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as an organising framework for future research**

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## **Extending understanding of IT innovation using innovation theory as an organising framework for future research**

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### **Abstract**

*Information technology innovation has been predominately examined from a diffusion and adoption perspective. Whilst this research is important, the existing body of knowledge concerning the developing, implementation and use of information technology potentially ignores key dimensions of innovation theory found within the innovation literature. This paper extends the idea of utilising an innovation perspective to consolidate definitions and understating of information technology innovation. It presents an initial methodological approach to address important dimensions of innovation theory and illustrates the potential of this approach with preliminary data from a case study involving IT innovation practice.*

### **Keywords**

Innovation, Information Technology, Information Systems

### **INTRODUCTION**

Information technology development and diffusion is often associated with innovation (Brynjolfsson and Saunders 2010). Information technologies are inherently configurable and/or programmable; they are routinely adapted and modified for use in variety applications across a range of domains. The general-purpose nature of information technology provides significant opportunity for information technology to become involved in innovation activity (Brynjolfsson, E & Hitt 2000).

The computer science and information systems literature (IT/IS literature) contain substantial theoretical and empirical knowledge concerning the development, implementation and use of information technology. This body of knowledge provides insight into what information technology innovation (IT Innovation) might be and what activities are involved. It outlines the importance of the diffusion and adoption of information technology (Cooper and Zmud 1990), the user acceptance of information technology (Agarwal and Prasad 1997; Davis et al. 1989), the complementary nature of information technology assets to produce organisational benefits (Brynjolfsson and Hitt 1998; Brynjolfsson and Kemerer 1996; Dedrick et al. 2003) and the contribution of external knowledge and markets for the supply of services and technical modification of information technologies (Iansiti and Richards 2005; King et al. 1994; Raymond 1999).

The IT/IS literature also discusses models concerning methods of design and development. The methodologies are many and varied but typically focus upon solving problems or exploiting opportunities via a process of planned design, construction/development and deployment using information technology. Within the literature these processes often conceptualised as linear models of staged activity.

However when contrasted with the innovation literature, the IT/IS literature does not appear to capture the range of factors often identified within innovation theory. Rarely is IT innovation differentiated clearly from IT development, implementation and use and there are often implicit assumptions that IT innovations are easily engineered and progress in a planned linear manner. Furthermore, conventional diffusion based models tend to rely on overly simplistic definitions of what IT innovation is, how it occurs and what factors are critical to its success and/or sustainability.

Innovation theory provides some complementary and contrasting views of innovation in the context of what is provided in the IT/IS literature. The innovation literature highlights the pervasiveness of innovation along with the role of collaboration amongst customers (users), competitors and suppliers operating within “innovation systems” (Edquist 2005; Malerba 2002). However the innovation literature also emphasises the complex nature of innovation, the role of uncertainty (Nelson and Winter 1977) and the emergent non-linear nature of technological development (Kline and Rosenberg 1986), which is historically constrained and particularly dependent on the developments and decisions made in the past (Arrow 2000; David 1986).

A large portion of the empirical experience associated with innovation theory is consolidated within Oslo Manual (OECD/Eurostat 2005) which can be distilled down to a high level conceptual model which can be used as an organising instrument for investigating IT innovation.

This paper highlights that there challenges with respect to how IT innovation should be defined and understanding what factors are involved with IT innovation. It presents an initial methodological approach to overcoming these challenges and illustrates with preliminary data from a case study involving IT innovation about how this approach may deliver new insights on understanding IT innovation.

## **IT INNOVATION AND THE IT/IS LITERATURE**

A number of important research streams exist within the IT/IS literature that deal with the development, implementation and use of information technology. A great proportion of the IT/IS literature deals with IT innovation within the context of diffusion and adoption (Chin and Marcolin 2001; Fichman 2004; Lucas et al. 2008).

IT innovation research was initially influenced by Rogers (1962) diffusion of innovations theory, although a range of theories also exist pertaining to the technology acceptance (Davis et al. 1989), technology fit (Goodhue and Thompson 1995) and models for successful implementation (Delone and McLean 1992; Delone and McLean 2002).

Over time, theory concerning IT innovation diffusion and adoption has fragmented. Several unsuccessful attempts have been made to unify or consolidate the various theories using an innovation perspective. Kwon and Zmud (1987) proposed an alternative diffusion model which was adapted from the organisational change management literature (Cooper and Zmud 1990). Swanson (1994) approached the diffusion and adoption phenomena from an organisational innovation perspective. It is one of the few studies to touch on a discrete definition for IT innovation, describing it (in the context of information systems) as “the organisational application of information technology” (Swanson 1994). A number of empirical studies of have since progressed using the organisational innovation perspective (Carlo et al. 2011; Grover et al. 1997; Wang and Ramiller 2009) edging closer to some of the main stream concepts found in the innovation literature.

Research conducted in the late 1990s also developed a comprehensive body of knowledge concerning the economic and organisational value of information technology investments. Part outcome of this research has been to establish the pathways by which information technology investments (innovation and adoption) generate value. Empirical studies point towards three major pathways: (1) Capital deepening – by providing increased access to information technology capital which is then used as a substitute for labour (Dedrick et al. 2003); (2) Multifactor effects – using information technology to induce improvements in other non-labour elements e.g. communication and collaboration, potentially resulting in “spill over effects” where the benefits of the information technology development are accrued beyond the initial investors and suppliers (Brynjolfsson and Hitt 1998; Brynjolfsson and Kemerer 1996; Dedrick et al. 2003); and (3) Structural deepening – the establishment of new specialised industry sub-sectors to improve and continue to support the development of information technology platforms, systems devices and components (Arthur 2009).

Successful outcomes and/or the realisation of economic benefits associated with information technology investment are often linked to a range of complementary organisational factors. These “firm effects” have been shown to have significant impact. Brynjolfsson & Hitt (1998) emphasise that up to half of the value generated by information technology investments are influenced by unique characteristics within the using organisation although it is suggested that configuring these unique characteristics was “costly and time consuming”.

Many information technology innovations are continuous incremental improvements on an existing information technology. Beyond the diffusion and adoption research paradigm there is also a substantial body of knowledge relating to the design and development of information technologies. For most parts, this literature presumes that most IT innovations are “engineered”. By engineered we are referring to the standard engineering practice associated with planning and constructing new versions of known or pre-existing technologies (Arthur 2009).

The development and deployment of IT/IS also appear to progress through community of producers, researchers, consumers and competitors. Iansiti & Richards (2005) make a distinction between two methods of competition

within an information technology ecosystem, suggesting actors compete by either providing applications or platforms. Applications are defined as products or services which solve specific problems or perform specific functions. Platforms on the other hand, are defined as a set of tools or components that provide the building blocks for applications.

The computer science and information systems literature also contain substantial theoretical and empirical work relating to the methods of design and development. The knowledge of these methods is also widely diffused within practice. Such methods often conceptualised as staged linear models of activity. Notable models include the systems development lifecycle (Royce 1970), soft systems methodology (Checkland 1989) and agile methods (Highsmith and Cockburn 2001). These methods whilst often prescriptive undoubtedly provide insight into some of the activities involved in IT innovation.

### **Challenges defining and understanding IT Innovation**

Despite the significant body of knowledge relating to the development, adoption and use of information technology, IT innovation is rarely defined or described within the IT/IS literature. It is either arbitrarily implied or encapsulated into the diffusion and adoption paradigm.

The role of the IT/IS diffusion and adoption literature is very important for understanding IT innovation (Fichman 2004; Ruttan 1996). It provides insights into the nature of IT innovation and what factors or dimensions are important for the successful adoption of IT innovations. Fichman (2004) highlights the contributions of this research, but also emphasise that IT innovation research needs to move beyond this “dominant paradigm” to further understand what may be other important dimensions IT innovation.

Diffusion of innovation theory (DOI) used in the context of IT/IS development has also been the subject of substantial criticism. DOI assumes that technologies are discrete packages that diffuse into a fixed homogenous environment. This has been found to be particularly untrue in the case of large complex information systems where implementation and adoption can be subjected to a range of alternative social interpretations in relation to context (Lyytinen and Damsgaard 2001).

DOI also implies that the adoption process follows a rational process of careful analysis and selection in order to maximise the benefits of the proposed adoption (Lyytinen and Damsgaard 2001). A notion particularly at odds with principles of uncertainty and entrepreneurship found within the innovation literature.

There are also problems determining a definition for operational adoption and distinguishing between acquisition at the organisational level and adoption at the end-user or individual level (Bayer and Melone 1989); and issues with the under emphasis of unsuccessful, abandoned or incomplete innovations (Rogers 1995) and under representing the influence of historical choice and path dependence (Arthur 1989; David 1986).

The theoretical and empirical work relating to IT/IS development and engineering is also an important source of knowledge relating to IT innovation. The knowledge relating to development and project management methodologies within the IT/IS disciplines provide considerable insight into activities and process involved in the successful development and adoption of IT/IS. However this knowledge is bound to notions of prescriptive staged/linear development processes and whilst this can be helpful, it potentially ignores the interactive and emergent dimensions of innovation. For example – what activities are actually undertaken for IT/IS invention or modification; and how and why are particular IT/IS artefacts invented, modified and used. The IT/IS artefact often goes unspecified in much of this work (Orlikowski and Iacono 2001; Weber 2003).

Theoretical and empirical work concerning the development, implementation and use of information technology still remains somewhat fragmented (Agarwal and Lucas 2005), particularly in the context of defining and understanding IT innovation. The existing IT/IS research is useful but it needs to be linked at least the theoretical level in order to establish a consolidated view of IT innovation. Linking these theories through the common notions of invention, innovation and diffusion have already been shown to assist understanding IT innovation. Extending this work and incorporating additional dimensions of innovation theory may also assist to consolidate IT innovation research.

### **INNOVATION THEORY**

Definitions of innovation are routinely traced back to work of Austrian economist and social scientist Joseph Schumpeter (OECD/Eurostat 2005). Schumpeter (1934) proposed that it was possible for an economy to change without the influence of external factors and that the source of these changes would be new combinations of capital and labour. This included (a) the creation of a new good or new quality of good, (b) the creation of a new method of production, (c) the opening of a new market, (d) the capture of a new source of supply, and/or (e) a new organization of industry (Schumpeter 1934).

There is a significant body of research which attempts to explain innovation and its various dimensions and characteristics. The proceeding summary is adapted from Smith (2007) and attempts to provide a concise summary of what has been learned about innovation from this research.

First, innovation is pervasive. There is a broad body of empirical research which demonstrates that innovation occurs across different industries, regions and sectors and that it is not exclusively restricted to high tech industries (Hirsch-Kreinsen et al. 2003). Innovation is uncertain and its outcomes are difficult to predict. In effect it is possible for innovators to take different courses of action to solve a problem even if they have the same resources, capabilities and access to information (Nelson and Winter 1977). Innovation occurs within innovation systems. Innovators operate within institutional systems or ecosystems, collaborating with customers, competitors and suppliers often using common infrastructures and learning systems (Edquist 2005; Tushman 1977). Innovation is path dependent. Many innovations are incremental improvements upon existing products and processes etc. As a consequence innovations are historically constrained and a product of history. This creates opportunities for improvement, modularisation or disruption and change (Arrow 2000; David 1986). Innovation is not a linear process. The idea that innovation follows some laid out sequential process discovery, development and diffusion is more conceptual than reality and the innovation literature now tends to see the process as somewhat emergent following a “chain linked” style of interaction between different actors and activities (Kline and Rosenberg 1986). Finally, innovation is very complex and there are often a range of unique characteristics and dimensions associated with innovation within a specific industry, sector or area of application. Rosenberg (1994) suggests that to understand innovation beyond more general concepts inevitably involves drilling down into the domain to examine the common patterns and cases.

Early studies of innovation focused on collecting data associated with formal research and development (R&D) activities. However it is now widely acknowledged that R&D is only one of a range of activities that can be carried out as part of the innovation process (OECD 2002). The continuous nature of most technological change has also been shown to blur the boundaries between the processes of invention, innovation and diffusion, with many innovation activities spanning across or spilling into invention and diffusion processes (Freeman 1991; Rosenberg 1976; Ruttan 1959).

A collaborative venture between the OECD and the European Commissions’ Eurostat developed a framework to assist researchers with the collection and interpretation of data around innovation (OECD/Eurostat 2005). The Oslo Manual (as it is more commonly referred) provides a comprehensive consolidation of contemporary innovation theory and defines some key areas for data collection relating to innovation. The guidance is not domain or industry specific and is oriented towards innovation phenomena in general.

### **Developing a conceptual model of innovation theory**

Innovation theory highlights the pervasiveness and complexity of innovation, the uncertain and emergent nature of innovation, the role of collaboration within institutional structures and ecosystems along with the lasting implications of historical choices and events. The experience and research knowledge obtained from empirical studies which are outlined in the Oslo Manual (OECD/Eurostat 2005) also help to consolidate and unify the important dimensions of innovation.

Figure 1 summarises the guidance provided by the Oslo Manual and provides a high level model for understanding the scope of contemporary innovation theory.

The core dimensions of this model are (1) the decision to innovate – understanding the reasons, motivations and/or objectives driving innovations; (2) innovation activity – “all scientific, technological, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations” (OECD/Eurostat 2005). This includes activity associated with research and experimental development, the acquisition of capital goods and services, the acquisition of external knowledge and activities associated with implementation and deployment; and (3) innovation outcomes – understanding the economic and social outcomes associated with innovation. Asking about the success or failure of innovation activities and possibly measuring the impact of innovation in terms of organisation performance, degree of novelty, breadth of diffusion and the creative effort required to progress innovation (OECD/Eurostat 2005; Smith 2005).

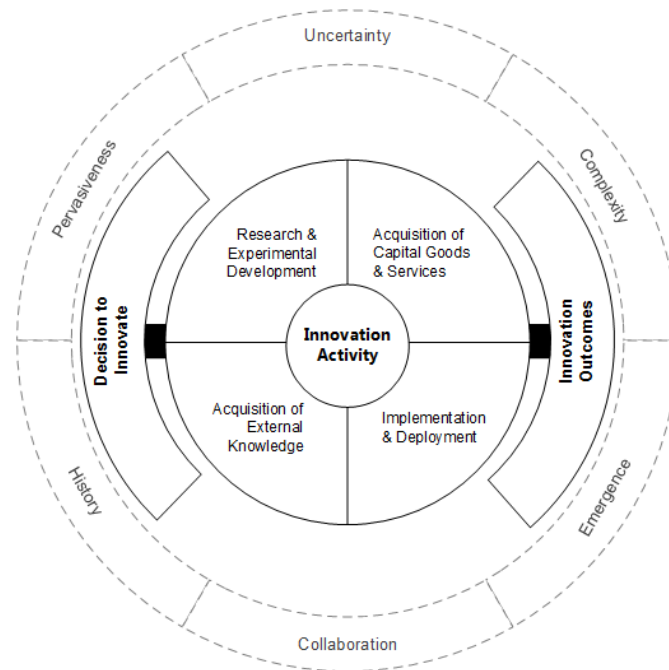


Figure 1 Conceptual Model of Innovation Theory

## HOW CAN INNOVATION THEORY HELP UNDERSTANDING OF IT INNOVATION?

In the context of IT innovation the IT/IS literature appears fragmented and somewhat dominated by diffusion and adoption style research. Whilst attempts have been made to unify this research using organisational innovation theory, this in itself possibly overlooks factors associated with technological product and process innovation. It is not possible to have diffusion and adoption without invention (Hall 2005) and this issue has not gone unexplored with the IT/IS literature (Orlikowski and Iacono 2001).

Contemporary understandings of innovation can assist to provide clarity and improve understanding of IT innovation. The conceptual model inspired by the guidance found in the Oslo Manual illustrates it is possible to abstract innovation theory to level that maybe useful for organising a more detailed enquiry about IT innovation.

Using innovation theory as an organising framework for research could not only assist with the fragmented IT innovation literature, but also provide an alternative theoretical perspective for understanding what IT innovation is and what it might involve.

### Illustrative Case Study

To illustrate the application of innovation theory to the study of IT innovation we provide a case study involving e-commerce systems integration in support of a regional place branding initiative. The setting for this case is an Australian SME operating in a regional travel and accommodation sector. The case focuses on an initiative to reposition the travel and accommodation assets of the business around a strategy to market experiences rather than products and services. The marketing strategy was unique to the geographic sector at the time and the approach to systems integration was also new to the business and rare within the travel and tourism sector.

The innovation featured in this case was ongoing and had commenced some four years prior to the time of data collection. A participant was selected who had been responsible for overseeing IT innovation activity since inception of the initiative. Data was collected using a semi-structured interview process and complemented by field notes. Interviews were then transcribed and summarised to produce a descriptive vignette (Miles and Huberman 1994) and to allow for a preliminary data analysis using the conceptual model of innovation as an organising instrument for a conceptually ordered display (Miles and Huberman 1994).

### Case Vignette

In 2005 the marketing division of the business involved with our case study initiated a place branding strategy which aimed to market experiences at locations where the business operated its travel and accommodation assets. The new marketing strategy included use of online communication channels i.e. property web sites in conjunction with various online travel and accommodation intermediaries.

The initial phase of this strategy included a brand redesign and the establishment of a number of websites for linked to key property and destination assets. Initially the development and hosting of websites was entirely outsourced. Concerned with local availability of reliable hosting services the organisation procured services from interstate service providers to maximise availability and performance. During the initial phase the initiative there was some uncertainty pertaining the overall potential for success and the use of the online channel to support it existing business model. Because of this uncertainty the organisation focused its efforts on web site development and the establishment of supporting online services. Back office business process to support order processing, inventory management and ticketing were left to be manual tasks. Orders were processed by email, with bookings and inventory updated manually property management systems and then on the various website and services. The initial phase proved to be very successful, with up to 5% of all sales being captured online within two years of commencing the initiative. The organisation also won a number of tourism and web design awards.

As online sales began to increase it became evident that the effort required to maintain the back office systems for order capture, accommodation inventory, ticketing would become unsustainable. The organisation responded by entering a new phase of IT innovation. It commenced a search for potential solutions to integrate the new online sales channels with the various back office operational systems. The technical team found a candidate middleware solution which used web services to update inventory between accommodation service providers and various online booking intermediaries. The technical team then assessed the solutions suitability to be extended to its own booking and inventory management systems.

Happy with the prospects for success the organisation progressed with an initiative to implement the middleware and interface the software to manage its accommodation inventory between back office systems, websites and third party intermediaries. In progressing the development of interfaces between systems, technical staff worked closely with the middleware vendor, internal marketing staff and the customer services staff that operated the various online systems. Technical staff were given the dual role of business analyst and software developer. Interfaces for the various online transactional systems were developed using .Net web services and platforms the organisation had already established to support existing operations. Detailed planning and development of a data warehouse also underpinned by the systems integration work. The case study participant emphasised the importance of the development of a formal data model during the information planning process, suggesting it was a major contributor to the final success of the initiative.

After three years sales capture via online channels had increased significantly. The IT technical staff were now intricately involved in its ongoing development and operation. The organisation appointed a project manager to progress with new work and the organisation introduced new change and user acceptance testing procedures to support ongoing development.

The overall initiative was considered a resounding and ongoing success. Innovation involving the use of IT for systems integration contributed significantly to the economic and operational sustainability of the place branding strategy. Automated workflow had reduced the overheads associated with updating some 16 different websites and various back office systems down to a process taking about 10 minutes. There had also been discussions about selling the intellectual property associated with the systems integration to a similar international concern, along with the prospect of including external bookings, inventory and ticketing from affiliated third party tourism operators operating in the same areas as the case study organisation.

### Data Analysis

Activities and events described by the case study participant were extracted from the interview transcripts and ordered in a display structured about the key dimensions of innovation described in our model (see Table 1).

Table 1. Conceptually ordered display

Innovation Dimension	Activities and Events
Decision to innovate	A decision to change the marketing strategy and promote place and experience over product and service features. Systems integration became necessary to sustain the original marketing innovation.
Innovation activity	
<ul style="list-style-type: none"><li>Research and experimental development</li></ul>	IT scope initially constrained because of uncertainty about the potential for success. Constrained the development to website branding and design in order to assess the potential for success.



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	<p>Eventually evolved into a search for a system integration solution resulting in the adoption of a middleware platform, the development of web services interfaces for various back office systems and the establishment of a data warehouse and architectural data model to support integration.</p> <p>Development of the information management component was reported to be highly formalised and planned.</p> <p>IT technical staff also performed worked closely with vendors, marketing staff and customer service staff.</p>
<ul style="list-style-type: none"><li>• Acquisition of capital goods and services</li></ul>	<p>Procured services for externally hosted web servers and located them to maximise availability amid concerns of network infrastructure and service reliability within the region they operated.</p> <p>Utilised third party online travel and accommodation intermediaries to manage some inventory.</p> <p>Acquired a middleware product to manage the update of inventory across systems and online services.</p> <p>Utilised existing platform investments to progress interface development.</p>
<ul style="list-style-type: none"><li>• Acquisition of external knowledge</li></ul>	<p>Outsourced the design of websites.</p> <p>Used a high proportion of in-house development skills for interfacing to back office systems. Utilised developers as business analysts to work with internal customer and user requirements.</p> <p>Engaged the middleware vendor to assist with product configuration and interfaces associated with the middleware endpoint.</p>
<ul style="list-style-type: none"><li>• Implementation and deployment</li></ul>	<p>Struggle with effort required to update bookings and inventory following the web site implementation.</p> <p>Eventually introduced a formal project management and user acceptance and testing process.</p> <p>Followed a phased and incremental implementation and deployment process for various components and features.</p>
Innovation outcomes	<p>Successfully captured 5% of all sales within two years, Significant portion of sales captured using the online channel after three years.</p> <p>Overall place branding initiative resulted in competitive advantage, with the IT innovation contributing to economic sustainability.</p> <p>Won a number of web design and tourism awards.</p> <p>Potential diffusion of innovation to external parties and affiliates.</p>

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## DISCUSSION

Whilst the interpretative limitations of the case analysis are acknowledged, the analysis provided in table 1 illustrates how the conceptual dimensions of innovation theory can be used to explore IT innovation practice.

From an IT innovation perspective the decision to innovate is concerned with why organisations and individuals choose to innovate with information technology, remembering that IT innovation may be the output of innovation activity, an input to innovation activity or possibly both. The illustrative case study shows IT artefacts being a key output and a major enabler of innovation.

Innovation activity comprises “all scientific, technological, financial and commercial steps which actually, or are intended to, lead to the implementation of innovations” (OECD/Eurostat 2005). For an IT innovation this involves the development, assembly and/or modification of information technology. The case study demonstrates many aspects of IT development within a single innovation. A particularly interesting facet of the case study was presence of possibly a hybrid development process. The overall project was somewhat emergent or incremental. The initial branding process that involved the development of several property oriented web sites, did not take on consideration for the back office operations. That’s not to say it wasn’t known to be an issue, it was simply scoped out of the initial stage. However as the systems integration progressed and it became

apparent what would be involved, a highly planned process followed. Whilst the process wasn't linear but it certainly wasn't entirely emergent.

The case study also demonstrates how the IT artefacts were involved. The middleware technology was shown to be integral. Mere adoption of the technology was not enough to progress the innovation and significant design and development work was required to successfully deploy that technology to the objectives of the innovation. Innovation theory mandates that information be collected about the role of capital goods and services and the IT/IS has been criticised for not paying sufficient attention to the IT artefact (Orlikowski and Iacono 2001). However, the complementary relationship between IT artefacts and other organisational assets is a concept consistent with both the innovation literature and the IT/IS literature.

External collaborators and internal users were also shown to be important to progressing this innovation.

The case study establishes that this innovation was successful. It also establishes that the success of this innovation was highly dependent on information technology. An important differentiation between invention and design and the notion of innovation is that innovation involves putting invention and designs into practice (Fagerberg 2005).

Beyond asking about the success or failure of innovation activities recent innovation studies have attempted to measure the impact of innovation in terms of impact on turnover, degree of novelty, breadth of diffusion and the creative effort required to progress innovation (OECD/Eurostat 2005; Smith 2005). With the exception of impact on turnover the illustrative case study also identifies the novel and broader diffusion aspects of this innovation.

The case study analysis also highlights the value of using a multiple theoretical perspectives to investigate empirical data. It reveals observations of events that are inconsistent and contradictory between the two perspectives, supportive of one but not the other or consistent with both perspectives.

## CONCLUSION

This paper presents an initial methodological approach to address issues of definition and understanding associated with IT innovation. It illustrates with preliminary data from a case study of IT innovation practice how this innovation theory can provide a method of theoretical triangulation (Denzin 2009) for IT innovation.

The IT/IS literature provides the current empirically tested understanding of IT innovation; but innovation theory contains guidance for potentially untested knowledge of IT innovation, alternative explanations for the same mechanism or the possible existence of multiple mechanisms and structures.

We acknowledge that the method of analysis used in this paper is inadequate for generating acceptable theory but propose that the method show promise and that more rigorous qualitative methods in conjunction with multiple case studies of IT innovation practice may yield better results.

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