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Process-Technology Fit: Extending Task-Technology Fit to Assess Enterprise Information Technologies

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PROCESS-TECHNOLOGY FIT: EXTENDING TASK-TECHNOLOGY FIT TO ASSESS ENTERPRISE INFORMATION TECHNOLOGIES

Breakthrough Ideas in Information Technology

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Abstract

In this research-in-progress paper, we investigate the fit between process and information technology (IT) and its impact on organizational process performance. A process-level fit model provides a greater understanding of enterprise IT than models focusing on group or task-level assessments. After reviewing related research, we identify and consolidate the process, task, and IT variables that have been found to be significant in influencing IT fit. Thereafter, we propose our process-technology fit (PTF) framework, which incorporates process-related, IT-related, and IT-use context variables in predicting process performance. Finally, a methodology for determining PTF is proposed. By understanding PTF, we hope to add an important dimension to explain enterprise IT usage, while helping organizations become more effective in supporting their business processes.

Keywords: Technology fit, process technology fit, enterprise IT, process performance

Introduction

As the communication and processing capabilities of information technology (IT) have vastly improved to enable intra-organizational and inter-organizational networks, many organizations are using enterprise IT to support their business processes. Enterprise IT, enabled by the Web and Internet, helps organizations seamlessly integrate information flowing through a company by uniting data from various repositories across functions and business units. Enterprise IT has shifted the focus from supporting activities to supporting processes that can lower costs, improve productivity and performance, increase user satisfaction, and improve communication and coordination of the entire process (Davenport, 1998). Meanwhile, researchers are assessing the impact of IT and its determinants from various perspectives, including from the perceptive of individual users (Goodhue and Thompson 1995; Lucas and Spitler 1999), from the perspective of a group of individuals working towards a common goal (Dennis et al. 2001; Townsend et al. 2001), and from the perspective of organizations (Devaraj and Kohli 2003; Shin 2001). As organizations increasingly focus their attention on supporting processes with IT, there is a growing need for process-centered Information Systems (IS) research that captures how the interaction between individuals and organizations shapes the uses of IT and its resulting impacts on both (Crowston 2003).

In this research, we propose a process-centered technology fit model that can help us understand better the determinants of IT effectiveness than the alternative of aggregating individual task technology fit (TTF) assessments. Poor fit of IT with the IT-enabled process can lead to non-usage and impede process performance goals. By examining technology fit using a process context, we hope to expand our ability to explain and predict enterprise technology usage, while helping organizations become more effective in supporting their business process and users. The rest of the paper is organized as follows. We present a review of related research to identify the variables that have been found to be significant in influencing technology fit. By grouping these variables, we identify a set of key variables to include in a process-level fit model. Next we discuss our proposed framework for technology fit, which we refer to as process-technology fit (PTF). We follow this by providing a systematic approach to determine and use PTF. Our framework provides researchers and practitioners with a method for understanding PTF for a variety of technologies and business scenarios.

Related Research

We begin this section by providing overviews of process literature and technology fit literature as we highlight the need for investigating PTF.

Process Literature

Although the definitions of a process vary among researchers (Davenport and Short 1990; Boudreau and Robey 1999; Keen and McDonald 2000; Crowston and Osborn 2003), they highlight three key components of processes: (a) activities (i.e., those events or tasks that comprise the process), (b) resources (i.e., the items that are created by or pass between activities), and (c) actors (i.e., those who execute the process and the resources used and created in the process) (Crowston and Osborn 2003). By placing the process as the unit of analysis of a research framework, researchers can capture both how IT alters the way individuals work and participate in an organization, as well as how organizational forces affect individuals' use of IT to do their work (Crowston 2003). Crowston (2003) further argues that conceptualizing dependencies between activities, rather than between the individuals or groups completing those activities, provides more insight as individuals or groups change throughout time. To emphasize the similarities and differences among various process instances when analyzing and representing organizational processes, Malone et al. (2003) use a two-stage approach that decomposes process activities into subactivities and tasks while identifying process specializations (variances).

Technology Fit Literature

The linkage between fit and performance is reflected in IS research at various levels of analysis and has been conceptualized using a variety of perspectives. Levels of analysis include the organizational level, the work group level, the job level, and the individual level (Nancy and Straub 1996; Leifer 1988; Mathieson and Keil 1998). The individual stream of TTF research focuses on understanding the impact of the match between individuals' task needs and technology capabilities in predicting performance (Goodhue 1995; Goodhue and Thompson 1995; Goodhue 1998). Goodhue and Thompson (1995) look at fit as the extent that technology functionalities match individuals' task requirements and abilities. Dishaw and Strong (1999) integrate Goodhue and Thompson's TTF framework (1995) with the Technology Acceptance Model (TAM) to compute fit by comparing the software functionalities that users expect to use in completing a task with software maintenance tools.

Researchers using the approach of "match" define fit as "the match between the needs of the task based on the important characteristics of a task to be performed and the capabilities of the technologies available for the tasks (Nance and Straub 1996, p.4) or "the extent to which a particular task can be performed effectively and efficiently with a particular technology (Mathieson and Keil 1998, p. 222)." Research conducted from the individual and group perspectives finds that the fit between an IT and an individual's (or a group's) tasks contributes to the usage of IT, as well as to the impact that the IT has on performance (Goodhue and Thompson 1995; Zigurs et al. 1999). Research conducted from the organizational perspective finds that organizations will not realize their desired organizational-level impacts from IT without the usage of IT by individuals in the organization (Van de Ven 1986).

The issues of developing the dimensions and measuring the fit of enterprise IT are identified as important areas for research in IS (Zhang et al. 2002). The wide-reaching standardization and system centralization common with enterprise IT can be problematic for individual or task-focused studies, as some level of system segregation or process customization may be necessary to allow the company to achieve business goals (Davenport 1998). This is even more of a concern in situations where the usage of enterprise IT is not mandatory, as individuals are driven by their day-to-day process needs in deciding whether to use the IT (Mathieson and Keil 1998). In addition, IT at the process level requires the consideration of multiple functionalities, multiple infrastructures, and multiple applications to support users, and communication and coordination is a critical requirement. To better our understanding of the impacts of enterprise IT and the determinants that drive its use, we also need to consider the process context of IT use (Heine et al. 2003).

A Process-Technology Fit Model

As defined in the previous section, a process is a collection of subactivities or tasks. Technology fit literature suggests that each task has its own degree of fit. However, our definition of process includes non-sequential and iterative combinations of the tasks. Hence, aggregating the individual TTF assessments will not provide insights into the changes to the whole process. Does the technology effectively support the overall needs of the process, even if some activities are not supported optimally? Do process attributes, such as the interdependencies among tasks, influence fit? Since enterprise technologies usually promote process-related initiatives rather than task-related initiatives, it is important that we extend TTF to capture relevant variables that influence fit on the process level.

The framework we propose in this paper is derived from ongoing theoretical work in process-technology fit (Shaw et al. 2006). The framework is illustrated in figure 1. We first describe the components of this framework and present a multi-step procedure in determining the ideal fit profiles (Zigurs and Buckland 1998) between a process and technology. The primary difference between current fit models and our framework is that PTF allows for the inclusion of process and IT use context variables that are not captured in the traditional TTF model. We discuss the framework in the following sections where we identify some of the process features, IT features, and IT Use context variables from literature.

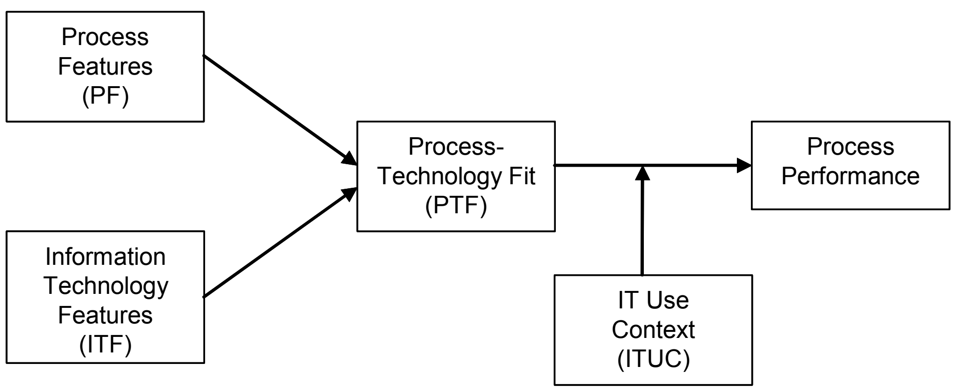

Figure 1. Process-Technology Fit Framework

Process Features

Processes serve as the bridge between individuals' work and organizational outcomes (Crowston 2003), and they represent the ways organizations accomplish desired goals (Cyert and March 1963; Simon 1964). The use of process features as determinants of technology fit removes attributes specific to the individual performing the job. This is because in an organizational context, an individual's technology needs and support are determined more by the underlying process than by his/her personal preferences. However, some of the task features whose aggregation affects the process have to be included when deciding the process features. Some of the process features identified in literature are described below.

Process Objectives – Process objectives determine the expected outcome from the process and the structure of activities in achieving the outcomes. This, in turn determines the information processing needs of the process and hence, the technology features that match those needs. Herman and Malone (2003) categorize processes into buy, make, sell, design, and manage based on the outcomes. Kim and Shunk (2004) look at the activities of the processes (i.e., information, negotiation, settlement, and after-sales activities of a procurement process).

Process/Task Type – Zigurs and Buckland (1998) classified tasks as the combination of the number of possible solutions for the task, the number of possible outcomes of the task, the conflict between possible solutions, and the uncertainty of the outcome. They identify five task categories: simple tasks, problem tasks, decision tasks, judgment tasks, and fuzzy tasks. These five task categories were paired with specific GSS configurations that would result in the best group performance (fit).

Process Routineness – Routineness is determined by the level of repetitiveness, structure, programmability, and analyzability of the task. In their study of e-procurement, Benslimane et al. (2003) argue that routine tasks require little or no additional information before they can be completed, while non-routine tasks require additional information and steps in the process.

Process Complexity – Process complexity is determined by the communication and coordination efforts required to execute the process. It can be measured by the number of actors, activities, and resources involved. Subramaniam and Shaw (2002) show that e-procurement technologies have the potential to provide higher benefits to moderately complex instances of a procurement process (i.e., purchase of office equipment) than to less complex instances (i.e., purchase of raw materials).

Process Interdependency – Goodhue and Thompson (1998) defined task interdependencies as the amount of users' tasks spanning between business functions. Rather than having an actor-centered definition of interdependency, we place the process and its activities as the focus. Process interdependency can be a function of the type or the level of interdependency among activities within a process. Furthermore, TTF research does not consider that all tasks are not equally critical in the completion of the process.

IT Features

Technology has many definitions and a variety of methods for classification in IS research. Goodhue and Thompson (1995) include hardware, software, data, and user support (e.g. training, help lines) in their definition of technology. Other researchers have more focused definitions of technology by narrowing in on a subset of those components. We reviewed the technology variables that have been used in the literature to identify relevant technology features for our PTF framework. Some of the technology features are described below.

IT Functionalities – Functionality represents the capabilities and tools of the technology's software (Gebauer et al. 2004), and has been identified as a dimension of system quality (DeLone and McLean 1992, 2003). The construct of technology is commonly assessed by its functional aspects (Gebauer et al. 2004). Zigurs and Buckland (1998) and Zigurs et al. (1999) classify technology based on its ability to provide communication support, information processing support, and process structuring support. Dennis et al. (2001) also describe technology by its structural capabilities in providing communication or information process support.

IT Reliability – In the literature, reliability is measured by user evaluations as well as by system-generated metrics. Goodhue and Thompson (1995) suggest that reliability is a dimension of TTF and find that users' evaluation of reliability influence utilization. Bailey and Pearson (1983) found that poor system reliability results in user frustration.

IT Ease of Use – Ease of use can be defined as the opposite of complexity, which is the degree to which using an innovation is perceived as being difficult to use (Moore and Benbasat 1991). Doll and Torkzadeh (1998) define ease of use as the degree to which a system is user friendly. Researchers have found that the importance of ease of use diminishes with use, with ease of use being important for IT adoption but not for continued usage (Karahanna et al. 1999). Others support the notion that ease of use becomes non-significant with increased experience with the technology (Davis et al. 1989; Venkatesh et al. 2003).

IT Support Available – IT Support Available is determined by the availability of assistance to aid individuals in using the system. Lim and Benbasat (2000) found that the appropriateness of available support impacts performance.

PTF and Process Performance

We define PTF as the match between the characteristics of a process and the technology capability that helps execute that process. PTF captures how well the characteristics of the implemented IT aids in obtaining the information resources needed to execute each activity in a process and in delivering the appropriate output resources of each activity in a process to other activities dependent on said resource. Similar to the way Gebauer et al. (2005) and Zigurs and Buckland (1998) defined task performance, we view process performance in a generic sense as the ability to reach stated process goals and to be operationalized in greater detail for specific process situations. Thus, performance is related to the accomplishment of process objectives, such as efficiency, effectiveness, and quality.

The Moderating Effect of IT Use Context

As useful as PTF is in determining the level of appropriateness between process and IT features, it assumes that all pairings of process and technology features are equally important and required in determining process performance. In reality, this is not always the case, as some process and IT features may not be as critical in determining process performance for certain process instances. In addition, the profiles determined in PTF do not include factors associated with the environment in which the IT is used. This can distort us from obtaining a clear assessment of technology fit, as the technology may provide adequate process support for certain process instances but not for other process instances. We propose that the relationship between PTF and process performance is moderated by features of the IT use context (ITUCs). Some variables in this category are described below.

Process Frequency – Process frequency represents the volume of similar process instances (i.e., transactions) in a given time period. Process frequency is important for consideration as the ideal technological support will change based on how many times the process has to be repeated. For example, technology that allows for automatic replenishment might better serve the ongoing need for a specific product than by the need for a product that is purchased only sporadically. Thus, frequency will affect how useful the IT system is seen for supporting the process.

Process Flexibility – Flexibility represents the extent of deviation allowed by the organization to work around the system to fulfill a process goal. Bailey and Pearson (1983) and Goodhue (1988) argue that it is expected that users can become frustrated by a general lack of flexibility in the IT to meet their changing data needs. This frustration towards the IT likely would be more apparent for process instances having a low amount of flexibility.

A major issue in information systems is to better understand how technology can help the user to perform her job better. By including the process-technology fit, we argue that technology by itself is less important and emphasize the interactions of the technology with the characteristics of the organization and its processes. In organizational settings, the user needs are easily captured by the needs of the underlying process. Thus, the PTF approach is an IS approach rather than an IT only approach. A systematic procedure to determine PTF is presented in the next section.

A Systematic Approach to Determining Process-Technology Fit

The first step in our framework to determine PTF is to determine the ideal fit between the process features and the IT features, as PTF represents the appropriateness of the various IT features in supporting each process feature. This is similar to the approach used by Zigurs and Buckland (1998) that predetermined various profiles of TTF that positively impact performance. The ideal profiles can be determined by creating a metric that evaluates each process feature with each ITF, as illustrated in Figure 2.

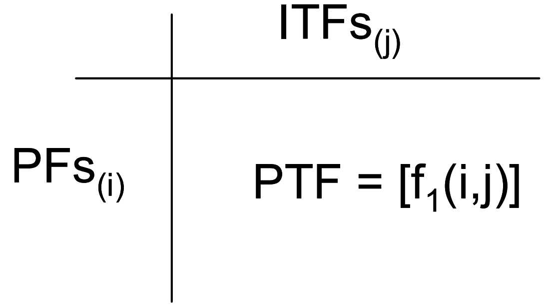

Figure 2. Metric for Process-Technology Fit

The metric for PTF consists of an (i x j) grid representing various process features PF(i) and IT features ITF(j). For example, if a specific process (P_e) can be represented by three PFs (i=3; Process Objectives, Process Complexity, and Interdependency) and three ITFs (j=3; IT Functionalities, IT Reliability, and IT Support Available), then the PTF value for the process (P_e) will comprise of 9 predicted fit values, derived from a 3 x 3 matrix, as illustrated in Table 1. The intersection of each PF(i) and ISF(j) in the metric identifies the predicted fit values for the range of possible values for each PF and ISF combination.

Table 1. Subsection of Fit Metric

		ITF(j)		
		IT Functionalities	IT Reliability	IT Support Available
PF(i)	Process Objectives	$f_1(i,j)$	$f_4(i,j)$	$f_7(i,j)$
	Process Complexity	$f_2(i,j)$	$f_5(i,j)$	$f_8(i,j)$
	Interdependency	$f_3(i,j)$	$f_6(i,j)$	$f_9(i,j)$

The fit values that would comprise each cell of the metric can be determined from previous research and by extending TTF metrics. Dishaw and Strong (1999) provide evidence to the fit between the task objective and IT functionalities, finding that as functionality increases, the fit with tasks increases. Dishaw and Strong (2003) provide support for the relationship between task activities and the use of a specific system. Dennis et al. (2001) and Zigurs et al. (1999) investigated the fit relationships between task types and the support provided by IT functionalities. Routineness has been investigated in some studies (Goodhue 1995; Subramaniam and Shaw 2002; Gebauer and Shaw 2004; Gebauer et al. 2005). Complexity has been found to affect the fit and use of IT systems (Dishaw and Strong 2003; Hoppen et al. 2002; Mishra et al. 2001). Some studies provide evidence for the impact that interdependency has on the ideal IT functionality (Gattiker and Goodhue 2004; Gebauer et al. 2005). Goodhue and Thompson (1995) also provide insights into the relationship between interdependency and support available in determining fit. Where we do not have expected fit values from current research, the fit can be estimated.

PTF can then be determined by averaging the fit for each process-technology pair, as notated in Figure 3, where n represents the product of the number of process features and the number of IT features.

$$PTF = \frac{\sum_{k=1}^{n} [F_k(i,j)]}{n}$$

Figure 3. Calculating Process-Technology Fit

Using the PTF framework

To determine PTF for a specific technology supporting a process, one would need to (a) identify and define a process by its process features, and (b) identify and define the IT by its IT features. Not all process and IT features would be necessary to determine a PTF value, but as the number of process and IT features that are identified increases, the more representative the calculated PTF value would be. After defining both the process and IT into its general attributes, the proposed methodology can be used to identify how well features of the IT aid in supporting the various features of the process. The process features would serve as the row headings of the metric, and the IT features would serve as the column headings of the metric. The range of values for each process feature and IT feature would be identified.

As discussed above, the fit values of each cell of the metric would be determined from previous research if available or via estimation if not available. Table 2 illustrates a subsection of the PTF metric. The profile of using Communication Support Functionality for a Choosing Task has a fit value of 2, with 5 representing the highest level of fit and 1 representing the lowest level of fit. Meanwhile, the profile of using Information Processing Support Functionality for an Executive Task has a fit value of 4. In other words, having Information Process Support provides greater fit in process occurrences having Executive Task Activities, while Communication Support provides less fit in process occurrences having Choosing Tasks Activities. PTF for a specific process occurrence would then consist of the composite of the predicted fit values for each intersection of PF(i) and ITF(j) that represents the process occurrence (P_e)

Table 2. Subsection of Metric Representing $F_1(i,j)$

		ITF(j) IT Functionalities	
		Communication Support	***Information Processing Support***
PF(i) Process Objectives	***Choosing Task***	***2***	***2***
	Generating Task	5	2
	Executive Task	2	4
	Negotiate Task	5	2

As stated above, process-technology fit can be specified as an ideal profile so that the fit can be managed and controlled in order to maximize the performance impacts of technology. But it has to be noted that process-technology fit can also be studied by measuring the existing performance impacts of a specific technology and linking the impacts to the associated process characteristics and technology characteristics.

Implications for Practitioners

More organizations are implementing enterprise IT applications such as e-procurement systems and supply chain management systems that leverage the Internet and World Wide Web to support processes. For these applications, the focus of IT support shifts from enhancing individual tasks to enhancing the entire process. For example, an e-procurement system brings together electronically the various activities and agents involved in procuring goods and services. The impact of the e-procurement technology is measured in terms of the improvement in process measures (e.g. procurement cycle time) rather than improvements in each activity making up the procurement process (e.g. identifying a supplier). Likewise, if the process is redesigned when the IT is implemented, some activities may become redundant. Thus, we argue that when evaluating the fit of an enterprise IT, it is more useful to consider process level characteristics than task level characteristics.

Conclusion

Our next step in this research-in-progress is to further develop the PTF metric as guided by the more comprehensive theory on PTF (Shaw et al. 2006) and by identifying the fit estimates for a wide-variety of process and IT features, so that it increases its practicality and applicability. Thereafter, the proposed framework and metric would be tested across a variety of technologies, a variety of processes, and a variety of IT usage contexts. Since each data set represents a different combination of processes, technologies, and usage contexts, the analysis of multiple data sets will illustrate and test the wider applicability of the model.

A combination of two approaches will be used to test the effectiveness of the PTF metric. First, the metric will be used to compute PTF, after which the computed PTF will be tested against the results of survey instruments assessing users' perceptions of PTF. Second, the metric will be used to compute PTF, and its results will be tested in its ability to predict process performance.

Significant and relevant contributions to both academia and practice are possible through this research agenda. From an academic standpoint, a major contribution of our research is the development of a PTF model and a procedure to compute fit. Our framework extends existing technology fit models from a task-level focus to a process-level focus. Researchers have included TTF to TAM to improve the explanatory power of the model (Dishaw and Strong 1999). Processes provide a useful next level of analysis that narrows problematic generalizations and can result in more meaningful theoretical conclusions. The process-technology fit proposed by us can be integrated with TAM to improve its explanatory power. In addition, the identification and measurement of process factors and their influences on technology fit is a valuable contribution in understanding the effectiveness of enterprise technologies.

From a practitioner standpoint, the PTF framework will help organizations to develop more effective IT strategies and better leverage technologies by identifying the right IT characteristics to match certain processes. In addition, the likelihood of acceptance of the IT can be increased by not overcomplicating the system with non value-added functionalities and by identifying the process actors whose usage of the technology can most contribute to better process performance. By improving PTF, companies should be in a better position to improve process performance and to maximize the enterprise benefits of IT.

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