

OUTBOUND OPEN INNOVATION DESIGN AND PRODUCT PERFORMANCE OF UK SMEs: A CONTINGENCY PERSPECTIVE

By

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Abstract

The study empirically investigated outbound open innovation adoption and product performance of SMEs in the UK. The respondents were 72 senior staff of selected SMEs in the manufacturing sector. The cross sectional survey research design was employed and the primary survey instrument was questionnaire. We employed multiple regression analysis technique. We found that outbound open innovation is positively related to incremental product performance but negatively related to radical product performance. Also we found that incremental and radical innovation moderate the effect of outbound open innovation on product performance. We conclude that outbound open innovation strategy affects product performance depending on the type of innovation. We suggest that outbound open innovation design should be aligned with the type of innovation produced.

Key words: Outbound Open Innovation, SMEs, Radical Innovation, Incremental Innovation, UK.

BACKGROUND OF THE STUDY

Small and medium scale enterprises (SMEs) could be highly instrumental to addressing the unemployment situations facing most economies of the world through their job creation potentials and are therefore globally recognized as engines of economic growth and development (Bruque and Moyano, 2007). For instance, in the UK, statistics show that the total number of employees directly employed in either a small or medium enterprise (SME) is estimated at 14.4 million, out of the 24.3 million total private sector employments which means that about 2 out of every 3 private sector employees in the UK are employed in an SME and the estimated combined turnover of the SMEs stands at £1, 600 billion (BIS, 2014). However, despite the undisputable critical roles that SMEs play in economic growth and development, many of them do not survive the first few years of existence (Bøllingtoft and Ulhøi, 2005) because the fast-changing and increasingly competitive global market (Zeng et al., 2010), makes innovations for SMEs more complex (Diez, 2000), thereby making it necessary for SMEs to combine their operations with that of other firms such as competing or complementary firms, research facilities, suppliers and customers in a manner that will foster knowledge sharing and also enable them to take advantage of complementary competencies (Bullinger et al., 2004; Tomlinson and Fai, 2013).

The foregoing scenario has resulted in a paradigm shift from the traditional innovation model whereby firms organised innovation and product development activities internally through the establishment of large centralized research and development (R&D) units (Vanhaverbeke, Van de Vrande et al., 2008; Lichtenthaler, 2011) to a new model called "Open innovation" (Chesbrough, 2003 cited in Van de Vrande, de Jong, et al. 2009; Gassmann, 2006). Open innovation is defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and expand the markets for external use of innovation" (Chesbrough 2006, cited in Chesbrough, 2012). The concept describes an innovation process whereby, on the one hand, firms consciously combine knowledge produced within the firm with those obtained from outside the firm - Inbound strategy also known as 'technology exploration' (Lichtenthaler, 2008) - through, for instance, collaborations with external partners, in order to improve the innovativeness of their product. On the other hand, it involves taking idle internally produced knowledge to the market - Outbound strategy, also referred to 'technology exploitation' (Lichtenthaler, 2008) - through engaging external channels (Chesbrough and Crowther, 2006). In a fully open setting, firms adopt coupled innovation strategy which implies a combination of both technology exploitation and exploration in order to create maximum value from their technological capabilities or other competencies (Chesbrough and Crowther, 2006).

Since Chesbrough (2003) coined and subsequently popularised the open innovation concept, there has been an increasing interest in research on open innovation by many scholars especially those in management, entrepreneurship and innovation disciplines, with emphasis mainly on the inbound strategy (Lee et al., 2010) whereas the outbound strategy has received little or no research attention. This study is therefore aimed at filling the gap in the literature by empirically investigating the relationship between the adoption of outbound open innovation design and the product performance of SMEs in the Manufacturing sector in the UK and how such relationship is influenced by the type of innovation being pursued by the SMEs. It is difficult to define SMEs, not only because the definition changes with time but because it varies from country to country and sometimes from author to author. For instance, the European Commission and the OECD (2005), cited in Spithoven et al., (2013) defined SMEs as firms that employ fewer than 250 persons while Van de Vrande et al. (2009) and Narula (2004) define SMEs as firms having fewer than 500 employees. The definition could be in terms of size, usually measured by the number of employees or in terms of turnover or capital base. However this study adopted the definition by the EU and OECD because the definitions are consistent with the practical realities of the sizes of small and medium enterprises from our personal observation and also from the data on company size collected from the SMEs. Following this definition, the size of small firms ranges from 10 to 49 while medium firms employ between 50 to 249 employees. It has been observed in the literature that the ability of SMEs to create innovation is hampered by insufficient resources and other complementary assets such as manufacturing facilities, financial resources, scant opportunities to recruit specialized workers, small

innovation portfolios, lack of protection for intellectual property, marketing channels and global contacts to access internal and external knowledge (Lichtenthaler and Ernst, 2007; Narula, 2004; Vanhaverbeke et al., 2002). These deficiencies therefore make collaborations with external firms particularly important for the SMEs (Lee et al., 2010; Vanhaverbeke and Cloudt, 2006 cited in Zeng, Xie et al., 2010, van de Vrande et al., 2009), because the collaborations offer the SMEs opportunity to complement their deficient resources with resources and expertise from other stakeholders in the environment (Dahlander and Piezunka, 2014) especially regarding the commercialisation of their innovations. However, it has been argued elsewhere in the literature that the same deficiencies can negatively affect the SMEs' ability to enter into innovation collaborative relationships because they may, technically speaking, have nothing to offer the external partners (Narula, 2004). Furthermore, Vanhaverbeke et al. (2002) see SMEs as being in a daisy situation because, on the one hand, their tendency to engage in open innovation due to their resources limitations makes them prone to future liabilities in the development of absorptive and transformative capacities thereby perpetuate their dependence on external parties, off-course, with its associated challenges and drawbacks. On the other hand, SMEs that are grossly involved in outbound open innovation strategy may run the risk of increased competition from competitors because through outbound strategy, they reveal the core competences that could give them competitive advantage to the competitors (Fosfuri, 2006; Spithoven et al., 2013). This study therefore becomes very imperative given the need to find solution to SMEs' general inability or ineptitude in the commercialisation of their innovations following the identified deficiencies.

The study will contribute to the existing stock of knowledge in the literature on open innovation by achieving the research objectives including to identify whether the SMEs adopt outbound open innovation strategy and how, examine the product performance goals they set, identify the specific types of innovation (radical or incremental) they pursue, evaluate how the adoption of the outbound open innovation strategy affects their product performance, and determine how the relationship between outbound open innovation adoption and product performance is moderated by the type of innovation. To realize these objectives, the study will specifically proffer answers to the following research questions:

- a. Do SMEs in the manufacturing sector in the UK adopt outbound open innovation strategy?
- b. What product performance goals do they set?
- c. How does the adoption of outbound open innovation strategy affect the product performance of the SMEs?
- d. What particular type of innovation do SMEs pursue?
- e. How does the type of innovation the SMEs pursue influence the relationship between open innovation adoption and their product performance?

This study is organised in the following way: the next session examined the theoretical lens of the study, followed by a review of related literature. Thereafter the methodology of the study was followed by the data analysis and discussion of findings. The concluding session is a presentation of the conclusions drawn from the discussions and the theoretical and managerial implication of the study was presented followed by the limitations and recommendations for further studies.

THEORETICAL BACKGROUND OF THE STUDY: CONTINGENCY THEORY

Contingency theory states that there are different ways to achieving every desired end result, and that all possible options are not equally effective under all conditions (Galbraith, 1973). The theory holds that organisations will need to effect changes in relevant organisational super and sub-structures in response to changing contextual factors so as to maintain high performance. The proposition of the theory is well captured in the contextual - response - performance model (Donaldson, 2001). Contextual variables represent those factors that are almost always present exogenously or endogenously within the phenomena of discussion. In the context of the present study, contextual variables represent endogenous factors that influence the innovation process such as types of innovation (incremental or radical) being pursued. Response variables refer to the actions taken by the firm in reaction to such contextual factors, and here it represents the adoption of outbound open innovation strategy. Finally, performance variables

measure the effectiveness of the fit between the contextual and the response variables and are measured here by the performance of the new product.

LITERATURE REVIEW

2.1 The Concept of Open Innovation

Most recently, the definition of open innovation has been modified as “a distributed innovation process based on purposively managed knowledge flows across organizational boundaries, using pecuniary and non-pecuniary mechanisms in line with the organization’s business model” (Chesbrough and Bogers, 2014). This implies that obtaining knowledge from or exporting knowledge to external partners does not happen by chance but takes a conscious effort of the focal firm, through financial and non-financial motivation strategies depending on the firm’s business model. The key concept underlying open innovation concept is that firms are naturally designed in such a way that their operations affect and are affected by other entities in the business environment (Spithoven et al., 2013). Open innovation models stress the importance of using knowledge obtained from many sources, including customers, rivals, academics, and firms in unrelated industries, for a firm’s innovation activities, while simultaneously using creative methods to exploit a firm’s intellectual property (IP) (West and Gallagher, 2006). Spithoven, Vanhaverbeke et al. (2013) identified some benefits of open innovation adoption including, but not limited to, improving firm’s learning effectiveness in absorbing external knowledge; providing access to complementary knowledge residing in innovation partners and grant access to intangible tacit knowledge and know-how; exploitation of economies of scale and scope in both research and development, enhancing the distribution of risks among the partnering firms.

Furthermore, many studies in the literature have found a positive relationship between open innovation adoption and innovation performance (Faems et al. 2010; Nieto and Santamaria 2007; Faems et al. 2005; Miotti and Sachwald, 2003). They argued that those firms which practice open innovation strategy produce more innovative products than those that do not. Faems et al (2010) particularly argued that the more the number of external partners used, the more innovative the resultant product. In extreme cases, Koschatzky (2001) cited in Enkel et al. (2009) warn that firms which do not engage in collaborations reduce their knowledge base on a long-term basis and may risk losing the ability to enter into future innovation collaborative relationships. But, Laursen and Salter (2006) have cautioned that the benefits to openness are subject to decreasing returns, suggesting that firms must be careful in deciding the number of collaborators they use because there is a point where additional search becomes unproductive because open innovation is usually associated with some costs and risks. The costs include finding new and useful avenues to exploit internal innovation, incorporating external innovation into internal development, and motivating outsiders to supply an ongoing stream of external innovation (West and Gallagher, 2006). However, Dahlander and Gann (2010) suggest that firms can adopt both formal (e.g. patent, trademark or copyright protection) and informal (e.g. lead times, first mover advantages, lock-ins) appropriability strategies to prevent the risk of knowledge loss, but they should do so moderately because firms that are too conscious of protecting their IP may risk suffering from what they called “Myopia of protection” (Laursen and Salter, 2014), meaning unconsciously sacrificing enhanced product innovativeness through collaborations with external partners on the altar of obsession for securing ownership (Dahlander and Gann, 2010). Consequently, Faems et al. (2010) suggest that firms should consider both the benefits and costs of openness when making new product development alliances decisions.

Furthermore, Laursen and Salter (2004) have asserted that “it is not statistically evident that larger firms are better than SMEs in breaking new grounds in innovation, meaning that SMEs may well have capacity for innovation, especially radical innovation”. It has been argued that open innovation practices provide an alternative strategy by which growth-oriented SMEs can access cheaper inter-firm resources, to overcome the identified challenges (Chesbrough, 2012). However, there have been very few studies regarding open innovation model specialised for SMEs (Lee et al., 2010). For instance, Bianchi, Campodall’orto et al. (2010) studied ways of identifying promising applications for commercially exploiting a proprietary technology. Their findings revealed that timely identification of opportunities for

out-licensing a firm's technologies outside its core business is a critical success factor in the practice of Open Innovation. Christensen et al. (2005) studied how SMEs in the consumer electronics industry manage open innovation depending on the age of the technology and the firm's position within the innovation system. Their findings reveal that SMEs explore potential collaborations and knowledge exchange with smaller firms in the early stages of their technology development, while progressively choosing larger firms when their technology is more mature. Furthermore, Spithoven, Vanhaverbeke et al. (2013) investigated the potential differences between how SMEs and large companies adopt open innovation practises in order to reveal their differences in terms of practices and benefits using a sample of 3322 innovating companies in Belgium. They found, among other things, that SMEs are more dependent on open innovation than large companies.

However, the present study is aimed at empirically investigating the relationship between outbound open innovation design and product performance of SMEs in the UK and the fit is contingent on the type of product innovation being pursued.

2.2 Product Performance

Product performance refers to the extent to which the firm's products fulfil the product objectives of the firm (Laursen and Salter, 2006). In this study, product performance is divided into radical and incremental product performance. Radical Product Performance is defined as the products that are perceived by the market as being entirely new (Laursen and Salter, 2006; Faems et al., 2010; Zeng, Xie et al., 2010), while the incremental product performance refers to the product innovation which is new to the firm but almost always not considered as new by the market (Laursen and Salter, 2006; Faems et al., 2010; Zeng, Xie et al., 2010). The product performance, in the present study, was measured with three-item, on a five-point Likert-type scale as adopted by (Song and Parry, 1999; Sethi & Sethi, 2009). It is noteworthy that the product performance is a means to the achievement of the business goals. The ultimate business performance was defined, in this study, by both financial and non-financial parameters. Non-financial measures include goals such as satisfaction and global success ratings made by owners or business managers while financial measures include assessments of the SMEs sales growth and return on investments (Rauch, Wiklund et al., 2009) achieved as a result of the engagement in open innovation activities.

2.3 Conceptual Framework and Hypotheses

The research model above is a diagrammatical representation of the proposed relationships of the constructs of the study. As the annotation of figure 1 in the appendix shows, there is a relationship between the adoption of and outbound dimension of open innovation strategy and the product performance of SMEs. We propose, in this study, that this relationship is contingent on the type of innovation that the SMEs are pursuing as depicted by the moderating role of the types of innovation-radical or incremental- in the model. The contingency theory lays down that the effect of a given variable on another will depend on the conditions that surround the relationship between the variables (Galbraith, 1973). This therefore follows that the adoption of either inbound or outbound dimensions of open innovation strategy by SMEs will affect their product performance depending on whether they intend to produce radical or incremental innovation (Garriga et al., 2013). Many empirical studies in the literature have found positive and significant influence of the type of innovation on the effect of factors that shape product innovativeness on product performance (Garcia and Calantone, 2002). The types of innovation include radical innovation, such as the microchip, and incremental innovation, such as improving an existing product (Henderson and Clark, 1990). Product innovativeness is usually defined by the extent to which the product is perceived as being usual or unusual either by the market or the firm. An innovation is referred to as radical if it is perceived as being entirely new by the market. While an innovation that is only perceived as new by the producing firm is termed incremental (Marsili and Salter, 2005). It is however noteworthy that, outside the scope of the model, some environmental factors influence the capability of SMEs to adopt specific open innovation strategy and by extension affect their product performance. These factors according to the literature, among other things, include market turbulence,

technological turbulence, competitive intensity (Wang et al, 2012), and technical synergy (Song and Parry, 1999). These environmental factors were controlled for in this study hence, they are employed as control variables. The next section discusses the proposed relationships in the model.

2.3.1 Outbound Open Innovation Strategy and Product Performance.

The outbound dimension of open innovation refers to “earning profits by bringing ideas to market, selling IP, and multiplying technology by transferring ideas to the outside environment” (Enkel et al., 2009). It focuses on external paths to commercialise innovations that have been developed internally (Spithoven, Vanhaverbeke et al. 2013), whereby “rather than relying entirely on internal paths to market, companies look for external organisations with business models that are better suited to commercialize a given technology”(Chiaroni et al., 2011). Chesbrough (2012) argued that the difference between the open innovation concept and previous models on collaborative innovation is the outbound dimension which deals with how firms could commercialize their internally produced innovation that are not currently in use through avenues such as licensing out of IP and/or spin-offs. To implement the outbound strategy, van de Vrande et al. (2009) have suggested three practices namely, venturing, outward licensing of intellectual property (IP), and the involvement of non-R&D workers in the innovation process. Venturing involves starting a new organisation through spin-off and spin-out process by taken advantage of existing competences and resources such as finances, human capital, legal advice administrative and other support services (van de Vrande et al., 2009).

Out licensing of intellectual property (IP) on the other hand involves Selling or offering licenses or royalty agreements to other organizations so as to profit from your IP (van de Vrande et al., 2009; Gassmann, 2006). The existence of IP is the core of collaborative relationships between firms (Arora, 1995). The strategy of involving non-R&D employees basically entails “Leveraging the knowledge and initiatives of employees who are not involved in R&D, for example, by taking up suggestions, exempting them to implement ideas, or creating autonomous teams to realize innovations” (van de Vrande et al., 2009). This could be achieved by taking advantage of the knowledge gained by current employees on their job or possibly through their informal relationships with employees of other firms in the industry which is referred to weak ties (De Vries, 1977) because not all smart people work for you (Chesbrough, 2012). The relationship between outbound open innovation strategy and product performance has not been well researched in the literature. However some studies have established some evidence of a relationship in this regard. For example, Allen (1983) illustrated outbound open innovation (what he called collective invention) using the case of the iron production industry in the 19th century England. According to him, firms used both verbal interactions and written materials to open up their product design ideas and performance of their blast furnaces with their competitors without any known means of IPR protections and this resulted in a general increase in the innovativeness of the society at that time.

Also, the findings of Nuvolari (2004) in his study of innovation in the Cornish mining district during the industrial revolution supports that firms revealed their product ideas to their competitors without any identifiable negative consequence. Henkel (2006) supports that firms could share their product idea with their collaborators without any negative effect on their product performance, however he suggests that this could be done selectively, possibly, to reduce the potential risk of loss of value to external partners (Helfat, 2006). This implies that sharing product idea with external collaborators could positively affect product performance of SMEs. However it is argued that when the product idea is being shared among firms in a given industry with the resultant effect of a general increase in the innovativeness of all, the products will be more homogenous than unique. We therefore expect that the outbound innovation will positively affect incremental product performance and negatively affect radical product performance. Following the arguments of the previous studies on outbound innovation and product performance it is hypothesize thus:

H1_a: Adoption of outbound dimension of open innovation will positively affect the incremental product performance of SMEs.

H1_b: Adoption of outbound dimension of open innovation will negatively affect radical product performance of SMEs.

2.3.2 Moderating Influence of Types of Innovation on the relationship between Outbound Strategy and Product Performance.

“No company is smart enough to know what to do with every new opportunity it finds, and no company has enough resources to pursue all the opportunities it might execute. Internal initiatives routinely leave a trail of orphans- promising ideas that have no natural home within the company” (Wolpert, 2002). Spinning out idle ideas could be a strategic option but it is difficult to implement and usually involves loss of intellectual property to outsiders (Wolpert, 2002). Knowledge and technology could flow in and out the organisations through different channels including partnerships with universities, alliances and acquisitions, external venture investments, recruiting and hiring, customers and suppliers, and the relationships and curiosity of individual employees (Wolpert, 2002) or licensing (Rigby and Zook, 2002). Licensing is important because it gives the innovating firm a sense of urgency to act before the outside firms do thereby improving the motivation and commitment of the employees including the creative people especially when the innovating firm is also intending to implement the innovation being exported (Rigby and Zook, 2002). It is noteworthy that this licensing deal does not enable the firm to produce any out-of-the-world offering (radical innovation) because radical innovation is the result of the introduction and acceptance in the market of a firm’s new products and services that is unusual (Voss et al., 2008) and the production requires novel types of knowledge often not available in the innovating firm and only possessed by specific specialized external entities such as specialized universities or lead-users (Lettl, 2007). Rather out-licensing arrangements just results in moderate product modifications (incremental innovation) because incremental innovations mostly occur in interaction with partners from the business sector often located at higher spatial levels beyond the region (Todtling et al., 2009) and usually help the licensee to generate additional revenue while enabling the licensors create industry operating standards in their own favour (Rigby and Zook, 2002). This implies that the more radical the innovation, the lower the influence of outbound open innovation on the product performance of the SMEs. On the other hand, it implies that the more incremental the innovation, the more the influence of outbound open innovation on the product performance of the SMEs. Following the above arguments, it is therefore hypothesized thus:

H₂: The more radical the innovation, the more negatively will be the influence of outbound open innovation strategy on the product performance of the SMEs.

H₃: The more incremental the innovation, the more positively will be the influence of outbound open innovation strategy on the product performance of the SMEs.

RESEARCH METHODOLOGY

3.1 Research Design

This study aims at investigating the adoption of outbound open innovation design and product performance of SMEs in the United Kingdom. The positivist philosophical stance was taken in this study because open innovation is seen in this study as a purposive knowledge management activity, following Chesbrough and Bogers (2014) cited in West, Salter et al. (2014). Moreover, open innovation is defined in terms of collaboration with external partners. As a collaborative agreement, the adoption of open innovation dimensions by an SME is believed to be a conscious managerial decision which is usually established, often times, through signing of a memorandum of understanding with external partners, say a university or a supplier. Therefore it is believed to have an objective existence hence we studied it scientifically using quantitative approach. Furthermore, the cross sectional survey approach was adopted

in this study, because the data was obtained from the activities of the SMEs within the last three years to enable us answer the broad research question, “How does the adoption of outbound open innovation strategy by SMEs affect their product performance as influenced by the type of innovation that the SMEs are pursuing?” The target population of the study is all SMEs in the manufacturing sector in the UK registered with the office of statistics. From the population, a randomly selected sample of 802 SMEs was obtained from Dun and Bradstreet. The respondents were managers, IT executives and senior supervisors of the chosen SMEs. These groups of people were selected because they are considered as the custodians of firm’s knowledge management activities.

3.2 Data Collection and Analysis Techniques

Furthermore, sets of questionnaire were used as survey instruments to obtain primary data for the study. The questionnaire was made up of sets of questions drawn from validated scales of measurement from previous studies in the area. The validity of the survey instruments was determined by discussing it with some senior academics in Newcastle University Business School while the reliability of the instrument was ascertained by computing the cronbach’s alpha (α) of the measures of the constructs. The values obtained indicate that all the constructs and their respective measurement items have very strong internal consistency and suitable for the study. The following are the constructs and their respective values: Radical innovation ($\alpha = 0.77$), Incremental innovation ($\alpha = 0.71$), Product Performance ($\alpha = 0.78$), Outbound innovation: incremental ($\alpha = 0.75$), Outbound innovation: radical ($\alpha = 0.71$), Market turbulence ($\alpha = 0.84$), Competitive intensity ($\alpha = 0.88$), Technological turbulence ($\alpha = 0.76$), Technical synergy ($\alpha = 0.82$). Out of the sample of 802 SMEs, only 577 had valid email addresses. Therefore 577 sets of questionnaire were administered on the respondents through their email addresses. Subsequently the respondents were contacted through their telephone numbers so as to confirm their receipt of the questionnaire, remind and encourage them to complete and return the questionnaire. Eventually, 120 sets of questionnaire were returned out of which 72 were duly completed and useable, representing 12.5% return rate. Secondary data about SMEs in the UK were also obtained from journals articles and textbooks to provide a useful source from which to answer, or partially to answer the research questions (Saunders et al. 2012). The data were measured on ordinal scale mainly on a five-point likert scale and subsequently analysed using multiple regression analysis technique with the help of SPSS version 21 in order to investigate the linear and curvilinear relationship between the criterion and predictor variables of the study, in line with Sawang (2012) who employed multiple regression technique to examine linear and curvilinear relationship between job demands and work engagement. The analyses were carried out at 95% level of significance ($\alpha = 0.05$) and the decision rule is to reject the null hypothesis if the computed statistic is less than 0.05 and accept the alternative hypothesis and vice versa.

3.3 Measurement of Variables

Dependent Variables

The dependent variable of this study is product performance. The product performance of the SMEs was divided into radical product performance and incremental product performance. Both the radical and incremental performance outcomes were measured with three items in this study, namely sales, market share and profits. The radical product performance was measured against the competitors’ product performance while the incremental innovation was measured against the SME’s previous products. All the items were measured on a five-point Likert scale ranging from far below expectation to far above expectation as adapted from Song and Parry (1999).

Independent Variable(s)

The independent variable of this study is the outbound dimension of open innovation and it was measured with 3 items on a five-point Likert scale ranging from very low to very high. The measure was derived from van de Vrande et al. (2009).

Moderating Variables

The type of innovation that the SMEs pursued was used as moderating variables of the study. The types of innovation were defined as either radical or incremental innovation. Radical innovation was measured

by 5 items on a five-point Likert scale ranging from very low to very high as adapted from Kim et al. (2012). In the same vein, the incremental innovation was measured with 5 items on a five-point Likert scale ranging from very low to very high which was obtained from Kim et al. (2012).

Control Variables

The following environmental variables were employed as control variables, namely competitive intensity, market turbulence, technological turbulence (Wang et al., 2012) and technical synergy (Song and Parry, 1999). Competitive intensity was defined as the rate of competition for the share of the customers' available resources. This construct was measured with 5 items on a five-point Likert scale ranging from very low to very high. The measure was adapted from Wang et al. (2012). Market turbulence referred to the rate at which the composition and preference of customers change. It was measured with 4 items on a five-point Likert scale ranging from very low to very high. The measures were adapted from Wang et al. (2012). Technological turbulence refers to the rate of technological advancements in the industry. It was measured with 3 items on a five-point Likert scale ranging from very low to very high. The measure was adapted from Wang et al. (2012). Technical synergy refers to balance between the set of skills and know-how an organisation possesses and resources needed to achieve its product development goals. This construct was used to measure the adequacy of R&D and technical resources in relation to the products the firm intends to produce. It was measured with 4 items on a five-point Likert scale ranging from very low to very high. The measure was adapted from Song and Parry (1999). See appendix B for items used to measure the constructs on the questionnaire.

DATA ANALYSIS AND HYPOTHESES TESTING

4.1 Data Analysis

We started the analyses by establishing the effect of the control variables on the criterion variable. First, we entered the control variables (market turbulence, technological turbulence, competitive intensity and technical synergy) as the independent variables and product performance as the dependent variable in the multiple regression equation. The results show that all the variables were significant and therefore have positive effect on the criterion variable. That means the more the market turbulence, competitive intensity, technological turbulence and technical synergy the more influence they will have on the effect of the predictor and moderating variables on the product performance. Hence the control variables were held constant in order to control for their effect on the model.

The relationship between adoption of outbound open innovation and the product performance was also examined. To determine the linear relationship between the adoption of outbound open innovation and the incremental product performance of the SMEs, we entered the outbound open innovation for incremental innovation (IOutbound) as the predictor and the product performance of the SMEs as the criterion variable.

The results from table 3 in the appendix below show that both R^2 and $\Delta R^2 = 0.920$ and the $\Delta F = 803.473$. This implies that the predictor variable accounts for about 92% of the changes in the criterion variable. It shows a significant relationship at $F(1, 70) = 355.871$, $*p < 0.05$. This outcome supports H1a.

To determine the relationship between outbound openness and radical product performance, we entered the predictor variable for outbound openness for radical innovation (ROutbound) and the outcome variable product performance into the multiple regression function and the results on table 4 in the appendix show $R^2 = \Delta R^2 = 0.970$, and $\Delta F = 2239.117$. This implies that the predictor variable accounts for about 97% of the change in the outcome variable. This shows a significant relationship between the predictor variable and the criterion variable at $F(1, 70) = 396.265$, $p < 0.05$ and therefore supports H1b.

Furthermore, the moderating effects of radical and incremental innovation on the effect of outbound openness on product performance were also examined in hypotheses 2 and 3. To determine the moderating influence of radical innovation the effect of outbound open innovation on product performance, we did two levels of independent variable entry in multiple regression analysis. In model 1, we entered the variables for product performance and outbound openness in the dependent and independent variable spaces respectively. In model 2, we entered a combination of the outbound

openness variable and the radical innovation variable as another set of independent variables. Model 1, was aimed at determining the relationship between outbound open innovation and product performance alone without the moderating influence of radical innovation while model 2 was aimed at determining the effect of the moderating variable on the subsisting relationship. The results on table 5 in the appendix below show a marginal increase in the R^2 value from 0.970 in model 1 to 0.974 in model 2 following the introduction of the moderating variable in model 2. The ΔR^2 specifically indicate that the moderating variable contributed about 0.004 (0.4%) of the changes in the criterion variable. This shows a very partial effect though significant at $F(1, 69) = 10.701, p < 0.05$. The results therefore partially support H2.

Also the moderating influence of incremental innovation on the effect of outbound open innovation on product performance was investigated. To determine the effect, we entered the variables for product performance and outbound open innovation as dependent and independent variables in the multiple regression analysis in model 1 to establish the relationship without the effect of the moderating variable. Then in model 2 we entered the variable for outbound open innovation together with the variable for incremental innovation as the predictor variables while retaining the product performance as the criterion variable. The results on table 6 in the appendix below show an increase in R^2 from 0.920 in model 1 to 0.965 in model 2. This implies that the introduction of the moderating influence of incremental innovation increased the effect of the predictor variables on the criterion from 92% to 97%. From the change statistics, we observe that the ΔR^2 for model 2 was 0.045 which indicates that the moderating variable alone accounted for about 5% of the changes in the criterion variable. The results show a positive relationship at $F(1, 69) = 87.719, p < 0.05$, hence H3 is supported.

DISCUSSION OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion of Findings

Following the review of related literature, three hypotheses, H1- H3 were formulated for the study. The results from the data analysis support H1b, H2 and H3 but H1a was partially supported. Below is the discussion of the findings.

H1_a predicted that adoption of outbound dimension of open innovation will positively affect the incremental product performance of SMEs. The findings agree with this hypothesis. The finding could be explained by the fact that the product idea that is lying idle in the firm and eventually gets exported to an external firm will help to produce more products which are generally familiar, at least, to the exporting firm. This finding supports Allen (1983) and Narula (2004) who found that outbound innovation generally increased the innovative performance of the society. However they failed to specify what type of innovative performance that is enhanced by outbound open innovation strategy. Furthermore, it is noteworthy that firms that adopt out bound innovation run the risk of increased competition (Fosfuri, 2006) and loss of value (Helfat, 2006) to the external partners. This finding partly answers the research question 1, 3 and 4.

H1_b: was based on the expectation that adoption of outbound dimension of open innovation will negatively affect the radical product performance of SMEs. The findings supported this hypothesis. The negative relationship between outbound open innovation and product performance shows that when SMEs want to achieve a radical product performance, they may not be able to achieve it by taking knowledge outside. This finding is in line with (Allen, 1983) who found a positive relationship between outbound open innovation and general increase in innovation performance in the environment which clearly indicates increase in incremental innovation. The reason is because when everyone else knows and can do what everyone else can, then the resultant innovation cannot be radical in the real sense of the word. This finding also partially proffers solution to questions 1, 2 and 3 of the research questions.

H₂ was formulated based on the expectation that the more radical the innovation the more negatively will be the influence of outbound open innovation strategy on the product performance of the SMEs. The findings partially support the hypothesis. This implies that radical innovation partially moderates the effect of outbound open innovation on the product performance. This is because the decision to export or not to export knowledge outside is affected by the target novelty of the product. This finding agrees Rigby and Zook (2002) that outbound innovation does not enable the firm to produce any out-of-the-world product (radical) rather just helps them make moderate product modifications (incremental), hence firms that want to produce radical product may not export their knowledge. This finding partly answers the question 5 of the research questions.

H₃ predicted that the more incremental the innovation the more positively will be the influence of outbound open innovation strategy on the product performance of the SMEs. The results support this hypothesis. This implies that incremental innovation moderates the effect of outbound open innovation on the product performance of the SMEs. In the same vein, this finding also partly answers the fifth research question.

5.2 Conclusions.

Drawing from a sample of 72 SMEs in the manufacturing sector in the UK, this study has empirically investigated the adoption of outbound open innovation design and the product performance of SMEs, looking specifically at the moderating influence of the type of Innovation (radical or incremental). The influence of environmental factors on product performance was accounted for by controlling for market turbulence, competitive intensity, technological turbulence and technical synergy. The findings from the data analysis indicate that SMEs adopt outbound open innovation strategies and also they pursue radical as well as incremental innovations. The findings reveal a positive and significant relationship between outbound open innovation and incremental product performance. But findings reveal a negative relationship between outbound open innovation and the radical product performance of the SMEs. The findings also reveal that incremental innovation moderates the effect of outbound open innovation on the product performance of the SMEs. Finally, findings surprisingly show that radical innovation partially moderates the effect of outbound open innovation on the product performance. It is therefore concluded that the decision to employ outbound open innovation strategy must be aligned with the type of innovation being pursued (Zang et al., 2014).

5.3 Limitations of the Study

The conduct of the study was not without some limitations. First our respondents were general managers, operations managers and IT executives of the selected SMEs so the data collected were obtained from people who are knowledgeable about the collaborative efforts and information systems of the SMEs. However, there was limited time to obtain more responses necessary for in-depth study that will give a broader view of the collaborative activities of SMEs and their product performance. Given sufficient time, it will be important to meet with the respondents to get first-hand information which may not have been captured in the questionnaire. But this was not possible in the present study due to time constraint. However despite these limitations, the study has made several contributions which have implications for policy makers, managers of SMEs in the UK and the open innovation literature.

5.4 Managerial and Theoretical Implications of the Study

The contributions of the study will be relevant to SMEs in the Manufacturing sector in the UK, Policy makers and future researchers on open innovation.

SMEs: the primary beneficiaries of the study will be the SMEs in the manufacturing sector in the UK.

The findings of the study will enable the managers of the SMEs to know the appropriate instrumentality of the outbound open innovation design in order to achieve a particular type of innovation. It is believed that knowing and adopting the most appropriate open innovation dimension for the appropriate type of innovation by the SMEs will result in successful adoption and by extension economic prosperity.

Policy Makers: the findings of this study will also enable policy makers to make informed and relevant

Polices that will make the exportation of knowledge from firms that possess surplus to firms that may not have the capacity to produce requisite knowledge. This will make open innovation practices adoption by SMEs more effective and efficient thereby enhance their performance and meaningful contribution to the viability of the economy.

The literature: the findings in this study have contributed to the existing stock of knowledge in the literature in the following ways: Firstly, there is dearth of empirical studies on the outbound dimensions of open innovation therefore this study will serve as a reference material to future researchers especially on the outbound dimension of open innovation. Secondly, it has identified the appropriate dimension of open innovation practice that the SMEs adopt in order to achieve a predetermined product performance goal and how this could be moderated by the types of innovation.

5.5 Suggestions for Further Studies and Recommendations

Owing to the identified limitations of the study, it is suggested that the study be replicated and done within reasonable time that will be enough to cover a wider scope and obtain more responses. This will help to improve the generalizability power of the findings of the study. We also recommend that further studies be carried out in the same study area but covering order sectors of the economy in order to fully investigate the overall impact of adoption of outbound open innovation design on the product performance of firms in other sectors of the UK economy.

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APPEDIXES

Tables:

1: Key Literatures on Open Innovation in SMEs Reviewed in this Study

Sno	Author/year	Aim	Method	Key Findings
1	Christensen et al. (2005)	To explore how SMEs, in the consumer electronics industry, manage open innovation according to both the maturity of the technology as well as their position within the innovation system	Qualitative Study	SMEs are exploring potential collaborations and knowledge exchange with smaller (yet established) firms in the early stages of their technology development, while progressively choosing larger firms when their technology is more mature
2	Henkel (2006)	To investigate firms performing open-source software development using Linux	Quantitative Study- Case study of Korean Integrated Contract Manufacturing Service (KICMS)	On average, about half of the firms will protect with various means half of the code, while firms with a longer history of open-source development are more willing to reveal their development processes than protect them. Among other things, he also found that the amount of revealed code ceteris paribus is larger for smaller firms, which likely benefit more from external development support.
3	Lee et al. 2010	To place the concept of open innovation in the context of SMEs; secondly to suggest the input of an intermediary in facilitating innovation; and finally to report accounts of Korean SMEs' success in working with an intermediary.	Qualitative Study	The research results support the potential of open innovation for SMEs, and indicate networking as one effective way to facilitate open innovation among SMEs.
4	Lichtenthaler (2008)	To investigate two types of technology transactions: external technology acquisition and external technology, as the main dimensions of a firm's approach to open innovation.	A questionnaire-based study of 154 middle-to-large companies	Open innovation practices are mostly used by large firms due to the large pool of internal resources they have, which allows them to build on their absorptive capacity
5	Van de Vrande et al. (2009)	To measure the extent to which SMEs apply open innovation practices, and to examine whether there is a trend towards increased adoption of the open innovation model over	A sample of 605 innovative Dutch SMEs	Open innovation practices in SMEs focus mainly on market-related targets. Furthermore, SMEs are more likely to be involved in 'in-bound' rather than 'outbound' open innovation practices
6	Bianchi et al. (2011)	To develop a methodology to assist SMEs to put outbound open innovation into practice	Qualitative Research- Case Study.	A quick and friendly-to-use approach for identifying opportunities for out-licensing SMEs' technologies is developed by SMEs to other firms
7	Spithoven, Vanhaverbeke et al. (2013)	To investigate how open innovation impact the innovative performance of SMEs in comparison to large companies.	Quantitative-Probit Regression testing	The key finding is that the effects of OI practices in SMEs often differ from those in large firms. SMEs are more effective in using different OI practices simultaneously when they introduced new products on the market, whereas this is less the case for large firms.

Source: Research Survey, 2015

Table 2: Constructs and Definitions

CONSTRUCT	Definitions	SOURCE(S)
Radical Innovation	Products new to the world market(INNWORLD).	Laursen Salter (2006) Faems et al., (2010)
Incremental Innovation	Products new to the firm (INNFIRM)	Laursen Salter (2006) Faems et al., (2010)
Outbound Open Innovation	in licensing-out and selling internally developed technology to external parties	Arora (1997), Spithoven et al. (2013)
Radical Product Performance	measured as the fraction of the firm's turnover relating to products new to the world market (INNWORLD).	Laursen Salter (2006) Faems et al., (2010), Zeng, Xie et al., (2010)
Incremental Product Performance	the fraction of the firm's turnover pertaining to products new to the firm (INNFIRM)	Laursen Salter (2006) Faems et al., (2010), Zeng, Xie et al., (2010)

Source: Research Survey, 2015

3: Outbound Open Innovation and Product Performance.

Model	Description	B(SE B)	β
	(Constants)	0.558*(0.352)	
1	IOUTBOUND	0.983 (0.035)	0.959
	R ²	0.920	
	ΔR^2	0.920	
	ΔF	803.473	

Note: The values reported represent the unstandardized coefficients (B) centred with standard error (SE B) in parentheses and β is the standardized coefficients. IOutbound is the outbound open innovation for incremental innovation. *P < 0.05 (2 tailed test). Source: Research Survey, 2015

4: Outbound Open Innovation and Product Performance

Model	Description	B(SE B)	β
	(Constants)	-0.346*(0.226)	
1	ROUTBOUND	1.012(0.021)	0.985
	R ²	0.970	
	ΔF	2239.117	

Note: The values reported represent the unstandardized coefficients (B) centred with standard error (SE B) in parentheses and β is the standardized coefficients. ROutbound is the outbound open innovation for radical innovation. * p < 0.05 (2 tailed test). Source: Research Survey, 2015

5: Moderating Influence of Radical Innovation on the effect of Outbound Open Innovation on Product Performance.

Model	Description	B(SE B)	β
	(Constants)	-0.346*(0.226)	
1	ROUTBOUND	1.012 (0.021)	0.985
	R ²	0.970	
	ΔF	2239.117	
	(Constants)	0.270 *(0.282)	
2	ROUTBOUND	1.308 (0.092)	1.272
	RADICAL INNOVATION	-0.212 (0.064)	-0.295
	R ²	0.974	
	ΔR^2	0.004	
	ΔF	10.876	

Note: The values reported represent the unstandardized coefficients (B) centred with standard error (SE B) in parentheses and β is the standardized coefficients. ROutbound is the outbound openness for radical innovation. *p < 0.05 (2 tailed test). Source: Research Survey, 2015

6: Moderating influence of incremental innovation on the effect of outbound open innovation on product performance.

Model	Description	B(SE B)	β
	(Constants)	0.558* (0.352)	
1	IOUTBOUND	0.983 (0.035)	0.959
	R ²	0.920	
	ΔF	803.473	
	(Constants)	-1.321*(0.309)	
2	IOUTBOUND	0.467 (0.060)	0.455
	INCREMENTAL INNOVATION	0.394 (0.042)	0.546
	R ²	0.965	
	ΔR^2	0.045	
	ΔF	87.719	

Note: The values reported represent the unstandardized coefficients (B) centred with standard error (SE B) in parentheses and β is the standardized coefficients. IOutbound is the outbound openness for incremental innovation. *p < 0.05 (2 tailed test). Source: Research Survey, 2015

Figures:

1: Research Model

