The Effect of Business Improvement Methods on Innovation in SMEs in Peripheral Regions

1. Introduction

Regional, national and EU level Governments face a significant policy and practice challenge in seeking to improve the competitiveness of (particularly indigenous) small- to medium-sized enterprises (SMEs) in peripheral regions[1] (such as North West Europe as in this study) and to limit the growing disparity in productivity between these regions and more central regions (Cooke and Swartz, 2008; Abreu, 2011, Arbuthnott and von Freidrichs, 2013). Because of their innate resource limitations, one area of policy has been a focus on improving both management and workforce skills through using business improvement methods (BIM)[2] to improve efficiency in production (e.g., Scottish Enterprise, 2012; Invest NI, 2012; Enterprise Ireland, 2012; Manufacturing Advisory Service, 2012). Such BIM have become relatively common, especially in manufacturing firms, in recent years although precise estimates of their take-up are difficult to ascertain.[3] While increases in efficiency help overall competitiveness, the former is only one element in determining (total factor) productivity; indeed increasing levels of competition, globalisation and technology development have challenged SMEs to increase their levels of innovativeness. Innovation (or technical change) and increases in efficiency are both seen as leading to greater competitiveness (DTI 2003; HM Treasury 2004; DIUS 2008; European Commission 2006a, 2006b). Hence, policy has increasingly focused on encouraging innovation development within SMEs using a range of approaches, and especially to assume that BIM (which is now commonly encouraged in SMEs) is also an enabler for innovation.

Although the emphasis is on measuring the impact of adopting BIM on innovation activities for SME's, in this study we control for other influences by including most of the standard determinants of innovation that have featured in the literature, such as: the characteristics of the firm, including which markets it sells in and ownership, as well as the importance of 'leadership', 'culture', and variables representing absorptive capacity. The inclusion of BIM is rare, except in the operations management literature that deals specifically with total quality management (and similar BIMs). And yet it is well known that BIM and innovation management strategies are likely to share a common organisational platform that facilitates the sharing of knowledge and skills, and thus lead to greater competitive advantage (Nowak, 1997). Thus there seem to be obvious, logical linkages between BIM and innovation, although previous (and rather limited) empirical analysis has generally found mixed results relating to this link. This is often 'explained' by assuming that firms have either not fully understood (and resourced) BIM, or that only specific methods that involve a more narrowly defined emphasis on incremental improvement is implemented, and this may actually truncate product and process innovations.

[1] A number of studies (e.g. Melançon and Doloreux, 2013; Skuras et al, 2008; Cooke et al, 1997) have shown that SMEs from peripheral regions are likely to be less competitive and innovative in comparison to more centrally located companies.

[2] E.g., Total Quality Management (TQM), ISO: 9001:2008, Continuous Improvement, Lean, Investors in People, and Six Sigma (see Bessant and Tidd, 2011, for a discussion).

[3] EEF (2008) estimate that just under three-fifths of UK manufacturing was using Lean in 2008 (with 41% take-up in those employing less than 50 rising to over 70% in those employing 500+). The Workplace Employee Relations Survey for 2004 (for Great Britain) shows that some 36% of plants benchmark against other organisations, 17% use quality circles (which can include Continuous Improvement, and other forms of problem-solving groups), and 37% have an Investors in People award.

The sample of firms used comprised SME's (employing between 10-250) that were the client companies of the Development Agencies (Invest NI, Enterprise Ireland and Scottish Enterprise) in the adjacent border regions of Ireland (north and south) and Scotland. In general the Development Agencies target firms to become clients that have characteristics that make them more likely to succeed in becoming innovative/productive/profitable[4]; as such this population of client-firms are more likely to adopt BIM and/or engage in innovation enhancing activities. That is, this sub-group of the population of SME's are a more appropriate sample given their growth potential and direct exposure to 'policy' designed to make them more competitive and profitable. If we had sampled the much larger population of all SMEs operating in the border regions it is very likely the overwhelming majority would have neither adopted BIM and/or been involved in innovations related activities. Thus in this study, we are effectively testing whether attempts by the Development Agencies to engage SMEs in adopting BIM also had an impact on innovation; if it did we will be in a better position to understand the efficacy of such policies designed to improve innovation outcomes in peripheral regions.

It is also likely that firms that use BIM have characteristics that make them on average more/less likely to achieve different innovation-related outcomes; that is, there is a potential issue of self-selection which if present would bias any attempt to measure the impact of BIM on innovation. Thus this study adopts the typical solution to this problem of self-selection by 'matching' the 'treated' group (those that use BIM) with a 'control' group ('untreated' firms which do not use BIM but which have very similar characteristics to the 'treated' group of firms – with both sets of firms being clients of the agency tasked with implementing policy).

All of the existing studies that test whether BIM and innovation are related treat the latter as a single construct – i.e., the firm produces product/process innovations or not. We take a different approach by distinguishing between firms that innovate successfully, those that invest in innovation-related activities but are unsuccessful, and those that do not undertake innovation-related activities. We thus allow BIM to potentially impact differently on whether the firm undertakes innovation-related activities or not, and if so whether BIM influences innovation outcomes.

Lastly, there have been a limited number of studies of the determinants of innovation in SME's in the geographies covered in this paper. These have typically been based on data collected directly by researchers[5] and which have looked a number of factors determining innovation within the framework of the 'innovation production function'; e.g., the earlier work of Harris and Trainor (1995) concentrated on the links between undertaking R&D and innovation outputs in manufacturing plants operating in Northern Ireland, while Hewitt-Dundas and Roper (2008) conduct similar analysis covering Ireland and Northern Ireland but with a more extensive set of variables representing knowledge sourcing and barriers to

[4] For example, Scottish Enterprise provides an especially intensive form of support to Account and Client Managed firms (commonly referred to as 'Direct Relationship Management' companies) that are considered to be capable of benefiting from a high level of attention. They are companies with a proven or likely higher growth potential. Each company is regularly reviewed by a 'client-manager' with the company offered the most appropriate (in-house) training, courses or programmes. Invest NI and Enterprise Ireland follow a similar approach.

[5] E.g., Harris and Trainor (1995) collected information on 140 manufacturing firms operating in Northern Ireland in 1991; Roper and associates have used the Irish Innovation Survey (IIS) which has several waves comprising between 750-1055 manufacturing plants (including non-SMEs) operating in Ireland and Northern Ireland; Harris and Trainor (2011) used 250 matched manufacturing plants in Northern Ireland. Note, none of the datasets are claimed to be representative of the population of SMEs operating in (Northern) Ireland. For example, the IIS reports levels of product innovation that are around twice the levels reported in the results from the Community Innovation Surveys conducted in each area.

innovation. More recent work using the Ireland and Northern Ireland data collected by Roper and associates covers what determines innovation persistence (Roper and Hewitt-Dundas, 2008); the impact of ownership on innovation (Love et. al., 2009); and how external knowledge sourcing (i.e., 'open' innovation) impacts on innovation (Roper et. al., 2013). However, none of these studies collected data on BIM, and therefore do not consider links between BIM and innovation – and especially the possibility that rather than being compliments, BIM might result in innovation in SMEs being less likely.

This article begins with a review of the theoretical and empirical literature on the relationship between BIM and innovation. Section 3 discusses the data used, and our modelling strategy. This is followed by a presentation and discussion of the results obtained (section 4). Finally there is a summary and conclusion, including the policy relevance of this study.

2. Literature Review

(a) BIM and innovation activities

Business improvement methods are part of the operation of business management models that usually comprise some or all of the following range of processes: the need to focus on the customer's needs, management involvement (in strategic planning and committed leadership to drive change), continuous improvement (in how work is organised and conducted, and thus how goods and services are produced), and employee involvement (and empowerment, e.g., through cross-functional training and work). The most comprehensive example is total quality management, often described as an integrative philosophy of management for continuously improving the quality of products and processes;[6] other BIM have a narrower focus. For example, Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes; Continuous Improvement lies somewhere in between as an ongoing effort to improve products, services, or processes, where these efforts can seek "incremental" improvement over time or "breakthrough" improvement all at once (ASQ, 2012).

As to the link between BIM and innovation, there are a number of reasons why BIM should have a positive impact on the ability of the firm to produce new products and processes.[7] Both rely on organisational learning to 'create' a stock of knowledge that can be utilised now and in the future (Darroch and McNaughton, 2002; Yu-Yuan Hung et. al., 2010). More specifically, Liao et. al. (2010, Table 4) summarise the arguments put forward in Prajogo and Sohal (2001) and Perdomo-Ortiz et. al. (2006) where each major element of TQM is mapped onto the set of positive and negative influences it can have on innovation (a comparable mapping between other BIM and innovation would concentrate on just those elements that are relevant to them). Sadikoglu and Zehir (2010, Tables 1 and 2) present very similar information. Thus, 'customer focus', where it involves meeting the changing needs of

[6] For example, Grant et. al. (1994) state "TQM comprises a group of ideas and techniques for enhancing competitive performance by improving the quality of products and processes" (p. 20).

[7] Note, the BIM-innovation relationship can be simultaneous and complementary, but it often argued that "in general business practice first incorporates the concept of quality management and then gradually integrates innovation" (Perdomo-Ortiz et. al., 2009). The theoretical underpinning for this is the resource-based and dynamic capabilities (RDBC) view, which incorporates an evolutionary view of management priorities being path dependent with the "quest for innovation performance (requiring) greater organizational complexity than that for quality" (Perdomo-Ortiz et. al., op. cit., p. 5088). The literature cited to back up such claims includes Foss (1993), Teece et. al. (1997), and Hodgson (1998). Note, later we have also tested the links between BIM and innovation using a 'matching' approach, that mitigates against any bias from that part of a simultaneous relationship due to self-selection issues.

customers, should lead to the development of new products and services and thus greater value. However such a focus can also lead to firms being reactive, more likely to respond through incremental changes, and too tied-in to *existing* customer needs, with the longer-term result being product conformance rather than innovation. People (i.e., management and employee) involvement and teamwork has positive effects, through encouraging taking responsibility (empowerment), participation and flexibility in decision making; greater cooperation and communication; and the use of cross-functional teamwork, all of which can lead to new-idea generation and risk-taking. This aspect of BIM might also stifle non-production activities and individual creativity, such that a lower common-denominator level of improvement becomes more the norm, especially as it involves what has been termed 'management by fact' which "necessitates a set of data, tools, and techniques with which to analyse the existing system, leading to solutions based on prior experience and inhibiting innovative solutions" (Sadikoglu and Zehir, op. cit., p. 15). Continuous improvement encourages change and creative thinking in not only work patterns, but also in product improvement. However, negative links to innovation can be workers adopting unambitious goals and standardised working, too much formalisation (and thus rigidity), with stable and standard, repetitive systems promoted.

Overall BIM involves different elements, comprising a 'hard' focus on efficiency and a 'soft' concentration on learning, and this can lead to a mechanistic vis-à-vis an organic approach to how the business operates (McAdam, 2000). Thus perhaps it is not surprising that the empirical literature offers contradictory conclusions. Work by Flynn (1994), Prajogo and Sohal (2003, 2004), Feng et. al. (2006), Martinez-Costa and Matrinez-Lorente (2008), Yu-Yuan Hung et. al. (2010) and Sadikoglu and Zehir (2010), suggests a positive relationship between (specifically) TQM and technological innovation; whereas Singh and Smith (2003), Prajogo and Sohal (2006) and Terziovski and Samson (1998) find a negative or non-significant relationship. Perdomo-Ortiz et. al. (2009) found the relationship to be negative when moderated by various aspects of innovation capabilities (linked to the firm's absorptive capacity).

Based on the these different elements in (different) BIM, and the mixed results obtained in previous work, there are some who argue there is a need to distinguish different BIM in terms of their 'hard'/'soft' focus in measuring their impacts on innovation.[8] In a similar vein, it has been argued (particularly by Perdomo-Ortiz et. al., 2009) that there is a need to look at the BIM-innovation relationship based on different types of organisation (mechanistic versus organic), with those having higher strategic fit (e.g., absorptive capacity) being more likely to see a positive relationship. Thus below, we go beyond our basic model and test whether different types of BIM (e.g., TQM versus Continuous Improvement) have different impacts, and whether the BIM-innovation relationship needs to include the mediating role of absorptive capacity or 'culture'.

As we stated in the introduction, all of the existing studies that test whether BIM and innovation are related treat the latter as a single construct – i.e., the firm produces product/process innovations or not. As explained below, we take a different approach by distinguishing between firms that innovate successfully and those that invest in innovation-related activities but are unsuccessful. We thus allow BIM to potentially impact differently on whether the firm undertakes innovation-related activities or not, and if so whether BIM influences innovation outcomes. We also do not use a structural equation modelling (SEM)

[8] Although it is worth noting that this distinction is not universally accepted as some influential studies – such as Utterback, (1971) and Freeman (1982) – suggest that so-called hard BIM practices support innovation performance.

approach (like many other studies). Although the latter is a statistically valid method, the SEM models estimated are usually not fully explained nor the results clearly interpreted; rather most studies simply established whether a statistically significant relationship existed between BIM and innovation.

Turning to what determines innovation outputs, these are normally, but not exclusively, the result of a decision by the firm to commit relevant resources, particularly by investing in formal R&D;[9] this relationship has been extensively examined in the empirical literature (e.g. Acs and Audretsch 1988; Freeman and Soete 1997; Mairesse and Mohnen 2005). When a firm allocates resources (e.g., to R&D) there is no guarantee that the investment will lead to new products or processes, but there is evidence that by undertaking the process of innovation the firm may develop its absorptive capacity by enhancing its capabilities and competencies in the accumulation and application of externally-acquired knowledge (Cohen and Levinthal 1990; Teece and Pisano 1998; Pavitt 1984; Simonen and McCann 2008). The value of absorptive capacity has been well-documented in the literature and is concisely summarized in Fabrizio (2009). Research by Parisi et al. (2006) provide evidence that the concept of absorptive capacity is important at the firm level - "internal R&D helps the firm in absorbing innovations generated outside the firm and embodied in new investment goods" (p. 2055). Escribano et al. (2009) considered the impact of absorptive capacity on innovative performance and concluded that "it pays dividends, in terms of innovative performance, to invest in enhancing absorptive capacity" (p. 104) while Harris and Moffat (2012) have shown that R&D and higher absorptive capacity (with the latter a determinant of the former[10]), inter alia, increases the probability of innovation as well as reducing barriers to exporting (all of which is likely to increase overall firm productivity).

(b) Other determinants of innovation activities

Other determinants of whether the firm commits relevant resources (e.g., R&D) with the aim of producing innovation outputs include the following:[11] the size (and/or age) of the firm; technological opportunity; (knowledge) spillovers from other firms in the same and/or other industries, which can be linked to the wider importance of absorptive capacity (since it involves internalising external knowledge); markets served, especially through exporting; ownership characteristics (such as whether the firm is family-owned or foreign owned); and such factors as culture in the firm, the role of strategy, and lifecycle effects.

Larger firms may have an innovation advantage due to economies-of-scale and scope, access to finance (cf. Fisher and Temin, 1973; Cohen and Klepper, 1996; Legge 2000), and being better placed to internalise R&D spillovers due to product diversification (see Cohen *et. al.*, 1987; Acs and Audretsch, 1991; and Almeida *et. al.*., 2003, from a learning perspective; also Lichtenberg and Siegel, 1991; Cohen, 1995; Legge, 2000; Henderson and Cockburn, 1996, for empirical evidence). Larger firms may also be more able to exploit complementarities

[9] Note, we do not limit innovation inputs to R&D, as many SME's do not engage in such (formal) activities. So in our empirical work we simply asked firms to tell us if they were engaged in innovation related activities, which we defined for them as committing resources to developing new products, processes or services and/or significantly improving existing products, processes or services, or developing new niches for the firm.

[10] At a practical level, studies point to the critical role of R&D investment and training that firms undertake in order to absorb, assimilate, and manage foreign technologies (Mowery and Rosenberg, 1989; Cohen and Levinthal, 1989, 1990; Globerman, 2000). Thus R&D is often used a proxy measure of absorptive capacity, but clearly when using this concept to explain why firms undertake innovation-related activities (including R&D) it is necessary to measure absorptive capacity in a more specific way, which we do later on when we introduce more direct proxies for absorptive capacity.

[11] E.g. see Shefer and Frenkel (2005).

between R&D and other business functions (Cohen, 1995).[12] For example, early theoretical work was particularly concerned with how productivity was related to size, the learning-by-doing effect associated with the age of the firm, and thus the likelihood of survival (cf. Jovanovic, 1982; Pakes and Ericson, 1998).[13] Learning-by-doing models have been extended to include the investments of individual firms (particularly on intangible assets – cf. Griliches, 1981) to allow for 'active learning'. According to resource-based theories[14], firms that invest in intangible assets, such as R&D, and consequently increase their specific internal capabilities and ability to absorb external knowledge, are more likely to increase their competitiveness.[15] Aw *et. al.* (2011) also allow firms to generate (external) knowledge through participating in new (e.g., export) markets, so that the evolution of firm productivity over time is determined by past productivity as well as investments in such knowledge acquiring activities as undertaking R&D (and exporting). Path-dependency is therefore an important theme of this type of approach; competitive advantage is dependent on accumulated firm-specific resources and production capabilities that have been (often slowly) developed over time and which cannot easily be acquired, replicated, diffused, or copied – they therefore cannot easily be transferred or built-up outside the firm (Nelson and Winter, 1982; Pavitt, 1984; David, 1985; Arthur, 1989; Teece and Pisano, 1998; Dosi et. al., 2000). Roper and Hewitt-Dundas (2008) present evidence that innovation persistence – presumably linked to accumulated capabilities – was a feature of firms in Ireland (north and south). Thus overall there is a need to take account of internal and external knowledge creation, including its obsolescence (as represented by the age of the plant).

Technological opportunity is usually proxied by industry structure (e.g., Jaffe, 1986; Klevorick *et. al.*., 1995)[16]. As alluded to above, the impact of exporting on R&D/innovation is traditionally justified by a 'learning-by-exporting' effect (e.g., Aw et. al., 2011, p. 1317). Firms that operate in more competitive export markets, and thus have access to (and knowledge of) these markets comprising better technologies and/or higher quality products, can obtain an additional (current and future) productivity benefit if they can internalise this additional knowledge and expertise (i.e., exporters may benefit from the technology of their customers). Direct information on technical and product development is often provided by customers and suppliers (Salomon and Shaver, 2005; Clerides et. al. 1998) that can stimulate the firm's own innovation outputs. The probability of undertaking R&D is also likely to be boosted by exporting because it is necessary to increase the capacity of the firm to absorb the useful knowledge obtained from exporting.

The inclusion of foreign ownership is justified by the observation that, to make it worthwhile for a foreign firm to incur the costs of setting up or acquiring a plant in the domestic market, foreign firms must possess characteristics that give them a cost advantage over domestic firms (Hymer, 1976). These characteristics may include specialised knowledge about

[12] The literature has also provided examples where small firms may be at an advantage, such as through exploiting behavioral (rather than material) advantages (Rothwell and Dodgson, 1994) such that the more rapid decision-making and better focus of smaller firms may be more important (Acs and Audretsch, 1990).

[13] Thus age and innovativeness are positively related, as the stock of knowledge and competences improves (e.g., Nelson, 1991); but they might also be negatively related if aging leads to internal rigidities within the firm (Sorensen and Stuart, 2000).

[14] The resource-based view (RBV) of the firm was initially put forth by Penrose (1959), and subsequently developed by Wernerfelt (1984) and Barney (1991, 2001). The thrust of this viewpoint lies in the established assumption that 'better' firms possess intangible productive assets that they are able to exploit to derive competitive advantages. See also footnote 4.

[15] Roper et al. (2013) found that firms in Ireland (north and south) had better innovation outcomes if they engaged in absorbing external knowledge.

[16] Cohen *et. al.*. (1987) found that sector dummy variables explained half the variance in R&D intensity in their data; Geroski (1990) found that at least 60% of the variation in R&D could be explained by industry effects.

production and better management or marketing capabilities, both of which would lead to higher productivity and thus a higher propensity to undertake innovation-related investments. It should be noted that, in the long-run, some of these advantages may dissipate as domestically owned firms learn to imitate the foreign firms as a result of knowledge spillovers (Harris and Robinson, 2003); the speed at which this process occurs will be dependent upon levels of absorptive capacity in the domestic firms. Furthermore, firms may undertake FDI to source technology from the host economy rather than to exploit superior technology from the home country (Driffield and Love, 2007). Plants owned by foreign owned firms that are motivated by technology sourcing rather than technology exploiting are likely to have lower productivity than plants owned by foreign owned that are technology exploiting (Fosfuri and Motta, 1999; Cantwell et al., 2004; Driffield and Love, 2007). Foreign-owned plants may also be expected to have lower levels of TFP if foreign-owned firms tend to keep their high value production at home and leave lower value added assembly operation to their foreign subsidiaries (Doms and Jensen, 1998). The latter will tend to employ lower-skilled workers and older technologies. This phenomenon may be especially problematic in peripheral regions as this is where multinationals often place low value added 'branch plant' activities (Harris, 1991). It is therefore not clear from the literature whether foreign owned plants should be expected to have higher or lower TFP than domestically owned plants, and thus a higher propensity to undertake innovation-related investments.[17]

As to the implications for innovation of whether the firm is family-owned, there are theoretical arguments as to why family-owned firms should act differently (i.e. have different governance arrangements and different management practices); these generally appeal to agency relationships and the associated costs that arise when owners (who are also engaged in the management of the company) face the moral hazard problem of how to engender a higher level of worker output (Chami, 2001). According to agency theory, owner-management should minimise agency costs, because ownership aligns managers' attitudes towards growth opportunities and risk, so there is much less need to reach, monitor and enforce agreements between owners and managers (Jensen, 1998). However, the extant literature on family-owned firms tends to reach the opposite conclusion, by providing evidence that such firms often use governance procedures and adopt practices that would seem to act as barriers to growth. This has lead to the extension of agency theory to incorporate altruism when looking at family-owned firms. Inter alia, altruism (towards members of the family) is likely to lead to a more general paternalistic approach to the workforce employed in the company; i.e., there is the likelihood that in family-owned businesses paternalistic behaviour reinforces and is reinforced by a high degree of altruism on the part of family members, and this will mean that the firm does not necessarily seek to just increase efficiency but is also concerned with equity issues (i.e. employees are 'looked-after' and treated fairly in return for their loyalty and effort). As shown in Chami (2001) when trust between owner, non-family managers, and the workforce is low and/or altruism is asymmetric, the agency problem in the family-owned business is exacerbated and often interferes with the survival of the family business. Thus, family-owned establishments are likely to take a different approach to employee involvement (EI) practices (e.g. with respect to consultation and communication) and indeed other HRM strategies related to worker effort, as well as their involvement in R&D, innovative activities and workplace change more generally. There is little empirical evidence in this area, although Zinger and Mount (1993) found that such firms do not see new products and services as a key concern. Moreover,

[17] Love et. al. (2009) found "… support for the view that innovators and non-innovators have different profitability determinants, and that the profitability of externally-owned plants depends on very different factors to those of indigenously-owned enterprises" (p.424).

Tanewski *et. al*. (2003) also found using Australian data that family-owned firms were less innovative, emphasised industry leadership less, but had a greater prospecting orientation than non family-owned firms. For Great Britain, Harris and Reid (2008) found that family-owned plants belonging to SME's were less likely to have formal strategic plans which set out objectives and how they will be achieved; they were less likely to service international destinations as their main market for sales; they were less likely to acquire the quality standards BS5750 or ISO9000; and most importantly for the present study, family-owned firms were less likely to be involved with product or process innovations.

With regard to the role of 'culture', essentially an argument can be made from the literature that a more open and inclusive SME culture is associated with more radical forms of innovation. Wilson and Stokes (2006) describe innovation as a "fundamentally social process" which is based on people and culture within the organisation. Thus, people and culture based constructs are identified as being key organisational aspects of innovation implementation that can promote or hinder innovation efforts (e.g. Hyland and Beckett, 2005; Voss, 1998; Schmidt, 1990). Indeed, Ghobadian and Gallear (1997) state: "SMEs are more likely to be people-orientated than system orientated". Verbees and Meulenberg (2004) found that the organisations' people and culture, along with its leadership, must be one of "openness" where innovation is recognised as a legitimate organisational value (McAdam, 2004). Thus a culture of innate flexibility and responsiveness to environmental changes within SMEs is likely to foster innovation beyond that of continuous improvement, processes and products (Naveh and Erez, 2004). A team-based culture in SMEs should promote empowerment amongst the SME workforce (Davenport and Bibby, 1999) and effective two-way communications (Ghobadian and Gallear, 1997) to develop innovative ideas from employees. Thus in general, culture is based on the ethos of team work at all levels in the SMEs (Pearce and Ensley, 2004; McAdam et al, 2010), a proactive change culture (Hyland and Beckett, 2005); effective two way communication between managers and staff at all levels (Verbees and Meulenberg, 2004); a clear organisational structure to support the culture; and clearly defined roles and responsibilities (Wan et. al., 2005). We have endeavoured to capture as many of these factors as possible below in our empirical analysis.

A number of studies have suggested that the lifecycle stage of an SME is likely to have a significant effect on innovation implementation (Oke et al, 2007; Cope and Watts, 2000). Different stages (cf. the models of Churchill and Lewis, 1983, and Moy and Luk, 2003) reflect growth and the availability of resources, and thus the ability to innovate (Vossen, 1999). In the earliest stage I (existence) the main problems of the business is obtaining customers and delivering the product or service. As the firm moves through stage II (survival), stage III (success), stage IV (take-off) to stage V (resource maturity) innovation implementation is likely to become more imbedded (Mohannak, 2007). Lifecycle (and also cultural) effects are also linked to the strategic approach taken by the firm (Miles and Snow, 1978), which determines its approach to innovation (Johnston and Pongatichat, 2008).

(c) BIM and small-to-medium sized firms

Since there are differences between larger and smaller firms in what determines innovation-related activities, and since the importance of BIM is usually considered with reference to large firms,[18] it is important to consider if the hypothesised links between BIM and innovation as set out above are only likely to be applicable to larger firms. It is well documented that, for example, SME's commit less resources to formal R&D (see footnote 7),

[18] Although we find over 60% of our sample of SME's used at least one form of BIM (see Figure 1). In addition, Ahire and Golhar (1996) found surprisingly that the size of the firm was not a critical factor in the implementation of TQM.

and are less formally involved in "organisational learning". For example, Freel (2000) summarises earlier work on the various constraints that have a particular relevance for innovation activities in SME's. He noted that "… small firms faced constraints associated with: lack of technically qualified labour; poor use of external information and expertise; difficulty in attracting/securing finance and relating inability to spread risk; unsuitability of original management beyond initial prescription; and, high cost of regulatory compliance" (p. 61). This is in addition to those studies that show that indigenous SMEs in peripheral regions are less competitive and innovative in comparison to more centrally located companies (e.g. Skuras et al, 2008; Cooke, 1996; Soderquist et al, 1997); and these geographical limitations are compounded with innate SME skill limitations (Pullen et. al., 2009; Pinho, 2008; Vossen, 1999). These include training and development (Jones, 2005; Barclay and Porter, 2005), and resources (Clark, 2010; Vester and Boshoff, 2007; Nooteboom, 1994).

Others have pointed to an increasing trend in larger organisations, which are under pressure to make up for shortfalls in existing large-scale markets, targeting niche markets, once the unique preserve of SMEs, offering specialist products and services innovations (Kumar, 2010). This effect creates the need for change in SMEs beyond that of incremental improvement in efficiency measures (Bhaskaran, 2006) and creates a demand for more radical change in terms of innovation as a sustainable source of competitive advantage. Ghobadian and Gallear (1999) state that SMEs: "must re-examine and modify their competitive strategies by fully incorporating innovation within their people, processes and products". Hence, as noted in the introduction, to address these limitations one area of Government policy over the past decade has been a focus on using BIM as an enabler of innovation and thus to improve competitiveness (Clark, 2010; Freel and Rodson, 2004).

Pinho (2008), in one of only a very small number of papers that have examined the relationship between TQM and performance in SME's (finding no significant link between TQM and innovation[19]), noted that the latter have been slow in adopting quality initiatives; although noting that while "…SMEs are usually associated with lack of competencies and resources, intense competition has forced them to increasingly adopt more formal quality system strategies as it is assumed that total quality orientated firms tend to evidence high levels of productivity and competitiveness" (p. 257). Indeed, Hewitt-Dundas (2006) has examined the resource and capability constraints to innovation in small and large plants in Ireland, finding that "… (such) constraints to innovation are remarkably similar for small and large plants. The only exception to this is the lack of finance, limited market opportunities and legislative or regulatory pressures, which were more significant for small plants" (p. 273).

Given our discussion of the different elements in BIM, it might be hypothesised that SME's are – e.g., because of their lack of resources – more likely to use BIM to take a hard focus on efficiency rather than a soft concentration on learning, leading to a mechanistic rather than organic approach when implementing such methods. Pinho (2008) goes as far to suggest that "…the efficiency of continuous improvement may have ultimately minimised and even removed available resources for innovation".

In conclusion, the above discussion suggests that looking at BIM and innovation for the SME sector is both justified and necessary; it is not a area this is only applicable to large firms, and indeed one of the main purposes of this study is to consider the size and strength of the

[19] Pinho (op. cit.) studied manufacturing plants in Portugal; in a different study, Moura e Sá and Abrunhosa (2007) looked at the Portuguese footwear industry (again finding a low linkage between TQM and innovation). Clark (2010) considered the case of 95 SME's in New Zealand, again finding little evidence supporting a link.

impact of BIM on innovation-related activities (broadly defined) in more inherently disadvantaged SME's.

3. Data

In November-December 2009 a telephone survey was conducted of 606 small-to-medium sized enterprises (employing between 10-250), covering the border counties of the Republic of Ireland and Northern Ireland, and the West of Scotland (as designated in the European Regional Development Fund guidelines, 2010).[20] The companies were clients of the three Government Development Agencies (Enterprise Ireland; Invest Northern Ireland, and Scottish Enterprise)[21]; as such they were more likely to have developed BIM agendas as a result of assistance provided by the Government agencies in these border regions.

The survey focussed on whether the respondent firms were engaged in innovation-related activities (defined here as committing resources to developing new products, processes or services and/or significantly improving existing products, processes or services, or developing new niches for the firm). We use the firms' responses to classify them as successful innovators (if they had introduced a major product or process innovation in the last 3 years), unsuccessful innovators (if they had engaged in innovation-related activities but had not introduced a major innovation), and non-innovators (did not innovate or spend on innovation-related activities).

Figure 1 about here

Figure 1 indicates that nearly 45% of firms had introduced a major new innovation during 2007-2009[22]; nearly 23% had engaged in innovation-related activities but without any major new innovation(s); and nearly 33% of firms overall did not engage in innovation-related activities. It also shows the extent to which our sample of firms used BIM and which type. Overall, some 38% of firms were not involved in BIM; of those who used BIM, the most popular was Continuous Improvement and ISI 9001 (quality management). Some 72% of those firms using BIM were involved in more than one scheme; nearly one-half used 3 or more schemes.

Table 1 about here

Given that the dependent variable here comprises 3 sub-groups (successful and unsuccessful innovators, plus firms not engaged in innovation-related activities); a multinomial logit model

[20] There is often an issue in collecting survey data of the impact of self-reported information (studies have suggested this can lead to bias – e.g., Cassar , 2010; Storey, 2011; Fraser et. al., 2007). Our study was part of a larger EU funded study involving SME's (see http://www.rdc.ie/index.php/established-business-support/support-programmes/ice) and so early on in the project, when devising the questionnaire, we engaged in face-to-face interviews with a small number of the firms in each region to satisfy ourselves that the information being supplied was accurate.

[21] The Development Agencies provided access to their SME client companies operating in the relevant areas (1,334 for NI; 346 for RoI; and 495 for Scotland). A random sample of these SMEs was used for the telephone surveys and we have tested the responses based on industry and size characteristics to ensure the samples are representative of the population of *client* firms operating in each region.

[22] Note, there were a small number of innovating firms (12%) who had introduced only a process innovation and not a product innovation as well; the majority of innovators (88%) had introduced a product innovation, and over 68% of innovators had introduced both a product and process innovation. Note, we have experimented with classifying innovators as successful/non-successful product innovators separately from successful/non-successful process innovators, and while there are small differences in the parameter estimates we obtain, the overall conclusions we obtain remain unchanged.

is estimated. Based on the questions asked in the survey,[23] a range of variables that potentially influenced innovation-related activities were included as determinants. These control for a wide range of influences on innovation and allow us to separate out the impact on innovation activities of BIM.[24] These variables are listed in Table 1;[25] as can be seen there was a tendency for firms that engaged in innovation-related activities, but which did not innovate, to be more likely to use BIM.

Information was also obtained on factors associated with the lifecycle of the firm, its strategic focus, leadership, culture, internal and external knowledge processes (the latter proxying absorptive capacity – see Harris and Li, 2009, and Table A7 in the appendix), and linkages with outside organisations. For each area, a set of associated questions were asked with respondents required to rank whether they strongly agreed to whether they strongly disagreed with each statement. Factor analysis was then used to extract the orthogonal information available from each series of questions asked; the number of factors chosen was based on the Kaiser criterion (Kaiser, 1960), such that principal components with eigenvalues greater than 1 were retained. The results of each factor analysis are reported in Tables A1 – A8 (in an unpublished appendix).

4. Results

(a) Based on full dataset

The multinomial logit model was initially estimated by including all the variables in Table 1 (preferring BIM-in place 2+ years over BIM-current, although the results are very similar), including 'depth of BIM'.[26] A test of the null hypothesis that certain variables were jointly insignificant in the model (including the employment size dummy variables) was undertaken (results are reported in Table 2) and these variables were dropped from the model to avoid over-fitting and the inclusion of 'nuisance' variables. Table 2 presents our results (marginal effects are reported that indicate the effect of each variable on the probably of belonging to a sub-group); the key result is that (cet. par.) firms that used BIM (for 2 years or more) were some 9.4% more likely to belong to the unsuccessful innovator group, and just over 11% less likely to belong to the non-innovator ('not engaged in innovation activities') sub-group.

Table 2 about here

Taking into account the 'depth of BIM' (i.e., it is entered as a composite variable for those firms that had BIM in place for 2+ years) allows us to check if there is an additional effect associated with not just having BIM, but also the extent to which it is embedded into the firms' activities. We find that firms with more 'depth' to BIM are more likely to belong to the

[23] See the unpublished appendix for the questions asked.

[24] As we only have access to cross-sectional data (as is usually the case in studies of this kind which rely on the collection of new information on variables of interest that is generally not available elsewhere), we cannot consider time-varying issues such as the pre- and post-impact of the introduction of BIM on innovation, nor test (using an instrumental variables – or similar – approaches) whether there is any systematic bias to the relationships we estimate between BIM and innovation because of endogeneity issues (due to causality going in both directions) – although see footnote 7 above. It could be argued that therefore our results are possibly only indicative of relevant associations between the variables concerned, and potentially biased in magnitude. However, in section 3(b) below, we have also used a 'matching' approach that should limit any bias due to possible simultaneity.

[25] 33 industry dummy variables are omitted from the table.

[26] Such 'depth' was measured using factor analysis based on agreement with statements such as whether there were clear goals for TQ/CI programmes, it was spread throughout the organisation, adequately resourced, and involved the majority of workers, etc. – see Table A5 in the unpublished appendix.

unsuccessful innovator sub-group; a one-standard deviation increase in the 'depth' variable for those with BIM boosts the probability of being an unsuccessful innovator to nearly 15% (i.e., 0.094 + 0.055). There is also some (statistically weaker) evidence that greater 'depth' also reduces the likelihood of being a successful innovator (significant at the 15% level).

Table 2 also shows that firms in Northern Ireland were (controlling for all other variables) more likely to be in the non-innovator group (16% higher probability) and less likely to be successful innovators (15% lower probability).[27] Those using product design as their competitive edge were over 20% more likely to be successful innovators (17% less likely to be non-innovators); the results for firms where cost effectiveness dominates was to 'push' them into the non-innovator sub-group. Selling in local (export) markets increased (decreased) the probability of belonging to the non-innovator group and decreased (increased) the probability of being a successful innovator. Family-owned firms were some 7% more likely to be non-innovators (although the impact is statistically weak), while foreign-owned firms tended away from non-innovativeness and towards being unsuccessful innovators (presumably as successful innovation occurs 'at home'). Interestingly, firms that are faced with issues over whether to expand or not are some 4% less likely to be successful innovators, implying that post-survival growth dampens down product innovation. However, firms with a narrow product range that are opposed to change are considerably more likely to be non-innovators and less likely to be successful innovators. A strong team and change culture, and higher absorptive capacity (associated with acquiring and internalising external knowledge) has the opposite effect by facilitating successful innovation and moving firms away from being not engaged in innovation-related activities; while being more likely to acquire knowledge from outside bodies increases the likelihood of successful innovation but decreases the probability of being an unsuccessful innovator. Lastly, the industries listed in Table 2 are more (less) likely to be associated with successful (unsuccessful) innovation.

Table 3 about here

For the reasons set out in the literature review, we go beyond our basic model and test whether different types of BIM (e.g., TQM versus Continuous Improvement) have different impacts, and whether the BIM-innovation relationship needs to include the mediating role of absorptive capacity or culture. Table 3 first presents results when only the variable 'BIM-in place 2+ years' is included, with 'depth of BIM' excluded (to make comparisons with other models easier). The results for the other determinants of innovation are omitted, but these generally do not change much from model to model.

The third model in Table 3 shows that allowing BIM to be moderated via an indicator of absorptive capacity (the principal component factor measuring 'strong internalisation of external knowledge') has little impact on the results obtained. Even though the composite variable has a significant, negative relationship with belonging to the 'not engaged in innovation activities' sub-group, this is at the expense of the (not shown) absorptive capacity variable becoming insignificant in the rest of the model. Similarly, including 'culture' to moderate the relationship between BIM and innovativeness, is not significant.

We also checked on any differences across the three regions covered. For Northern Ireland (but note, not the Republic of Ireland) just engaging in BIM for the last two years strengthens the likelihood that firms become unsuccessful innovators. But when this is coupled with greater depth of BIM, then Table 3 (last set of results) shows that there is some evidence that SMEs in the Republic of Ireland with greater 'depth' are more likely to be successful rather

[27] Note, the employment size dummies were not significant in the model and were therefore dropped.

than unsuccessful innovators.

Lastly, we limited BIM to only cover the two most popular models – TQM and Continuous Improvement, to allow for any 'hard' and 'soft' impacts of BIM. The results from including only TQM are much weaker, which might suggest that a 'soft' concentration on learning (which is more likely to be associated with TQM) does lower the likelihood of becoming an unsuccessful innovator, but it also lowers the probability of moving away from a firm not engaging in innovation related activities (i.e., usually TQM is multifunctional and CI is typically focused on a unitary area which causes differences in the learning potential). Limiting BIM to a 'harder' focus on efficiency also has only a small impact on the results obtained, although there is some evidence that it results in a slightly stronger push into becoming an 'unsuccessful' innovator, which is consistent with a priori expectations.[28]

(b Robustness checks allowing for selection effects

The model estimated above includes all the observations available in the dataset. However, if firms that use BIM have characteristics that make them on average more/less likely to achieve different innovation-related outcomes, then our measurement of the BIM-innovation relationship may be biased due to selection effects (see, for example, Moffitt, 2004; Heckman, 2000; Heckman and Navarro-Lozano, 2004; and especially Imbens and Wooldridge, 2009, for a discussion and practical approaches that can be taken) – such firms would be predicated towards achieving the innovation-related outcome observed, even if they do not use BIM. The typical solution to this problem of selection is to use 'matching', whereby 'untreated' firms which do not use BIM are matched on their characteristics to the 'treated' group (those that use BIM), to as far as possible (given the limitations of the dataset available) create a control group that has (very) similar characteristics to the treated group of firms. Thus, any difference between the treated and control sub-groups of firms, in terms of the impact of BIM on innovation-related activities, should not be contaminated by selection effects.

We use a probit model of the determinants of which firms use BIM, to compute propensity scores which are then used by the PSMATCH2 algorithm in STATA to create 'treated' and 'control' sub-groups. We use one-to-one matching, without replacement, and limit the two sub-groups to have 'common support' (i.e., we drop members of the 'treated' group that have propensity scores higher/lower than the maximum/minimum values for the 'control' group). The result is that we loose 110 firms from the sub-group of 'untreated' firms that cannot be matched into the control sub-group.[29] The results obtained when limited to observations contained in the 'treatment' and 'control' sub-groups are provided in Table 4 confirming our findings above with regard to the impact of BIM on innovation outcomes, including any regional differences. For the latter, there remains some evidence that SMEs in the Republic of Ireland with greater 'depth' are more likely to be successful rather than unsuccessful

[28] It might be argued that there is an internal contradiction with different BIM's. For as long as learning - absorptive capacity and other proxies - is a feature of BIMs, then the likelihood of SMEs being innovators is enhanced, though not guaranteed. The problem seems to be with the efficiency element and its relative emphasis in the BIM used by firms. Thus perhaps it is not surprising that certain BIMs lead to unsuccessful innovation. For example, some are innovation (CI) whilst others are explicit tools/frameworks for innovation (balanced scorecard), or not. Others are mixtures (TQM). Lastly, note we have experimented with other specifications of the key BIM variables, but the results are always weaker.

[29] We use the procedure PSTEST to check if the means of the variables determining whether firms use BIM differ between 'treated' firms and those in the 'control group'. We find that in all cases differences are reduced significantly to the extent that t-tests of differences across means values indicate that for all variables there is no statistically significant difference when comparing 'treated' and 'control group' firms (whereas there were differences before applying 'matching'). The results from the PSTEST procedure are available in the unpublished appendix (Table A9).

innovators. There is also some indication that SME's in Northern Ireland with greater depth of BIM are more likely to be in the 'not engaged in innovation' sub-group, rather than be unsuccessful innovators. It would seem, based on the 'matched' data, that greater involvement in BIM detracts from product and process innovation to a much greater extent in Northern Ireland, which given that it is often rated lowest in terms of innovation (see Harris and Trainor, 2011) is a concern.

Table 4 about here

Finally, as a further check we have also estimated two simple probit models where the dependent variable includes successful innovators versus unsuccessful innovators (those not engaged in innovation activities are dropped) in the first model; and unsuccessful innovators versus those not engaged in innovation activities in the second model. Both models were estimated using all firms comprising the sub-groups included, as well as models where 'matching' had also been used. The results are provided in Table A10 (in the unpublished appendix), again confirming our overall findings.

5. Conclusions

The study seeks to contribute to the relative paucity of studies on the effects of Business Improvement Methods (BIM) on innovation in client SMEs located in peripheral regions who are directly helped by regional development agencies, while at the same time controlling for a wide range of other (standard) determinants of innovation outcomes. The increased pressure on SME's in underperforming regions to implement innovation to remain competitive, particularly in times of economic downturn, has led to a need to probe the role of BIM in stimulating increased innovation implementation at more radical levels (i.e., by increasing technological improvements and not just improvements in efficiency).

Given the current extensive 'push' by regional development agencies to use BIM, as well as government policy more generally to extend their take-up, in the belief that this will improve efficiency *and* innovativeness (i.e., productivity), it is important to test whether BIM fosters or inhibits innovation. Our findings show that on average adopting BIM diverts assisted SME's away from successful innovation (i.e., especially in terms of new products/services in the past three years), and instead is associated with undertaking innovation-related activities while remaining non-innovators. Indeed reinforcing BIM (through greater 'depth' of use) may lead to further exclusion from successful innovation, especially in Northern Ireland.

The findings are therefore relevant for existing policy, and whether the latter is in fact in a majority of existing cases truncating product innovation in those SME's government agencies are trying to help become more innovative. Thus the implications for business development agencies are significant, and we would argue they need a clearer understanding of BIM and to carefully monitor the impact of BIM when they provide assistance to firms. They need to be clearer on how BIM is 'sold' to clients (e.g., what is the intended outcome – is the emphasis on learning or efficiency? – and is this achieved?). This raises the question of whether agencies need to adjust the way they promote BIM. Thus the results from this study will be useful in developing a wider understanding of how government agencies, SME managers, and the consultants employed by both can effectively use scarce resources to improve innovation implementation and hence competitiveness, without necessarily having to trade-

off efficiency and technology gains.[30]

Our review of BIM suggests there is no inherent reason to expect a trade-off between efficiency and innovation; as long as such practices are used, for example, as an integrative philosophy of management for continuously improving the quality of products and processes, and as long as they concentrate on increased organisational learning to 'create' a stock of knowledge that can be utilised by the firm now and in the future (rather than just the exploitation of existing knowledge) The alternative is standardisation of the production process (cf. Wright et. al., 2012), which while it creates order and offers the potential for improved performance via routinization, simplification, and cost economies, the outcome is usually the antithesis of innovation. Thus, being aware of the potential positive and negative aspects of the BIM-innovation nexus is a necessary ingredient when devising and, more importantly, implementing innovation policy.

There are a number of limitations to this study that we would hope to address in future work; clearly, it would be useful to extend the analysis to not just peripheral regions of Scotland and Ireland (north and south), and to also include SME's that were not the clients of public agencies[31], who are attempting to improve competitiveness in the firms being studied. We also did not explicitly cover the role of design in determining innovation-related activities, which given its importance (NESTA, 2009) is an area to include in future work.

[30] During 2012 we feed-back our results to Scottish Enterprise, Invest NI and Enterprise Ireland, through presentations.

[31] That is, it is possible that SMEs who are not clients of regional development agencies and who adopt BIM may experience a different outcome to that which we found here and it is also possible that SMEs in other peripheral regions also could have different BIM-innovation relationships. A priori we think this is unlikely, but it would be useful to test whether the results presented here can be generalized.

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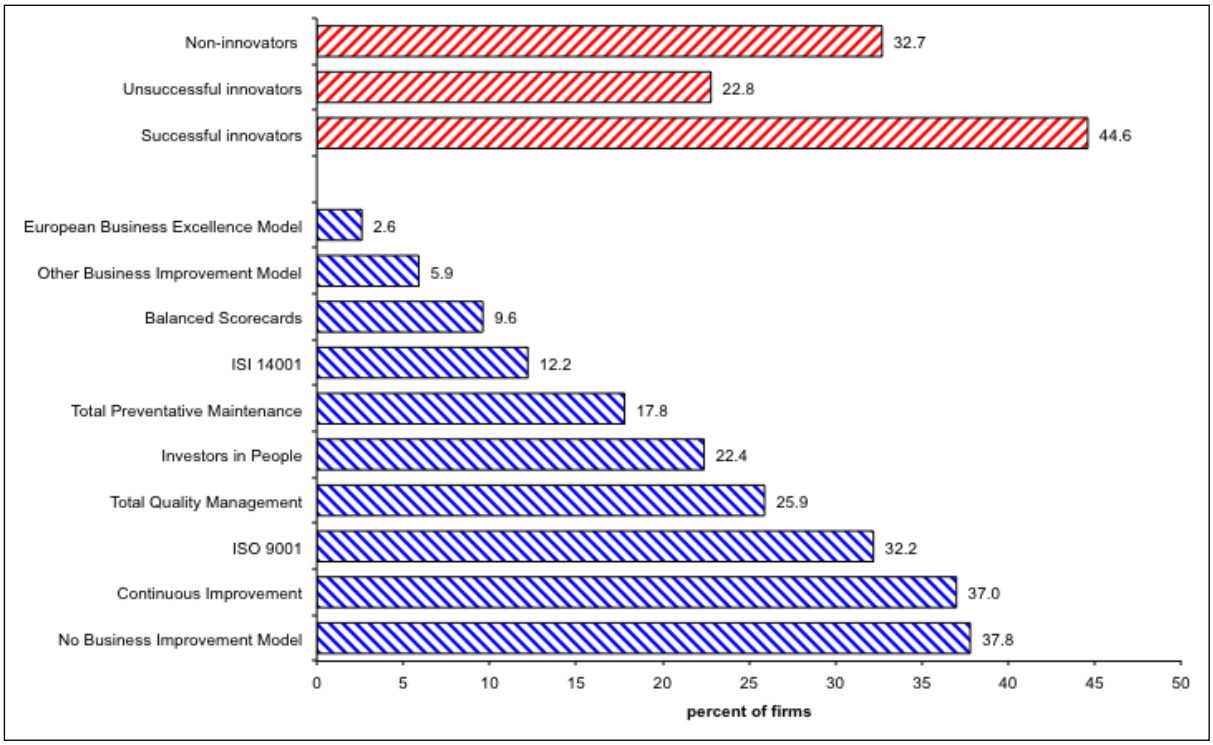
FIGURE 1

Percentage Of SMEs Engaged In Innovation-Related Activities And Use Of Business Improvement Methods (BIM)



Source: data from authors' own survey

TABLE 1 - Definitions of Variables

Variable	Definition	Successful innovator $\overline{X}$	Unsuccessful innovator $\overline{X}$	Non-innovator $\overline{X}$
BIM–in place 2+ years	Coded 1 if any Business Improvement Method has been used for 2+ years (coded 0 otherwise)	0.552	0.667	0.444
Scotland	Coded 1 if company located in Scotland (coded 0 otherwise)	0.333	0.384	0.318
N. Ireland	Coded 1 if company located in Northern Ireland (coded 0 otherwise)	0.300	0.297	0.394
Age	No. of years operating in NI/Scotland/RoI	25.637	32.399	27.798
Employs <10	Coded 1 if company currently employs <10 in NI/Scotland/RoI	0.185	0.181	0.237
Employs 10-15	Coded 1 if company currently employs 10-15 in NI/Scotland/RoI	0.200	0.181	0.242
Employs 16-27	Coded 1 if company currently employs 16-27 in NI/Scotland/RoI	0.193	0.210	0.177
Employs 28-55	Coded 1 if company currently employs 28-55 in NI/Scotland/RoI	0.200	0.217	0.207
Employs 56+	Coded 1 if company currently employs 56+ in NI/Scotland/RoI	0.222	0.210	0.136
Product design	Coded 1 if product design the single most important factor providing competitive edge in next 3-5 years (coded 0 otherwise)	0.419	0.290	0.162
Cost effectiveness	Coded 1 if cost effectiveness the single most important factor providing competitive edge in next 3-5 years (coded 0 otherwise)	0.181	0.239	0.404
% local sales	Percentage of sales to own region (NI/Scotland/RoI)	43.848	56.361	70.004
% exports	Percentage of sales to non-British Isles destination	22.011	11.995	5.374
Family-owned firm	Coded 1 if company is 50%+ family-owned (coded 0 otherwise)	0.526	0.543	0.646
Foreign-owned firm	Coded 1 if headquarters of company is outside own region NI/Scotland/RoI (coded 0 otherwise)	0.096	0.101	0.045
Lifecycle - expansion dominates	PCF[a] based on lifecycle questions (see Table A1)	-0.059	-0.041	-0.108
Lifecycle - survival dominates	PCF based on lifecycle questions (see Table A1)	-0.064	0.024	0.070
Strategy – narrow products & seldom adjusts	PCF based on strategic focus questions (see Table A2)	0.260	0.015	0.345
Strategy - continual search for better	PCF based on strategic focus questions (see Table A2)	0.104	-0.030	-0.121
Leadership - proactive for change	PCF based on leadership questions (see Table A3)	0.159	0.058	-0.257
Culture – strong team and communication	PCF based on culture questions (see Table A4)	0.127	0.057	0.212
Culture - good HRM	PCF based on culture questions (see Table A4)	0.031	-0.073	0.009
Depth of BIM	PCF based on BIM questions (see Table A5)	0.050	0.138	-0.165
Knowledge-strong internal structures/processes	PCF based on internal knowledge questions (see Table A6)	0.052	-0.095	-0.004
Strong internalisation of external knowledge	PCF based on knowledge acquisition questions (see Table A7)	0.269	0.133	0.274
Knowledge acquired from outside bodies	PCF based on knowledge acquisition questions (see Table A7)	0.078	-0.159	-0.005
Strong networking capabilities	PCF based on linkage questions (see Table A8)	0.093	0.046	0.095

[a] Principal component factor

Source: data from authors own survey (see unpublished appendix for details)

TABLE 2 Marginal Effects From Multinomial Logit Model Of Innovativeness

Variables	Successful innovator $\partial p / \partial x$	z-value	Unsuccessful innovator $\partial p / \partial x$	z-value	Not engaged in innovation activities $\partial p / \partial x$	z-value	$\overline{X}$
BIM – in place 2+ years	0.017	0.32	0.094	2.20	-0.111	-2.30	0.543
BIM – in place 2+ years × Depth of BIM	-0.066	-1.46	0.055	1.64	0.010	0.26	0.303
Scotland	-0.061	-0.97	0.044	0.86	0.017	0.30	0.340
N. Ireland	-0.154	-2.58	-0.004	-0.08	0.158	2.69	0.330
Age[a]	-0.032	-1.06	0.028	1.58	0.004	0.19	27.883
Product design	0.203	3.77	-0.033	-0.76	-0.170	-3.74	0.305
Cost effectiveness	-0.051	-0.82	-0.066	-1.46	0.116	2.11	0.267
% local sales[a]	-0.084	-2.69	0.002	0.07	0.082	2.91	55.244
% exports[a]	0.073	2.27	-0.006	-0.24	-0.067	-1.91	14.295
Family-owed firm	-0.021	-0.42	-0.047	-1.14	0.068	1.56	0.569
Foreign-owned firm	0.055	0.57	0.134	1.45	-0.190	-3.40	0.081
Lifecycle - expansion dominates[b]	-0.039	-1.54	0.016	0.81	0.023	1.03	0.000
Strategy - narrow products & seldom adjusts[b]	-0.108	-4.20	0.016	0.81	0.092	4.20	0.000
Culture - strong team and communication[b]	0.055	2.05	0.024	1.15	-0.079	-3.47	0.000
Strong internalisation of external knowledge[b]	0.143	5.26	-0.064	-3.06	-0.079	-3.40	0.000
Knowledge acquired from outside bodies[b]	0.049	1.92	-0.053	-2.65	0.004	0.16	0.000
Manufacture of food, beverages and tobacco	0.192	2.49	-0.125	-2.58	-0.067	-1.05	0.104
Manufacture of rubber and plastic products	0.311	2.70	-0.233	-6.95	-0.078	-0.70	0.030
Man. of other non-metallic mineral products	0.282	1.97	-0.187	-2.85	-0.095	-0.74	0.017
Manufacture of machinery and equipment n.e.c	0.160	1.87	-0.079	-1.41	-0.081	-1.11	0.089
Manufacture of transport equipment	0.103	0.59	-0.185	-2.74	0.083	0.49	0.020
Manufacturing not elsewhere classified	0.129	1.71	-0.157	-3.71	0.028	0.39	0.127
$\hat{p}$	0.463		0.244		0.293		
N	606						
Pseudo R^2	0.193						
Log-likelihood	-519.447						
H_0: omitted variables = 0 ($\chi^2_{28d.f.}$)	16.52						

[a] All continuous variables are measured with respect to a standard deviation increase in X.
[b] All principal component factors measured with respect to the mean of the variable (results are very similar to measuring with respect to a standard deviation increase in X since the mean and standard deviation of PCF's is 0 and 1, respectively).

TABLE 3 Marginal Effects From Various Multinomial Logit Models Of Innovativeness (based on full sample of 606 observations)

	Successful innovator		Unsuccessful innovator		Not engaged in innovation activities		
Variables	$\partial p / \partial x$	z-value	$\partial p / \partial x$	z-value	$\partial p / \partial x$	z-value	$\overline{X}$
Baseline model							
BIM – in place 2+ years	-0.021	-0.42	0.124	3.26	-0.103	-2.40	0.543
Preferred model (Table 2)							
BIM – in place 2+ years	0.017	0.32	0.094	2.20	-0.111	-2.30	0.543
BIM – in place 2+ years × Depth of BIM	-0.066	-1.46	0.055	1.64	0.010	0.26	0.303
Moderated by absorptive capacity							
BIM – in place 2+ years	-0.021	-0.43	0.138	3.55	-0.116	-2.68	0.543
BIM – in place 2+ years × Strong internalisation of external knowledge	0.049	0.93	0.043	1.02	-0.092	-2.08	0.025
Moderated by culture							
BIM – in place 2+ years	-0.021	-0.42	0.123	3.24	-0.103	-2.39	0.543
BIM – in place 2+ years × Culture - strong team and communication	-0.009	-0.18	-0.000	-0.01	0.009	0.22	0.017
Limiting BIM to TQM							
TQM – in place 2+ years	-0.041	-0.75	0.077	1.63	-0.036	-0.75	0.243
Limiting BIM to Continuous Improvement							
CI – in place 2+ years	-0.051	-1.00	0.140	3.21	-0.089	-2.04	0.338
Moderated by location							
BIM – in place 2+ years	0.049	0.59	0.107	1.73	-0.157	-2.04	0.543
BIM – in place 2+ years × located in Northern Ireland	-0.134	-1.17	0.073	1.67	0.061	0.54	0.173
BIM – in place 2+ years × located in Republic of Ireland	-0.080	-0.67	-0.017	-0.18	0.097	0.81	0.198
Moderated by location							
BIM – in place 2+ years	-0.003	-0.04	0.113	2.63	-0.111	-2.24	0.543
BIM – in place 2+ years × Depth of BIM	-0.126	-1.89	0.148	3.03	-0.022	-0.37	0.303
BIM – in place 2+ years × Depth of BIM × located in Northern Ireland	0.046	0.09	-0.153	-2.21	0.107	1.29	0.106
BIM – in place 2+ years × Depth of BIM × located in RoI	0.206	2.02	-0.196	-2.61	-0.010	-0.11	0.142

TABLE 4 Marginal Effects From Various Multinomial Logit Models Of Innovativeness (based on 'matched' sample of 496 observations)

	Successful innovator		Unsuccessful innovator		Not engaged in innovation activities		
Variables	$\partial p / \partial x$	z-value	$\partial p / \partial x$	z-value	$\partial p / \partial x$	z-value	$\overline{X}$
Baseline model							
BIM – in place 2+ years	-0.048	-0.86	0.157	2.44	-0.109	-2.92	0.442
Preferred model (Table 2)							
BIM – in place 2+ years	-0.010	-0.25	0.103	2.02	-0.093	-1.67	0.442
BIM – in place 2+ years × Depth of BIM	-0.066	-2.15	0.109	2.60	-0.043	-0.82	0.249
Moderated by absorptive capacity							
BIM – in place 2+ years	-0.055	-1.00	0.184	4.03	-0.129	-2.65	0.442
BIM – in place 2+ years × Strong internalisation of external knowledge	0.071	1.22	0.048	1.08	-0.119	-2.29	0.022
Moderated by culture							
BIM – in place 2+ years	-0.055	-1.00	0.168	3.77	-0.113	-2.35	0.442
BIM – in place 2+ years × Culture - strong team and communication	0.049	0.80	-0.010	-0.22	-0.039	-0.67	0.008
Limiting BIM to TQM							
TQM – in place 2+ years	-0.134	-2.16	0.165	2.77	-0.030	-0.52	0.204
Limiting BIM to Continuous Improvement							
CI – in place 2+ years	-0.088	-1.50	0.229	4.30	-0.141	-2.86	0.280
Moderated by location							
BIM – in place 2+ years	-0.007	-0.07	0.140	1.98	-0.157	-2.04	0.442
BIM – in place 2+ years × located in Northern Ireland	-0.121	-0.98	0.110	1.89	0.061	0.54	0.149
BIM – in place 2+ years × located in Republic of Ireland	-0.022	-0.16	-0.031	-0.31	0.097	0.81	0.137
Moderated by location							
BIM – in place 2+ years	-0.033	-0.49	0.134	2.54	-0.101	-1.73	0.442
BIM – in place 2+ years × Depth of BIM	-0.106	-1.32	0.200	3.46	-0.094	-1.24	0.249
BIM – in place 2+ years × Depth of BIM × located in Northern Ireland	-0.006	-0.05	-0.171	-1.98	0.176	1.60	0.094
BIM – in place 2+ years × Depth of BIM × located in RoI	0.218	1.78	-0.209	-2.30	-0.008	-0.07	0.105

Unpublished Appendix

Table A1: Structure matrix of factor loadings: correlations between variables and rotated common factors: Lifecycle issues[a]

Input Variables[b]	Factor 1: Expansion issues dominate	Factor 2: Survival dominates	Uniqueness	Kaiser-Meyer-Olkin Measures
The main problems of the business are obtaining customers and delivering the product or service.	0.209	***0.778***	0.351	0.471
The Company has now developed with sufficient customers and satisfies them sufficiently with its products or services.	0.213	***-0.700***	0.464	0.533
The decision facing owners at this stage is whether to expand or to keep the company stable and profitable, providing a base for alternative owner activities.	***0.656***	0.122	0.555	0.574
The key problems facing the company are how to grow rapidly and how to finance the growth.	***0.645***	-0.037	0.583	0.569
The challenges are to consolidate and control the financial gains brought on by rapid growth and to retain the advantages of small size, including flexibility.	***0.781***	-0.115	0.377	0.549
			Overall =	0.553

[a] Factors extracted using principal-component method (all factors with eigenvalues > 1), then rotated using orthogonal varimax technique.

[b] Respondents were asked to strongly agree (coded 2), agree (coded 1), neutral (coded 0), disagree (coded -1) or strongly disagree (coded -2) with each statement.

Table A2: Structure matrix of factor loadings: correlations between variables and rotated common factors: Strategic focus[a]

Input Variables[b]	Factor 1: narrow products & seldom adjusts	Factor 2: continual search to be better	Uniqueness	Kaiser-Meyer-Olkin Measures
The company has a narrow range of products and markets.	***0.774***	0.001	0.401	0.556
The company continually searches for new market opportunities.	-0.228	***0.724***	0.423	0.549
The company watch their competitors closely for new ideas, and then rapidly adopt those which appear to be the most promising.	0.089	***0.822***	0.317	0.533
The organisation seldom makes adjustments of any sort until forced to do so by environmental pressures.	***0.775***	-0.121	0.384	0.540
			Overall =	0.545

[a] Factors extracted using principal-component method (all factors with eigenvalues > 1), then rotated using orthogonal varimax technique.

[b] Respondents were asked to strongly agree (coded 2), agree (coded 1), neutral (coded 0), disagree (coded -1) or strongly disagree (coded -2) with each statement.

Table A3: Structure matrix of factor loadings: correlations between variables and common factors: Leadership[a]

Input Variables[b]	Factor 1: proactive for change	Uniqueness	Kaiser-Meyer-Olkin Measures
The senior management team makes a point of "being seen" around the organisation	0.491	0.759	0.866
Management fosters creative thinking and innovation in the company	0.718	0.484	0.850
Our top managers like to try new ways of doing things	0.751	0.437	0.850
Management spend adequate time planning change	0.706	0.502	0.843
If the company is performing well, change is still a priority	0.675	0.545	0.897
The organization is working to a clear business plan	0.624	0.610	0.888
Management encourages everyone in the organization to come up with new ideas.	0.718	0.485	0.895
The management team take time to think constructively/creatively about the future	0.775	0.400	0.865
		Overall =	0.867

[a] Factors extracted using principal-component method (all factors with eigenvalues > 1)

[b] Respondents were asked to strongly agree (coded 2), agree (coded 1), neutral (coded 0), disagree (coded -1) or strongly disagree (coded -2) with each statement.

Table A4: Structure matrix of factor loadings: correlations between variables and rotated common factors: Culture[a]

Input Variables[b]	Factor 1: strong team and communication	Factor 2: good HRM	Uniqueness	Kaiser-Meyer-Olkin Measures
There is a strong team spirit at all levels of the organisation	***0.704***	0.278	0.428	0.911
The culture in this organization promotes change	***0.687***	0.198	0.489	0.839
Two way communication happens at all levels of the organisation	***0.730***	0.306	0.373	0.930
There is a clear organisational structure which everyone understands	***0.626***	0.459	0.398	0.888
There are clearly defined roles and responsibilities	***0.557***	0.507	0.433	0.885
The structure of the organization facilitates change	***0.699***	0.294	0.425	0.898
The organization is not bureaucratic	***0.645***	0.003	0.584	0.933
There is a feeling of openness in this organization	***0.667***	0.339	0.441	0.902
Overall, employees have access to all the resources needed to get the job done	0.503	0.409	0.580	0.946
Employees are involved in setting and agreeing performance targets	0.091	***0.794***	0.361	0.917
Everyone in the company has a good grasp off how the organization is performing	0.264	***0.764***	0.347	0.902
Employees get useful feedback about their work	0.326	***0.741***	0.345	0.917
			Overall =	0.903

[a] Factors extracted using principal-component method (all factors with eigenvalues > 1), then rotated using orthogonal varimax technique.

[b] Respondents were asked to strongly agree (coded 2), agree (coded 1), neutral (coded 0), disagree (coded -1) or strongly disagree (coded -2) with each statement.

Table A5: Structure matrix of factor loadings: correlations between variables and common factors: Business Improvement methods[a]

Input Variables[b]	Factor 1: BIM depth	Uniqueness	Kaiser-Meyer-Olkin Measures
The organisation has a formal/informal total quality – continuous improvement programme	0.756	0.429	0.990
Responsibilities for the TQ/CI programme are clearly defined	0.964	0.071	0.941
The TQ/CI programme has clear goals, objectives and measures of success	0.968	0.063	0.936
Successful TQ/CI problem solving teams are spread throughout the organisation	0.928	0.138	0.968
The programme is adequately resourced	0.941	0.116	0.968
There is a clearly defined reward and recognition scheme for TQ/CI activity	0.891	0.207	0.979
Greater that 50% of the workforce are involved in TQ/CI	0.894	0.200	0.982
The TQ/CI programme is used to improve processes	0.964	0.071	0.918
A number if quality improvements have been achieved from the programme	0.964	0.072	0.912
		Overall =	0.951

[a] Factors extracted using principal-component method (all factors with eigenvalues > 1)

[b] Respondents were asked to strongly agree (coded 2), agree (coded 1), neutral (coded 0), disagree (coded -1) or strongly disagree (coded -2) with each statement.

Table A6: Structure matrix of factor loadings: correlations between variables and common factors: Knowledge incorporation[a]

Input Variables[b]	Factor 1: Strong internal knowledge	Uniqueness	Kaiser-Meyer-Olkin Measures
Everyone is in possession of the information/ knowledge necessary to do their job	0.700	0.511	0.929
Knowledge that employees hold in their heads (i.e. tacit knowledge) is managed and captured effectively	0.764	0.417	0.928
Efforts are made to share information/knowledge across the organization	0.797	0.364	0.930
Lessons learned from daily experiences and projects are captured and disseminated	0.861	0.258	0.890
New information/knowledge is effectively incorporated within the processes and routines within the organization	0.873	0.237	0.868
Active management of information/knowledge produces a range of business benefits	0.866	0.250	0.879
		Overall =	0.899

[a] Factors extracted using principal-component method (all factors with eigenvalues > 1)

[b] Respondents were asked to strongly agree (coded 2), agree (coded 1), neutral (coded 0), disagree (coded -1) or strongly disagree (coded -2) with each statement.

Table A7: Structure matrix of factor loadings: correlations between variables and rotated common factors: Knowledge acquisition[a]

Input Variables[b]	Factor 1: Strong internalisation of external knowledge	Factor 2: Knowledge acquired from outside bodies	Uniqueness	Kaiser-Meyer-Olkin Measures
We conduct frequent market research so that we are aware of customer needs	***0.574***	0.195	0.633	0.735
Licensing is a method we often use to obtain information/knowledge or technology	***0.684***	-0.052	0.529	0.736
We have developed new products/services and/or processes in collaboration with other firms	***0.601***	0.145	0.618	0.748
We are well aware of the information/knowledge and technologies being developed by our competitors	***0.642***	0.069	0.584	0.730
We have become an information/knowledge or technology supplier to other firms in the sector	0.516	0.486	0.498	0.746
We usually go to outside private sector bodies (e.g. consultants) to find out about fresh opportunities for introducing new products/services	0.106	***0.848***	0.269	0.664
We usually go to outside public sector bodies (e.g. universities) to find out about fresh opportunities for introducing new products/services	0.062	***0.867***	0.244	0.633
			Overall =	0.702

[a] Factors extracted using principal-component method (all factors with eigenvalues > 1), then rotated using orthogonal varimax technique.

[b] Respondents were asked to strongly agree (coded 2), agree (coded 1), neutral (coded 0), disagree (coded -1) or strongly disagree (coded -2) with each statement.

Table A8: Structure matrix of factor loadings: correlations between variables and common factors: Linkages[a]

Input Variables[b]	Factor 1: Strong networking capabilities	Uniqueness	Kaiser-Meyer-Olkin Measures
Sufficient resources are allocated to support network activities with other organisations and collaborators	0.808	0.348	0.941
The organisation uses a range of activities and mechanisms to initiate new relationships with other organisations	0.875	0.235	0.917
Information is freely exchanged across other organisational partners in networks	0.858	0.264	0.936
Network activities are systematically linked to organisation plans	0.869	0.245	0.940
Where appropriate the company adapts its activities to fit with the needs of specific networks	0.878	0.229	0.950
Relationships between employees and those of other organisations in networks are carefully managed.	0.880	0.226	0.952
The company has performance measures to measure the effectiveness of networks with other organisations	0.833	0.305	0.885
Company employees receive sufficient training in network relationship management	0.843	0.289	0.894
		Overall =	0.927

[a] Factors extracted using principal-component method (all factors with eigenvalues > 1)

[b] Respondents were asked to strongly agree (coded 2), agree (coded 1), neutral (coded 0), disagree (coded -1) or strongly disagree (coded -2) with each statement.

Table A9: PSTEST results from 'matching' procedure

	Unmatched	Mean			% reduction	t-test	
Variable	Matched	Treated	Control	%bias	|bias|	t	p>|t|
Scotland	U	0.316	0.368	-11.0		-1.4	0.178
	M	0.352	0.352	0.0	100	0.0	1.000
N. Ireland	U	0.319	0.343	-5.1		-0.6	0.535
	M	0.338	0.338	0.0	100	0.0	1.000
Employs 16-27	U	0.185	0.199	-3.3		-0.4	0.683
	M	0.215	0.215	0.0	100	0.0	1.000
Employs 28-55	U	0.249	0.155	23.5		2.9	0.004
	M	0.228	0.228	0.0	100	0.0	1.000
Employs 56+	U	0.231	0.144	22.3		2.7	0.007
	M	0.160	0.160	0.0	100	0.0	1.000
Mining and quarrying except energy materials	U	0.006	0.014	-8.3		-1.0	0.301
	M	0.000	0.000	0.0	100	.	.
Manufacture of textiles and textile products	U	0.033	0.036	-1.5		-0.2	0.858
	M	0.009	0.009	0.0	100	0.0	1.000
Manufacture of wood and wood products	U	0.073	0.087	-5.0		-0.6	0.535
	M	0.064	0.064	0.0	100	0.0	1.000
Manufacture of pulp paper and paper products; publishing and printing	U	0.024	0.040	-8.7		-1.1	0.279
	M	0.005	0.005	0.0	100	0.0	1.000
Manufacturing n.e.c	U	0.116	0.141	-7.6		-0.9	0.353
	M	0.055	0.055	0.0	100	0.0	1.000
Education	U	0.009	0.004	6.9		0.8	0.405
	M	0.000	0.000	0.0	100	.	.
Health & social care	U	0.030	0.004	20.8		2.5	0.014
	M	0.000	0.000	0.0	100	.	.
Culture – strong team and communication	U	0.031	-0.037	6.8		0.8	0.402
	M	0.018	0.025	-0.6	90.6	-0.1	0.935
Knowledge acquired from outside bodies	U	0.096	0.114	-21.1		-2.6	0.010
	M	0.023	0.085	-10.9	48.6	-1.2	0.237
Lifecycle - survival dominates	U	-0.059	0.070	-13.0		-1.6	0.112
	M	0.095	-0.037	-5.8	55.7	-0.7	0.504
% local sales	U	53.130	57.755	-12.7		-1.6	0.120
	M	54.593	56.264	-4.6	63.9	-0.5	0.625

Table A10 Marginal Effects for BIM Variables Based on Preferred Model Of Innovativeness (based on full and 'matched' samples of observations)

	Successful versus unsuccessor innovator		Unsuccessful innovator versus not engaged in innovation	
Variables	$\partial p / \partial x$	z-value	$\partial p / \partial x$	z-value
Full sample				
BIM – in place 2+ years	-0.098	-1.77	0.171	2.65
BIM – in place 2+ years × Depth of BIM	-0.059	-1.36	0.082	1.47
N	408		336	
Matched sample				
BIM – in place 2+ years	-0.140	-2.43	0.167	2.46
BIM – in place 2+ years × Depth of BIM	0.070	1.94	0.098	1.63
N	323		312	

Innovation Benchmark Survey

A. Background Information

A1. What is the main product or service produced by your company? *Refer to Industrial Classification sheet and after confirming with respondent write most appropriate code:* ☐

A2. Where is the Headquarters of your company? *Code one of the following.*

Northern Ireland	**1**
Scotland	**2**
Republic of Ireland	**3**
England or Wales	**4**
Other EU	**5**
North America	**6**
Japan	**7**
Other country	**8**

ALL THE FOLLOWING QUESTIONS I am going to ask you RELATE *ONLY* TO OPERATIONS IN (*NI/RoI/Scotland)*

Firstly, I shall ask you some background questions relating to your operations in Northern Ireland

A3. In which year did this business commence operations? ……..

A4. How many are currently FTE employed by the company in (*NI/RoI/Scotland)*? ……..

A5. Is the company a family-owned business? *Defined as 50+% ownership with the family*

Yes ☐ No ☐

If YES, how many generations has the family held control of this firm:

First generation ☐ First/second ☐ Second ☐ Second/third ☐ Third or more ☐

A6. What % of your sales from operations in (*NI/RoI/Scotland)* are sold in the following markets: *(Please check that answers sum to 100%)*

Northern Ireland	…….%
Scotland	…….%
Republic of Ireland	…….%
England or Wales	…….%
Other EU	…….%
North America	…….%
Japan	…….%
Other country	…….%

If the respondent has a problem breaking down sales, then concentrate on a NI, Scotland, RoI and' rest' split

A7. **(a)** In the next 3-5 years what single most important factor would you say will provide the competitive edge of your business here in (*NI/RoI/Scotland)*? Will it be:

Read options and tick 1 box.

Your product design	☐
Your process technology	☐
Your cost effectiveness	☐
Your marketing	☐
Your financial management	☐
Other (please specify ……)	☐

B. New Products and Services

B1. Have you introduced any new products/services produced in (*NI/RoI/Scotland)* in the last 3 years?

Yes ☐ No ☐ ***(If NO go to C1)***

B2. How many new products/services have there been? …….

If unsure best guess answer will do

B3. How many of them were designed or developed mainly in (*NI/RoI/Scotland)* ?.....

B4. Approximately, what percentage of your current (*NI/RoI/Scotland)* sales/turnover is accounted for by these new products/services introduced in the last 3 years?.....

B5. Considering the most important new product(s)/services(s) introduced in the last 3 years, I am going to read out a list of possible factors which may have influenced your design and development process. Please tell me which factors had the most influence. *(Circle all that are mentioned)*

Production staff at the establishment crucial	**1**
R&D department crucial	**2**
Technical inputs from customers crucial	**3**
Cooperation with customers crucial	**4**
Company staff located outside (*NI/RoI/Scotland)* crucial	**5**
Local consultant advice crucial	**6**
Consultant advice from outside (*NI/RoI/Scotland)* crucial	**7**
Financial resources crucial	**8**
Market testing/evaluation crucial	**9**

B6. Without the need for any fundamental, major changes in its design or specification how many years have your current most important product(s)/service(s) been available to customers?

……years

B7. How modern is your current most important product(s)/service(s) when compared to your competitors? *(Circle one answer)*

Very up-to-date	**1**	Up to 1 year behind	**2**	1-3 years behind	**3**
More than 3 years behind	**4**	Don't know	**5**		

B8. I am going to read out some statements; could you tell me if you strongly agree, agree, neither agree or disagree, disagree, or strongly disagree:

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
We are committed to making our existing products and services obsolete by introducing new ones	1	2	3	4	5
We regularly compare our products and services with those of our competitors	1	2	3	4	5
Or products/services have a high level of technology built into them	1	2	3	4	5
Our products and services use better technology than our competitors	1	2	3	4	5

C. Involvement in Innovation Activities

Moving on now to looking at your involvement in innovation related activities in (*NI/RoI/Scotland)* where innovation related activities is defined as ***committing resources to*** developing new products, processes or services and/or significantly improving existing products, processes or services, or developing new niches for the firm.

C1. Is your business engaged in innovation related activities in (*NI/RoI/Scotland)*?

Yes ☐ No ☐ ***IF NO GO TO E1***

C2. For how many years has your business been involved in innovation related activities in (*NI/RoI/Scotland)*? .....**years**

C3. Have innovation related activities undertaken in (*NI/RoI/Scotland)* resulted in any **major** product or process innovations introduced into your (*NI/RoI/Scotland)* plants in the last 3 years? *Check back to B1 and ensure consistent. If answer is 'yes to new products in B1' but 'no' on product innovation in this question check to confirm that no significant local resources were involved in producing 'new products in B1'.*

Product innovation Yes ☐ No ☐
Process innovation Yes ☐ No ☐

(Approx.) How many product innovations in the last 3 years? …….

(Approx.) How many process innovations in the last 3 years? …….

C5. How many of these have been patented? Product …… Process ……

C6. Could you tell me if any of the following are very important source(s) of knowledge and information *(K&I)* for your innovation related activities?
Tick as many as apply and tick main reason.

	Tick **ALL** that apply	Tick **MAIN** reason only
K&I from within the establishment (e.g. design, production, operational)		
K&I from within the enterprise (e.g. parent company)		
K&I from other local company/companies		
K&I from other company/companies located in *(UK/RoI)*		
K&I from other foreign company/companies		
K&I from Suppliers of equipment, materials etc.		
K&I from Customers		
K&I from Consultants		
K&I from Universities/Government research organisations		
K&I from Private research institutes		
K&I from Other public sector bodies e.g. Invest NI/Scottish Enterprise/Enterprise Ireland		
K&I from Trade associations/ Trade fairs		
K&I from Regulatory bodies e.g. Health & Safety, Environmental Standards		
Other K&I		

D. Reasons and Attitudes regarding innovation related activities

Moving on now to looking at your reasons for undertaking innovation related activities in *(NI/RoI/Scotland)*:

D1. **A.** Does your business carry out innovation related activities in order to ……..? *(Read out list)*

B. What is the main reason? *(Read out answers from column A that were ticked and choose 1)*

	A	**B**
	Tick **ALL** that apply	Tick **MAIN** reason only
a. to Develop new products		
b. to Improve existing products		
c. to Adapt existing products to meet market demands		
d. to Replace existing products		
e. to Reduce production costs		
f. to Increase speed of production		
g. Other (please specify)		

Turning now to your attitudes towards undertaking innovation related activities in *(NI/RoI/Scotland)*:

D2. Which of the following statements **BEST** describes the importance of innovation related activities to your business? *Circle one letter*

a. innovativeness has always been vital to our business
b. innovativeness is becoming increasingly important to our business
c. innovativeness is important but not essential to our business
d. innovativeness is not important to our business

D3. Which if the following statements best describes your business plans for innovation?

a. We expect to increase our involvement in innovation related activities
b. We expect to maintain our current level of involvement in innovation related activities
c. We expect to decrease our level of involvement in innovation related activities
d. We expect to cease our involvement in innovation related activities

GO TO section G

E. Previous/Future Involvement in Innovation Related Activities

E1. Has you business been engaged in innovation related activities in (*NI/RoI/Scotland)* at any time in the last 5 years?

Yes ☐ No ☐

E3. Do you expect your business to engage in innovation related activities at any time in the next 3 years?
Yes – definite plans exist ☐ GOTO E4

Yes – but no definite plans ☐
Possibly ☐
No ☐
} GOTO F1

E4. What are your reasons for planning to undertake innovation related activities within the next 3 years? Are they ……(*Read out list and tick as many as apply*)

a. to Develop new products	
b. to Improve existing products	
c. to Adapt existing products to meet market demands	
d. to Replace existing products	
e. to Reduce production costs	
f. to Increase speed of production	
g. because Senior management regard innovation related activities as a strategic priority for the future	
h. Other (please state)	

F. Reasons for Not Undertaking Innovation Related Activities

Moving on now to looking at your reasons for not undertaking innovation related activities in (*NI/RoI/Scotland)*.

F1. For each statement that I read out please tell me if you strongly agree, agree, neither agree or disagree, disagree, or strongly disagree.

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree

The nature of our product or production process does not require or justify expenditure on innovation related activities	1	2	3	4	5
It is a corporate decision **not** to invest in innovation related activities in (*NI/RoI/Scotland)*	1	2	3	4	5
External economic/market conditions associated with risk and uncertainty prevent us from undertaking innovation related activities	1	2	3	4	5
Lack of access to finance (including government aid) restricts our ability to undertake innovation related activities	1	2	3	4	5
There is limited competition in the market for our products (i.e. our product is highly price sensitive), so we do not engage in innovation related activities	1	2	3	4	5
We are unable to engage in innovation related activities due to a lack of appropriate skills within the business	1	2	3	4	5
There is too long a time lag between undertaking innovation related activities and generating financial returns	1	2	3	4	5
It makes more sense to wait and copy the innovations of competitors than undertake these activities ourselves	1	2	3	4	5
Senior management do not regard innovation related activities as a strategic priority	1	2	3	4	5
We are unable to develop links with external bodies/organisations that would stimulate innovation related activities	1	2	3	4	5

F2. Which of the following factors is most likely to encourage your business to undertake innovation related activities in (*NI/RoI/Scotland)* in the future? (*Read out list and tick most important)*

	Most important
a. An improvement in the financial performance of the business	
b. The recruitment of staff with appropriate skills	
c. A change in management attitudes to innovation related activities	
d. A greater demand for innovative products	
e. Stronger competition in the market	
f. Less price sensitivity for products	
g. Technological developments in the industry	
h. A change in corporate policy regarding (*NI/RoI/Scotland)* operations	
i. Improved government incentives for innovation related activities (e.g. grants)	
j. The nature of our business means that innovation related activities would **never** be considered	
k. Other (please state)	

Business and management factors relating to innovation effectiveness

G. Lifecycle

For each statement that I read out please tell me if you strongly agree, agree, neither agree or disagree, disagree, or strongly disagree.

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
The main problems of the business are obtaining customers and delivering the product or service.	1	2	3	4	5
The Company has now developed with sufficient customers and satisfies them sufficiently with its products or services.	1	2	3	4	5
The decision facing owners at this stage is whether to expand or to keep the company stable and profitable, providing a base for alternative owner activities.	1	2	3	4	5
The key problems facing the company are how to grow rapidly and how to finance the growth.	1	2	3	4	5
The challenges are to consolidate and control the financial gains brought on by rapid growth and to retain the advantages of small size, including flexibility.	1	2	3	4	5

H. Strategic focus

For each statement that I read out please tell me if you strongly agree, agree, neither agree or disagree, disagree, or strongly disagree.

	Strongly Agree	Agree	Neutral	Disagree	Strongly disagree
The company has a narrow range of products and markets.	1	2	3	4	5
The company continually searches for new market opportunities.	1	2	3	4	5
The company watch their competitors closely for new ideas, and then rapidly adopt those which appear to be the most promising.	1	2	3	4	5
The organisation seldom makes adjustments of any sort until forced to do so by environmental pressures.	1	2	3	4	5

I. Leadership

Moving on now to looking at the leadership style for supporting innovation related activities in (*NI/RoI/Scotland)*. For each statement that I read out please tell me if you (a) strongly agree, (b) agree, (c) neither agree nor disagree, (d) disagree or (e) strongly disagree. *Please circle one answer for each statement.*

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The senior management team makes a point of "being seen" around the organisation	1	2	3	4	5
Management fosters creative thinking and innovation in the company	1	2	3	4	5
Our top managers like to try new ways of doing things	1	2	3	4	5
Management spend adequate time planning change	1	2	3	4	5
If the company is performing well, change is still a priority	1	2	3	4	5
The organization is working to a clear business plan	1	2	3	4	5
Management encourages everyone in the organization to come up with new ideas.	1	2	3	4	5
The management team take time to think constructively/creatively about the future	1	2	3	4	5

J. Culture

Moving on now to looking at the culture within the organisation for supporting innovation related activities in (*NI/RoI/Scotland)*.

For each statement that I read out please tell me if you (a) strongly agree, (b) agree, (c) neither agree nor disagree, (d) disagree or (e) strongly disagree.

Please circle one answer for each statement.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
There is a strong team spirit at all levels of the organisation	1	2	3	4	5
The culture in this organization promotes change	1	2	3	4	5
Two way communication happens at all levels of the organisation	1	2	3	4	5
There is a clear organisational structure which everyone understands	1	2	3	4	5
There are clearly defined roles and responsibilities	1	2	3	4	5
The structure of the organization facilitates change	1	2	3	4	5
The organization is not bureaucratic	1	2	3	4	5
There is a feeling of openness in this organization	1	2	3	4	5
Overall, employees have access to all the resources needed to get the job done	1	2	3	4	5
Employees are involved in setting and agreeing performance targets	1	2	3	4	5
Everyone in the company has a good grasp off how the organization is performing	1	2	3	4	5
Employees get useful feedback about their work	1	2	3	4	5

K. Business Improvement Methods

Moving on now to looking at the business improvement methods within the organisation for supporting innovation related activities in (*NI/RoI/Scotland)*.

K1 Please indicate which of the following business improvement methods are used within your organisation to drive innovation activities:

	present	If present, greater than 2 years?
Total Quality Management (TQM)		
Continuous Improvement		
European Business Excellence Model		
Balanced Scorecards		
Total Preventative Maintenance (TPM)		
Investors in People (IiP)		
ISO 9001		
ISI14001		
Others – please list:		

K2 In relation to the method(s) used for each statement that I read out please tell me if you (a) strongly agree, (b) agree, (c) neither agree nor disagree, (d) disagree or (e) strongly disagree.

Please circle one answer for each statement.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The organisation has a formal/informal total quality – continuous improvement programme	1	2	3	4	5
Responsibilities for the TQ/CI programme are clearly defined	1	2	3	4	5
The TQ/CI programme has clear goals, objectives and measures of success	1	2	3	4	5
Successful TQ/CI problem solving teams are spread throughout the organisation	1	2	3	4	5
The programme is adequately resourced	1	2	3	4	5
There is a clearly defined reward and recognition scheme for TQ/CI activity	1	2	3	4	5
Greater that 50% of the workforce are involved in TQ/CI	1	2	3	4	5
The TQ/CI programme is used to improve processes	1	2	3	4	5
A number if quality improvements have been achieved from the programme	1	2	3	4	5

L. Internal and External Knowledge processes

L1. Knowledge Incorporation

I will now read out a set of statements that will help us understand how your organisation incorporates or uses knowledge and information internally.

For each statement that I read out please tell me if you (a) strongly agree, (b) agree, (c) neither agree nor disagree, (d) disagree or (e) strongly disagree. *Please circle one answer for each statement.*

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Everyone is in possession of the information/ knowledge necessary to do their job	1	2	3	4	5
Knowledge that employees hold in their heads (i.e. tacit knowledge) is managed and captured effectively	1	2	3	4	5
Efforts are made to share information/knowledge across the organization	1	2	3	4	5
Lessons learned from daily experiences and projects are captured and disseminated	1	2	3	4	5
New information/knowledge is effectively incorporated within the processes and routines within the organization	1	2	3	4	5
Active management of information/knowledge produces a range of business benefits	1	2	3	4	5

L2. Knowledge Acquisition

I will now read out a set of statements that will help us understand how your plant identifies and employs information/knowledge developed elsewhere. *Please circle one answer for each statement.*

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
We conduct frequent market research so that we are aware of customer needs	1	2	3	4	5
Licensing is a method we often use to obtain information/knowledge or technology	1	2	3	4	5
We have developed new products/services and/or processes in collaboration with other firms	1	2	3	4	5
We are well aware of the information/knowledge and technologies being developed by our competitors	1	2	3	4	5
We have become an information/knowledge or technology supplier to other firms in the sector	1	2	3	4	5
We usually go to outside private sector bodies (e.g. consultants) to find out about fresh opportunities for introducing new products/services	1	2	3	4	5
We usually go to outside public sector bodies (e.g. universities) to find out about fresh opportunities for introducing new products/services	1	2	3	4	5

M. Linkages

I will now read out a set of statements that will help us understand how your networks with other organisations in *NI/RoI/Scotland)*:

For each statement that I read out please tell me if you (a) strongly agree, (b) agree, (c) neither agree nor disagree, (d) disagree or (e) strongly disagree.

Please circle one answer for each statement.

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Sufficient resources are allocated to support network activities with other organisations and collaborators	1	2	3	4	5
The organisation uses a range of activities and mechanisms to initiate	1	2	3	4	5

new relationships with other organisations					
Information is freely exchanged across other organisational partners in networks	1	2	3	4	5
Network activities are systematically linked to organisation plans	1	2	3	4	5
Where appropriate the company adapts its activities to fit with the needs of specific networks	1	2	3	4	5
Relationships between employees and those of other organisations in networks are carefully managed.	1	2	3	4	5
The company has performance measures to measure the effectiveness of networks with other organisations	1	2	3	4	5
Company employees receive sufficient training in network relationship management	1	2	3	4	5

N. Background on your operations

N1. Based on the following bands, what was your sales turnover in (*NI/RoI/Scotland)* during the most recent period for which you have data? *Code one of the following:*

<250k ☐ 250-500k ☐ 500-999k ☐ 1000-1999k ☐ 2000-2999k ☐ 3000-3999k ☐ >4000k ☐

N2. Over the last three years would you say that the level of competition you face from your rivals has:

Increased significantly ☐ Increased ☐ Same ☐ Decreased ☐ Decreased significantly ☐

N3. Compared to your rivals, how would your rate your overall performance in the last year?

Significantly better ☐ Better ☐ Same ☐ Worse ☐ Significantly worse ☐

O. Next stage of project

O1. As well as carrying out this survey in (*NI/RoI/Scotland)*, a number of companies are being invited to take part in a series of workshops and in-house support to help in the development of their innovative capacity and capability, aimed ultimately at improving their competitiveness through the commercialisation of new ideas, products, services and processes on a cross border and cross regional basis. Would you be willing to allow your contact details (linked to the answers to this survey) to go forward to the project team to indicate your interest in being involved in this further stage in the project?

Yes ☐ No ☐

O2. Would you like to receive a copy of the overall anonymised results from this survey? If so, this implies you give consent for your contact details to go forward to the project team (although these will not be linked to your responses to this survey).

Yes ☐ No ☐

THANK YOU FOR TAKING PART IN THIS SURVEY