The Impact of Past Innovation Activities on the Future Innovation Success in the B-to-B Sector

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***Abstract*—The innovation success of a firm is often measured by factors such as the number of patents or the turnover of new products developed in the last three years. Those measurements share the principle to rate the innovation success of a firm by its past performances. They show whether a firm has done a good job in an innovation context. This leads to the question, if that kind of rating is also valid to rate the future innovation success of a firm. Some authors mention beneath past-orientated innovation factors also measurements to anticipate the future innovation success. Additionally, past innovation activities may have an effect on the future innovation success. Accordingly, this article addresses the impact of past innovation factors on the future innovation success based on a quantitative survey within the B-to-B sector. The contribution of ex-post innovation factors will be tested with regard to their contribution to the future innovation success. If there is a link between past innovation activities and the future innovation success, this could be used to develop the innovation strategy of a firm, for instance.**

***Index Terms*—Innovation success, innovation performance, innovation competence, success factors.**

I. Introduction

Innovations play a vital role in literature and practice [1], [2], [3]. In particular, innovation success factors are of interest since they can lead to future innovation success [4]. Due to the increasing speed of technology changes there seems to be the need to continuously come up with new products [5], [6]. As a consequence, the importance of future innovation success rises. That leads to the question what a firm can do to continuously keep its innovativeness. The innovation success is often measured by factors such as the number of new products within the last three years, for instance [7]. That kind of measurements can be classified as performance indicators [8] that describe the innovation success from an ex-post perspective [4]. Therefore, these criteria help to understand the success rate of past innovation activities. However, these factors can lead to a misunderstanding of the current innovation status of a firm. As an example, Nokia brought up a lot of innovative products and was still growing after the dotcom crises in 2001 [9]. From an ex-post innovation perspective, Nokia was still an innovative firm in 2007. However, in the same year apple introduced the iPhone. From that time onwards, Nokia lost its innovative position within the smartphone sector. This could be understood as missing competencies in regard to the future innovation success. Consequently, [4] recommends using ex-post measures and future innovation factors to rate a firm's innovativeness. This leads to the question, how to measure future innovation success factors. A qualitative approach could be a possibility to measure those factors by analyzing the development competencies with regard to new products, for instance. Additionally, the quantified results of the past innovation activities could be used to rate the future innovation success. As an example, the number of patents describes the innovation activity of a firm from an ex-post perspective. Since patents can lead to new product ideas [10] there seems to be a positive impact on the future number of new products. Thus, the number of patents can be interpreted as an influencing factor for the future innovation success. If there is a link between the ex-post perspective and the future innovation success a firm could use this information to derive innovation activities to favor the future innovation success.

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II. Objectives

The research focus of this article is to identify and rate ex-post innovation factors with regard to their influence on the future innovation success. It bases on an innovation factor categorization and a quantitative study performed by [4]. This study is focused on product innovations within the technical B-to-B sector. More precisely, the industry sectors of the sample resulted in 31% automotive industry, 38% consumer electronics and 31% general technical industries. Consequently, this is also the industry focus of the current article. The data will be used to determine the influence of past innovation activities on the future innovation success. Subsequently, the research question of the current article is about which innovation factors from an ex-post perspective influence factors of the future innovation success. Relating thereto, there has been only little research. Thus, this study can be categorized as an explorative analysis. In a first step, the differentiation between an ex-post and ex-ante perspective with regard to innovation activities will be terminologically defined. These perspectives correspond with the past innovation performance and the future innovation success of a firm. Since innovation success is about innovation and the future, it will be aligned with the innovation management and the future research. Subsequently, ex-post and ex-ante innovation factors will be obtained from the literature. In a further step, the data with regard to the ex-post and ex-ante innovation factors will be statistically evaluated. That results in answering the research question by defining and ranking those ex-post innovation factors that boost the ex-ante innovation factors respectively the future innovation success.

III. Literature Review

The innovation research is typically focused on sectors such as a dimensional respectively categorical view [4], a

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process-based view [11] or the measurement of the innovation success [12]. Particularly, the innovation success seems to be of importance, since innovation success leads to competitive advantages [13], [14], [15]. Furthermore, the term innovation implies success since only those inventions can be called innovations that are successful on the market [14], [16]. Success factors help to measure the success of innovations [17]. The corresponding research differs between factors measuring the success and factors measuring the failure rate of innovations [18], for instance. Alternatively, innovation success factors can be categorized by a temporal perspective [4]. Following this approach, the innovation performance and the innovation competence build the segmentation of the success factors. The current article aims at analyzing the influence of the past to the future innovation success. Therefore, the further research process bases on a temporal perspective.

The future aspect of the innovation success corresponds with the future research. This research field is typically about predicting the future in a social context [19]. For instance, it covers topics such as better decision making, understanding the world, or building consciousness in regard to the future [20]. As an example, corresponding journals are named as "future of children", "future of food" or "future hospital". Therefore, there doesn't seem to be a direct connection to the future innovation success. However, [19] argues that future research changes from a data driven science to a rather competence-orientated research. Equally, the future innovation success seems to be related to innovation competences [4]. This can be interpreted as an ex-ante innovation perspective. Reference [21] sees apart from innovation competences also the innovation performance as a precondition for market success. More precisely, the innovation performance can be seen as an ex-post success perspective [17]. As a consequence, the current article differs between an ex-post and an ex-ante perspective on the innovation success.

With regard to the ex-post perspective, quantifiable indicators seem to be suitable for the measurement of the innovation performance [17]. Since those factors describe the past innovation success, they can be referred to as ex-post innovation factors. For instance, absolute numbers such as the revenue share of new products measure the innovation performance of products [8], [22]. The ex-post innovation factors of this study originate from an evaluation of [8]. The authors extracted performance factors out of several studies. These ex-post factors are the share of the innovation revenue, the share of the innovation profit as well as the innovation expenditures by comparison to the overall investments. Additional factors are the number of new products and patents within the last three years. As a result, five ex-post innovation factors will be used to model the link between the past and future innovation success.

Reference [23] defines competences by repeatable, learning-based capabilities to handle resources. In an innovation context, competences can be seen as capabilities that are typically needed within the innovation process [4]. This could be capabilities to generate ideas, develop new products, and to introduce new products to the market [3]. Since such capabilities describe the future innovation success, they can be interpreted as ex-ante innovation factors. Following [4], innovation competences can be segmented into four categories. These are the development, the market introduction, the internal interaction and the management competence. The development competence refers to the development phase of the innovation process. Therefore, this competence is about transferring new ideas into marketable products [3]. Furthermore, a standardized development process seems to favor innovations [24]. Additionally, sufficient development resources can be seen as a driving innovation factor [25]. The competence market introduction is about introducing new products into the market [4]. This competence is linked to the market introduction phase of new products. Capabilities such as market orientation as well as market knowledge seem to be necessary for a successful market introduction [26]. Complementary, professional marketing activities can be seen as an important success factor [27]. The innovation competence internal interaction defines the capability to interact and communicate between different departments within a firm [4]. That kind of an interdisciplinary interaction as well as determined communication processes can be seen as an important innovation factor [28], [29]. Particularly, an interaction between marketing and research and development appears to be important to boost innovations [30]. Based on that, [31] recommends integrating a communication strategy into the innovation process. From a management perspective, it seems to be recommendable to establish an innovation strategy and to implement an innovation process [32]. Additionally, an innovation culture fostering the idea generation and accepting risks favors the innovation success [33], for instance. These aspects can be conducted to the management competence [34] that seems to be a precondition for the innovation success [35].

IV. Research Method

To answer the research question, this study tests the influence of the past innovation performance on the future innovations success. The test bases on a quantitative survey from [4] that include data in regard to the innovation performance and innovation competences. The participants of that survey were innovation specialists of different management levels that rated ex-post and ex-ante innovation factors within the technological B-to-B sector. Following the literature review in the previous section, the ex-ante factors form the future innovation success respectively the innovation competences. The ex-post factors correspond to the past innovation performance. The data consist of revised data with n=115 samples. Therefore, additional pre-tests such as correlation analyses, distribution aspects or the search for outliners will be neglected. Regression analyses will evaluate the influence of the ex-post factors on the four ex-ante factors. Subsequently, the corresponding statistical model incorporates the ex-ante factors the development, the market introduction, the internal interaction and the management competence as the dependent variables. The ex-post factors the revenue share, the number of new products, the profit share, the number of patents and the expenditure share represent the independent variables. For each of the ex-ante factors separate regression analyses consisting of two models will be performed. Model 1 corresponds to a regression

analysis integrating all independent variables. A second model bases on a stepwise regression analysis with the Akaike information criterion. This kind of model selection leads to a maximum goodness of fit with an equal or reduced number of independent variables. The resulting regression coefficients of model 1 correspond with the influence level of each ex-post innovation factor on the corresponding innovation competence. Consequently, these ex-post factors will be ranked by the value of their regression coefficient. Furthermore, t-tests will be performed for each of the regression coefficients to define the significance level of the ex-post factors. The significance level is set to 5%. However, these results will be aligned with the results of the second model. The integrated ex-post factors of the second model will be discussed with regard to their contribution to the future innovation success. Thus, the most significant factors with regard to the future innovation success will be identified.

V. Findings

The regression analyses based on the development competence as dependent variable result in highly significant models, as shown in Table I. Model 2 results in a minimalistic lower value of R^2 than model 1. However, the adjusted R^2 of the second model resulted in 0.445 compared to 0.443 at the first model. In this study, the rating of the innovation competencies is based on an ex-post perspective. Due to this tight perspective, an R^2-value of 0.467 can be seen as a good fit of the model. The regression coefficients and p-values of the independent variables of model 1 are shown in a descending order. Following these results, the revenue share and the number of patents are highly significant. Further on, this is reflected by the high values of the regression coefficients compared to the other independent variables. However, three of the ex-post factors don't show any significance. Consequently, they correspond with low coefficient values. Thus, their influence on the development competence seems to be negligible.

TABLE I: Results of the Regression Analyses Based on the Development Competence

	Model 1 R^2=0.467, p =0.000		Model 2 R^2=0.452, p =0.000	
Variable	Coefficient	p-value	Coefficient	p-value
Revenue	0.381	0.000	0.463	0.000
Patents	0.353	0.000	0.374	0.000
Expenditures	0.098	0.258		
Profit	0.070	0.416		
New products	0.032	0.735		

Additionally, the corresponding results from the second model are shown in the last two rows in Table I. Correspondingly, model 2 leads to the integration of only the two ex-post factors the number of patents and the revenue share. Since the results of model 1 and 2 coincide, the revenue share and the number of patents seem to be the main influencing factors on the development competence. The revenue share of new products can be interpreted as the success rate of new products. Consequently, new products comply with the expectations of the market. This can be understood as a professional and qualified development of marketable products. Thus, it explains the high significance of the revenue share. Since patents base on ideas and development knowledge [36] the number of patents can be interpreted as skilled development competence. This illustrates the significant link between the number of patents and the development competence.

Table II shows the results of model 1 and 2 with regard to the competence market introduction as dependent variable. Both models lead to a similar model validity following their coefficients of determination. With regard to the regression coefficients and p-values of model 1, particularly the number of new products and the number of patents seem to have a high contribution to the market introduction competence. The stepwise regression of model 2 leads to an inclusion of the three ex-post factors the number of new products, the number of patents and the revenue share. Therefore, the variable selection of model 1 and 2 differs.

TABLE II: Results of the Regression Analyses Based on the Market Introduction Competence

	Model 1 R^2=0.335, p =0.000		Model 2 R^2=0.329, p =0.000	
Variable	Coefficient	p-value	Coefficient	p-value
New products	0.267	0.020	0.297	0.004
Patents	0.243	0.004	0.249	0.003
Revenue	0.195	0.085	0.246	0.015
Profit	0.096	0.347		
Expenditures	0.049	0.631		

Additionally, model 2 integrates the revenue share. Generally, the disposal of professional marketing skills as a part of the market introduction competence favors the sales of new products [37]. Thus, the revenue share can be seen as an influencing factor for the market introduction competence. The introduction of new products requires marketing resources. This explains the significant relation between the number of new products and the market introduction competence. The number of patents seems to be rather a part of the development competence. However, there is a link to the market since patents can be rated by a market-orientated method [38]. As a consequence, generating patents requires apart from development respectively technological skills also knowledge about the market. Furthermore, patents can be offered to the market [10]. Reference [39] calls this kind of externalization of knowledge the inside-out process of open innovation. This emphasizes the relation between the number of patents and the market introduction competence.

The two regression models in regard to the internal interaction competence result in two highly significant models as shown in Table III. However, the low value of R^2 leads to the assumption, that the models deliver only little explanation with regard to the internal interaction competence. Only one factor out of five shows a significant p-value. That corresponds with the low R^2-values.

The stepwise regression approach results in two variables. Beneath the number of patents also the profit share is integrated into model 2. Internal interaction such as an interaction between a cost-oriented and a development-oriented department can lead to a positive cost influence to new products, for instance. Therefore, the profit share seems to be suitable to rate the status of the internal

interaction competence of a firm. As described in the literature section, the internal communication seems to be an important factor within the innovation process. Thus, the internal interaction competence has a direct link to the number of patents. Furthermore, interdisciplinary knowledge can be seen as an important factor for generating patents [40], [41]. As a consequence, the internal communication appears to be elementary in regard to patents.

TABLE III: RESULTS OF THE REGRESSION ANALYSES BASED ON THE INTERNAL INTERACTION COMPETENCE

	Model 1 R^2=0.131, p =0.008		Model 2 R^2=0.121, p =0.001	
Variable	Coefficient	p-value	Coefficient	p-value
Patents	0.243	0.014	0.279	0.003
New products	0.134	0.314		
Profit	0.123	0.303	0.166	0.111
Revenue	0.031	0.815		
Expenditures	-0.052	0.664		

Table IV gives an overview of the results of the two models with regard to the management competence. Beneath the high significance of both models, the R^2-value can be rated as a good explanation of the management competence considering the previous mentioned tight focus of the current study.

TABLE IV: RESULTS OF THE REGRESSION ANALYSES BASED ON THE MANAGEMENT COMPETENCE

	Model 1 R^2=0.252, p =0.000		Model 2 R^2=0.245, p =0.000	
Variable	Coefficient	p-value	Coefficient	p-value
Revenue	0.241	0.039	0.295	0.005
Patents	0.214	0.013	0.220	0.010
New products	0.117	0.314	0.149	0.154
Profit	0.103	0.328		
Expenditures	0.052	0.622		

Model 1 leads to the two significant variables the revenue share and the number of patents. The stepwise regression analysis of model 2 integrates the variables revenue share, the number of patents, and additionally, the number of new products. In general, the revenue share of new products can be allocated to the management. The management finally decides which ideas will be transferred to products. Thus, there seems to be an explainable link. Similarly, the number of patents proofs a professional management competence since inventing patents can be seen as a time-consuming task with the consequence of high costs [41]. As a consequence, the management can influence the number of patents by providing resources. A high number of new products can be seen as resource-intensive factor, similarly to the number of the patents. Thus, there seems to be a correlation to the management competence.

As a summary, the regression model of the development competence shows the highest amount of explained variance. Hereafter follow the models of the market introduction, the management competence, and the internal interaction competence. Concerning the contribution of the ex-post factors, the number of patents seems to be the main indicator for the future innovation success. It shows significance for each of the four innovation competencies. That seems to be comprehensible since patents can lead to future rents [42]. The revenue share and the number of new products show a significant influence on three respectively two of the innovation competences. The profit share appears to influence only the internal interaction competence. Finally, the expenditures share did not show any significance with regard to the innovation competences.

VI. CONCLUSION

This article has shown that some of the ex-post innovation factors influence the future innovation success of a firm. That knowledge can support in building an innovation strategy. As an example, a firm found out that its number of patents is far below the industry average. Following the results of the current study, the ex-post factor number of patents has a significant contribution to all of the innovation competences. Thus, there seem to be patent-specific deficits within the firm. With regard to the development competence, additional patent-oriented employees could solve this deficit. Furthermore, the management could implement a patent-friendly culture by means such as incentivizing the generation of patents. A strong internal interaction between marketing, sales and the research and development could lead to more patents with marketable character. Thus, a firm could keep its innovativeness by analyzing the significant ex-post factors on a regular basis. As a consequence, this rating method can be seen as a new integrative concept within the creation of an innovation strategy.

However, the results of the current evaluation cannot be seen as the single way to determine the status of the innovation competencies. For instance, increasing the number of patents doesn't lead automatically to new ideas. To finally end up in innovation success further competencies such as generating marketable ideas seem to be necessary. Building on that, combining the results of the current article with complementary competencies can be seen as a further research step. Additionally, the integration of an open innovation perspective into the ex-ante view seems to be reasonable. For instance, [4] proposes to add the external interaction competence of a firm as an additional innovation competence. Furthermore, the results base on a quantitative survey of 115 samples. Thus, it is not representative for the technological business-to-business sector. In that regard, further surveys with a more comprehensive database would increase the validity of the results. Finally, the results of this article could be integrated into the research field future management. This would result in a comprehensive business approach for the future innovation success.

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