IT Impact on Innovation at the Individual and Group Level – A Literature Review

Stanislav Mamonov
Montclair State University
stanislav.mamonov@montclair.edu

Richard Peterson
Montclair State University
richard.peterson@montclair.edu

Abstract

Information technology (IT) is broadly recognized as an important element that supports innovation within organizations, however there has been relatively little integration of research in Information Systems on this topic. In this literature review, we examine and synthesize studies on the effects of IT in supporting innovation at the individual and group levels of analysis published in the past ten years in the leading Information Systems journals. We find that although innovation is inherently done by individuals and groups, there have been relatively few studies that examined how technology affects the innovation process and outcomes at the individual or group level. Further, much of the extant research is narrowly focused on incremental innovation. Through synthesis of the extant research, we identify opportunities for future research on the role of technology in innovation.

1. Introduction

Innovation, i.e. development of new products and services as well as entry into new markets, has been long recognized as an essential element of business strategy [55]. Information technology plays an important role in supporting innovation within organizations [38], as well as being a component of innovative product [41] and service offerings [35], and a conduit into new markets [41]. While there is a growing body of literature examining the role of technology in supporting and enabling innovation across different contexts, there has been little theoretical integration within this stream of literature [20].

We take the initial step towards a theoretical integration of the emergent insights here by conducting a literature review of innovation-related research. This study is a part of a broader project that examines interdisciplinary research on the effects of IT on innovation across different levels of analysis. Here we present the results of the initial study which follows the recommendations on literature review development [55] and focuses on the top Information Systems journals as sources of studies with significant theoretical impact.

The following research questions guide our literature review. RQ1: *What are the focal innovation-related constructs at the individual and group levels of analysis in Information Systems?* RQ2: *Which theoretical perspectives are being applied in studying IT-enabled innovation at the individual and group levels of analysis?* RQ3: *What is known about the role of IT in supporting individual and group level innovation?*

We find that although there have been over 400 studies which examined the role of technology in innovation published in the leading Information Systems journals over the past ten years, only 15 of them conducted analysis at the individual or the group level. Our examination of the extant research through the lens of an innovation typology that distinguishes internal/external, incremental/radical, and closed/open innovations reveals that much of the published research has been focused on incremental innovations. Further, all studies in our review that included innovation-related outcomes are limited to ideated innovation, i.e. innovation that has been conceived, but has not been commercialized yet. The lack of research on commercialized innovation limits the practical relevance of extant research [52] and points to opportunities for developing this stream of research to better understand how information technology can contribute business value through innovation.

The remainder of the manuscript is structured as follows. In Section 2, we provide a brief overview of innovation-related research that guides the framing of our analysis. In Section 3, we discuss the methodology underlying the selection of the studies included in this review, in Section 4, we present the analysis of the selected literature and, in Section 5, we discuss the implication of the results.

2. Theoretical background

Innovation has been the focus of research across disciplines [8, 21, 42, 46] and a full review of prior work is beyond the scope of the current manuscript. Here we

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summarize two themes in the organizational innovation research that are relevant to our work. First, we outline a typology that distinguishes different types of innovations. Different innovation types present different challenges and may benefit from different types of IT. Second, we summarize the key factors that have been shown to have a significant effect on innovation in management research. Understanding the organizational factors that impact innovation can help us understanding the interplay between the IT and these organizational factors.

2.1. Innovation and innovation types

To understand how information technology can affect innovation at the individual and the group levels within organizations, we need an operating definition of innovation. While many competing definitions of innovation have been proposed [14], we draw on the definition recently developed by Anderson *et al.* [5] which emphasizes that innovation as a concept describes both the *process* and the *outcomes* of "attempts to develop and introduce new ways of doing things." This conceptualization of innovation covers a very broad range of activities and outcomes. With the goal of identifying more coherent subgroups of innovation-related studies, we further draw on several established typologies of innovation that distinguish 1) *internally* versus *externally* focused 2) *incremental* versus *radical*, and 3) *closed* versus *open* innovation [13, 33, 40].

Internally focused innovation aims at developing new ways of doing things within the organization, whereas externally focused innovation aims at developing new product or service offerings for the markets [15]. The distinction between incremental versus radical innovation is determined in relation to the starting state [16, 17]. Radical innovations are often discussed as disruptions within industries because they introduce fundamentally new products or services and reshape the markets [17], whereas incremental innovations seek to add features or functionality to existing products or services. Internally focused radical innovations reshape value creation within the organizations, commonly offering substantial cost savings and scale benefits to the innovating organizations [27].

Open innovation is distinguished from closed innovation by the participation of external agents, e.g. partners and customers in the innovation process [13]. Open innovation poses novel challenges in terms of structure and governance related to the external agent participation in the innovation process [18, 22].

Prior analysis of innovation-related studies in management noted that innovation success is affected by individual and group factors as well as the context within which the innovation is being developed [5]. Different types of innovation contexts present different environmental considerations. By focusing on the specific innovation context subtypes, we aim to synthesize the insights from extant research on the role of IT within the specific contexts and identify opportunities for further research.

2.2. Organizational factors that affect innovation

Innovation management has been a very active area of research in management and several authors have offered a synthesis of extant management research [2, 3, 4, 36, 43]. We draw on Anderson *et al.* [4] for a summary of factors identified through a systematic analysis of top management journals. In as much as technology can be utilized to support innovation by individual users and groups, the list of known individual and group constructs is helpful in understanding how IT can affect the underlying individual and group processes and outcomes. Anderson *et al.* [4] provide the following list of factors that have been shown to affect organizational innovation at the individual and group levels of analysis.

Individual	Group
Personality (self-confidence, openness to experience, originality, etc.)	Team structure (minority influence, cohesiveness, longevity, etc.)
Motivation (intrinsic/extrinsic, determination to succeed, etc.)	Team climate (participation, vision, norms for innovation, conflict, constructive controversy, etc.)
Cognitive ability (intellect, task-specific knowledge, divergent thinking, ideational fluency, etc.)	Team composition (heterogeneity, education level, etc.)
Job characteristics (autonomy, span of control, job demands, support for innovation, etc.)	Team processes (reflexivity, integration skills, decision-making style, etc.)
	Leadership style (democratic, participative, etc.)

3. Methodology

In developing this literature review, we follow the guidelines in [55]. The present study is a part of a larger effort focusing on a comprehensive examination of the role IT in enabling and supporting innovation. Google Scholar returns over 3.5 million results for the "innovation and technology" search phrase. Given the overwhelming volume of research in this domain and following the recommendations in [55], we focused this initial review on the research published in the eight journals in the Information Systems (IS) senior scholars' basket of journals which includes *European Journal of Information Systems (EJIS)*, *Information Systems Journal (ISJ)*, *Information Systems Research (ISR)*, *Journal of the Association for Information Systems (JAIS)*, *Journal of Information Technology (JIT)*, *Journal of Management Information Systems (JMIS)*, *Journal of Strategic Information Systems (JSIS)*, and *Management Information Systems Quarterly (MISQ)*.

To select the studies for the analysis we searched the respective journals for articles containing the word "innovation" in either the title, the abstract or the list of keywords. In aggregate, we retrieved 1178 manuscripts across the eight journals. Table 1 summarizes the manuscript count retrieved from each journal.

Table 1. Distribution of innovation-related studies in the senior scholars' basket of journals

	Search results	% contribution
EJIS	24	2.0%
ISJ	146	12.4%
ISR	282	23.9%
JAIS	67	5.7%
JIT	323	27.4%
JMIS	62	5.3%
JSIS	190	16.1%
MISQ	84	7.1%

In the next step, because our focus is on the role of information technology in innovation, we examined the abstracts and, where necessary, full manuscripts to determine whether IT-enabled innovation was a substantive part of each study. We excluded review articles and editorials from our analysis. The remaining set consisted of 432 studies. Next, we examined the studies to determine the level of analysis in each. For this literature review, we selected only the studies at the individual and group level of analysis. We identified 15 empirical and theoretical studies that focus on the role of information technology in innovation at either of these levels of analysis.

4. Analysis

4.1. Theoretical perspectives and focal innovation-related constructs

In the first step of our analysis, we examine the theoretical perspectives and focal innovation-related constructs. We find a broad set of theories being employed in the studies focusing on the individual level of analysis. The theoretical perspectives include theories of individual memory activation [9], information processing [53], personality [28], motivation [23], consumer psychology [19] and social capital [31].

We also find a very broad spectrum of dependent constructs and measures used to capture innovation-related individual perceptions and behaviors. Two studies in our set focus on examining the employee ability to develop innovative ideas or ways of doing work [31, 53]. Two other studies examine idea contributions in online ideation platforms [9, 28] and several studies focus on constructs that are only tangentially related to innovation, e.g. consumer empowerment [19]. Table 2 summarizes the theoretical perspectives and the associated innovation-related construct measurements at the individual level of analysis.

Table 2. Theories and innovation-related construct measures at the individual level of analysis

Study	Theoretical perspective	Innovation-related measurement construct and method
[31]	Social capital	Not explicitly defined Survey
[50]	Social capital	Entrepreneurial success
[19]	Consumer empowerment theory	Consumer empowerment Survey
[9]	Spreading in associative memory	Number, depth and breadth of generated ideas.
[23]	Game theory	Knowledge transfer
[53]	Technostress	ICT-enabled innovation Survey

[28]	Machiavellianism	Quantity of ideas and comments contributed in an online innovation platform.
[39]	Theory of IT repurposing	Theory development, no empirical data.
[24]	Inductive study relying on comparative causal mapping	Effective knowledge sharing
[30]	Diffusion of innovation	Innovation legitimacy

At the group level of analysis, we find fewer studies, but an equally diverse set of theoretical perspectives. While some studies draw on the well-established dynamic capabilities literature [44], others develop context specific theories [47]. Notably, only one of the studies actually includes a measure of innovation-related activities [44]. Table 3 summarizes the theoretical perspectives and the associated innovation-related construct measurements at the group level of analysis.

Table 3. Theories and innovation-related construct measures at the group level of analysis

Study	Theoretical perspective	Innovation-related construct and measurement method
[26]	Strategy-as-practice	Process focus – no actual measurement of innovation.
[47]	Descriptive case study – no overarching theory	Process focus – no actual measurement of innovation.
[6]	IT institutionalization	Process focus – no actual measurement of innovation.
[44]	Dynamic capability theory	Idea volume and diversity of ideas
[56]	Knowledge contextualization	Collaboration capability

4.2. IT effects on innovation

Focusing on the studies that examined IT-supported innovation at the individual level, we find that along with studies examining the traditional IS constructs, e.g. system quality [19] and IT use [31], there are also studies that propose more novel perspectives on the role of technology in innovation. For example, Nevo *et al*. [39] suggest that technology users can come up with innovative uses for existing IT systems and the authors outline the process that can help guide future research on innovative uses of existing IT systems.

Several studies point to the importance of considering IT users' personality and motives in understanding the technology effects on innovation. For example, a study focusing on the personality effects on the idea and comment contributions in ideation platforms found that Machiavellian personality factors produced a complex set of effects on user activities. While the distrust towards others reduced idea contributions, the need for status was positively associated with commenting. Geng *et al.* [23] further suggest that misaligned incentives can cause people to share purposefully erroneous information leading to shared knowledge distortion. Tarardar *et al.* [53] also point out that while technology is commonly seen as a positive factor in optimizing information flow and generation of new ideas, IT can also be a source of technostress that can undermine operational performance. Table 4 summarizes the focal IT-related constructs and key insights from studies on innovation at the individual level.

Table 4. IT effects on innovation – individual level

Study	Focal IT construct	Insights
[31]	Enterprise-social software use	Enterprise social software enabled inter-team communications are associated with innovative performance
[19]	Experienced tool support	Experienced tool support has a positive effect on perceived enjoyment and perceived empowerment in product co-design platforms.
[9]	No IT-related construct	Priming has a positive effect on the number, breadth and depth of generated ideas.
[23]	No IT-related construct	Game theoretic modeling suggests that misaligned incentives can lead to shared knowledge distortion.
[53]	Technostress creators	Technostress can have a negative effect on technology user performance.
[28]	No IT-related construct	Machiavellianism (distrust of others, amorality, desire for status) have a complex pattern of effects on idea

		and comment contributions in idea generation platforms.
[39]	Technology reinvention theory	Re-appropriation of existing technology for novel uses proceeds through hypothetic reinvention, technology re-composition, reinvention narrative stages before yield novel uses.
[24]	Perceived barriers in software development	Managers and developers differ in their perceptions of the key barriers to effective knowledge sharing in agile projects. Whereas managers are most concerned about the project scope, individual developers are more concerned about the team capabilities.
[50]	Computer efficacy	Successful entrepreneurs have higher general IT self-efficacy
[30]	No IT-related construct	Successful adoption of innovative systems is dependent on the new systems gaining pragmatic, cognitive, normative and regulative legitimacy

At the group level of analysis, we also find a diverse set of IT-related constructs that include routine and innovative IS use, institutionalization of IT, IT business process outsourcing and emergent IT strategy. The studies in this subset also point to the equivocality of IT contribution to innovation. For example, while Roberts, *et al*. [44] show that innovative uses of IT can help in the environmental opportunity sensing, Baptista *et al.* [6] show that IT can also impede innovativeness by institutionalizing incumbent business practices. Sandeep *et al*. [47] emphasize that the success of IT-enabled initiatives is often dependent on an external network of social agents. Henfridsson and Lind [26] further point to the fact the enacted IT strategy often emerges in the process of the planned IT strategy execution and it necessarily accommodates the emergent requirements. Table 5 summarizes the focal IT-related constructs and key insights from studies on innovation at the individual level.

Table 5. IT effects on innovation – group level

Study	Focal IT construct	Insights
[26]	Emergent IT strategy	IT strategy is often the result of a deliberate plan and emergent patterns during the execution process.
[47]	IT business process outsourcing	The success of innovative IT business process outsourcing is dependent on a network of social actors.
[6]	Institutionalization of IT	Institutionalization of IT can have an impeding effect on innovation when incumbent business practices are embedded within IT.
[44]	Routine IS use, Innovative IS use	Innovative IS use can improve both the quantity and diversity of new ideas through environmental sensing.
[56]	System design features	System design features affect business team performance through facilitating knowledge contextualization and consequently increasing collaboration and absorptive capacity of the teams.

4.3. Types of innovation and the role of IT

The success of innovation efforts is greatly dependent on the context [5]. Different types of innovation challenges may benefit from various IT-related systems and processes. To assess the current state of research in the leading journals in terms of the IT contribution to innovation within different contexts, we examined the IT-related constructs that have been studied in different internally versus externally oriented, incremental versus radical, closed versus open innovation contexts.

We find that there is no conceptual overlap in terms of the focal IT-related constructs in our sample and, consequently, there is little opportunity to generalize across the studies. We find some countervailing insights in the internally focused closed incremental innovation contexts. While a study of enterprise messaging system use suggests that such systems can have a positive effect

on the internal process innovation within organizations [31], Tarafdar *et al.* [53] show that IT systems can also introduce information overload and stress, and consequently reduce the opportunities for innovation in internal business practices.

Focusing on open innovation, we find that extant research has primarily focused on externally-oriented innovation efforts and has uncovered that both technical [19] and psychological [24] barriers associated with IT systems meant to support open innovation efforts can interfere with individual contributions. Table 6 summarizes the IT-related construct mappings within different innovation contexts.

Table 6. IT constructs vis-à-vis innovation types – individual level

	Incremental		Radical	
	Closed	Open	Closed	Open
Internal focus	Enterprise-social software use [31] Technostress [53]		Computer efficacy [50]	
External focus		Experienced tool support [19]		Perceived barriers in software development [24]

The studies analyzing the effects of IT at the group level of analysis have concentrated primarily on closed internal incremental innovation. While several studies have noted the potential positive effects of IT on innovation through novel uses of existing IT systems [44], new system design to support group-level innovation [56], and flexible IT strategy that can accommodate new information during innovative project execution [26], we also find a note of caution pointing to the potential role of IT systems in impeding innovation in cases when the IT systems become *de facto* institutionalization structures for incumbent business processes [6]. Table 7 summarizes the IT-related construct mappings within different innovation contexts at the group level of analysis.

5. Discussion

5.1. Theoretical frames and innovation-related constructs

Focusing on the theoretical frames that are used to examine innovation-related phenomena in Information Systems, we find a broad spectrum of theories being employed, ranging from the spreading in associative memory (SIAM) theory that has been leveraged to understand the effects of priming on creativity in

Table 7. IT constructs vis-à-vis innovation types – group level

	Incremental		Radical	
	Closed	Open	Closed	Open
Internal focus	System design features [56] Emergent IT strategy [26] Innovative IS use [44] Institutionalization of IT [6]	IT business process outsourcing [47]		
External focus				

technology-mediated contexts [9] to game theory that provides the foundation for agent-based modeling. We also find a native IS theory which focuses on the process of IT repurposing for novel innovative uses [39].In terms of the dependent innovation-related constructs, we find that most of the group-level studies focus on the processes involved in innovation development without an assessment of the process outcome. At the individual-level, the studies that include measures of innovation outcomes focused primarily on ideated innovation, e.g. the quantity and quality of ideas contributed in ideation platforms [9, 28].

Commercialized innovations are distinct from ideated innovations in that they actually reach the markets and hopefully create value for the companies [29]. The lack of research that examines how technology can be leveraged towards developing commercially successful innovations limits the practical relevance of insights. Xerox PARC research center famously ideated many innovations, including laser printing, but generally failed to harvest the value from these innovations [11, 12]. At the moment, there is little empirical evidence that the processes that have been studied actually produce business value for the firms. This is an important gap in the current research.

5.2. Effects of IT on innovation

Equivocality of IT in the innovation process is the most important insight that emerges in our study. Both at the individual and at the group levels of analysis, we find that technology can have both innovation promoting and innovation impeding effects. At the individual level, IT can facilitate communication to enhance innovation opportunities [31], but IT also be a source of information overload [53]. At the group-level, IT can be useful in sensing external opportunities [44], but IT can also serve as an institutionalization mechanism for established business practices and therefore impede innovation [6].

5.3. Opportunities for further research

Studies focusing on the interplay between individual and/or group factors in the innovation process constitute a small minority of innovation-related research in Information Systems. Only 15 of 432 studies in our sample examined the role of information technology at the individual or group level. Provided that innovation is fundamentally a human activity [7, 37], it is surprising to find the relative lack of research on how information technology affects both individual and group level innovation processes and outcomes.

We found no studies that examined the role of information technology group-based radical innovation development. Radical innovation is recognized as an essential element of long-term organizational success across industries [32, 49, 54] and the lack of research on the effects of technology in supporting group-based radical innovation efforts is a clear opportunity for Information Systems research.

We see relatively little integration of insights from innovation management literature in studies that we reviewed. There are only two studies that considered individual motivations [23] or personality [28] in evaluating information sharing and idea contributions respectively. None of the studies focusing on the group-based innovation considered team structure, team composition, team climate or other group-level constructs known to play a role from the innovation management literature [4]. The integration of known group-level factors and re-evaluation of the effects of technology in technology-mediated group innovation presents an attractive opportunity for further research.

Another surprising finding is the lack of studies that examine the effects of information systems on knowledge sharing in the innovation-related contexts. Knowledge sharing within groups and integration of external knowledge have been shown to be central to the success of innovation efforts within organizations [34, 45]. The effects of technology on knowledge management is a central theme in Information Systems research [25, 45, 48]. There is an opportunity to reevaluate the insights from the decades of research on the role of technology in knowledge management [1] in the innovation related contexts.

Lastly, we did not find any evaluation on the role of technology in the established practice-based innovation frameworks, e.g. the Stanford method or the double diamond method developed by the British Design Council [3, 10, 51]. This is yet another opportunity for future research.

6. Conclusion

This study is the first step in a broader effort to integrate insights from research on the role of information systems in innovation. This review focuses on the individual and group levels of analysis and IT equivocality is the key emergent insight. IT can have both positive and negative effects in the innovation process. Our review also reveals that there has been relatively little research on the role of IT in the innovation process and outcomes at the individual and group levels and the published research has generally left out integration with prior efforts in IS and innovation management research. These observations provide clear opportunities for future studies in IT-enabled innovation.

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Appendix – Study summaries

Ref	Summary
[10]	The study focuses on the use enterprise social systems (ESS) in the UK. It finds that intra-team ESS use is associated with an increase in the routine task performance and Inter-team ESS use is associated with innovativeness.
[6]	A field study focusing on the geographic separation effect in collaboration technology use, involving one co-located and one distributed team at IBM. The authors show that distributed teams rely more on knowledge codification and less on broadcast emails to coordinate their work.
[7]	The study examines processes and contingencies that affect the emergent strategy formulation. It followed four subgroups within an automaker. The study illustrates that strategy formulation is a dynamic process within the organizations.
[13]	The study explores how companies engage in impact sourcing in India. Impact sourcing is bringing digitally-enabled outsourcing jobs to marginalized communities. It shows that Indian entrepreneurs developed a number of different strategies to engage underprivileged communities in servicing outsourced positions.
[1]	The longitudinal study examines the impact of the institutionalization of a particular IT on the strategic awareness and use of IT in the organization. The case study shows that adoption of an intranet at a bank resulted in institutionalization of different business practices within the intranet and made it challenging for management to become aware of novel strategic opportunities.
[4]	The study evaluates factors that affect user empowerment perceptions in product co-creation platforms. It finds that individual characteristics (degree of product involvement, creativity) and the quality of the design tools affect the individual perceptions of empowerment.
[2]	The study looks at how priming affects idea generation. It finds that priming can lead to an increase in the number, breadth and depth of generated ideas.
[5]	The study examines how misalignment of incentives affects organizational learning. Managers with misaligned incentives may distort shared knowledge.
[15]	The study explores how organizations can overcome technostress and support innovation. Innovation support can help reduce technostress and promote innovation.
[8]	The study examines how Machiavellianism affects idea and comment contribution in online ideation platforms. It finds that distrust of others is associated with a greater number of ideas, whereas amorality and desire for status is associated with a lower number of contributed ideas.
[11]	Theory development focusing on novel uses for IT. Novel applications of existing IT develop through stages: hypothetical reinvention, technology recomposition, reinvention narratives, practical experimentation
[14]	The study focuses on actual IT use. It finds that technology use is subject to adaptation of technology and adaptation of task.
[12]	The study examines how the organizational environment affect dynamic managerial capabilities. It finds that innovative IS use, autonomy and innovativeness have a positive relationship with the number and diversity of ideas.