activities [39]. This is done by estimating payouts and intervals for financial benefits through the responsible business experts. By aggregating these figures to project values and summing them up, the company is able to determine values for payouts and profits of the OI activities in mobile app development projects which can be seen in Table 1. Project risk is obviously no issue here, which is subject to further research. The values for payouts include payouts for the actual execution of the OI activity, but also for preparation, conceptualization, the processing of results including the description and evaluation of ideas emerged from the respective OI activities. Due to the confidential character of the data, all values were transformed.

Table 1. Input values for the practical example

OI activitiy	Description	Payouts l	(estimated) profit P (l)
1st	Lead user interviews 1	45 thousand (T)€	0.5 T€
2nd	Lead user interviews 2	20 T€	8 T€
3rd	Field observation	25 T€	49.25 T€
4th	Online survey	60 T€	168.25 T€
5th	Idea competition	100 T€	290 T€

By using the values from Table 1 in the profit function P (l), a linear system of five equations with five unknown variables comes into being. Thus, the company is able to determine the values for the objective function (a = 0,01, b = 5, c = 1, d = 0,005 and cs_0 = 50). For the next investment amount on OI activities we can find the overall optimum to be l^*=312,078 € resulting in a maximized profit of P(l^*)=604,844 €. Thus, it makes good economic sense for the company to invest this overall amount of money in OI activities. Below or above this amount, the over-fulfillment of customer expectations is lower, customer satisfaction decreases and revenue is below the maximum. In this example, investing more than the economic optimum will lead to worse results than investing an equal amount less, e.g. an investment sum of l =250,000 € (-62,078 € less the optimum) will result in 532,750 € profits, whereas an investment sum of l = 374,156 € (+62,078 € more than the optimum) will only generate 508,827 € profit. Investing more than 456,424 € will even lead to losses, since the continuous OI activities lead to customer dissatisfaction. Since the company already invested 250,000 € for the OI activities above in sum, the recommendation for the management is to invest another 62,078 € to reach the optimum l^* with the next OI activity. Above this amount of money, it is not reasonable to invest more in OI activities. However, in practice, the calculated optimum from our theoretical model cannot be assumed to be exactly valid. The calculated optimum should therefore be interpreted as an indicator for a range for the next investment in OI activities rather than an exact number. In order to refine the results, experimental projects regarding investments in OI activities in mobile service development and refining the input values for the objective function is advisable. This holds especially true with regard to the fact that the values of the objective function may change over time due to influences like a dynamic competitive environment, company restructuring or scale and learning effects. For this reason, we suggest not to rely on a unique determination of the optimal investment amount in OI activities but to stress the input values on a regular basis and update the data basis with current project data.

6 Summary and Outlook

Mobile service innovations' potential for valuable economic impact attracts companies to conduct significant investments. To develop and launch successful mobile services, integrating customers in the idea generation process through OI activities bears high potential and is hence desirable. However, the lack of a precise analysis of the relation between OI investments and generated revenues leads to a lack of well-founded economic decisions regarding investments in OI activities. This paper aims at replacing the black box between OI investments and revenue with an effect chain in section 3. In section 4, we formalized the effect chain putting special emphasis on the specifics of mobile services and represented the effects of OI with a flattening curve assembled from the attributes of customer satisfaction of the Kano model regarding mobile services. Through mathematical optimization, we aim at determining the optimal investment amount in OI activities and show the model's utility in section 5 with an example based on real-world data. Nevertheless, several restricting assumptions and resulting conditions of this paper have to be examined critically. First, the relation between OI investments and the over-fulfillment of customer expectations must be examined in more depth in order to calibrate the model to practice thus guaranteeing valid outcomes. Second, Peppers and Rogers [36] note that the success of OI depends on the quality of information that is gained by customer integration. Thus, it is necessary to distinguish between different kinds of OI activities and integrate them in the model. Third, all factors of the model are considered to be deterministic. Due to the high dynamics of the domain, it is likely that the estimation of parameters necessary for the objective function is quite demanding. The enhancement of the model to a decision calculus considering risk therefore requires further research. Fourth, though the model formalizes the effect of customer integration in an economic model, it is necessary to validate all assumptions and the effect chain by testing through empiricism. However, the model presents a starting point for further research on the economic effects of customer integration in mobile service development to take full advantage of the high potentials of OI in mobile industries.

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