Open Innovation

effects from external knowledge sources on abandoned innovation projects

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Open Innovation: Effects of external sources of knowledge on abandoned innovation projects

Abstract

Purpose - Innovation projects are often risky and costly. But not all innovation projects lead to commercialisation; some are abandoned, and these abandoned innovation projects can be classified as a waste of resources. Therefore, this article studies the influence of different external sources and a firm's decision to abandon an innovation project. The aim is to provide a broader understanding of abandoned projects.

Methodology approach - The data applied are quantitative data and the empirical background is the Danish Innovation Survey 2009. The sample consists of Danish manufacturing firms with 10 employees or more (N = 840). The results are based on logistic regression analysis.

Findings - Results reveal that firms should consider that the involvement of customers can lead them to abandon innovation projects. However, if firms combine customers with universities, it will decrease the likelihood of innovation projects being abandoned. A more in-depth analysis shows that the involvement of customers from ‘Europe’ (countries in Europe excluding Denmark) and the ‘US’ leads to innovation projects being abandoned while customers from ‘other countries’ (the rest of the world, including China and India) have the opposite effect.

Originality – The contribution is to the limited literature on abandoned innovation projects by suggesting that the type of external sources is a significant factor in firms’ decisions to abandon innovation projects. The article identifies that the involvement of certain external sources leads firms to decide to abandon innovation projects, and that the country of origin of the external sources is an important criterion to consider in relation to a firm’s decision to abandon innovation projects.

Keywords - abandoned innovation projects, open innovation, external sources of knowledge, country of origin, logistic regression analysis.

Paper type - Research paper
1. Introduction

Innovation projects are often risky and costly, and firms’ resources for innovation projects are often limited (Blanchard et al., 2013; Mahoney & Pandian, 1992; Peteraf, 1993), and so it is important for firms to avoid using external sources of knowledge and other types of input that would lead to an undesirable direction or strategy. Sources of knowledge involved in innovation projects may be in-house and/or external partners (Chesbrough, 2003; de Faria et al., 2010), as firms do not necessarily have all the internal knowledge and resources needed to create successful innovation projects (Cassiman et al., 2009; Chesbrough, 2003; West & Bogers, 2014). It is necessary, therefore, to open up their innovation projects for input from external sources. An important and well-explored question is: What makes an innovation a success or a failure when it is introduced to the market (Cooper & Kleinschmidt, 1987; Van der Panne et al., 2003)? However, sometimes firms abandon their innovations before introduced to the market. The issue is that these abandoned innovation projects can be classified, for example, as a waste of resources, because firms get no return from the abandoned innovation projects. Therefore, this paper’s aim is to shed more light on what types of external sources of knowledge lead firms to decide to abandon innovation projects.

Current literature on abandoned innovation projects is somewhat limited and the focus is mainly either on why firms abandon projects (Galia & Legros, 2004; Garcia-Vega & Lopez, 2010) or on the type of firms abandoning projects (Paunov, 2012). Furthermore, the number of studies on the relationship between external sources and abandoned innovation projects are limited (Hyll & Pippel, 2016). The explanation usually given for these abandoned innovation projects is that there are problems in the partnership between the firm and the external sources (Lhuillery & Pfister, 2009), or in the type of external partners used (Hyll & Pippel, 2016). Therefore, this article adds to the existing, although limited, literature on abandoned projects by investigating the influence of different types of external knowledge sources on the decision to abandon innovation projects. This leads to the following research question: How does involving different types of external knowledge sources influence firms’ decisions to abandon innovation projects?

The aim of this article is to shed more light on the relationship between external sources and firms’ decisions to abandon innovation projects, because if firms invite the ‘wrong’
type of partners to participate, it may lead the firms to abandon their innovation projects. It is difficult, however, to avoid innovation projects being abandoned, because firms lack knowledge of the difficulties projects may face during the innovation process (Garcia-Vega & Lopez, 2010). This article points to some effects from external sources that firms should consider.

Besides contributing to the literature on abandoned innovation projects, the paper also contributes to the discussion on the benefits and downside of open innovation, by pointing to the negative effects of external sources in terms of innovation projects being abandoned. It is an important issue and it is of relevance for both academia and managers to investigate not only successful innovation projects, but also abandoned projects in open innovation settings.

The external knowledge sources studied are: customers, suppliers, universities and competitors, similar to other studies on CIS (Community Innovation Survey) data (de Faria et al., 2010; Franco & Gussoni, 2014; Santamaria & Surroca, 2011). The different external sources are tested not only in relation to abandoned innovation projects, but also in relation to ongoing innovation projects. The motivation for studying both is that it is important to be able to compare what leads firms to decide whether to abandon innovation projects or not, as suggested by Cooper and Kleinschmidt (1987). The data used in this article are drawn from the Danish Innovation Survey 2009 (CIS data).

The article is structured in the following way: firstly, the literature on abandoned innovation projects and the involvement of the different types of external sources are discussed and then the hypotheses are put forward in Section 2. Following this, data and variables are presented in Section 3, and the results based on logistic regression are presented in Section 4. Finally, Section 5 includes a discussion of the effects from different types of external sources, and the country of origin of the external sources, on the firms’ decision to abandon innovation projects. Section 5 also includes a conclusion and directions for future research, implications and limitations.
2. Abandoned innovation projects

Innovation has for a long time been considered an important factor for firms’ performance, competitive advantage, and long-term survival (Brown & Eisenhardt, 1995; Kleinschmidt & Cooper, 1991; Poot et al., 2009). For some firms, the innovation process changed from a solely in-house activity to collaboration with different external partners, motivated by the opportunity to pool complementary resources and knowledge from the outside (Powell et al., 1996; Un et al., 2010). The strategic challenge for firms is to explore the complementarity between internal sources, such as employees from e.g. R&D (Research & Development) or marketing, and external sources, such as customers or suppliers, and thereby to find the optimal combination to maximise and sustain innovation (Chen et al., 2015; Love & Roper, 2009).

Sometimes firms cancel an innovation project before commercialisation, or having achieved the predefined goal(s), but the decision to abandon projects can be difficult to make (Havila et al., 2013). Current literature has identified certain factors that firms should monitor in innovation projects to help them decide whether to abandon or continue a project. Factors such as the likelihood of success (e.g. technical success and the number of customers), changes in the environment (e.g. changes in regulation and competition), and internal aspects like the profitability of the firm and the possibility to get support from e.g. employees, are pointed to as important to consider in relation to the decision to abandon or continue (Balachandra, 1984). Furthermore, firms need to be aware of type 1 and type 2 errors: Type 1, firms abandoning an innovation project that may become successful when commercialised, and type 2, firms failing to abandon an innovation project that turns out to be a failure after commercialisation. Chesbrough (2004) refers to false-negative projects, that is projects which may be unpromising in the beginning, but may eventually have commercial value.

The literature on abandoned innovation projects is fairly limited, but one study has investigated what types of projects are abandoned and found that firms are more optimistic about and committed to radical product innovation projects, compared to more incremental product innovation projects, and hence they are more inclined to abandon incremental product innovation projects (Schmidt & Calantone, 1998).
Garcia-Vega and Lopez (2010) show that firms' size, degree of R&D and level of exports, influence the decision to abandon innovation projects. R&D-intensive firms and export firms have a higher likelihood of abandoning projects and this is supported by Paunov (2012), while firms with less than 250 employees and firms that receive public support for innovation are less likely to abandon innovation projects (Garcia-Vega & Lopez, 2010). In situations with uncertain market demand, we can see that small and medium-sized firms (fewer than 250 employees) abandon innovation projects, while problems with finding sources for collaboration make larger firms (with 250 employees or more) abandon projects (Garcia-Vega & Lopez, 2010). Obstacles like costs, risks, uncertainty, and lack of customer responsiveness have also been shown to lead to projects being abandoned (Galia & Legros, 2004; More, 1982). Additionally, it can be argued that internal aspects may lead to projects being abandoned, such as lack of planning and control, or inconsistency between an innovation project and the overall strategy of the firm (Unger et al., 2012).

Current literature emphasises that innovation projects being abandoned may be difficult to avoid (Havila et al., 2013). This is the case because of firms' lack of knowledge of the difficulties they risk facing in their projects and because the future is unknown (Garcia-Vega & Lopez, 2010).

2.1 Involvement of external sources
The advantages of involving external sources in the innovation process are well-documented (Chesbrough, 2003; Dyer & Singh, 1998; Wognum et al., 2002), and there seems to be no end to the possibilities that firms can choose in order to open up their innovation process to external sources (Kovács et al., 2015; Pisano & Verganti, 2008). An incentive for involving external partners is to gain access to the partners’ resources, e.g. complementary knowledge, the possibility to learn from a partner (Inkpen & Tsang, 2005; Powell et al., 1996), and in order to share risks (Tether, 2002). The literature has looked at the number (breadth and depth) of sources (Garriga et al., 2013; Laursen & Salter, 2006), the effect of different types of external sources on innovative performance (Fitjar & Rodriguez-Pose, 2013; Lau et al., 2010; Un et al., 2010), and the combination of external sources (Knudsen, 2007; Nieto & Santamaría, 2007). However, the literature on open innovation demonstrates conflicting performance results through involving external knowledge sources. Some studies show the benefits of collaborating with
external sources, for example, that it has been shown that it is beneficial for the firms' innovative performance to collaborate with suppliers and customers (Chen et al., 2015) and that collaborating with international partners is more beneficial for innovation than with domestic partners (Fitjar & Rodriguez-Pose, 2013). Other studies have shown that it is only beneficial to collaborate with a certain number of external sources (Laursen and Salter, 2006). They find that search breadth is related curvilinearly to all degrees of novelty of innovation. Similar results on breadth are found by Leiponen and Helfat (2010). Others have presented more critical results. Knudsen and Mortensen (2011) indicate that increasing openness of the firms would lead to slower and more expensive innovation projects and Tranekjer & Søndergaard (2013) show that the involvement of customer and embedded suppliers would lead respectively to a lower level of market performance and increased project costs. Other disadvantages of open innovation are the risk of partner firms stealing or imitating ideas, or revealing secrets (Dahlander & Gann, 2010), the costs related to creating, controlling and monitoring relationships (Nieto & Santamaria, 2007; Stuermer et al., 2009) and the risk of relying too much on certain external sources, due to the fact that it may hamper the firm's search for partners (West & Bogers, 2014). Another potential barrier for successful open innovation co-operations may be the firm and its culture (Boschma, 2005; van de Vrande et al., 2009).

In open innovation relationships, different types of external sources have different characteristics.

The decision to involve customers in innovation projects is motivated by the goal of improving innovative performance. It gives firms a better understanding of customers’ needs and developments in the market (Freng Svendsen et al., 2011) and provides the firms with resources complementary to the firms' internal resources (Santamaria & Surroca, 2011). Some benefits are faster projects, reduction of market failure, lower costs, and exploitation of fewer resources (Feng et al., 2010).

Customers are willing to contribute to the innovation projects because they are the first to benefit from the new innovation (Von Hippel, 2005). However, a disadvantage with involving customers is that the knowledge provided by customers may be difficult to transfer and access, due to the fact that the knowledge might be complex or tacit (the opposite of explicit knowledge) (Un et al., 2010). Lhuillery and Pfister (2009) explain
that involving customers will lead to a higher probability of problems in the partnership between the firm and the customers (‘collaboration failures’), leading the firm to abandon an innovation project. The literature is, however, inconsistent in its conclusions regarding the effects of the involvement of customers in innovation projects, but I believe that involving customers will lead to innovation projects being abandoned. This expectation is also supported by the results of Lhuillery and Pfister (2009), where they study the relationship between external sources like customers and abandoned innovation projects.

H1: The involvement of customers increases the likelihood of firms deciding to abandon innovation projects.

The incentive for firms to collaborate with competitors is that both parties are in similar situations and want to fulfil similar needs, and their knowledge is also quite similar (Bouncken et al., 2015; Knudsen, 2007; Un et al., 2010). Collaboration with competitors may be initiated by the opportunity to share costs and reduce the time to market (Belderbos et al., 2004; Tsai, 2009). One of the challenges when involving a competitor is that the competitor is not necessarily committed to the rival firm’s innovation project and there is a possibility that the firm will lose control over the innovation project. Also, competitors may withhold their knowledge, making it difficult to access the knowledge, and the risk of unintended knowledge spill-over and opportunistic behaviour is high (Bouncken et al., 2015; Chen et al., 2011; Rindfleisch & Moorman, 2001). (See Bouncken et al. (2015) for a discussion on coopetition.) In Lhuillery and Pfister’s (2009) study of abandoned projects, they showed that competitors increase the probability of projects being abandoned due to problems within the innovation partnership between the firm and the competitor (i.e. cooperation failures) (Lhuillery & Pfister, 2009). This is supported by the study of Hyll and Pippel (2016). As a result of the ‘problems’ highlighted in connection with involving competitors, the following hypothesis is put forward:

H2: The involvement of competitors increases the likelihood of firms deciding to abandon innovation projects.

Involving suppliers in innovation is a well-studied topic in the current literature, especially on supply chain management (see Johnsen, (2009) and Kazemargi et al. (2016)). To benefit from suppliers in innovation projects, firms need to understand and
accept that the supplier is a member of the innovation project and that the knowledge provided by the supplier is consistent with the objectives of the project (Ragatz et al., 2002; Santamaria & Surroca, 2011). Benefits gained from involving suppliers are improvement of product quality, reduced costs and time savings (Feng et al., 2010; Johnsen, 2009; Ragatz et al., 2002). Furthermore, involving suppliers is particularly beneficial in innovation projects that experience technical difficulties (Primo & Amundson, 2002). Suppliers may contribute with knowledge that matches a firm's requirements or needs, and knowledge from a supplier is easy for firms to access and integrate, as the firm and the supplier are in the same or similar industries (Roy & Sivakumar, 2010; Un et al., 2010). Knowledge and input provided by a supplier are complementary to those of the firm, and the supplier’s objectives for providing knowledge to the firm’s innovation projects are similar to the firm’s objectives: a successful innovation project ready for commercialisation (Un et al., 2010). Because of the benefits of involving suppliers and the type of knowledge gained from suppliers, it is expected that the collaboration with a supplier will lead firms to continue the innovation project. The following hypothesis is therefore put forward:

H3: The involvement of suppliers decreases the likelihood of firms deciding to abandon innovation projects.

It is considered that universities are an important source of innovation (Perkmann et al., 2013). But the ‘distance’ to the universities may be a challenge, as employees in universities are more focused on scientific value than market value (Hyll & Pippel, 2016). Firms and universities may have different perceptions of the time horizon and the deadlines of the innovation projects (Goduscheit & Knudsen, 2015). Hence, knowledge provided by universities can be harder for firms to access (Lhuillery & Pfister, 2009). Based on the different perspectives that can be seen between firms and universities, the following hypothesis is put forward:

H4: Collaboration with universities increases the likelihood of firms deciding to abandon innovation projects.

3. Method and Data
The data used in this article are from the Danish Innovation Survey 2009, carried out by Statistics Denmark, and were collected in the first half of 2010. The survey is based on
the Eurostat Community Innovation Survey and is collected annually. The aim of the Danish Innovation Survey is to examine innovation activities. The methods and types of questions are described in the Oslo manual, and the data are therefore comparable with data from other OECD countries. The total survey population is approximately 23,000 firms, and the survey was sent to approximately 5,600 firms (both manufacturing firms and service providers), based on stratified simple random sampling. Three reminders were sent and resulted in a response rate of 93%. The data in the survey consist of self-reported answers, and therefore there is a possibility of subjective answers. In the dataset there are questions about whether the relevant innovation projects are stopped or ongoing during the period 2007 to 2009.

The sample used for this article consists of Danish manufacturing firms with 10 employees or more (N=840), according to OECD’s definition and categorizing of firms. In total, 90 firms abandoned an innovation project during the period 2007 – 2009, where 54 (60%) of the firms are medium-tech firms and 47 (52.2%) have between 10 and 250 employees (OECD’s definition of an SME).

3.1. Variables
In addition to the dependent variable for abandoned innovation projects, I also apply a variable to ongoing innovation projects. The motivation for applying these two variables is the possibility to control and compare the two types of outcomes and thus make it possible to discriminate between abandoned and ongoing innovation projects, as suggested by Cooper and Kleinschmidt (1987).

I measure *Abandoned innovation projects* on the basis of whether a particular firm started innovation activities in the period 2007 - 2009 and abandoned them without result (0 = no/1 = yes). 11% of the firms in the sample abandoned an innovation project in the period 2007 - 2009 (Table 1).

I measure *Ongoing innovation projects* on the basis of whether a particular firm started innovation activities in the period 2007 - 2009 that were still active in 2009 (0 = no/1 = yes). 32% of the firms have ongoing innovation projects (Table 1).
The variable for abandoned innovation projects is a decision. The firm decides to abandon the innovation project, as opposed to the variable for ongoing innovation projects, which is more a status on the projects and not necessarily an action/decision taken by the firm. So it could be argued that the decision to abandon/continue is exactly the same decision, because if the firm decides to abandon a project, it has implicitly decided not to continue. However, I apply the ongoing innovation projects variable as a ‘dependent’ variable’, being well aware of the fact that the innovation project may not have reached the evaluation phase, or later on may be abandoned. The motivation is that the model with the ongoing innovation projects variable may provide indications on what type of external sources are beneficial in ongoing innovation projects.

80 firms in the sample have abandoned innovation projects as well as ongoing innovation projects in the period 2007 – 2009. However, due to the design of the survey, it is not possible to investigate the results of the ongoing projects if they were already implemented or abandoned later. Likewise, it is not possible to investigate the reason why firms decided to abandon an innovation project.

The independent variables are the different types of external sources of knowledge. Creation of the four different types of external sources, suppliers, customers, universities and competitors, is based on the question: “Specify collaboration partners and their country: Denmark (yes/no), Rest of Europe (yes/no), USA (yes/no), China/India (yes/no), and other countries (yes/no)”. A variable for the total use of the external sources is generated. If the firm answers yes to the questions one or more times, the aggregated variable is coded 1; otherwise the variable is coded 0. I apply the same procedure for all four types of external sources. Due to the design of the survey, it is not possible, however, to specify how the firm and the external sources collaborate further, whether it is an organized or more emergent collaboration. Neither is it possible to see how and to what extent the external sources are involved, e.g. the degree of formality or what type of knowledge is exchanged between the four different types of sources and the firm.

I apply the following controls in the regression models: firm size, industry, firm's level of product and process innovation, and R&D intensity. Furthermore, in the models with abandoned innovation projects as the dependent variable, I control the models for ongoing innovation projects, and vice versa (the variables for abandoned and ongoing innovation
projects are explained above in the section on dependent variables). The motivation for controlling, for abandoned and ongoing innovation projects respectively, is due to the limitation of the measurements.

The measurement for *Firm size* is by the number of employees. The variable is skewed and therefore I use the logarithm (ln) to correct for the skewness.

The measurement for *Industry* is the OECD scale: 1 = low-tech firms (i.e. if firms belong to NACE (The Statistical classification of economic activities in the European Community) 15, 16, 17, 18, and 20 - 22); 2 = medium-tech firms (NACE 24, 25, 26, 27, 28, and 29), and 3 = high-tech firms (NACE 30, 31, 32, and 33). I created dummies for the three industry types. High-tech represents the omitted variable and thus the reference group.

The measurement for a firm’s *level of product innovation* is as follows: Did the firm introduce a new product in 2007 - 2009? [0 = no/1 = yes]. Product innovation is defined in the survey as market introduction of new or significantly-changed products. From Table 1 it is evident that 42% of the firms introduced a new product in the period 2007 - 2009.

The measurement of a firm’s *level of process innovation* is as follows: Did the firm introduce a new process in 2007 - 2009? [0 = no/1 = yes]. Process innovation is defined in the survey as the introduction of a new or significantly-changed production process, work procedure, distribution method or support function. 26% of the firms introduced a new process innovation in the period (Table 1).

*The measurement for R&D intensity* is the number of employees related to R&D divided by the total number of employees in the firm. The mean for the variable is .05, which means that 5% of the employees work in R&D activities (Table 1).

Furthermore, in the model with the abandoned innovation projects as the dependent variable, I control the model for ongoing innovation projects and the other way around.

***************Insert Table 1 Descriptive statistics***************
4. Results

Tables 1 and 2 present the Descriptive statistics and Correlation matrix for the different variables. The correlation matrix gives preliminary indications about the importance of the different types of external sources in relation to firms’ decision to abandon. These correlations are significant. The correlations between the individual external sources are also significant, indicating that there may be a complementary effect between the different types of sources, thus leading to investigating interaction effects between the different types of sources. Furthermore, the size of the firms, the level of innovation of the firms (both product innovation and process innovation) and the R&D intensity of the firms influence the dependent variable.

Due to significant correlations between the individual sources (the independent variables), I calculated the variance inflation factor (VIF). The VIF for the main model is between 1.187 and 2.193, which indicates that there is no problem with multi-collinearity (Wooldridge, 2009).

Firms that decide to abandon innovation projects are larger and have a higher R&D intensity than firms without any abandoned projects (t-test sig .000). Firms that decide to abandon innovation projects are also more innovative with respect to product and process innovation (Pearson Chi-square .000). The explanation for these results may be that these types of firms have a higher number of innovation projects and therefore also a higher probability of abandoning more projects, which is in line with Garcia-Vega and Lopez (2010) and Hyll and Pippel (2016). However, no significant difference between the abandoned projects and industry variables was found (Pearson Chi-square .157), as may have been expected initially, e.g. high-tech firms may have a higher number of innovation projects, and therefore also a higher probability of abandoning projects. These results are not presented in a table.

4.1. Regression analysis
The dependent variable is binary, and to determine whether the different types of external knowledge sources influence the decision of firms to abandon, I apply logistic regression models (binary logistic regression in IBM SPSS Statistics, version 19).

***************Insert Table 3 Logistic regression model (abandoned)************

Table 3 presents all the direct effects of the four different types of external sources on the decision of firms to abandon innovation projects. In the model, the variable customers is significant at the .01 level, indicating that collaborating with customers increases the likelihood of firms’ deciding to abandon innovation projects, supporting H1. No significant results from suppliers, competitors, or universities on abandoned innovation projects were identified (no support for H2, H3, and H4). Furthermore, the control variables, size, process innovation and ongoing innovation projects are significant, indicating that bigger firms and innovative firms (in terms of process innovation and ongoing innovation projects) have a higher likelihood of innovation projects being abandoned.

The correlation matrix indicated that there may be a complementary effect between the different types of external sources. Therefore, I tested the interaction effect between customers and the three other sources. The only significant result is presented in Table 3 – last column – showing that combining customers and universities will decrease the likelihood of innovation projects being abandoned. Furthermore, the direct effect from customers will be less significant/weaker (sig level = .085) when firms are combining customers with suppliers, but no significant effect from the interaction term between suppliers and customers was identified (not presented in the table).

***************Insert Table 4 Logistic regression models (ongoing)************

Table 4 presents the direct effects of the different external sources on ongoing innovation projects. Suppliers are significant at the .01 level, indicating that collaboration with suppliers will increase the likelihood of innovation projects being ongoing, and that collaboration with the supplier is beneficial for the innovation project. Moreover, the control variables, size, process and product innovation and abandoned innovation are significant, indicating that bigger firms and firms with respectively product or process...
innovation have a higher likelihood of innovation projects being ongoing (Table 4). No significant interaction effects between the sources were identified.

It is possible to investigate the effects of the different external sources a little deeper, due to the formulation of the questions in the survey. The respondents were asked to report if they collaborated with respectively a Danish supplier, a supplier from the rest of Europe, a supplier from US, a supplier from China/India or a supplier from other places in the world. However, due to the low number of responses to the questions related to China/India and other places in the world, these two have been added together as one category named ‘other countries’.

The results in Table 5 indicate that the country of origin of the external sources matters with respect to abandoned innovation projects. The results show that the negative results from customers presented in Table 3 can be fine-tuned, so that the negative effect is from customers located in Europe and the US, while involving customers from other countries (China, India and the rest of the world) decreases the likelihood of innovation projects being abandoned (Table 5). Furthermore, there is no effect detected from Danish customers, indicating that national customers do not have any effect on the decision to abandon innovation projects, in contrast to international customers.

**********Insert Table 5 Logistic regression model (Country of origin)**********

5. Discussion and conclusion
This article began by pointing out the importance of external sources for innovation and that firms need a further understanding of the link between external sources and abandoned innovation projects. The article contributes to the limited literature on the relationship between external sources and abandoned innovation (Hyll & Pippel, 2016; Lhuillery & Pfister, 2009) by pointing out the importance of understanding how external sources influence a firm’s decision to abandon innovation projects. The results show that involving customers leads to innovation projects being abandoned, whereas involving suppliers has a positive effect on ongoing innovation projects. The results also show that combining customers with universities will decrease the likelihood of firms abandoning innovation projects, and that the partner's country of origin matters on a firm’s decisions whether to abandon or not. This awareness may lead to firms learning from their
abandoned projects, e.g. learning by failing (Huber, 1991; Shepherd et al., 2014). A possible way to transfer the potential learning to future innovation projects is through post-project reviews (Koners & Goffin, 2005, 2007).

The regression analysis demonstrated that involving customers may increase the likelihood of firms deciding to abandon projects. This result supports the results of Lhuillery and Pfister (2009), but contradicts literature that finds positive effects on innovative performance from collaborating with customers, e.g. Le Roy et al. (2016). However, the impact of the involvement of customers on the abandonment of projects may be explained by some of the customer traps that firms may experience (Bower & Christensen, 1995), like e.g. the risk of customers acting opportunistically (Noordhoff et al., 2011), or firms getting too close to the customers, cf. the discussion on weak or strong ties for innovation (Tranekjer & Søndergaard, 2013). ‘Glitches’ could be another way to explain why the involvement of customers may lead to innovation projects being abandoned. Glitches occur when firms have no prior experience with the partner, or when knowledge is not successfully transferred from the partner to the firm (Hoopes, 2001). These glitches may lead to increased costs and the firm may then decide to abandon projects (Hoopes, 2001; Hoopes & Postrel, 1999).

This may explain why some firms decide to abandon innovation projects when they are collaborating with customers. From the survey, it is not possible to identify if the firms have prior experience with the customers, or have the capability to transfer knowledge successfully. However, this information will be relevant for future studies on abandoned innovation projects. Additionally, Cui and Wu (2016) divide the customers into three groups, based on the customers' role in the projects: as information sources, co-developers or innovators. Customers having different roles in the projects may provide an explanation and a further understanding of why the involvement of customers leads to innovation projects being abandoned.

The more detailed results of the country of origin demonstrated that collaborating with customers from Europe and the US leads firms to abandon innovation projects, while customers from other places (China/India and the rest of the world) decrease the likelihood of projects being abandoned. An explanation for the negative results may be that there is a cultural difference between the firm and the external sources, but this cannot explain the more positive effect of customers from ‘other places’. An explanation for the
positive effects may be that the knowledge provided by customers from ‘other places’ is more novel or important to the innovation project, see Fitjar and Rodríguez-Pose (2013) for a similar result, or that customers from ‘other places’ do not lead to ‘cooperation failures’, as suggested by Lhuillery and Pfister (2009). So future studies need to investigate the link between the countries of origin of the different external knowledge sources and abandoned innovation projects need to be more detailed in order to provide an explanation for why customers from certain countries/geographic areas lead to innovation projects being abandoned and others do not. One possible way to study this link is to include a firm’s motives for choosing domestic and/or international sources, because the motivation for choosing an external source may explain this diversity of results from customers. Arvanitis and Bolli (2013), for example, explain that firms with a more knowledge-oriented motive will be looking for international partners, while firms with a more cost-oriented motive will look for national partners. Besides including motives for collaboration, the type of knowledge and the degree of redundancy will be of relevance in future studies in order to understand the link between the countries of the different external sources and abandoned innovation projects.

The regression analysis demonstrated that suppliers increase the likelihood of innovation projects being ongoing and the performance effects of suppliers are in line with the literature on the benefits of involving suppliers in innovation projects (Primo & Amundson, 2002; Ragatz et al., 2002). It may be explained by the knowledge from a supplier being easier to integrate (Roy & Sivakumar, 2010) and due to the fact that the firm and the supplier are in the same or a similar industry (Un et al., 2010), and therefore it has not created problems that might lead a firm to decide to abandon the innovation project.

The results also showed that process innovation will lead a firm to abandon innovation projects, while having both process and product innovation leads to innovation projects being ongoing. Speculation on these results, especially in the context of abandoned projects, may be explained by firms having a lower level of familiarity with process innovation, or if there is a higher degree of complexity in process innovation compared to product innovation. Both conditions lead firms to abandon process innovation. However, in addition to the study of Hyll and Pippel (2016), it is of relevance to investigate if certain types of innovation, process or project innovation lead firms to
abandon, and it is also important to establish the motivation why respectively process or product innovation projects are abandoned.

This article contributes to the current literature on abandoned innovation projects by pointing out that involving customers may lead to the decision to abandon innovation projects. The article is not suggesting that firms should refrain from inviting customers to participate in innovation projects, as they are still valuable to innovation projects (Mahr et al., 2014). However, the current literature needs to be expanded with further research in order to understand the motivation to abandon innovation projects and the type of knowledge customers provide to specific innovation projects.

Furthermore, this article contributes to the discussion of the benefits and disadvantages of open innovation (see Section 2 for a discussion). It may be argued that firms being open to input from external sources, whose goals and agendas may not be consistent with the firms’ objectives, increases the likelihood of firms deciding to abandon their innovation projects. In projects where there is no alignment between the firm and the goals of the external sources, this may lead to problems in the partnerships and therefore lead the firm to stop the projects, and result in problems being labelled as ‘collaboration failures’, as outlined by Lhuillery and Pfister (2009).

In addition to the previously-referenced need for future research, variables in organisational structures (Faems et al., 2005), or the level of absorptive capacity (Cohen & Levinthal, 1990), account for internal aspects that are relevant to innovative performance and are therefore also of interest in relation to the decision to abandon innovation projects. Internal aspects, such as the concept of absorptive capacity, may indicate whether firms are able to recognise, assimilate and apply the knowledge provided by external knowledge sources. Furthermore, for understanding abandoned innovation projects in future research, it will be relevant to investigate the role of the firm’s innovation strategy. As an example, I would suggest including questions in future surveys on the strategic fit of the portfolio, like e.g., “our project portfolio is consistently aligned with the firm’s future”, see Unger et al. (2012) p. 682.

5.1. Implications
These findings have the following implications. For researchers, as suggested above, further research is needed on the topic of abandoned innovation projects. The current findings lead to different implications for practitioners. Firstly, it is important to point out that generally it is beneficial to invite suppliers to join innovation projects, though it is more problematic with customers, as can be seen from results. However, practitioners should consider why some innovation projects are abandoned while others continue. Is it because of the increased complexity as a result of inviting multiple partners to join the project? Or is it because there is no alignment between the firms’ objectives and those of the partners? Hence, managers must remember to conduct post-evaluations of all projects, including abandoned innovation projects, in order to increase their understanding of the complexity of inviting different types of external partners to participate and what may then lead to abandonment. To begin with, managers of innovation projects need to present their expectations to the external partners regarding the projects in question. The innovation objectives may be part of such a presentation, in order to ensure alignment between firms’ expectations and the contribution of external partners. In addition, firms should remember that abandoned innovation projects may provide useful knowledge for future innovation projects. The implication for the public is that when firms announce that they have stopped an innovation project, it should not be classified by the public as a total waste of resources/money, due to the potential learning effect from abandoned innovation projects.

5.2. Limitations

The limitations are a result of the design and scope of the survey. Firstly, it is not possible to identify what types of innovation projects (incremental/radical, product/process innovation) are abandoned, in what phases of the innovation process firms decide to abandon innovation projects, and the motivation for the firm to abandon them. Secondly, it is not possible to specify the type of collaboration, the degree of involvement or the type of knowledge exchanged. Another limitation is that it is not possible to identify if ongoing innovation projects are implemented or abandoned later, or if firms have answered on the basis of their most frequent types of project. The sample for this article consists of Danish manufacturing firms, and therefore similar studies in other kinds of firms (e.g. service firms) and geographical settings will provide comparative insights, relevant for the understanding of abandoned innovation projects.
References


