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Understanding Employee Use of Web 2.0 Tools for Front End of Innovation Activities

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ABSTRACT

In this research-in-process paper, we develop a model for understanding employees' use of Web 2.0 tools and applications, in the presence or absence of organizational adoption, for activities at the front-end of innovation. Web 2.0 applications often exhibit organic pathways to use, which differ from the IT department-led technology adoption more commonly studied. They share similarities with tasks at the front end of innovation. The former are highly structurable and given to flexible use. The latter, such as knowledge sharing, collaboration and information search are decentralized and unstructured. It is thus reasonable to assume that Web 2.0 tools should be beneficial for these tasks. Our model draws primarily from adaptive structuration theory, but also integrates concepts and constructs from theories of technology acceptance and task-technology fit. Implications for theory and practice are addressed.

Keywords

Web 2.0, front-end of innovation, technology use, adaptive structuration theory, task-technology fit, adoption

INTRODUCTION

Research on adoption and diffusion has traditionally focused on information systems and technologies introduced by management, such as enterprise systems for example (e.g. Rajagopal 2002), typically via the organization's IT department. The proliferation of Web 2.0 and social media applications, their rapid acceptance and their widespread utilization by the general populace provide an opportunity to examine a different pathway to use -- that of organic use by employees who adapt their personal experience with the technology to their workplace needs. Because the software needed to implement Web 2.0 applications resides within the browser itself, the user does not necessarily need to rely on organizational initiatives in deciding whether and when to use them. Further, the applications can be employed in different ways, for a variety of tasks and processes. Emerging research (for example, Al-Natour and Benbasat, 2009) is thus beginning to recognize the importance of understanding how the user's interaction with an IT artifact during adoption, shapes its use and utilization.

Much of the literature on Web 2.0 and social media technologies addresses their application to areas such as brand management and crowd-sourcing (e.g. Kozinets, deValck, Wojnicki and Wilner, 2010). Researchers have paid little attention to the processes by which Web 2.0 and social media applications are adapted for specific organizational processes and tasks. Yet, it would seem that these applications are ideal for many tasks, especially those that call for collaboration, communication and information sharing. Our research focuses on their use for "Front End of Innovation" (FEI) tasks, those occurring during the earliest stages of the innovation process, where the opportunity for innovators to share their thoughts, learn what others are doing, and search for related work is critical to their success. Specifically we draw from Adaptive Structuration Theory (AST), but also integrate concepts and constructs from theories of technology acceptance and task-technology fit to understand the use of Web 2.0 and social media applications by innovators working on FEI activities and tasks.

In this research-in-progress paper, we first address the theoretical grounding for this research, focusing on the front end of innovation, Web 2.0 and social media, the intersection between them, and the models relevant to the study of technology use in this context. Then, we present our research model. We conclude with a discussion on next steps and potential contributions.

THEORETICAL BACKGROUND

The Front End of Innovation

The front end of innovation is a widely-used term typically meant to denote activities that occur during the formation of an idea through the time the idea becomes recognized by its organization and its further exploration and development are formalized as a project. Because the FEI is characterized by a lack of structure, it is often referred to as the "Fuzzy Front End" (Cooper, 1988; Koen, Ajamia., Burkart, Clamen, et al., 2001). Work at the FEI is experimental and often chaotic, interspersed with occasional Eureka moments and frequent "back to the drawing board" periods of disappointment. It is the subject of much research (see, for example, Boeddrich, 2004; Poskela & Martinsuo, 2009) because success at the FEI is critical to an organization's overall success at innovating (Cooper, 1988; Gupta and Wilemon, 1990; Kim & Wilemon; 2002, Murphy & Kumar, 1997; Verworn, 2009). It is recognized as well by practitioners with an annual FEI conference and a "Front End of Innovation" LinkedIn group.

The FEI cannot be viewed as a process in the traditional sense. Activities constituting FEI typically cannot always be planned or even sequenced, and are often repeated. Nevertheless, some or all of the following activities almost always take place at various times at the FEI: opportunity identification, idea genesis, opportunity analysis, idea selection, and concept and technology development (Koen et al, 2001). Some of these activities might take place in the execution of an existing project, when weaknesses and shortcomings in the product or service under development become apparent and motivate the need for new solutions. The ability to search inside and outside the organization, mine the organization's knowledge bases and resources, and identify communities of interest and expertise are critical capabilities for achieving success in FEI tasks.

Web 2.0 and Social Media

There is little consensus as to how to define "Web 2.0." The term was popularized by Tim O'Reilly, who wrote widely about Web 2.0 circa 2005 and whose company co-sponsored the first Web 2.0 Conference (O'Reilly, 2005). There is some disagreement as to who first coined the term, but it is clear that it was used as early as 1999 (DiNucci, 1999) and that its definition has evolved and continues to evolve. For purposes of this research, we define "Web 2.0 and Social Media" as the set of applications designed and marketed to allow non-IT professionals to place content on the web for sharing with others. The objective of sharing is effectively what makes Web 2.0 a social medium. The following applications typically conform to this definition of Web 2.0 and social media: blogs, electronic social networks (ESNs), micro-blogs, podcasts, social bookmarks, social tags, virtual worlds, and wikis.

It should be noted that despite the frequent use of the phrase "Web 2.0 technologies" in the literature and popular press, the distinction between Web 2.0 and Web 1.0 is functional and operational, not technological. The ability of the web to collect data from a user has existed since the earliest days of the web's existence. However, Web 1.0 uses were entirely transactional, typically to transfer product selection and payment information between a buyer and seller. The data collector in most cases went to great lengths to insure that the data collected would be kept private. With Web 2.0 applications, the user sends information to the data collector with the intent of sharing or publishing it. Web 2.0 applications differ from Web 1.0 applications in how they store and process the data and how they inform others of its availability.

Theoretical gaps at the interface of the FEI and Social Media

At later stages of innovation, innovators and their managers use a wide variety of IT tools, such as CAD/CAM, project management software, market forecasting software, and financial and operational simulation models. But, the process of innovation at its earliest stages tends to be IT free, and often IT avoiding (Gordon & Tarafdar, 2010). One reason for this phenomenon is a cultural gap that exists between innovation leaders and IT practitioners at the FEI. Innovators often view their IT departments as charged with imposing structure, standards, repeatability and automation upon corporate or organizational processes. This mission, if it really exists, would be an anathema to innovation, as it can only crush creativity. A second reason for this phenomenon is that IT department members rarely have sufficient market knowledge, science knowledge, customer knowledge and product knowledge to understand the underlying objectives of the innovations themselves. There are various actions that IT management, R&D management, and the executive ranks can take to minimize the disconnection between IT and innovators, but innovators also often act independent of the IT department to acquire their own IT tools (Gordon & Tarafdar, 2010). Web 2.0 tools offer the promise of bypassing corporate IT to achieve interconnectedness and communication among those interested in the innovation under consideration, broadcasting of and exposure to cutting-edge knowledge, expert finding, and search capabilities that often aren't available through traditional IT-supported technologies. The lack of structure in Web 2.0 tools also fits with the lack of structure at the FEI and with the temperament of innovators. Whether innovators have been able to take advantage of Web 2.0, and if so, how, has not been explored in prior research.

Theoretical Perspectives on IT Adoption and Use

Adaptive Structuration Theory (AST)

Structuration theory (Giddens, 1984) suggests that human actions can be best explained by analyzing them within the context of the social structure in which they take place. Orlikowski (1992) applied structuration theory to the understanding of technology by proposing a duality, in which technology, while constructed by human actors under the influence of their social environment, is appropriated by other actors in its application through the "different meanings they attach to [the technology] and the various features they emphasize and use." Adaptive structuration theory (DeSanctis & Poole 1994; Jones & Karsten 2008; Markus & Silver 2008) augments structuration theory to posit that the way in which the application is appropriated then influences the structure itself. Use is thus an ongoing and iterative phenomenon. The appropriation of an application is influenced by its characterizing elements or "structure". Primary sources of structure include the "technical objects" and "functional affordances" associated with the application. Technical objects, for purposes of this study, refer to the tools and objects associated with Web 2.0 applications such as intranet and extranet functionality, analysis tools, search tools, specified file and data formats, security features, and collaboration and social networking features. Functional affordances describe functionalities possible from the application when it is used, such as, to continue with our example, capabilities of searching, tagging, specifying relationships among tags, uploading, downloading, building information hierarchies, posting and editing content and online discussion. Another source of structure is the nature of the task (and associated activities and workflows) that is accomplished using the application (DeSanctis et al., 1994). FEI tasks include unstructured problem solving, searching for and accessing knowledge from different sources, locating people with relevant knowledge processing large amounts of information, brainstorming and analysis. Depending on the scope offered by these sources of structure, the user "appropriates" an application in specific ways that determine how it is used.

Technology Acceptance Model (TAM) and Unified Theory of Acceptance and Use of Technology (UTAUT)

The appropriation of Web 2.0 applications for FEI tasks must be analyzed in the context of alternative technologies that can provide similar functions. The TAM (Davis, Bagozzi, and Warshaw, 1989) explains users' acceptance of technology using a set of utilitarian beliefs. The presence of these beliefs, centered around performance expectancy and effort expectancy, increases the intent of the user to adopt a particular application and ultimately its acceptance and use. Performance expectancy signifies the extent to which the user perceives the application to be useful for his or her tasks, captured in perceived usefulness, task-job fit and relative advantage (Compeau & Higgins 1995; Davis et al 1989; Venkatesh, Morris, Davis & Davis, 2003). Effort expectancy describes the effort that the user expects to make in using the system, described by variables such as perceived ease of use and complexity. Relative advantage and effort expectancy are functions not only of the technology itself but also of the degree to which the technology is supported by the organization. Successive refinements in the TAM model (e.g. the UTAUT) (Venkatesh et al 2003) have suggested that performance expectancy and effort expectancy associated with a particular application, along with social norms regarding acceptability and prestige associated with its use, predict behavioral intention regarding its adoption. These predictions may be moderated by user demographics such as gender, age and experience with the technology.

Task Technology Fit (TTF) Model

The TTF model goes beyond adoption intentions and looks at utilization (Dishaw & Strong 1999; Goodhue 1995; Goodhue & Thompson, 1995). It states that the utilization of a particular application will depend on the extent to which it fits with the requirements of the task that the user executes using that application. That is, the application should support the particular task and enable the user to perform it more effectively and efficiently. As the fit between application functionality and the requirements of the task or job increases, the greater the application's usage become. The task-technology fit is measured through data quality (currency, accuracy, level of detail) ease of data location, timeliness, compatibility with existing formats, authorization and security enabling, and ease of use. Task characteristics are measured through equivocality (non-routine, ill-defined problems) and interdependence (involving more than one business function).

Proposing a Multi-Theoretic View

The use of Web 2.0 applications for FEI is informed by three primary considerations as described below, suggesting a multi-theoretic approach for our research model.

First, the FEI process is characterized by unstructured and emergent tasks that require collaboration, knowledge creation and problem solving. Web 2.0 applications, characterized by decentralized and often spontaneous content creation, social network development, information sharing and group processes of communication, would seem to be especially amenable to be applied to such tasks. Therefore, the TTF perspective suggests a *high level of fit* of these applications with FEI tasks.

Second, Web 2.0 applications can be employed in a plethora of ways and for various FEI tasks. For instance, two different FEI teams could use the same wiki application (e.g. Google Wikis) in very different ways and apply it to different FEI tasks. One could use it as a means to share emergent information on a particular problem; another could use it for brainstorming. Furthermore, their utilization often takes places in decentralized and unsupervised contexts. Users often apply these applications (e.g., a wiki) to particular tasks, evaluate benefits and outcomes therein and then adapt or structure the application (in this case perhaps the design and arrangement of the wiki). Therefore it is important to understand the nature, extent and process of their *use* (rather than merely adoption or adoption intent), if they are to be gainfully applied to the FEI process. The *process* of their use, as is that of what the literature refers to as "intelligent technologies", is thus *emergent, adaptive and iterative* (Al-Natour and Benbasat 2009); use contexts that are particularly well-analyzed using adaptation structuration concepts. We therefore draw from the AST view, and suggest that the use of Web 2.0 applications for FEI processes is characterized by iterative appropriation based on the structure-related parameters provided by their technical capabilities.

Third, Web 2.0 applications are easy to use. Thus, individuals will probably at least adopt Web 2.0 tools and try them out, even if they are initially uncertain about their usefulness. Use however, would depend on the performance expectancy. The TAM and UTAUT views inform our model through the influence of performance expectancy on appropriation.

Description of research hypotheses in the next section explains how each of these theoretical approaches guides our conceptualization of specific aspects of use of Web 2.0 technologies for FEI.

RESEARCH MODEL

Figure 1 illustrates the theoretical research model. Informed by literature on structuration, technology acceptance and task-technology fit, we suggest a multi-theoretical view of adoption and use of Web 2.0 technologies by individuals in the organization during FEI activities. We next describe the hypotheses that constitute the model.

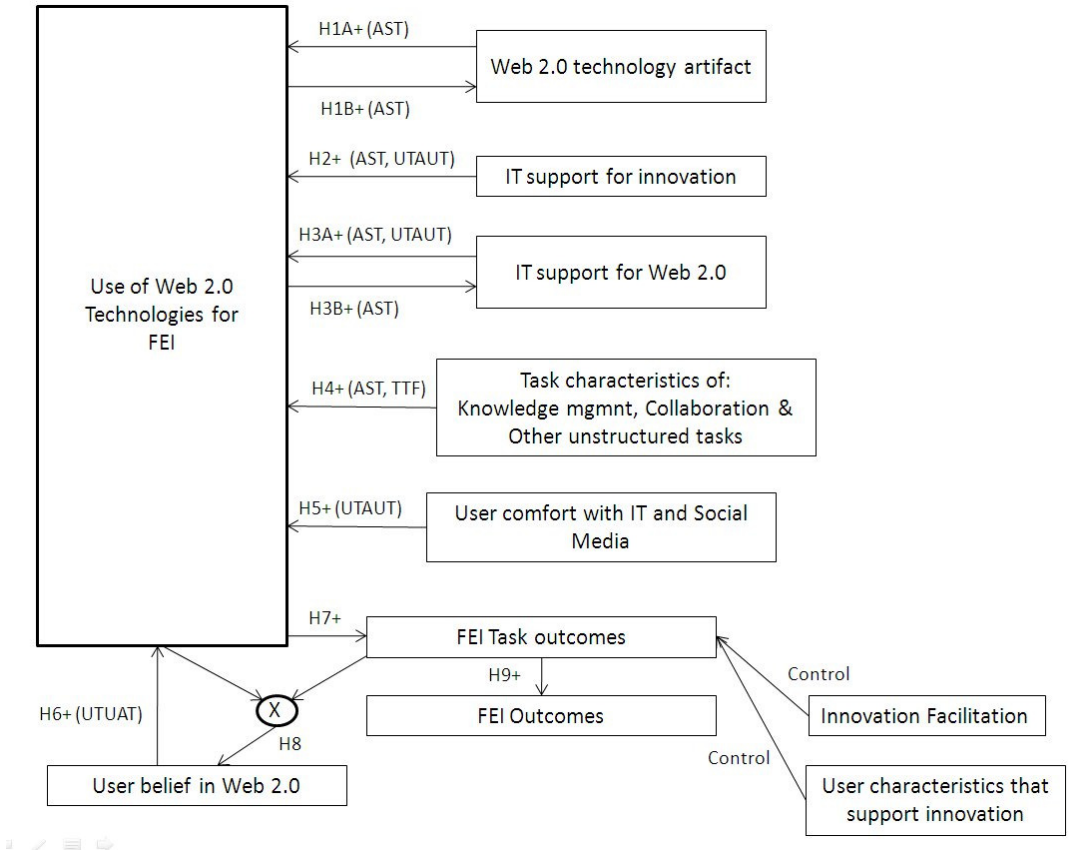

Figure 1. Research Model

Drawing from AST, we hypothesize that the Web 2.0 IT artifact is a major factor affecting adoption and use of Web 2.0 applications for FEI activities (H1A). The artifact is a complex variable, as many Web 2.0 technologies exist and most can be used outside the firewall, permitting sharing of information with the general public, or constrained to operate inside the firewall, with organizational restrictions on what sharing can take place. Further it is associated with many functionalities that are relatively easy to use. FEI innovators are thus likely to appropriate these functionalities for many different tasks such as publishing questions, ideas and solutions, collaborating and organizing information search and retrieval.

AST also holds that the meta-structure within which the FEI process operates should provide structuration aspects that have an impact on how Web 2.0 technologies are used. Drawing from this theory, we incorporated two constructs – IT support for Web 2.0 applications and IT support for innovation within the larger context of the firm. ATUAT suggests that by reducing effort expectancy and increasing adherence to expected norms, the impact of these factors on the appropriation and use of Web 2.0 applications should be positive (H2 and H3A). We are mindful, however, of the cultural gap and mistrust alluded to earlier, which often exists between innovation leaders and IT practitioners and which could impede the realization of this potential. For IT support to be meaningful, it must not be seen as an institutional directive coming from the IT department. Rather, in the spirit of true support, it should simply simplify and enable the use of IT in the organization (for H2) and provide an environment in which Web 2.0 tools are available and their use is welcome (for H3A).

AST argues that task related aspects of structure affect the use and appropriation of technology. The lack of structure associated with Web 2.0 fits well with relatively unstructured tasks of the FEI, such as generating ideas, locating experts, assessing customer needs, and making sense of conflicting signals. We thus draw upon AST and the TTF model to hypothesize that the extent to which such unstructured tasks are performed, is positively associated with adoption and use (H4).

Based on the TAM and UTAUT models' criteria of "effort expectancy" and "social influence," we hypothesize that user comfort with IT and social media, associated respectively with these two criteria, positively influence adoption and use of Web 2.0 tools for FEI activities (H5). Finally, drawing on the "performance expectancy" criteria, we propose that user belief in the effectiveness of Web 2.0 technologies for FEI activities positively affects their appropriation of those technologies for that purpose (H6).

AST argues that the technology artifact and the meta-structures surrounding its use are not truly exogenous. The technology artifact is itself affected by the extent and manner of user adoption (H1B). This creates a feedback loop by which the features of a technology available to a given group may evolve in response to their use. For instance, FEI innovators might use a wiki for publishing questions, ideas and solutions, for collaborating and for organizing information search. The design, functional capabilities and layout of the wiki would likely evolve as a result of the nature of its ongoing adoption and use. Successive design enhancements would in turn enable additional uses of the wiki to be appropriated for FEI processes. Similarly, as adoption affects the meta-structure, a higher and more varied extent of adoption and use is associated with greater interaction with and requirements from IT professionals regarding support and technical assistance. We thus hypothesize that IT support for Web 2.0 is affected by users' adoption of Web 2.0 tools (H3B).

While the primary focus of this research is on the causes of adoption and the usage of Web 2.0 technology, we are also interested in the outcome of adoption. We have modeled Web 2.0 adoption to affect FEI outcomes indirectly, through FEI task outcomes (H7 and H9). FEI task outcomes can be measured through individuals' success in their execution of FEI tasks. FEI outcomes, evaluated for example, by the extent to which the FEI process generates high pay-off innovation projects, exist at a corporate level and are dependent on individual task outcomes. We recognize that task outcomes differ by individual according to their skills, experience, and innate ability, so we have included user characteristics as a control variable. Also, because innovation task success will vary greatly from company to company depending on the support for innovation provided, we include innovation facilitation as a control variable.

Finally, drawing from TAM and UTAUT, we hypothesize that user belief in the effectiveness of Web 2.0 for innovation is dependent in large part on their experiences and the experiences of their peers (H8). When Web 2.0 tools are used and task outcome is positive, there is a positive impact on belief. Conversely, when Web 2.0 tools are used and outcomes are negative, there is a negative impact on belief. If Web 2.0 tools are not used, users' beliefs are probably not affected at all by the outcomes.

NEXT STEPS

The theoretical development described in this paper forms the basis of a larger project for understanding the role of Web 2.0 and social applications in facilitating the FEI process. Our intention is to validate the research model using qualitative and quantitative data. For the former, we are in the process of conducting interviews with researchers/innovators working on FEI

tasks, to analyze and possibly refine the relationships we have envisaged. We plan to seek data from around 15 FEI innovators, based on the authors' contacts in R&D departments in large organizations. For the latter, we are in the process of designing a web-based survey to be self-administered to FEI innovators. The construct items in the survey are partly drawn from concepts in the literature and partly from observations and analysis of our qualitative data. They have not yet been finalized and validated, but we have included a sample of the types of questions and indicated prior research where these have been drawn from in Table 1. Our survey sample will consist of innovators working in and for corporate R&D departments. It will be drawn from (1) contacts based on the authors' prior experience and (2) professional groups such as LinkedIn. We expect to present details of our findings in the workshop.

Construct	Definition	Illustrative Question
Use of Web 2.0 for the FEI (dependent variable)	The extent to which Web 2.0 tools (defined above) are used in FEI activities (defined above). (e.g. Venkatesh et al., 2003)	For each of the following tasks [listed by row], how frequently do you use each of the following applications [listed by column]
Web 2.0 technology artifact	Web 2.0 applications as well as the infrastructure, architectures, rules, and structures supporting and constraining their use. (e.g. Markus et al., 2008)	Which of the following applications can you use for company work [An application list follows]
IT support for innovation	The extent to which the group or department supporting IT services in the company [hereafter called the "IT Department"] supports the process by which the business innovates less the extent to which it impedes the innovation process. (e.g. Gordon & Tarafdar, 2010)	How strongly do you agree with the following statement [Hereafter abbreviated as HSDYA]: "Corporate IT allows innovators to work around corporate standards"
IT support for Web 2.0	The extent to which the IT Department supports the use of Web 2.0 in the business, both inside and outside the firewall less the extent to which it impedes such usage. (e.g. Chang, Li & Fang, 2010)	HSDYA, "Corporate IT provides tools for social networking"
Task characteristics of KM, collaboration, and unstructured tasks	The importance of unstructured tasks, knowledge management, and collaboration to the success of the FEI. (e.g. Verworn, 2009)	For each of the following tasks, rate how important it is to the FEI [A task list follows]
User comfort with IT and social media	The extent to which the respondent considers himself or herself comfortable with IT in general and social media and Web 2.0 applications, in particular (e.g. Venkatesh et al., 2003)	HSDYA, "I use social media at home"
FEI Task outcomes	The extent to which the user achieves success in the completion of his or her FEI tasks. (e.g. Koen et al., 2001)	HSDYA, "I contribute substantially to the generation of ideas for new products or services for our company"
FEI outcomes	The extent to which the company achieves success in its FEI efforts. (e.g. Verworn, 2009)	HSDYA, "Our project pipeline is full of good ideas"
User belief in Web 2.0	The extent to which the respondent feels that use of Web 2.0 applications is effective in improving FEI outcomes for the company. (Venkatesh et al., 2003)	For each of the following technologies, indicate how useful you feel it could be for accomplishing your FEI tasks: [technologies listed by row]
Innovation facilitation	The extent to which the organization supports innovation activities (e.g. Scott & Bruce, 1984)	HSDYA, "Innovation is a high priority for my company"
User characteristics in support of innovation	The extent to which the respondent demonstrates characteristics are known to be conducive to being innovative (e.g. Amabile, 1983)	HSDYA, "I am a creative person"

POTENTIAL CONTRIBUTION

The potential theoretical contribution of the research reported in this paper is in developing a basis for understanding how decentralized and highly structurable IT applications, such as Web 2.0 applications, can be used for FEI processes, which require collaboration, knowledge sharing and information search, and for identifying organizational supporting mechanisms

that facilitate such use. Our expected findings, we believe, can be applied to other organizational processes with similar characteristics such as group decision making and market research. In the domain of managerial practice, we note that organizational reaction to the phenomenon of Web 2.0 and social media adoption has been varied. Some companies have actively sought to ban the use of publicly available social media applications such as Google Wiki or Facebook for organizational information sharing, for fear of IP leakage or wasted time (Robert Half Technology, 2009). (We note here that this is different from the concept of "Open Innovation" (Chesbrough 2003) where ideas are sourced from innovators external to the firm through competitions, but they are not shared with external entities). Others have adopted Web 2.0 applications designed to operate behind the firewall (Melcrum, 2010). And, others have created positions to build communities of interest around their products and services and to actively monitor and react to discussion about their brand (Bughin, Manyika & Miller, 2008; Halligan, Shah & Scott, 2009). We expect our findings to guide innovators, innovation managers and IT managers in gainfully bringing to bear the use of Web 2.0 and social media applications on FEI processes.

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