

How do collaboration and investments in knowledge management affect process innovation in services?

Article

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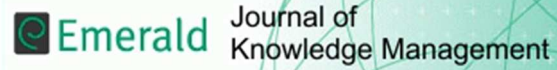
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**HOW DO COLLABORATION AND INVESTMENTS IN
KNOWLEDGE MANAGEMENT AFFECT PROCESS INNOVATION
IN SERVICES?**

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3 **HOW DO COLLABORATION AND INVESTMENTS IN KNOWLEDGE MANAGEMENT**
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11 **ABSTRACT**

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13 *Purpose:* Despite the keen interest in *radical and incremental innovation*, few studies have tested the
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15 varying impact of firm-level factors in service sectors. This paper analyses how *collaboration with*
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17 *existing and prospective users*, and *investments in knowledge management (KM) practices* can be
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19 adapted to maximise the outputs of radical and incremental process innovation in a Knowledge-
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21 Intensive Business Service (KIBS) industry.
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25 *Methodology:* Original survey data from 166 Information Technology Service (ITS) firms and
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27 interviews with 13 executives provide the empirical evidence. PLS-SEM is used to analyse the data.
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31 *Findings:* Collaboration with different types of users, and investments in KM practices affect radical
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33 versus incremental process innovation differently. Collaboration with existing users influences
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35 incremental process innovation directly, but not radical innovation; and prospective user
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37 collaboration matters for radical, but not incremental innovation. Furthermore, for radical
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39 innovation, investments in KM practices mediate the impact of prospective user collaboration on
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41 innovation.
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45 *Implications:* While collaboration with existing users for incremental process innovations does not
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47 appear to generate significant managerial challenges, to pursue radical innovations firms must
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49 engage in intensive collaboration with prospective users. Higher involvement with prospective users
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51 requires higher investment in KM practices to promote efficient intra- and inter-firm knowledge
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3 *Originality:* This study is based on a large-scale survey, together with management interviews.
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5 Radical and incremental innovations in the service industry require engagements with different kinds
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7 of users, and the use of knowledge management tools.
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1 INTRODUCTION

Radical and incremental innovations are key constituents of a firm's strategy to sustain competitive advantage. Together they strengthen the future innovation paths available to a firm. Radical innovations are associated with the long-term competitiveness of a firm and their implementation entails a greater level of change, which results in a friction between the old and new way of working (Ettlie et al., 1984; Norman and Verganti, 2014). In contrast, incremental innovations are perceived as less disruptive. Firms implementing incremental change work on familiar knowledge, encounter lower uncertainty, and try to protect their current market share; thereby engage in a search for knowledge that is in close proximity to their current knowledge-base (Zahra and George, 2002; Kim et al., 2014).

Firms are challenged by the need to adjust their strategies for the implementation of both radical and incremental innovation, and often find it difficult to strike a balance between them (Garcia and Calantone, 2002; Norman and Verganti, 2014). Nevertheless, theoretical and managerial guidelines on the topic are limited. Past studies report that the influence of factors is often similar (or does not vary) across radical and incremental innovation (Van Riel et al., 2004; Damanpour, 2010). In addition, there is scarce empirical investigation of the organisational environment or formal knowledge management (KM) practices that support the introduction of new-to-firm and new-to-market innovations (Arundel et al., 2006). Indeed, despite the key role of external knowledge for radical change, and the key role of users in the service sector, there is a limited understanding of the influence of collaboration on incremental and radical innovation.

This paper analyses how *user collaboration* and *investments in knowledge management (KM) practices* influence the outputs of process innovation in a particular Knowledge-Intensive Business Service (KIBS) industry: the Information Technology Services (ITS). KIBS firms play a vital role in the knowledge-based economy, and they are key enablers, sources, and users of innovation. User collaboration is especially integral to the provision of IT services, where both existing and new users

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3 co-create knowledge with these providers (Salter and Tether, 2014). However, the feasibility of such
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5 co-creation and its impact on a firm's performance lacks clarity (Santos-Vijande et al., 2013).

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7 Similarly, there is lack of consensus on how user collaboration influences the performance of radical,
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9 in comparison to incremental, innovation (Gustafsson et al., 2012). Thus, our first research question
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11 is: *(i) Does collaboration with existing and prospective users show a differing impact on radical*
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13 *versus incremental process innovation?*
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17 We also analyse the effect of a firm's *investments in KM practices* on innovation in response
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19 to the research gaps identified by Serenko and Dumay (2015). This is because knowledge is a key
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21 firm-level asset, and the benefits from knowledge exchanges (through collaboration) are not
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23 automatic. They are dependent on a firm's absorptive capacity, which is the firms' capability to
24
25 integrate, internalise and exploit external knowledge for financial gains (Cohen and Levinthal, 1990).
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27 We argue, given that KM practices are fundamental to the way services are co-created by ITS firms
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29 and their users, investments in KM practices become key to increase this absorptive capacity, as they
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31 enable the firm to build capabilities to translate external knowledge into firm-specific competences
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33 (Salter and Tether, 2014). Efficient KM practices allow the ITS providers to translate learning from a
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35 customised solution to generic offering (Doroshenko et al., 2013). As a result, the second research
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37 question considered is, *(ii) Do investments in KM practices mediate the impact of collaboration on*
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39 *radical and incremental process innovation?*
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44 Given that the implementation of radical innovation entails a higher degree of change and a
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46 higher friction between the old and new ways of working (Du Plessis, 2007), the third research
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48 question is, *(iii) Do investments in KM practices show differing impact on radical versus incremental*
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50 *process innovation?*
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53 Our paper begins with a discussion of the theoretical background and defines the hypotheses
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55 for testing. We then describe our survey data from the 166 ITS firms that constitute the empirical
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57 evidence for our study, and analyse this data using the PLS-SEM advanced techniques. The results
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3 obtained are also validated with qualitative data stemming from the feedback received from 13
4 executives. Finally we conclude with a discussion of the theoretical and managerial implications of
5 our study.
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10 11 12 **2 THEORETICAL BACKGROUND AND HYPOTHESES**

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14 The concept of radical innovation dates back to Schumpeter's (1961) seminal work. Later studies
15 drew attention to the fact that successful radical innovation is rather rare; in fact, most firms benefit
16 from incremental innovation which extends the benefit of the dominant design, technology, product,
17 or process (Norman and Verganti, 2014)). Although, radical and incremental innovations are
18 undertaken for distinct objectives and entail varying degrees of change, a balanced approach towards
19 the implementation of both types of innovation leads to sustained performance in the long-run;
20 especially in the service sector (Damanpour et al., 2009) and in the context of software process
21 innovations (Fichman and Kemerer, 1997).
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33 In this study, *process innovation* is defined as the implementation of a new or significantly
34 improved production or delivery method that is of value to the user; process innovation includes
35 significant changes in techniques, equipment and/or software (OECD, 2005). Radical and
36 incremental innovation are viewed as the higher and lower extremes of degrees of innovativeness:
37 which represents the degree of departure of innovation from the current paradigm or current state at
38 the innovating firm (Reichstein and Salter, 2006; Norman and Verganti, 2014). We define *radical*
39 *process innovation* as the delivery of 'new to the market' methods, and *incremental process*
40 *innovation* as the delivery of either 'significant improved' or 'new to the firm' methods (Tether,
41 2002; Van Riel et al., 2004).
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53 Although, the need for incremental and radical innovation for sustained competitive
54 advantage is understood (Bauer and Leker, 2013), managers face challenges in allocating limited
55 resources to the degrees of innovativeness. The existing literature on radical (exploratory) and
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3 incremental (exploitative) innovation remains unclear on the factors influencing these innovations
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5 (Jansen et al., 2006). The objective of this study is, therefore, to improve the predictability of the
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7 degree of process innovativeness in KIBS firms, more specifically in the ITS providers, through the
8
9 control of user collaboration and investments in KM practices. Following Damanpour, 1991, we
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11 expect that the impact of the factors studied on radical and incremental process innovation outcomes
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13 will vary in the strength of relationship, but not in the direction. The research model and the
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15 hypotheses tested are captured in Figure 1.
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18 -----Figure 1 about here-----
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21 22 **2.1 Collaboration**

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24 Although extensively discussed, the differential impact of collaboration on radical and incremental
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26 innovation lacks “systematic evidence” (Jansen et al., 2006, p. 1661), a gap addressed in this paper.
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28 We define *collaboration* as the joint creation of value by a firm and its partners, which involves
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30 exchange, sharing and co-development (Gulati, 1995; Prahalad and Ramaswamy, 2004)¹. Although
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32 KIBS firms can benefit from collaborating with a wide variety of partners, collaboration with users
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34 in the ITS context has been found to be especially important because these providers depend on user
35
36 information more heavily than other service providers or manufacturing firms (Hertog, 2000). In fact,
37
38 previous studies show that the user–ITS firm collaboration triggers knowledge transfer and
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40 innovation across both partners (Doroshenko et al., 2013). Therefore, within our research model we
41
42 focus on *collaboration* with *end-users (existing and prospective)* because they are intrinsic to the
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44 operations of ITS firms.
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58 ¹ Thus, outsourcing arrangements where there is no active engagement with the partner is not regarded as collaboration.
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2.1.1 Existing and prospective user collaboration

Users are the consumers and co-producers of value and they expect benefit from using a product or service. *Existing users* are consumers who have a working relationship with the firm, and *prospective users* are new consumers the firm wishes to acquire in an existing or a target market. The co-creation of value with users is intrinsic to a KIBS firm's operations (Salter and Tether, 2014). KIBS firms employ personnel who combine professional knowledge and customer inputs to develop innovative services in response to customer needs. Despite the importance of the topic, several research gaps exist. There is lack of consensus on how and whether user collaboration benefits radical and incremental innovation performance differently (Gustafsson et al., 2012).

Firms that wish to minimise risks tend to respond to demands from current users, which normally results in incremental improvements (von Hippel, 2005; Robertson et al., 2012). Firms develop expertise in problem-solving through repeated practice; however over-specialisation in current capabilities deters them from straying too far from the current knowledge-base (Hiernerth et al., 2014). Existing users are impacted by the "functional fixedness" effect: they tend to perceive the future application of innovation within their existing frame of knowledge, which generates incremental change and blocks radical application (Hiernerth et al., 2014, p. 191). Therefore, engagement with existing users is more likely to lead to incremental innovation.

In contrast, firms that are more risk oriented, tend to explore novel innovation opportunities, and are more likely to collaborate with new or prospective users (Jansen et al., 2006). Indeed, users that are open to experimentation are able to visualise a novel solution and formulate complex strategies for the adoption of radical innovation (Hiernerth et al., 2014). For example, in the study of the effect of customer interaction on new product performance, Menguc et al. (2014) find that interactions with existing customers had a significant but negative effect on the performance of radical innovation. These authors conclude that firms adopting radical innovation will benefit by interacting with new or lead users.

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3 Based on these ideas, we present the following argument. Collaboration with existing users is
4 constrained by their current experiences, whilst prospective users (perhaps due to their experiences
5 with other firms or industries) can help a firm to fundamentally change its processes. We argue that
6 engagement with existing users is expected to lead to incremental process innovation. In contrast,
7 because radical change takes a firm away from its current competences, we expect collaboration with
8 prospective users to show a greater impact on radical (as compared to incremental) process
9 innovation.
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19 *Hypothesis 1 (H1): Existing user collaboration will show a greater impact on incremental (as*
20 *compared to radical) process innovation.*
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23 *Hypothesis 2 (H2): Prospective user collaboration will show a greater impact on radical (as*
24 *compared to incremental) process innovation.*
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30 **2.2 Investments in KM practices**

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32 A key usage of the information assimilated from external partners is to implement innovation, which
33 however creates a friction between the old and new knowledge. Consequently, firms need to dedicate
34 internal resources to create KM practices that enable the development of absorptive capacity and the
35 undertaking of process innovation. In this paper, *KM* is defined as a capability to leverage (internal
36 and external) knowledge in order to enable superior performance, encourage innovation, and enhance
37 customer value (Gold et al., 2001; Du Plessis, 2007). KM practices are critical in today's dynamic
38 and competitive business context, because they enable innovation by maximising the benefits
39 extracted from tacit knowledge and facilitate collaboration (Du Plessis, 2007; Jones and Mahon,
40 2012). Thus, KM practices are fundamental to the way services are co-created by KIBS firms and
41 their customers. The importance of KM practices is emphasised for our research context, because
42 ITS firms' KM practices are essential to capture and translate external learning into firm-specific
43 capabilities (Salter and Tether, 2014). Indeed, ITS firm's KM practices is a fundamental part of their
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3 activity, as collaboration with customers lies at the heart of this sector (Doroshenko et al., 2013).

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5 However, as argued by Heisig's (2015) review of the KM literature, there is still a challenge in
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7 demonstrating a link between investments in KM practices and organisational outcomes.
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10 Although the importance of designing formal KM practices for innovation is widely
11 researched, investments in KM practices to support absorptive capacity in the context of radical
12 innovation has not been widely investigated (Lane et al., 2006). Radical innovation not only requires
13 the effective recognition of valuable external knowledge, but it also calls for the creation of
14 absorptive capacity to internalise new knowledge. Furthermore, as discussed above, radical change
15 represents a clear departure from a firm's current state of affairs. Therefore, we expect that the
16 implementation of radical (as compared to incremental) process change will require higher
17 investments in KM practices to integrate new and diverse knowledge through the creation (or
18 adoption) of new capabilities, technologies, and training programmes.
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30 Resources allocated to KM practices are of a greater importance for radical process change
31 because these practices help a firm to search the environment for new trends (Camp, 1989; Kang and
32 Kang, 2014). For instance, benchmarking is an important KM tool that enables firms to reduce the
33 cost of innovation and control risks (Du Plessis, 2007). Previous studies show that the value
34 extracted from radical innovation is limited by a firm's knowledge and capabilities (Sorescu et al.,
35 2003). Thus, we argue that investment on KM practices will be more beneficial for firms that
36 implement radical, as against incremental process innovations, as these investments will generate the
37 internal capability to translate new and diverse knowledge into firm-specific benefits.
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47 *Hypothesis 3 (H3): Investments in KM practices will show a greater impact on radical (as compared*
48 *to incremental) process innovation.*
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2.3 Investments in KM practices mediate the impact of user collaboration on process innovation

There is a tension between the absorption of knowledge associated with incremental innovation and the adoption of novel knowledge associated with radical innovation (Ritala and Hurmelinna-Laukkanen, 2013). Investments in KM practices helps firms to mitigate this tension through the development of internal innovation capabilities that are needed to translate external knowledge efficiently into the organisational context. Du Plessis (2007) discusses that collaboration with partners enhances the gathering of tacit knowledge, and positively impacts the KM practices, which in turn help firms to control the costs and risks of innovation. We therefore argue that the impact of user collaboration on the degrees of innovativeness will be mediated by the extent to which the firm invests in KM practices, as these investments will shape the firm's absorptive capacity.

Theoretical models of absorptive capacity, argue that a firm's internal innovation capability will mediate the benefit of external knowledge sources on innovation (Zahra and George, 2002; Lane et al., 2006). Prior research shows that the translation of user knowledge into a firm-specific advantage is especially complex; information shared by users is not valuable unless a firm invests resources to interpret this knowledge within the organisational context (Nicolajsen and Scupola, 2011). KIBS firms have to promote a fusion of their knowledge set and that of the client's. However, this asymmetry of knowledge between the customer and the KIBS firm can prove challenging (Santos-Vijande et al., 2013). It will be easier to assimilate the knowledge of existing users, because experience mitigates absorption, and pre-existing routines will assist firms in internalising customer knowledge sets, relative to prospective customers. In contrast, greater investments in KM practices are required to assimilate the knowledge residing in prospective users and make it useful for achieving to radical innovations. Thus, we hypothesise that:

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3 *Hypothesis 4A (H4A): The impact of existing user collaboration on process innovation will be*
4 *mediated through investments in KM practices, being greater for incremental, as compared to*
5 *radical, process innovation.*
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10 *Hypothesis 4B (H4B): The impact of prospective user collaboration on process innovation will be*
11 *mediated through investments in KM practices, being greater for radical, as compared to*
12 *incremental, process innovation.*
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16 17 18 19 **3 RESEARCH DESIGN**

20 21 **3.1 The sample**

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23 The data used for hypotheses testing came from survey responses from 166 ITS firms and
24 discussions with 13 executives, who validated the findings. ITS firms play a central role in the
25 economy: they work very closely with their users, often in multi-disciplinary teams. They facilitate
26 their client firms to translate new information, and extract tacit knowledge from these partners. The
27 study of the factors that impact radical and incremental innovation in ITS is of particular importance
28 because they are also known to deliver projects with varying degrees of innovativeness (Salter and
29 Tether, 2014).
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39 We adopt Gartner's taxonomy to identify firms operating in the ITS industry; these firms are
40 involved in consulting, implementation, IT outsourcing, business process outsourcing, and software
41 support and hardware support (Blackmore and Hale, 2012). We designed an online questionnaire to
42 collect the data. We followed Campbell's (1955) guidelines to check that the informants are
43 competent to respond to the questionnaire. We took various steps to boost the response rate and
44 enhance the precision of the responses.² Instructions were provided for the informants to reflect (on
45 behalf of their firm) on their activities for the last year and to complete the survey at the Business
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55 ² Informants were contacted via email to explain the research context, to discuss the potential business implications of the
56 survey and to assure confidentiality; we also promised to share the research summary with our contributors. Senior
57 managers were chosen as respondents, as they are more likely to understand their firm's perspective on the research
58 topic.
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3 Unit level if they performed various roles. The questionnaire was sent out in three waves in May,
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5 July, and October 2012. The sample for this study was obtained from two sources: from experienced
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7 postgraduate network members and a professional networking site.³ The choice of these sources is
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9 appropriate for our research's focal industry because ITS providers are lead users of social networks
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11 and communication channels. Additionally, these firms use these channels to attract a skilled
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13 workforce and to connect with their online-active users; these providers are known to exploit
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15 valuable knowledge exchanged on these networks (Ridder and Cohen, 2013).
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19 The questionnaires were sent to 612 respondents. After cleansing the data, a usable sample of
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21 166 responses was obtained.⁴ This gave us a 27 percent response rate, which is comparable to
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23 response rates in previous organisational studies (Baruch and Holtom, 2008); especially on the topic
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25 of innovation (Sauermann and Roach, 2013). We ascertained that the sample size met guidelines
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27 discussed in Bartlett et al. (2001), Tabachnick and Fidell (2007), and Hair et al. (2013). In light of
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29 the sampling method, we tested for non-response bias using accepted procedures. We compared
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31 responses based on the wave that the survey were sent out, the time taken to complete the survey,
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33 and the early and late responses across the waves (Armstrong and Overton, 1977). No evidence of
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35 difference was found in these tests.
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41 **3.2 The variables and measures**

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43 New scales for all the constructs were developed in line with Churchill (1979) guidelines, as
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45 appropriate existing scales were not found. Although the European Union's Community Innovation
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47 Survey (EU CIS) and its customised versions have substantially influenced our body of knowledge
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49 on innovation, these surveys do not incorporate detailed indicators on the depth and breadth of
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52 ³ Sources include the Henley Business School's postgraduate programmes for experienced professionals and LinkedIn.

53 ⁴ Responses with less than 25 percent missing data were used; responses of 'Not Applicable' and 'Don't Know' were
54 treated as system-defined missing data. Outliers were deleted and special attention was given to missing data analysis.
55 This is because missing data creates an issue for further analysis using structural equation modelling (Allison, 2003). We
56 concluded that the data was missing completely at random because Little's MCAR test showed $p > 0.05$. The EM
57 algorithm was used to replace missing data, which is an accepted practice for latent variable models and factor analysis
58 (Schafer and Graham, 2002).
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3 process innovation, knowledge management practices adopted by KIBS firms to enable process
4 change, and extent of user collaboration. There are also limited guidelines on how to measure KM
5 practice (Darroch, 2003), and previous studies' use of R&D expenditure as a proxy for a firm's
6 investments in KM practices (to develop absorptive capacity) has been criticised (Lane et al., 2006).
7
8 We identified a mix of three inward- and two outward-looking management practices based on the
9 recommendations by Foss et al. (2011) with the attempt to capture investments in KM practices
10 contributing to develop absorptive capacity in the service sector. The inward-looking indicators of
11 investments in KM practices were investigated because they help the firm to learn and break away
12 from the old ways of working (Zairi and Sinclair, 1995). The outward-looking indicators of
13 investment of KM practices in benchmarking were used to assess a KIBS firm's strategy towards
14 process performance comparison (Anderson and McAdam, 2004). New measures were validated
15 through discussions with 28 executives, whose feedback was used to improve the clarity of the
16 instrument. The questionnaire was further pilot-tested with 41 executives.
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32 We defined the research model as a reflective model, where the indicators were created to
33 reflect the underlying construct (Chin, 1998a). The reflective indicators were defined on a one-to-
34 seven scale because this allowed us to capture a greater variation in the responses in comparison to a
35 five-point scale (Lietz, 2010). We labelled only the extremities: scale one was labelled as 'Strongly
36 Agree' and seven as 'Strongly Disagree'. In order to perform group-analysis, we first established that
37 the indicators perform adequately across the sub-groups (Chin and Dibbern, 2010), and took steps to
38 address redundancy issues among the indicators (Cronbach, 1951). The constructs, their measures
39 and loadings are captured in Table 1.
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3.3 The method of analysis

3.3.1 Use of mixed methods

Mixed methods were used to investigate the research questions. The online survey was followed by qualitative interviews with ITS executives to validate the survey findings and to delve deeper into ITS firms' strategies relating to radical versus incremental process change. Mixed methods reduce the uncertainty of interpretation of results and can be a superior approach in social science to highlight convergence, inconsistency, and contradiction across the data sources (Johnson et al., 2007).

3.3.2 Survey data analysis

We adopted partial least squares-structural equation modelling (PLS-SEM) techniques for our exploratory study and use SmartPLS (Ringle et al., 2005). This is because our research objectives did not meet the assumptions laid down by covariance based-structural equation modelling. The use of PLS is suitable because we developed an exploratory theory to ascertain the differing impact of firm-level factors on radical versus incremental process innovation. Our aim was to maximise the predictability of the dependent construct: process innovation (Hair et al., 2013). Further, PLS path modeling generates reliable results with a smaller sample size and is preferred for a complex model (Henseler et al., 2009).

We followed the guidelines for the selection of PLS-SEM, and met the sample size requirements to conduct a group-analysis using PLS path modelling (Chin, 1998b; Hair et al., 2013).⁵

Group-analysis was undertaken by segmenting the data based on the degree of innovativeness. The respondents were instructed to report the proportion of radical and incremental process innovations implemented in the last year, where the online survey tool mandated that these proportions add up to 100 percent. The median value of radical process innovation (as per guidelines

⁵The sample size required for a PLS group-analysis is ten times the maximum number of (i) formative indicators for a construct, or (ii) structural paths to an endogenous construct. Since we use reflective indicators in our study, the sample size requirement is based on the maximum number of paths to an endogenous construct, which is three paths, thus the required sample size is 30 cases per sub-group; this criterion is met.

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3 in Sosik et al. (2009)) was used to split the data to identify firms implementing relatively more
4 radical, in comparison to more incremental, process innovation. This gave 58 sample cases for the
5 radical process innovation sub-group and 75 cases for the incremental sub-group. Descriptive
6 analysis (captured in Table 2) was followed by the assessment of the inner and outer models across
7 the sub-groups using accepted procedures. Furthermore, to assess common method bias arising due
8 to the use of a single source for dependent and independent variables, an ex-post Harman's one
9 factor test was undertaken. The un-rotated factor analysis results reveal that there was no common
10 factor loading on all the measures, thus common method bias was regarded as insignificant
11 (Podsakoff and Organ, 1986). Finally, a post-hoc statistical power analysis was undertaken, which
12 demonstrated strong support for our research model, with an observed statistical power greater than
13 0.99 for both sub-groups.⁶

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30 31 3.3.3 *Interview data analysis*

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33 The findings from the survey responses were further corroborated by undertaking in-depth
34 discussions with 13 executives from the focal industry. These executives did not participate in the
35 online survey. They were selected for the discussions because of their extensive knowledge of the
36 research topic: implementing process innovation (see Table 3). They had an average of 20 years of
37 professional experience each. The interviews were recorded and transcribed; the transcripts were sent
38 back to the participants for validation. A thematic analysis technique was used to interpret and report
39 the interview findings.

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49 -----Table 3 about here-----
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55 ⁶ Used Post-hoc Statistical Power Calculator for Multiple Regression [Software accessed on 22nd Feb 2016], entered
56 probability level as 0.05, number of predictors as three, and the respective observed R^2 and sample size values.
57 <http://www.danielsoper.com/statcalc3/calc.aspx?id=9>
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4 RESULTS

4.1 Quantitative data results

We use the guidelines to test reflective inner and outer models for PLS-SEM (Chin, 1998a; 1998b; Henseler et al., 2009).

4.1.1 *The outer model (measurement model)*

We check that the measures perform adequately across the sub-groups (Chin and Dibbern, 2010) and the reliability and validity of the constructs is assessed across the sub-groups (see Table 4). The composite reliability measure is used, as opposed to the Cronbach's alpha value (Chin (1998a), Henseler et al. (2009)). All constructs report composite reliability values greater than 0.88, so exceeding the 0.7 criterion across the sub-groups. The construct's convergent validity is ascertained because the average variance extracted (AVE) is greater than 0.5 for all the sub-groups' constructs. Finally, discriminant validity is tested in three ways: by the qualitative assessment of face validity, by checking construct cross-loadings (Chin, 1998b) - Table 5, and by checking that the square root of all the sub-groups' construct's AVE is greater than the correlation with the other constructs (Henseler et al., 2009) - Table 6. The bootstrap analyses use 5000 samples and the number of cases for each sub-group.

-----Table 4 about here-----

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4.1.2 *The inner model (structural model)*

We assess the inner model in Table 7 and its paths in Figure 2. Unlike the covariance based-SEM, PLS does not have a global goodness-of-fit index; hence various tests, discussed in Chin (1998b), are undertaken to assess the robustness of the results and to investigate the explanatory power of process innovation. We evaluate the issue of multi-collinearity of the predictor constructs, and find no

concerns as all the VIF values are less than 5 across the sub-groups (Hair et al., 2013). We also undertake blindfolding and find that the model has predictive relevance, since the Q^2 values are greater than zero for both the endogenous variables across the sub-groups (Hair et al., 2013).⁷

The hypotheses are tested in a four-step process: firstly, by inspecting the standardised path coefficients (and their t-values) obtained through bootstrapping (**Error! Reference source not found.**); secondly, by comparing the effect sizes (using Cohen's (1992) guidelines) of the predictor constructs on the endogenous constructs (Table 7); thirdly, by comparing the construct mean values across the sub-groups (Table 8); and fourthly, by assessing the significance of the path coefficient differences (Table 9). Special attention is paid to checking that the standardised path coefficients are at least 0.20 so as to be considered meaningful (Chin, 1998a).

----- Figure 2 about here-----

----- Table 7 about here-----

----- Table 8 about here-----

----- Table 9 about here-----

Quantitative data results

H1 is partially supported, because the direct impact of existing user collaboration on process innovation is significant only for incremental process innovation; it is weak and insignificant for radical process innovation. Further, the size effect of existing user collaboration on process innovation is higher for the incremental process innovation sub-group. Although the path coefficient difference and the mean difference (of the existing user collaboration construct) are as hypothesised, these differences are not significant.

H2 is supported; the direct impact of prospective user collaboration is significant only for radical process innovation. Further, the mean difference of prospective user collaboration is greater

⁷ The distance is set at six. The rule for setting the distance for blindfolding is that the sample size should not be divisible by the distance, and the distance should be set between five and ten (inclusive) (Hair et al., 2013).

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3 for radical process innovation and the difference is significant at 0.00 (two-tailed). Similarly, the
4 difference in the path coefficients for H2 is significant at 0.03 (one-tailed).
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7 H3 is supported because radical process innovation shows a greater impact of investments in
8 KM practices (with the mean difference significant at 0.01 level, two-tailed) and a greater effect of
9 investments in KM practices (the difference in the path coefficients is significant at 0.10, one-tailed).
10
11 Furthermore, the effect size of investments in KM practices on process innovation is larger for the
12 radical sub-group.
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18 In H4, investments in KM practices are expected to mediate the impact of collaboration on
19 process innovation. Baron and Kenny's (1986) three step guidelines are used to test the mediation
20 effect of investments in KM practices on the impact of user collaboration on process innovation.
21 Additionally, Sobel's (1982) test for indirect effect of the independent variables on the dependent
22 variable is undertaken and the results corroborate the inferences drawn on the mediation effect.
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30 Firstly, H4A is not supported. As mentioned above, the impact of existing user collaboration
31 is significant only for incremental process innovation; and this impact is direct thus not mediated
32 through investments in KM practices. Additionally, existing user collaboration has a small effect on
33 investments in KM practices across the sub-groups. This suggests that in the ITS context, existing
34 users are endogenous to a firm's incremental process change. The extraction of value from existing
35 user collaboration seems to happen in conjunction with the normal operation of a KIBS firm.
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43 H4B is supported, as the impact of prospective user collaboration on radical process
44 innovation is fully mediated by investments in KM practices. Firms implementing radical process
45 innovation show a greater impact of prospective user collaboration on investments in KM practices
46 (path coefficient difference is significant at 0.01 level, one-tailed) and in turn a greater impact of
47 investments in KM practices on process innovation. Further support comes from the investigation of
48 the effect size of prospective user collaboration on investments in KM practices across the sub-
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3 groups; this effect is large for radical process innovation and small for incremental process
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5 innovation.

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7 Using our research model, firms implementing radical process innovation in our sample
8 reported a R^2 of 0.56, in comparison to the R^2 of 0.35 reported by incremental process innovation
9
10 firms. Although the evaluation of R^2 depends on the context and the conceptualisation of the
11
12 constructs, scholars propose that an R^2 value of around 0.30 is satisfactory (Chin, 1998b; Henseler et
13
14 al., 2009), and our results meet this criterion. However, the difference in R^2 values (between radical
15
16 and incremental process innovation sub-groups) is not statistically significant, because the 95 percent
17
18 confidence interval for this difference is [0.46, -0.03] includes the value zero (Olkin and Finn, 1995).
19
20 Though, we conclude that KIBS firms can improve the certainty of radical process innovation with
21
22 the use of appropriate user collaboration and KM practice policies; they can demonstrate a predictive
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24 power that is similar to (if not better than) incremental process innovation using our model.
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32 **4.2 Qualitative data results**

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34 Our interviews reiterated the importance of user collaboration for process innovation in ITS firms.

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36 Extracts of our discussion with an executive emphasises this point:

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39 *“[ITS firms] need to employ [a] bunch of people who will understand the unmet needs today*
40 *and a bunch of people who will imagine the future needs and together they can help decide*
41 *what is important for the future. Before you undertake process innovation, go out to your*
42 *existing and prospective end-users and [then] come back and decide what is required.”*
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48 The interviews confirmed H1 that existing user collaboration only seems to influence
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50 incremental process innovation. In the words of some of our ITS executives:

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52 *“Existing users fully understand/comprehend the current process. Their contribution would*
53 *primarily be in the form of suggestions towards enhancements, which translate to change*
54 *requests. [These requests] result in upgrades that are incremental in nature – a release based*
55 *model with minor revisions to the process version every few months.”*
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3 “I agree, if you or I are going through process innovation and engage with existing end-
4 users, who are living in a certain environment and [are] focused on the current rather than
5 the future needs; they are more likely to help with incremental change.”
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10 “For incremental process innovation, we tend to work on the same things or similar themes
11 [...] There is no real variation in our approach to process issues. So we engage with known
12 and current end-users as against trying a new relationship.”
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16 The quantitative data also confirms H2, that collaboration with prospective users’ matters
17 more when firms are interested in radical innovation. This view resonates with the sentiments
18 expressed in the following responses taken from a selection of the ITS executives:
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23 “The best example I can give you, before we went and created a new business model we went
24 to 250 Small and Medium Entrepreneurs, who were all prospective end-users. The power of
25 prediction [of radical process innovation] went incrementally up, because we collaborated
26 with them very effectively to define what is required.”
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31 “If there is larger participation by prospective end-users, then the organisation shows a
32 strong and aggressive drive for process change. Also, by involving the prospective end-users
33 the firm has taken care of the future expectations.”
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38 “New users bring in a fresh perspective which is totally new and unbiased with regard to the
39 existing features and functionality. This fresh perspective and view of process capabilities
40 [...] will] results in a complete overhaul or reengineering of the process; a new process
41 architecture bearing little or no resemblance to the as-is but yet achieving higher capabilities
42 and maturity levels.”
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49 Although the degree of innovativeness differentiates the impact of existing and prospective user
50 collaboration on process innovation, the quantitative analysis found that existing user collaboration
51 influences incremental process innovation directly, and was not mediated by investments in KM
52 practices. ITS firms seemed to be using ongoing engagement with existing users as an effective
53 mechanism to influence incremental process change. Service firms tend to use inexpensive and easier
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3 market research tools (like complaint management, observations and interviews/questionnaires) to
4 search for user ideas; however these tools are intrinsically related to the existing services, and hence
5 ideas generated using these tools lead to incremental innovation (Skiba and Herstatt, 2008). Current
6 users are not only fundamental to the firms' operations, but are endogenous to incremental process
7 change, a view supported by our executive respondents, two of whom said:
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14 *"It is always easier to collaborate with existing end-users, [while] prospective end-user*
15 *collaboration requires organisational will."*
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19 *"Incremental change takes a short term view, and it happens in the current environment, so*
20 *there is less [organisational] focus [...] Remember, in the short term, the organisation is*
21 *unable to alter its competencies (significantly) to respond to market changes, [...or] imitate*
22 *novel technological advances and underlying practices [...Therefore] the current customer*
23 *engagement processes are key for incremental process innovation, as they help the*
24 *organisation to learn and internalise existing end-user knowledge."*
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31 Why does user collaboration affect incremental innovation directly, but radical innovation
32 only indirectly, through investments in KM practices? In the services context, incremental process
33 innovation happens through the ongoing process of value co-creation with existing users, thus
34 requiring no additional resource commitment. However, radical change requires higher investments
35 in KM practices to enhance internal capabilities to translate new (and new combinations of)
36 knowledge into firm-specific outcomes. The executives' summarised the reasons for the divergent
37 strategies as follows:
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46 *"Let me give you a scenario, [an]organisation already had a [quotation] system and was*
47 *working continuously with its stakeholders, including existing end-users, to improve parts of*
48 *the process. The objective was to continually improve the productive and reduce the timeline;*
49 *[thus] incremental improvements just happened all the time. [However...] the organisation*
50 *was challenged to reduce the quotation time drastically for[new] high value customers.[...]*
51 *Based on the need for a radical process change, [...] the organisation committed substantial*
52 *resources [for KM practices], and included prospective end-users."*
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3 *“In order to do radical innovation, humongous commitment towards knowledge management*
4 *is required, [because] the risks are very high and the time it takes to implement radical*
5 *innovation is also very long. In contrast, the problem statement for incremental change will*
6 *primarily come from an ongoing relationship with our existing customers*
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11 *“For me the purpose of collaboration for incremental change is a learning journey;*
12 *[...where] the method by which collaboration happens can happen without the existing*
13 *customer knowing it is going on.[... By contrast,] radical innovation challenges the dominant*
14 *paradigm. So radical innovation is when the trend line bends. [...] The important thing is that*
15 *it [radical innovation] impacts a lot of people and you have to bring [them] with you. The*
16 *business commitment [to KM practices] is not only necessary to convince the people inside*
17 *the organisation, but also essential to get [external] key shareholders on board.”*
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25 Overall, we found that firms implementing radical process innovation showed a greater
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27 commitment in, and enjoyed a greater benefit from, investments in KM practices. This result is
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29 unanimately supported by our executive respondents:
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31 *“I would imagine the in-house competencies [built by the investment in KM practices] limit*
32 *just how radical innovation can be. The whole of IT learned from Xerox; they invented the*
33 *mouse, the GUI, the printer etc. Yet Xerox saw themselves as a photocopying company so*
34 *they did not back any of their own ideas; Microsoft, Apple, IBM etc. did.”*
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39 *“You have to be at your best to achieve radical process innovation, something will trigger the*
40 *process but you need to invest, manage and look at it in a concerted way, whilst the*
41 *incremental change happens in the current environment, so there is less focus – it is about*
42 *improving bit by bit and needs a different culture to radical change.”*
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49 **5 DISCUSSION AND CONCLUSIONS**

50 **5.1 The theoretical contributions**

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52 The study of process innovation is especially vital because the process of interaction between firms
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54 and their users improves the propensity of clients to innovate and enhances the quality of service
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3 provided (Doroshenko et al., 2013). However, promoting process innovation, especially radical
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5 process change, is fraught with difficulty as the evidence shows that process change projects often
6
7 fail to deliver expected results (Abdolvand et al., 2008).
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10 There is keen academic interest in how users and ITS firm collaborate as the viability of such
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12 co-creation and its impact on the firm's performance is not well understood (Santos-Vijande et al.,
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14 2013). Further, there is a lack of consensus on how user collaboration benefits radical as compared to
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16 incremental innovation performance (Gustafsson et al., 2012). We found that user collaboration with
17
18 existing users mainly impacts incremental process innovation. This indicates that current end-users
19
20 are a key source of knowledge for ongoing incremental process change. In contrast, the effect of
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22 collaboration with prospective end-users is significant only for radical process innovation.
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25 While the importance of KM practices to enhance absorptive capacity is well established, the
26
27 understanding of the impact of investments in KM practices on the degrees of innovativeness
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29 (especially radical change) is limited (Lane et al., 2006). Investments in KM practices are essential
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31 for KIBS to transform external learning into firm-specific capabilities (Salter and Tether, 2014).
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33 However, researchers have found it challenging to establish a link between KM and organisational
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35 outcomes (Heisig, 2015); a topic addressed in this paper. ITS firms invest greater resources in KM
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37 practices for radical change, because higher degree of innovativeness pushes the boundaries of
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39 current processes and forces the firm to engage in an extensive search of the environment for new
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41 knowledge (Ritala and Hurmelinna-Laukkanen, 2013).
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45 We also found that investments in KM practices play a crucial role in extracting value from
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47 external (user) knowledge for process innovation. Our findings reinforce the proposition that
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49 continuous communication and ongoing knowledge exchange enhance value co-creation between the
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51 current customers and the service provider. Existing end-users are so familiar that they may be
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53 viewed as endogenous to the service firm's effort to undertake continuous and incremental process
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55 change.
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3 We find that collaboration with prospective users impacts radical process innovation only
4 indirectly, being mediated by investments in KM practices. We argue that radical innovation
5 challenges the firm's current capabilities, knowledge and technology, and triggers the firm's search
6 for novel knowledge from prospective users. However, the extraction of value from new and
7 unfamiliar sources requires greater commitment of resources to enhance internal innovation
8 capabilities. We are, thus, able to validate the theoretical proposition that a firm's innovation
9 capability plays a fundamental role in extracting value from knowledge sources (Lane et al., 2006).
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21 **5.2 The managerial implications**

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23 Process innovation projects often fail to deliver the expected benefits; a problem that particularly
24 applies to radical change. The results obtained by this study are thus intended to provide managers
25 some indications on how user collaboration and investments in KM practices may be adapted to
26 maximise the outputs of radical and incremental process innovation in a KIBS industry.
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33 In relation to user collaboration practices, we find that interaction with existing users seem to
34 be more important for incremental process innovation. This is not surprising as service firms work
35 closely with their users and this ongoing relationship also enables incremental process change.
36
37 However, managers should note that if a higher degree of process innovativeness is desired, this
38 requires them to search for knowledge that is further away from their current paradigm. We find that
39 ITS providers who adopt radical process innovation depend on, and benefit from, prospective users
40 far more than firms implementing incremental innovation. Existing users seem to find it difficult to
41 understand the need for radically new solutions, as they may be blocked by their previous experience
42 (Menguc et al., 2014). Therefore, ITS managers implementing new-to-market processes will gain by
43 evaluating their problem-solving strategy, and by overcoming the current users' functional fixedness
44 issue by integrating new (prospective) users.
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We find that while collaborating with existing users for incremental process innovation may not require significant managerial efforts (as they are very familiar with the firm, and vice versa), just increasing a firm exposure to external knowledge by engaging with prospective users is not enough to translate this into effective radical innovations. Managers should be aware of the fact that translation of the prospective users' novel ideas into radical solutions will depend on a firm's internal capabilities (Gustafsson et al., 2012). This means that in order to benefit from more intense collaboration with prospective users, a higher managerial effort through investments in KM practices is fully needed so as to be able to develop the absorptive capacity required to transform the external learning into capabilities for radical innovations. Our results and discussions with executives show that developing effective KM practices appear to be critical for KIBS firms to be able to benefit from the more distant knowledge residing within these prospective users. Specifically, we find that the three inward-looking KM practices studied (investment in technological change, training and publishing) and the outward-looking KM practices (investments in benchmarking with direct competitors and market leaders) are likely to be more important for ITS firms to extract value from prospective (as compared to existing) users for radical (as compared to incremental) process change.

5.3 Limitations and suggestions for further research

First, the results and conclusions drawn should be viewed in light of the potential sources of bias, operational definitions, focal industry, and sample demographics. Second, over the course of time an innovation may be regrouped across the scale of innovativeness and the distinction between degrees of innovativeness is subjective (Dewar and Dutton, 1986). Third, this paper takes an ex-post view of the differing impact of firm-level factors on radical versus incremental process innovation. Thus, we are unable to corroborate if service firms actually planned the activities to align with their innovation objectives. Fourth, while our group-analysis adheres to the sample size requirements, testing of the research model in a larger sample will reinforce the implications. Fifth, we took a cross-functional

view in this study, but it should be acknowledged that process innovation steps are iterative in nature.

Hence researchers and managers should note that the use of collaboration and investments in KM practices is expected to vary across the process change journey. Therefore it will be beneficial for future studies to test the hypotheses using a longitudinal design.

Although in this study we tried to shed some light on the role that investments in KM practices may have on a firm's absorptive capacity in a KIBS sector, we believe that further research into the implicit relationship between these two concepts will extend the academic and managerial understanding of how external knowledge is translated into firm-specific capabilities and outcomes.

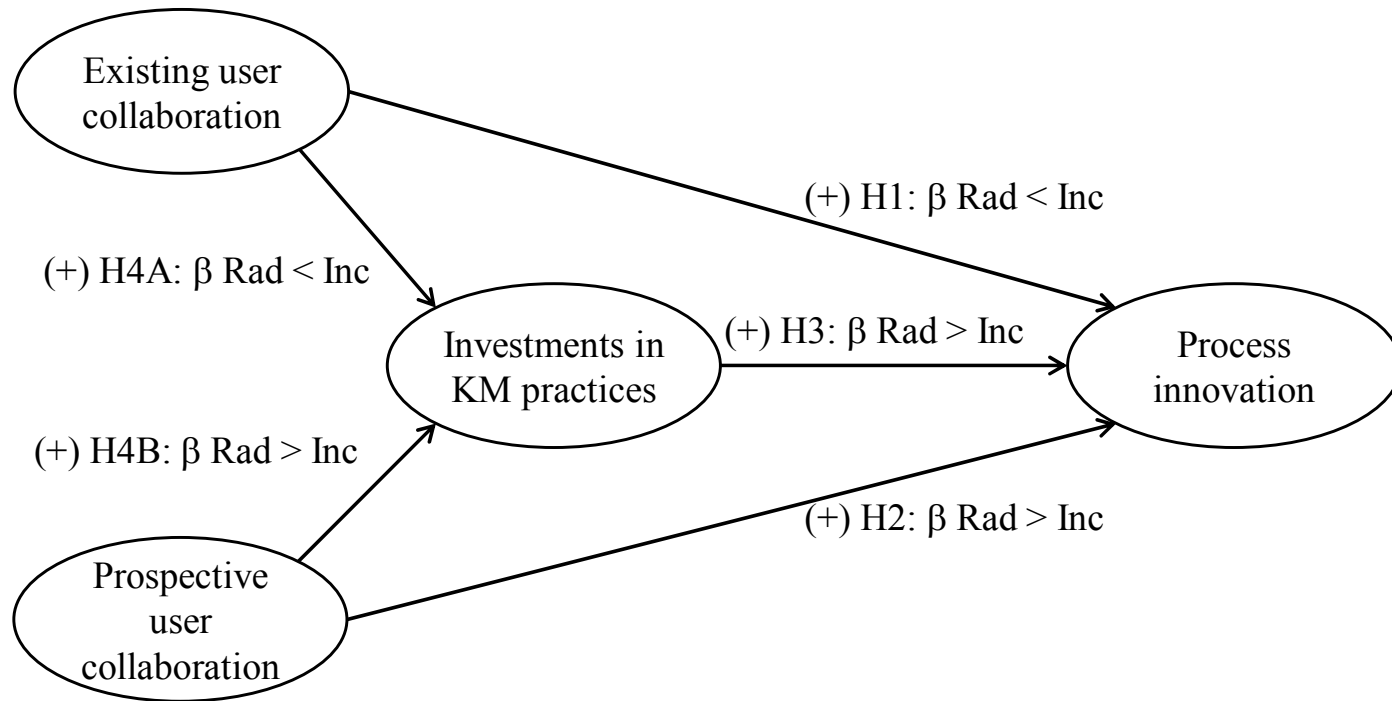
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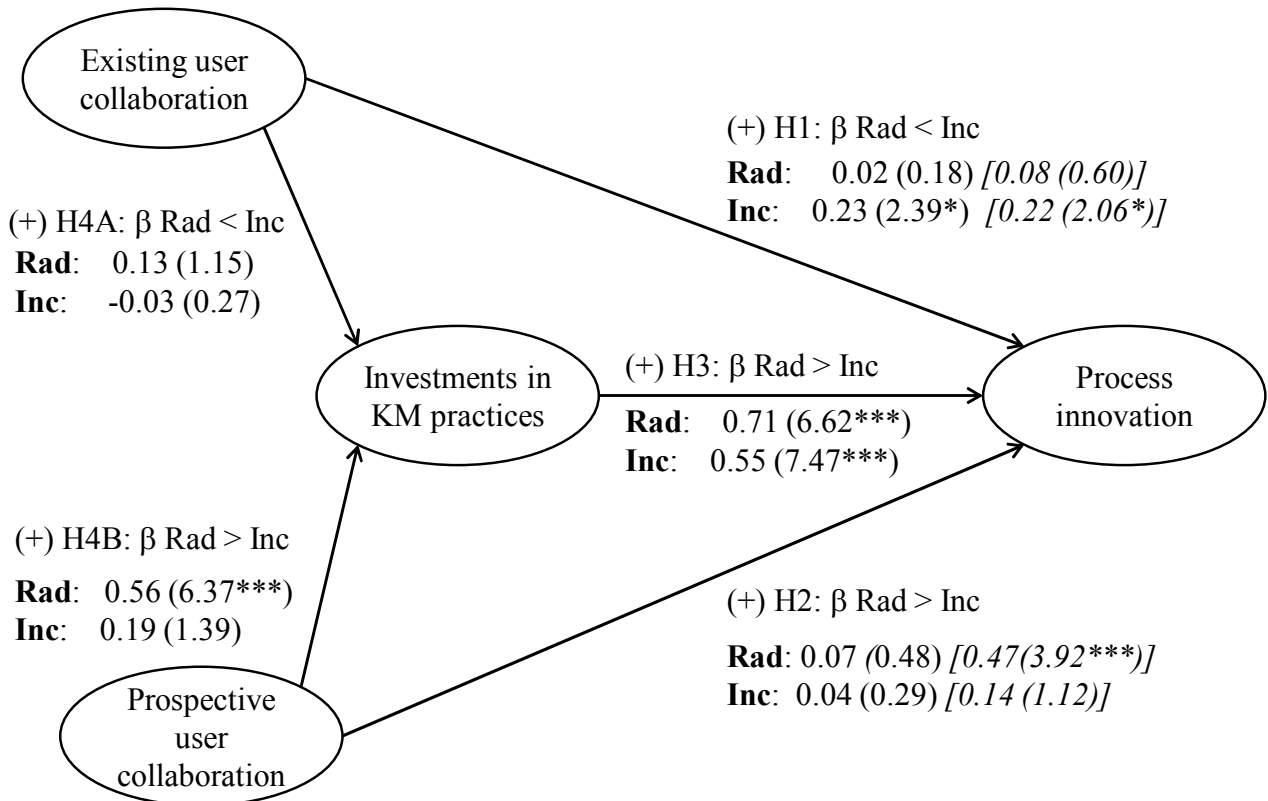
Rad – radical process innovation sub-group

Inc – incremental process innovation sub-group

Figure 1: The differing impact of firm-level factors on process innovation based on the degree of innovativeness

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Notes:
Rad: radical process innovation sub-group, **Inc:** incremental process innovation sub-group
 Numbers represent standardised path coefficients (t-statistic)
 * significant at 0.05, ** significant at 0.01 *** significant at 0.001 (all two-tailed)
 Numbers *in italics and in []* are standardised path coefficients (t-statistic) for direct effect
 Both the direct effect in the absence of the mediator, and the indirect effect through the mediator are studied

Figure 2: Path assessment – standardised path coefficient (t-statistic) for sub-groups

ment

Table 1: The measurement scale and model loadings for the degrees of innovativeness

The measurement scale and model loadings		Process innovation sub-groups (outer loading)	
Construct-Indicators	Measurement scale	Radical	Incremental
<i>Process innovation (PI)</i>	<i>Created five reflective indicators to capture the depth and breadth of process innovation outcomes (OECD, 2005; UKIS, 2012).</i>		
Our organisation has delivered a new or significantly improved process:			
PI1 across the business unit		0.87	0.77
Our organisation delivered ‘process innovation’ that:			
PI2 increased profit margin on sales		0.90	0.76
PI3 led to new customer acquisition		0.89	0.83
PI4 provided competitive advantage	0.93	0.91	
PI5 enhanced capability to deliver customer needs	0.91	0.88	
<i>Investments in KM practices (IKM)</i>	<i>Created five reflective indicators. Three indicators captured inward-looking investments in KM practices (Jones and Mahon, 2012; UKIS, 2012) and two indicators studied the outward-looking investments in KM practices of benchmarking (Camp, 1989; Kang and Kang, 2014).</i>		
In comparison to the past, in the last year our organisations strategy towards ‘process innovation’ has changed and our organisation now:			
IKM1 invests more in technological changes		0.74	0.85
IKM2 invests more in training		0.82	0.70
IKM3 publishes more case studies, articles, papers and sections in a book		0.80	0.78
At the beginning of ‘process innovation’, our organisation benchmarked the process against best practices:			
IKM4 with direct competitors	0.74	0.74	
IKM5 with market leading companies	0.75	0.76	
<i>Existing user collaboration (EEU)</i>	<i>Created one reflective indicator based on the definition adopted.</i>		
The end users that collaborated in ‘process innovation’ with our organisation:			
EEU1 were existing end users	1.00	1.00	

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The measurement scale and model loadings		Process innovation sub-	
		groups (outer loading)	
Construct-Indicators	Measurement scale	Radical	Incremental
<i>Prospective user collaboration (PEU)</i>	<i>Created two reflective indicators based on the definition adopted.</i>		
The end users that collaborated in 'process innovation' with our organisation:			
PEU1 were prospective end users from existing market		0.96	0.93
PEU2 were prospective end users from target markets		0.95	0.94
<i>Degree of innovativeness</i>	<i>Created three indicators based on the definition adopted.</i>		
Estimated percentage split of the 'process innovation' delivered by our organisation last year:			
Radical: % new to the market			
Incremental: % new to our organisation			
(add) % significantly improved but not new			

Table 2: Sample descriptive analysis

Demographic		Percent of sample (process innovation sub-groups)	
		Radical	Incremental
<i>Firm size</i>	Small (<=50 employees)	10	5
	Medium (>50 and <=1000 employees)	16	17
	Large (>1000 employees)	74	77
<i>Country pertaining to the process innovation experience</i>	(rest of) Europe	12.1	14.7
	India	24.1	28.0
	North America	22.4	16.0
	UK	29.3	29.3
	Others	12.1	12.0

Table 3: Titles and professional experience of the interviewees

Title	Professional Experience at the time of discussions
Principal Consultant	Over 31 years, roles include: subject matter expert (QMS, ISO, CMMi), consultant (business planning, resource planning and management), Six Sigma (SS)-Master Black Belt (MBB)
Director	Over 21 years, roles include: director, global head - small and medium business solutions, global head – SS consulting
President	Over 24 years, roles include: chief process officer, executive vice president, global business innovation lead, COO, VP continental Europe, CEO of not-for-profit organisation, assistant professor, researcher (holds a doctorate)
Business Transformation Manager	Over 19 years, roles include: business transformation manager, business manager, commercial lead and commercial contracts manager
CEO	Over 14 years, roles include: CEO, facilitator, keynote speaker, trustee of an NGO, software tester, CMM consultant, process improvement consultant, soft skills trainer, accountant
Global Account Executive	Over 20 years, roles include: director level positions within business development, growth and transformation
Sr. Vice President & Global Head - Business Excellence, Six Sigma & Organization Development	Over 20 years, roles include: business strategy and balanced scorecard deployment consultant, lean SS deployment lead, operations manager, lead MBB
Industry Transformation Consultant	Over 20 years, roles include: innovation services lead, business strategy and transformational change consultant, VP, member of journal editorial board, value management researcher, senior lecturer, PhD supervisor and examiner (holds a doctorate)
Corporate Process Improvement Centre of Excellence, Consultant	Over 17 years, roles include: subject matter expert – SS-MBB, process improvement consultant, lead trainer, QA assessor
Consultant Director	Over 23 years, roles include: director of development, consultant director, QA manager, project manager, research officer
Associate Practice Leader	Over 14 years, roles include: associate director – business process management solutions & presales, process improvement consultant, SS-BB, founder and SBU head
Global Account Executive	Over 21 years, roles include: global account executive, strategic global pursuit lead, enterprise client delivery executive, IT portfolio executive, delivery executive
Corporate Process Excellence Consultant; Data Analysis and Metrics Expert	Over 13 years (2013), roles include: SS-MBB, consultant (functional, process improvement), lead trainer for statistics and quantitative methodology, data visualization and analytics consultant

Table 4: The outer model's reliability and validity for the degree of innovativeness sub-groups

Constructs	Process innovation sub-groups			
	<i>Radical</i>		<i>Incremental</i>	
	AVE	Composite reliability	AVE	Composite reliability
Process innovation	0.81	0.96	0.69	0.92
Existing user collaboration	1.00	1.00	1.00	1.00
Prospective user collaboration	0.91	0.95	0.87	0.93
Investments in KM practices	0.59	0.88	0.59	0.88
<i>n (sample size)</i>		58		75
<i>Model R²</i>		0.56		0.35

Table 5: Discriminant validity, the cross loading test

Constructs Indicators	Process innovation sub-groups (outer loadings)							
	Radical				Incremental			
	Existing user collaboration	Investments in KM practices	Process innovation	Prospective user collaboration	Existing user collaboration	Investments in KM practices	Process innovation	Prospective user collaboration
PI1	0.29	0.69	0.87	0.35	0.27	0.43	0.77	-0.05
PI2	0.13	0.68	0.90	0.39	0.10	0.31	0.76	-0.02
PI3	0.05	0.68	0.89	0.61	0.02	0.51	0.83	0.21
PI4	0.20	0.70	0.93	0.52	0.15	0.53	0.91	0.17
PI5	0.21	0.62	0.91	0.31	0.24	0.43	0.88	0.08
IKM1	0.28	0.74	0.72	0.45	-0.08	0.85	0.49	0.20
IKM2	0.31	0.82	0.67	0.51	0.15	0.70	0.40	0.01
IKM3	0.12	0.80	0.47	0.36	-0.16	0.78	0.44	0.13
EEU1	1.00	0.27	0.19	0.24	1.00	-0.06	0.19	-0.17
PEU1	0.29	0.60	0.52	0.96	-0.20	0.15	0.14	0.93
PEU2	0.16	0.53	0.40	0.95	-0.13	0.20	0.05	0.94
IKM4	0.08	0.74	0.49	0.40	-0.05	0.74	0.33	0.19
IKM5	0.17	0.75	0.44	0.53	-0.05	0.76	0.41	0.18

Note: the numbers in bold are the highest outer loadings for the indicators. All indicators show higher correlation with their construct, as compared to other constructs.

Table 6: Discriminant validity, the correlations of constructs and $\sqrt{\text{AVE}}$ test

Constructs	Process innovation sub-groups (correlations)							
	<i>Radical</i>				<i>Incremental</i>			
	A.	B.	C.	D.	A.	B.	C.	D.
A. Existing user collaboration	<i>n/a</i>				<i>n/a</i>			
B. Investments in KM practices	0.27	0.77			-0.05	0.77		
C. Process innovation	0.19	0.75	0.90		0.2	0.54	0.83	
D. Prospective user collaboration	0.24	0.59	0.49	0.96	-0.17	0.19	0.10	0.93

Note: The **bold and italicised numbers along the diagonal** are square root of AVE, and *n/a* is entered for a single-item construct

Table 7: Inner model assessment and goodness-of-fit indices for the degree of innovativeness

Endogenous constructs	Radical process innovation						Incremental process innovation					
	VIF Values	R ²	Adj. R ² _a	ΔR ²	f ² _b	Q ² _c	VIF Values	R ²	Adj. R ² _a	ΔR ²	f ² _b	Q ² _c
<i>Process innovation</i>		0.562	0.54			0.44		0.35	0.33			0.20
Existing user collaboration	1.08			0.56	0.01		1.03			0.301	0.08	
Prospective user collaboration	1.52			0.58	-0.03		1.07			0.35	0.00	
Investments in KM practices	1.54			0.27	0.68		1.04			0.07	0.42	
<i>Investments in KM practices</i>		0.37	0.33			0.21		0.04	0.01			0.02
Existing user collaboration	1.06			0.35	0.03		1.03			0.04	0.00	
Prospective user collaboration	1.06			0.08	0.46		1.03			0.00	0.03	

^a Adjusted R² = 1-(1-R²)*(n-1)/(n-v-1), where n=sample size and v=number of predictor variables for the endogenous construct

^b f² = (R² included-R² excluded)/(1-R² included)

^c cross-validated redundancy approach

Table 8: Construct mean comparison across the degree of innovativeness sub-groups

Constructs	Process innovation sub-groups		Mean difference	t-test for Equality of Means	
	Radical Mean (Std dev)	Incremental Mean (Std dev)		t-statistic	Sig.(two-tailed)
Process innovation	2.73 (1.43)	2.92 (1.33)	-0.188	-0.78	0.44
Existing user collaboration	2.14 (0.86)	2.07 (0.88)	0.07	0.45	0.66
Prospective user collaboration	3.18 (1.44)	4.42 (1.49)	-1.24	-4.82	0.00
Investments in KM practices	3.18 (1.23)	3.82 (1.32)	-0.64	-2.84	0.01

The Levene's test for equality of variances reported significance values of greater than 0.05 for all constructs, thus the t-test values are reported for 'equal variances assumed'

Mean values are in reference to a one (strongly agree) to seven (strongly disagree) scale, thus lower values indicate higher process innovation, existing user collaboration, prospective user collaboration, and investments in KM practices results.

Table 9: Differences in standardised path coefficients across the degree of innovativeness sub-groups

Pathways	t-statistic of path coefficient differences ^a	Sig. ^b
H1 (+) Existing user collaboration -> Process innovation (direct effect in the absence of the mediator)	-0.84	ns
H2 (+) Prospective user collaboration -> Process innovation (direct effect in the absence of the mediator)	1.91	0.03
H3 (+) Investments in KM practices -> Process innovation	1.28	0.10
H4A (+) Existing user collaboration -> Process innovation (indirect effect)		
Existing user collaboration -> Investments in KM practices	1.04	ns
Existing user collaboration -> Process innovation	-1.87	0.03
H4B (+) Prospective user collaboration -> Process innovation (indirect effect)		
Prospective user collaboration -> Investments in KM practices	2.21	0.01
Prospective user collaboration -> Process innovation	0.19	ns

^a Standardised path coefficients' differences are calculated between radical and incremental process innovation sub-groups.
^b One-tailed test for significance, ns means the t-statistic of the difference is not significant.