

The Role of IT in Innovation at the Organizational Level – A Literature Review

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Abstract

Information technology (IT) is broadly recognized as an important element that supports innovation, 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 role of IT in innovation at the organizational level of analysis published in the past ten years in the leading Information Systems journals. We find that while much of the research has generally demonstrated positive effects of IT investments on innovation, IT can also be a cause of hyperturbulence in specific industries, and many factors can moderate the returns realized from IT investments. We also note that extant research is grounded in a relatively narrow theoretical foundation and we discuss the opportunities for developing the theoretical base on the role of IT 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 [80]. Information technology plays an important role in supporting innovation within organizations [51], as well as being a component of innovative product [56] and service offerings [48], and a conduit into new markets [56]. 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 [33].

We take a step toward theoretical integration of the emergent insights here by conducting a literature review of innovation-related research at the organizational level of analysis. 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 [49]. Here we present the results of a systematic review [80] that focuses on the top Information Systems journals as sources of studies with significant theoretical impact.

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

We find that much of the published research on innovation is narrowly theoretically grounded in either the resource-based view (RBV) [8, 10] or the dynamic capabilities theories [27]. Much of the published work examines the effects of IT investments on high-level outcomes of innovation efforts reflected in the financial performance of a firm (firm survival, sales, stock price). Studies generally document a positive association between IT investments and firm performance [7, 44], however more recent studies suggest diminishing returns for smaller firms [39] and non-technical sectors of the economy [65]. We also find two native IS theories in our sample. Ning and Tanriverdi [52] highlight the dual role of IT as a source of disruptions in the market and as an essential component of a competitive response to market disruptions. Lusch and Nambisan [28] offer a service-dominant logic perspective on the critical role of IT in innovation that emphasizes resource *liquification*, i.e. decoupling of information from its physical form, as the foundation for service innovations.

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 [12, 33, 58, 63] and a full review of prior work is beyond the scope of the current manuscript.

Here we 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 at the organizational level in management research. Understanding the organizational factors that impact innovation can help in 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 organizational level, we need an operational definition of innovation. While many competing definitions of innovation have been proposed [22], we draw on the definition recently developed by Anderson *et al.* [4] 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 [18, 45, 53].

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 [24]. The distinction between incremental versus radical innovation is determined in relation to the starting state [26, 29]. Radical innovations are often discussed as disruptions within industries because they introduce fundamentally new products or services and reshape the markets [29], 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 [38].

Open innovation is distinguished from closed innovation by the participation of external agents, e.g. partners and customers, in the innovation process [18]. Open innovation poses novel challenges in terms of structure and governance related to the external agent participation in the innovation process [31, 34].

Prior analysis of innovation-related studies in management noted that innovation is affected by firm-level factors as well as the context, e.g. the level of

competition in the industry, within which the innovation is being developed [4]. 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 [1, 2, 3, 50, 60]. Crossan and Apaydin [22] suggest that the key factors that affect organizational innovation can be grouped into three themes: leadership, managerial levers, and business processes.

Leadership encompasses the CEO as well as senior executives within a company and the board of directors. For example, prior research has shown that the CEO’s tolerance for change and the board’s professional diversity are significantly correlated with organizational innovation [23, 35].

Managerial levers encompass a broad spectrum of structures and activities that include a firm’s strategy, line-of-business systems, allocation of resources, organizational culture and organizational learning support mechanisms [22]. Among other results, research in this domain has shown that the alignment of innovation initiatives with the firm’s overall strategy [74], establishment of an organizational climate that is supportive of experimentation [5], and investment in employee development [21] have positive effects on the innovation output of a firm.

Business process related factors cover a wide range of institutionalized processes that enable and support innovation-related activities. These include formalization of the ideation process, innovation portfolio management strategies, systems and tools that support communication and collaboration as well as market entry and development strategies [22]. Prior research in this areas has shown that formalized market opportunity sensing [19], implementation of ideation platforms [13], and systematic approach to market analysis [78] can positively influence organizational innovation.

3. Methodology

In developing this literature review, we follow the guidelines in [80]. 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 [80], we focused this initial review on the research published in the top four Information Systems journals: *Management Information Systems Quarterly (MISQ)*, *Information Systems Research (ISR)*, *Journal of Management Information Systems (JMIS)*, and *Journal of the Association for Information Systems (JAIS)*. Top journals were selected because they emphasize novel theoretical contributions as a key consideration for publication [69] and therefore they serve as a good lens for identifying the core theoretical discourses in the published literature.

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 495 manuscripts across the four 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
<i>MISQ</i>	84	17.0%
<i>ISR</i>	282	57.0%
<i>JMIS</i>	62	12.5%
<i>JAIS</i>	67	13.5%

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 301 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 organizational level of analysis. Due to the length constraints of this manuscript, we excluded studies focusing on value co-creation and open innovation from the present analysis. This left us with 35 empirical and theoretical studies that focus on the role of information technology in innovation at this level 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 IT and innovation-

related constructs. We find that studies focusing on innovation as an outcome generally follow a very different blueprint when compared to studies focusing on innovation as a process. Whereas outcome focused studies tend to present empirical evaluation of elaborations on the established theories, much of the process focused literature attempts to develop novel perspectives on innovation through case studies.

The majority of the innovation outcome focused studies are based in either the resource-based view (RBV) [9] or the dynamic capabilities literature [73]. We also find elaborations on the RBV and dynamic capabilities in the form of knowledge-based view of the firm [75] and organizational learning theory [82], as well as a study leveraging agency theory to understand how contracting affects a firm’s ability to capture value from innovations [70]. Consistent with the dominant theoretical frames, we find that the focal IT-related constructs examine investment in IT assets/resources [20, 25, 65] or IT-enabled capabilities, e.g. IT-enabled absorptive capacity [42] and big data analytics capability [16].

Focusing on the innovation-related dependent variables in our sample, we find that many studies focus on firm survival and firm overall performance. Firm performance is measured as sales, firm value, and/or profitability. We also find studies focusing on ideation within an organization [61], new product development [54], product/service introductions [82], and patents [44]. Table 2 summarizes the theoretical perspectives, IT and innovation related focal constructs as well as the key insights from the studies focusing on the innovation related outcomes.

Process-focused innovation-related research in our sample, without exception, leverages case studies to evaluate extant theories as well as to develop novel theoretical ideas. For example, a case study of rural telehealth initiative in India suggests that neither path dependency nor contingency theories fully capture the path of the initiative [67]. The authors suggest that a “path constitution” perspective that recognizes some path-related dependencies, while also acknowledging the generative nature of the innovation process is a better theoretical frame for understanding how innovations evolve. Process-oriented studies note that more established firms often take a measured approach to implementing innovations within organizations [37], whereas startups emphasize rapid data-driven innovation as the core mode of operation [40]. Table 3 summarizes the key insights that emerged from the process-focused research in our sample.

Table 2. A summary of theories, IT and innovation-related constructs in outcomes focused research

Reference / Theoretical perspective	IT-related construct(s)	Focal (innovation related) construct(s)	Key insights
[25] RBV	IT assets	Profitability Risk	An analysis of Fortune 1000 firms in the period between 1987-1994 shows that IT investment is associated with increased risk. The effects are stronger for service firms.
[20] RBV	IT investment	Labor investment Financial capital investment	An analysis of 800 firms in the period between 1987-1998 shows that IT investment is substitutive to labor, but it is complementary to capital investment.
[43] Absorptive capacity	IT-enabled absorptive capacity	Innovations (patents and product/service introductions)	There is relatively weak relationship between potential and realized IT-enabled absorptive capacity. Realized absorptive capacity is strongly related to ideated innovation. IT-enabled social integration capacity interacts with ideated innovation to produce commercialized innovation.
[54] Dynamic capabilities	IT-enabled improvisational capabilities	New product development	The authors propose that IT contributes to the improvisational capabilities of a firm and distinguish improvisational capabilities from dynamic capabilities. The study shows that while dynamic capabilities play a key role in moderately turbulent environments, improvisational capabilities dominated in highly turbulent environments.
[77] Theory development	IT is conceptualized as an enabling mechanism in the evaluation, planning and execution of competitive actions.	Innovation is implicitly embedded in the competitive action plan.	Practitioners recognize the embedded role of IS within the competitive actions. Managers see IT as a resource that provides opportunities for competitive action. IT supports information flow within the organization and this is critical in the conception of the strategic action plan. IT also supports evaluation of competitive action options and the execution of the chosen plan.
[46] Dynamic capabilities	Operational capabilities	Firm survival	IT-enabled operational capability has the largest effect on firm survival across 5827 software firms between 1995-2007.
[79] RBV	IT investment	Firm performance	Firms investing in the latest technology have higher reputation and higher executive compensation. No effect is found for IT investments on performance in the short term, but there is an improvement in performance over the longer term.
[70] Agency theory	IT capabilities	Firm survival	Economic modeling shows that contractual misalignment with the underlying cost structure undermines business sustainability. The cost of contractual adjustment is also a factor in a firm's ability to align the contractual structure.
[44] RBV	IT investment	Sales # of patents	An analysis of large manufacturing firms between 1987-1997 shows that a 10% increase in IT spending is associated with a 1.7% increase in sales.
[82] Organizational learning theory	IT assets	Innovation (new product introductions)	Panel data analysis of 341 firms from 2003-2005 shows that lower levels of industry dynamism, munificence, and complexity IT assets are associated with greater efficiency. Higher complexity (more competing firms) is associated with more innovation.
[62] Organizational agility	IT investment	Customer agility – responsiveness to customer-based opportunities for innovation.	A survey of 188 marketing managers shows that IT facilitates “knowledge creating” synergy that is derived from the interaction between a firm's web-based customer infrastructure and its analytical ability. IT also supports “process enhancing” synergy that arises from the interaction between a firm's coordination efforts and its level of IT integration and enables the firm to respond to opportunities.
[65] RBV	IT investment	Stock returns Stock volatility	IT investment opportunities are diminished in some sectors of the economy, e.g. logistics.
[72] RBV	IT investment	Value added	IT returns are substantially lower in midsize firms. IT returns materialize more slowly in large firms.
[7] RBV	IT investment	Firm value	Investments in IT complement investments in R&D to deliver business value.

[32] RBV	IT assets	Return on IT investment	Innovation resource/posture misalignment diminishes returns on IT investments. Innovation posture – the innovation stage: comprehension, adaption, implementation, assimilation. IT innovation resource – the stock of human and organizational resources conducive to efficient and effective innovation with IT.
[15] Dynamic capabilities	IT resources	Perceptions of firm innovation	A survey-based study shows that organizational wisdom, courage and temperance are associated with improvisational capabilities.
[16] Dynamic capabilities	Big data analytics capability	Firm value	Expected benefits, technology capability, organizational readiness and competitive pressure affect big data analytics use. Analytics use is positively associated with asset productivity and business growth.
[61] Dynamic capabilities	Routine IT use Innovative IT use	Volume and diversity of ideas for organizational innovation.	A survey of 248 managers reveals that routine IT use does not affect ideas for organizational innovation. Innovative use of IT is positively related to the volume and diversity of ideas. Organizational autonomy and innovativeness are positive moderators.
[6] Dynamic capabilities	Collaborative technology use	IT-enabled collaborative capability	Collaboration technology use has a positive effect on the collaboration satisfaction. This effect is stronger for employees involved in new product development.
[59] RBV	IT investment	Firm value	Panel data analysis of 161 firms in the period 1991-2003 shows that IT investments can mitigate diminishing returns from R&D investments. The effect is stronger for more complex R&D sectors.
[75] Knowledge-based view	IT capabilities	Process innovation	Panel data analysis of Swiss firms between 2005-2011 shows that IT capabilities (data access and network connectivity) interact with the number of external knowledge sources in their effect on process innovation.
[52] Theory development	IT assets	Hyperturbulence response	IT can be a cause of hyperturbulence by being a component of disruptive innovations. IT can also alleviate a firm's response to hyperturbulence in supporting absorptive capacity.
[64] Absorptive capacity	Information processing and analytical capabilities	Innovation (patents)	Analytical information processing capability interacts with information-intensive customer involvement and relational information processing interacts with product-focused customer involvement in producing positive effects on the number of patents filed.
[30] RBV	Big data assets	Firm productivity	Big data asset ownership is associated with 3-7 percent improvement in firm productivity. The effect is present for IT-intensive and highly competitive industries. It is not present for non IT-intensive less competitive markets.
[11] RBV	IT outsourcing	Firm value	Announcements related to outsourcing of mature IT services have a positive near-term effect. The value of less mature IT outsourcing decisions takes longer to be realized.
[36] RBV	IT investment	Firm value	Panel data analysis of 294 firms in the period 1999-2008 shows that environmental turbulence increases the positive interaction effect between IT and R&D investments.
[68] RBV	IT investments	Firm value	IT investments benefit the firm when the firm has the capacity to monetize the acquired technology.

Table 3. A summary of process-focused research

Ref	Summary of insights
[37]	The study of several IT projects within a Scandinavian airline suggests that projects progress through adoption, innovation and scaling stages. The adoption stage captures the initial introduction of a technology within organization, innovation is the effective use of novel technology within a unit, and scaling refers to organization-wide adoption of the technology.
[67]	A case study of rural telehealth in India through the lens of innovation and path dependency theories suggests that neither path dependency nor contingency perspectives offer a good fit to the observed platform development. The authors suggest a “path constitution” perspective as an alternative view.

[40]	A case study of WeCash, a Chinese digital payment venture, suggests that data-driven operation, instant release and swift transformation are the key generative mechanisms that underpin successful rapid scaling.
[41]	A case study of eKutir platform in India identifies the following elements of the ecosystem: communities, intermediaries, technology, institutions and partners. Different elements are involved throughout the development process of the ecosystem.
[71]	A case study of Volvo's connected car initiative suggests that to embrace digital innovation, incumbent firms must develop new capabilities. Digital innovation has generative capacity – the process of innovation must be the key focus. External collaboration is essential in digital innovation. Governance mechanisms are essential for digital innovation. Successful project completion requires management of episodic conflict. There is path dependency in sequential conflict resolution.
[81]	Four case studies across insurance, banking, telecom, and e-commerce industries through the service-dominant lens show that big data analytics services enable sourcing, storage, event recognition and prediction, behavior recognition and prediction, rule-based actions and visualizations to support service automation and analytics-enabled services.
[28]	The authors propose a novel theoretical perspective to address the growing development of IT-enabled services. The key tenets of the perspective which the authors term “service dominant logic” are that 1) innovation is a collaborative process, 2) service development requires specialized capabilities and 3) IT-enabled services lead to resource liquefaction that underpins the generative nature of IT-enabled service innovations. The authors also argue that service innovation typically occurs within ecosystems (actor networks) and it often takes shape of service platforms. Technology is both an operant and operand resource in value co-creation.

4.2. The effects of IT on innovation

Focusing on the effects of IT on innovation within organizations we find that investments in IT have a positive effect on the organizational operational capabilities and improve the probability of firm survival [46]. Investments in IT affect the competitive options available to a firm [46]. IT investments that contribute to the improvisational capabilities of a firm can be particularly beneficial in hyperturbulent environments [52, 55].

An analysis of manufacturing firms showed that a 10% increase in IT spending was associated with a 1.7% increase in sales in the period between 1987-1997. However, later studies found diminishing returns to IT investments, particularly in the non-technology sectors of the economy [65]. In the technology sector, investments in IT can help mitigate diminishing returns from R&D investments [59].

Research focusing on the interplay between different types of investments found that IT investments had a substitutive effect on labor investments, whereas IT investments were complementary to financial capital investments [20]. More recent studies focusing on the IT-enabled analytical capabilities have found that ownership of big data assets was associated with 3-7% improvement in the firms' productivity [30], and analytical processing capabilities have a positive relationship with the number of patents [64].

Several studies have also documented potential negative effects of IT. Technology-driven innovations can produce disruptions undermining value chains of existing businesses and leading to hyperturbulence within industries [52]. A study of IT investments by Fortune 1000 firms has also documented that a greater investment in IT was associated with higher stock price volatility implying greater investment risk [25].

4.3. Moderators of IT effects on innovation

A number of studies have examined both organizational as well as environmental variables as moderators of the effects of investments in IT assets and IT-enabled capabilities. Focusing on the organizational factors, Joshi et al. [43] showed that potential IT-enabled absorptive capacity is not always realized and this can undermine firm performance. The firm size is an important factor in the value generated from IT investments – larger firms tend to realize greater benefits [72]. Susarla and Barua [70] showed that contractual misalignment with the underlying cost structure can prevent a business from realizing value from IT investments. Focusing on the environmental factors that affect value of IT investments, we find that IT-intensity and level of competition within an industry have a positive effect on the return from IT investments [30].

4.3. Native IS theories

In our sample, we find two manuscripts that develop novel IS theories. Ning and Tanriverdi [52] address the question of how IT-enabled capabilities affect firm response to environmental hyperturbulence. Through agent-based modeling, the authors argue that while external IT-driven innovations can be a source of environmental hyperturbulence, internal IT-enabled capabilities can support an effective firm response through IT-enabled innovation.

The Lusch and Nambisan manuscript on service dominant logic [28] is the second theoretical manuscript in our sample. The authors argue that IT-enabled services require a novel theoretical perspective to understand the factors that underpin service innovation. The authors propose that a service-

dominant logic that emphasizes the collaborative nature of innovation, the strategic value of specialized competencies within the value networks, and the generativity of digital innovations affords an opportunity to gain richer insight. Importantly, within this framework IT is both an operand and operant resource, i.e. IT is both a resource for service delivery and the product of the innovation effort.

5. Discussion

5.1. Dominant theories and their limitations

In our analysis of the dominant theories in our sample, we find that the resource-based view and the dynamic capabilities theories are the most cited theoretical frameworks. RBV argues that rare, valuable, hard to imitate and to substitute resources offer a competitive advantage to the firms that possess them [8, 10]. Dynamic capabilities theory builds on RBV and it posits that it is not just the resources, but rather what organizations do with the resources that gives firms an advantage [27].

The appeal of both RBV and dynamic capabilities is that it is relatively easy to instrument both the predictors and the dependent variables in the empirical assessments of the frameworks. Despite their appeal, both RBV and dynamic capabilities theories have significant weaknesses. RBV has a problem with potential tautology of the argument [57]. The *valuable* aspect of the resource evaluation requires the benefit of hindsight to know which resources would prove valuable in the context of continually evolving industries. The value of resources is hard to assess before disruptions occur. For example, Polaroid and Kodak held many valuable resources (technology, patents, brand recognition, marketing channels, etc.), yet the companies were unable to realize the asset value potential with the emergence of the digital cameras, which in turn have largely lost the market to smart phone manufacturers [47, 76].

The dynamic capabilities theory inherits the weakness of the RBV argument. Capabilities are typically instrumented as managerial perceptions of organizational competencies. It is difficult to know which capabilities would prove advantageous without knowing the next step in the evolution of specific markets and industries. One might expect that the innovation capability, i.e. the ability of a firm to develop technical innovations, would be highly advantageous in this domain, yet we find cases of companies that had spectacularly failed to commercialize their innovations. Xerox PARC developed many of the core innovations in modern

computing, e.g. the graphical user interface, laser printing, and Ethernet network technologies, yet the company largely failed to monetize these innovations [17]. More recently, Yahoo was an early leader in the big data analytics domain, yet the company generally failed to monetize its capabilities, and Yahoo's technical innovations and talent were absorbed by other firms [66].

5.3. Novel frameworks and opportunities for future research

While we found only two novel theoretical frameworks among the studies in our review, both address important emergent topics. Ning and Tanriverdi [52] examine the role of IT-enabled capabilities in a firm's response to disruptive innovations and suggest that IT-enabled capabilities are a critical component of a successful response. The service dominant logic articulated by Lusch and Nambisan [28] draws attention to IT-enabled services which represent a growing sector of the economy [14]. The proposed framework highlights the distributed nature of value creation and the key role of IT-enabled services in supporting flexibility in continuous re-architecting of business value creation and delivery [14]. The two theoretical frameworks address the key modern business challenges: transition to IT-enabled service delivery across many industries with the consummate revision of value delivery that often involves industry disruptions.

While it is clear that IT will play a central role in creating the disruptions, there are ample opportunities to develop more cohesive perspectives on the key factors and practices that affect business performance and competitive position. We have found limited integration of known organizational factors within the studies in our sample. Integration of research across management and information systems literatures will likely yield key insights on the interplay between individual, social and organizational factors with IT in developing a sustainable advantage through innovation.

6. Conclusion

This study is a step in a broader effort to integrate insights from research on the role of information systems in innovation. This review examined studies published in the past ten years in the top four Information Systems journals focusing on the organizational level of analysis. We found that while a relatively narrow theoretical base supports much of the published research and there is limited integration of known organizational factors, e.g. leadership, in the studies of IT effects on innovation, novel theoretical

perspectives recognize the dual role of IT both as a source of environmental turbulence and as a critical element of competitive response. The service-dominant logic also promises to serve as a fertile foundation for research on the role of IT in the growing service economy.

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