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PERFORMANCE IMPACTS OF IS AT THE INDIVIDUAL LEVEL: AN INTEGRATED MODEL

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Abstract

In this paper, we propose an integrated model that explains performance impacts of IS at the individual level. We include nature of IS use, task-technology-fit and IS use as determinants of performance impacts of IS at the individual level. Based on data from 434 respondents from different functional areas in six different organizations, we empirically validate the integrated model for an individual IS productivity application. Our results indicate that integrated model explains nearly 60% of the variance in performance impacts of IS at the individual level. Overall, the results provide support to our position that the integrated model provides a fuller understanding of performance impacts of IS at the individual level by including both task-technology-fit and nature of IS use, an aspect not addressed in the extant IS literature. The theoretical contribution of this research lies in the development of a model for performance impacts of IS that has significantly higher explanatory power than the existing models.

Keywords: value, Performance impacts of IS, Nature of IS use, Task-technology-fit

1 INTRODUCTION

While there are a number of studies that focus on performance impacts of IS at the firm level, there are few empirical studies in the IS literature that analyze the effect of different factors on performance impacts of IS at the individual level. We build an integrated model of performance impacts of IS at individual level based on technology-to-performance chain model proposed by Goodhue and Thompson (1995). The integrated model incorporates the technology-to-performance chain model (Goodhue and Thompson, 1995) in that both models posit that IS use and task-technology-fit together lead to performance impacts of IS at the individual level. However, the integrated model proposed in this paper is different from technology-to-performance model in three ways: (a) it highlights the importance of post adoptive IS usage behavior, (b) the integrated model proposes a link between IS use and nature of IS use, thereby, highlighting both direct as well as indirect effect of IS use (through nature of IS use) on performance impacts of IS, and (c) the model integrates the constructs from pre-adoption (task-technology-fit) and post-adoption (IS use and nature of IS use) and is, therefore, more comprehensive than technology-to-performance chain model in identifying the antecedents of performance impacts of IS at the individual level.

In the subsequent sections, we describe the integrated model of performance impacts of IS, and the theoretical rationale for the relationships embedded therein.
2 RESEARCH STREAMS WITH FOCUS ON PERFORMANCE IMPACTS OF IS AT THE INDIVIDUAL LEVEL

We first discuss the three streams of research that have implications for performance impacts of IS at the individual level. These three streams of research include those focusing on IS utilization, task-technology-fit, and post adoption IS use behaviour of individuals. We discuss each of these streams of research and their implications for performance impacts of IS.

2.1 IS utilization-based research

IS utilization is a significantly researched concept in the IS field (Taylor and Todd, 1995; Venkatesh et al., 2003; Compeau and Higgins, 1995; Davis et al., 1989; Szajna, 1996). The research based on the technology acceptance model (TAM) proposed by Davis (1989) focuses primarily on developing understanding of the factors that lead an individual to accept and subsequently use technology. Most of the IS utilization based research is grounded in the theories of attitudes and behavior (Bagozzi, 1982; Fishben and Ajzen, 1975; Triandis, 1980). The underlying premise of this stream of research is that information systems must be utilized before any performance impacts can be observed.

2.2 Task-technology-fit based research

Task-technology-fit (TTF) is defined as “fit between functionalities of the technology and the task requirements of the user” i.e. the ability of the technology to support user tasks (Goodhue and Thompson, 1995). TTF based research (Goodhue and Thompson, 1995; Benbasat et al, 1986; Dickson et al, 1986; Zigurs and Buckland, 1998) posits that technology will be used only if the functions available to the use through the technology support or fit the user activities. From this standpoint, task-technology-fit is an antecedent to IS utilization in addition to the other behavioral antecedents of IS utilization identified elsewhere (Taylor and Todd, 1995; Venkatesh et al., 2003).

2.3 Post adoption IS use based research

IS use behavior of the individual after the technology has been accepted by the user forms the focal point of post-adoptive behavioral research. The post adoptive IS use behavior of the individual is important to understand performance gains experienced by an individual. After a technology, which provides appropriate support for the user tasks (i.e. has significant task-technology-fit), has been accepted by an individual, it is likely that the user’s performance will be a function of how he/she uses the technology. For example, some individuals may underutilize a technology by restricting their use of the system functionalities to a handful of features while others may fully leverage it by exploiting the technology functionalities. Such IS use differences across individuals arise from many factors such as personality, experience, perceptions, self-efficacy, and user competence (Agarwal, 2000; Marcolin et al., 2000; Boudreau and Seligman, 2003) and manifest themselves in actual use behavior.

We synthesize the three streams of research, namely, IS utilization research, task-technology-fit research, and post adoptive IS use behavior research to develop an integrated model of performance impacts of IS at the individual level. In this model, we incorporate the three constructs, IS use, task-technology-fit, and nature of IS use, partly borrowed from earlier research. In the next section, we describe the two key constructs used in our model, nature of IS use and task-technology-fit.

3 CONCEPT DEVELOPMENT

The two key constructs of interest in this study are nature of IS use and task-technology-fit. We first describe nature of IS use construct.
3.1 Nature of IS use construct

The key construct of interest is nature of IS use. We define nature of IS use (NU) to be the characteristics that describe the IS use process of a user. Individuals differ in their use of the information systems based on their personality, experience, perceptions, self-efficacy, and competence levels (Agarwal, 2000; Marcolin et al., 2000; Boudreau and Seligman, 2003). Such differences manifest themselves in actual IS use behavior of an individual. For instance, an individual may use only limited functionalities or features of an application compared to another individual who may exhibit heightened level of value added use of IS (Agarwal, 2000). Similarly, differences across individuals in IS use behavior also arise because, over time, IS applications are enhanced by some users themselves (or based on their feedback), which result in more sophisticated usage, and greater integration into the user’s work system (Kling and Iacono, 1984). While differences in IS use behavior may not be significant across individuals for certain technologies, these differences become more evident in the case of a complex technology with the potential for multiplicity of use or intentions to explore (Tornatzky et al., 1990). Past studies in IT infusion (Sagia and Zmud, 1994), IT innovation (Agarwal and Prasad, 1998; Nambisan et al, 1999), and post-adaptive behavior of individuals with respect to IS (Marcolin et al., 2000; Boudreau and Seligman, 2003) provide us some conceptualizations for individuals’ IS use behavior. The nature of the IS use construct is conceptually closest to extended and emergent use proposed by Sagia and Zmud (1994). It is important to point out, at this stage, that there could be other potential dimensions of nature of IS use across which individual differences can be observed. For example, intentional use versus habitual use or voluntary versus mandatory use could be aspects of nature of IS use. While we are aware of the possibility of such dimensions, we have attempted to address only those aspects of nature of IS use that reflect the richness of IS use.

3.2 Task-technology-fit construct

We define task-technology-fit (TTF), based on the prior definitions of this construct (Goodhue and Thompson, 1995) as the “degree to which a technology assists an individual in performing his or her portfolio of tasks”. Though we borrow the dimensions of TTF from Goodhue and Thompson (1995), we do not include all the eight dimensions proposed in the TTF construct by Goodhue and Thompson (1995). We retain two of the original dimensions, namely, compatibility and ease of use/training. We modify the third dimension in the original TTF construct, quality, to make it relevant to the application context of our study. We dropped five of the original dimensions from the TTF construct because our focus is on performance impacts of IS at the individual level as opposed to an organization level application used by the individuals in case of Goodhue and Thompson’s study (1995). Since dimensions of locatability, authorization, production timeliness, and relationship with users are not relevant in context of an individual productivity application, we decided to drop these four dimensions from our construct. The fifth dimension of system reliability focuses on availability and stability of the system. However, off-the-shelf software applications like spreadsheets have, over time, become widely available and relatively more reliable unlike other organization level custom applications. Since the context of this study is an individual productivity application, namely spreadsheets, system reliability seems less relevant to task-technology-fit construct and therefore, we decided not to include that in our construct.

The TTF construct in this study is operationalized differently from the original TTF construct of Goodhue and Thompson (1995) in that we conceptualize task-technology-fit as a second order construct (Staples and Seddon, 2004) as opposed to eight dimensions analyzed individually in Goodhue and Thompson’s (1995) study (See AppendixA).
4 RESEARCH MODEL

Figure 1 shows our integrated research model. As explained earlier, our research model is grounded in the streams of research focusing on IS use, task-technology-fit, and post adoptive IS use behavior.

![Research Model Diagram]

*Figure 1. Research Model*

We now discuss each of the key relationships in this model.

4.1 IS Use and Performance Impacts of IS

While some past studies report a positive relationship between IS use and performance impacts at the individual level (Torkzadeh and Doll, 1999; Goodhue and Thompson, 1995; Crawford, 1982; Robey, 1979), some others have reported either no relationship or a negative relationship between IS use and performance (Pentland, 1989). Delone and McLean (1992) identified IS use as an antecedent of performance impact and re-emphasized the relationship between IS usage and net benefit/performance impact in a subsequent study (Delone and McLean, 2003). Straub (1994) used the IT diffusion model to study the link between IS use and productivity benefits. While the evidence about the relationship between IS use and performance impacts appear to be mixed, it is logical to contend that no performance impacts can be observed if the system is not used. In other words, systems must be utilized before they can deliver performance impacts (Goodhue and Thompson, 1995). From this standpoint, it is expected that with increase in IS use, there will be improvement in performance impacts of IS. Therefore, a positive relationship should exist between IS use and performance impacts of IS.

H1: There is a positive relationship between IS use and performance impacts of IS
4.2 Task-Technology Fit (TTF), IS Use, and Performance Impacts of IS

Task-technology-fit is the degree to which a technology assists an individual in performing his or her portfolio of tasks (Goodhue and Thompson, 1995). The higher the degree of fit between the technology functionalities and the requirements of the user’s tasks, the higher is the probability that technology will be used and impact individual performance. The positive relationship between TTF and performance has been confirmed in prior research (Staples and Seddon, 2004; Goodhue and Thompson, 1995; Benbasat et al, 1986; Dickson et al, 1986). Therefore, it is logical to expect that the higher the task-technology-fit, the higher will be the performance impacts of IS. Therefore, we hypothesize,

H2: There is a positive relationship between task-technology-fit and performance impacts of IS

Prior research provides mixed support for the relationship between TTF and IS use (Goodhue and Thompson, 1995; Dishaw and Strong, 2003). Some studies report a positive relationship between TTF and IS use (Dishaw and Strong, 2003) while some other report insignificant relationship between the two (Goodhue and Thompson, 1995) constructs. Despite mixed results, it seems logical that an individual is likely to use a technology that fits his/her job tasks more than the one, which does not. Therefore, it leads us to hypothesize:

H3: There is a positive relationship between task-technology-fit and IS use.

4.3 Nature of IS Use and Performance Impacts of IS

While IS use is necessary to observe performance impacts, it may not be sufficient to explain variation in performance impacts of IS realized by different individuals. Some studies suggest that true performance impacts of information systems are delivered only through the appropriate use by its target user group (Lucas, 1993; Soh and Markus, 1995). It is likely that individuals who discover new and innovative ways of exploiting technology (Agarwal, 2000) will experience higher benefits of using technology. The implication is that how an individual uses the system (nature of IS use) will lead to positive performance impacts of IS. Tornatzky et al. (1990) support this by arguing that the way the individuals use IS accounts for the differences in performance impact of IS in case of complex technologies. Therefore, we hypothesize,

H4: There is a positive relationship between nature of IS use and performance impacts of IS

4.4 IS use and Nature of IS Use

In a post adoptive scenario, the amount of time a user spends using a system provides a user with opportunities to explore the system. This includes how a user manipulates the software which might involve multiple dimensions like creativity, serendipity, lateral thinking, using the software differently, developing workarounds, learning short-cuts, using new functions etc. to get the work done. All these activities determine the nature of IS use for a given user. A user who tends to spend more time on the system will tend to learn new ways of exploiting the system’s capabilities or become more adept at “discovering” more efficient ways of manipulating the software. Similarly, users who are content with minimizing their use of the software (Boudreau and Seligman, 2003) reduce their opportunities to discover new use patterns for the application or develop “workarounds” to established ways of using the application. This implies that users, who tend to use the application more, will tend to have more varied experiences with the application. The variety in user’s experiences results from two factors. First, given high levels of use, users will tend to encounter functionalities and features that a low-level user may not typically encounter (Agarwal, 2000). Such exposure, over a period of time, leads to experiences with trouble-shooting and problem resolution, that propel users into a more sophisticated mode of using the application. Secondly, considering a user as a rational actor, the user
will attempt to optimize her use by seeking out either new ways of accomplishing an IS-enabled task faster, or a more efficient workaround, or be serendipitous about IS use in general. Therefore, we hypothesize:

H5: There is a positive relationship between IS use and nature of IS use

5 RESEARCH DESIGN

In order to operationalize the research model, we employed a survey research design. The sample for our study consisted of 434 individual users in six organizations. These organizations belonged to the telecommunications, defence, government and public sector, financial and banking, aerospace and the hospitality sectors. In this study, we tested the research model presented in Figure 1 for an individual productivity application, namely, spreadsheets. The choice of this application was driven by three factors. First, given the ubiquitous nature of spreadsheets, results of this study will lend themselves to generalizability. This is particular important because we are operationalizing the TTF construct for individual level application rather than organizational level application. Second, the focus of this study is on individual productivity. Spreadsheets are often considered as part of office productivity applications. From this standpoint, spreadsheet application seems more appropriately related to individual productivity than others. Finally, we wanted to test our research model across an application that provides relatively different degrees of freedom to a user in terms of using it differently. For example, although spreadsheet is considered a very useful tool, its use often depends on the nature of a user’s tasks, and a user’s predisposition to using spreadsheets, among other factors.

5.1 Operationalization of Constructs

The theoretical model for this study consists of four key constructs. They are task-technology-fit, nature of IS use, IS use, and performance impacts of IS. The construct, IS use, has been operationalized in terms of number of hours respondents used the application on daily basis. This operationalization of IS use is consistent with prior research (Taylor and Todd, 1995; Venkatesh et al., 2003; Compeau and Higgins, 1995; Davis et al., 1989; Szajna, 1996). The two constructs, nature of IS use and performance impacts of IS were measured by incorporating three items each. The third construct, task-technology-fit, is a second order construct with first order constructs being task-support, extended task-support, ease of use/ training, and compatibility.

5.1.1 Task-Technology-Fit Operationalization

We operationalize the task-technology-fit construct based on four dimensions developed using the three dimensions out of the eight originally proposed by Goodhue and Thompson (1995). The four dimensions used in our study are task support (TS), extended task-support (ETS), ease of use/training (EOU), and compatibility (CMP). As explained earlier, we conceptualize TTF as a second order construct and test the validity of the construct using second order confirmatory factor analysis.

5.1.2 Nature of IS Use Operationalization

We operationalized the nature of IS use construct using three items, each of which addresses a select attribute of the differences in IS use in terms of how the information system is used by the individuals. The first item captures if there is a difference in level of sophistication of IS use across individuals. While the second item captures the individual’s use of different available features in the IS application to do things differently compared to others, the third item focuses on individual’s use of different features in an efficient manner compared to others. We present the definition and rationale for each of the items used for operationalizing nature of IS use construct in Table 1.
Three levels of IS use infusion: extended use, integrative use, and emergent use, with each level being more sophisticated than the preceding one (Saga and Zmud, 1994). Infusion is defined as “the extent to which an innovation’s features are used in a complete and sophisticated way” (Fichman, 2000; p. 110). In addition, Agarwal (2000) also distinguishes between surface level utilization deeply ingrained and heightened level use with latter being considered more sophisticated than the earlier one. Individuals, confronted with an identical technology implemented within the same organizational context, may use the technology differently (Boudreau and Seligman, 2003).

This item is based on “intentions to explore” construct (Nambisan et al, 1999) and has been adapted to reflect actual behavior in this study.

Table 1. Nature of IS use construct operationalization

<table>
<thead>
<tr>
<th>Item</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>NU1</td>
<td>My use of spreadsheet is sophisticated</td>
</tr>
<tr>
<td>NU2</td>
<td>I use features in spreadsheet to do things differently</td>
</tr>
<tr>
<td>NU3</td>
<td>I try new features in spreadsheet</td>
</tr>
</tbody>
</table>

5.1.3 Performance Impacts of IS Construct Operationalization

While it is preferable to collect objective measures of performance gains to avoid any bias in reporting performance gains, it is nevertheless difficult to get such measures. Therefore, self-reported measures are used in most studies (Robey, 1979; Crawford, 1982, Goodhue and Thompson, 1995). In this study also, we use self-reported measures of performance impacts of IS adapted from Goodhue and Thompson (1995) and based on two dimensions of IS impact on work, namely, task productivity (Kraemer and Danziger, 1990; Sulek and Marucheck, 1992) and task innovation (Davis, 1991). Performance impacts of IS construct was operationalized using three items, adapted from Goodhue and Thompson (1995), to suit the contextual requirements (Appendix A).

6 ANALYSIS AND RESULTS

The survey questionnaires were distributed to a random sample of all users in six organizations. A total of 1000 questionnaires were distributed. In all, 434 valid and usable responses were received, giving a response rate of 43%. The respondents for the survey came from a variety of organizational levels ranging from clerical to senior management. Nearly 57% of the respondents belonged to middle management, supervisory or technical staff level.

6.1 Measurement Properties: Assessment of scale reliability and validity

We conducted a factor analysis on first order constructs in our model, namely, task-support, extended task-support, compatibility, ease of use/training (all these are first order constructs of TTF, a second order construct), nature of IS use, and performance impacts of IS. A factor analysis indicates the factorial validity of the scales. Based on a varimax rotation, the manifest variables divide cleanly into six factors, indicating existence of six distinct constructs. As shown in Table 2, indicator loadings exceed a suggested minimum of 0.60 (Bagozzi and Yi, 1988). Overall, these loadings confirm the structure of six primary first order constructs and the suitability of their respective indicators. We also reviewed the composite reliability for evidence of internal consistency and found that composite reliability exceeds recommended minimum of 0.80 (Werts et al, 1978) except in case of compatibility construct where it is nearly 0.80.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
<th>Factors</th>
<th>Composite Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1 2 3 4 5 6</td>
<td></td>
</tr>
<tr>
<td>Task-support (TS)</td>
<td>TS1</td>
<td>0.149</td>
<td>0.820</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>TS2</td>
<td>0.012</td>
<td>0.853</td>
</tr>
<tr>
<td>Extended task-support</td>
<td>ETS1</td>
<td>0.173</td>
<td>0.334</td>
</tr>
<tr>
<td>(ETS)</td>
<td>ETS2</td>
<td>0.190</td>
<td>0.102</td>
</tr>
<tr>
<td>Construct</td>
<td>Task-support</td>
<td>Extended task-support</td>
<td>Ease of use/Training</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>--------------</td>
<td>-----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Task-support</td>
<td>0.749</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extended task-support</td>
<td>0.517</td>
<td>0.779</td>
<td></td>
</tr>
<tr>
<td>Ease of use/Training</td>
<td>0.439</td>
<td>0.615</td>
<td>0.810</td>
</tr>
<tr>
<td>Compatibility</td>
<td>0.374</td>
<td>0.483</td>
<td>0.472</td>
</tr>
<tr>
<td>Nature of IS Use</td>
<td>0.366</td>
<td>0.510</td>
<td>0.561</td>
</tr>
<tr>
<td>Performance impacts of IS</td>
<td>0.620</td>
<td>0.609</td>
<td>0.485</td>
</tr>
</tbody>
</table>

Table 3. Correlations between constructs (*significant at p < 0.05. Average variance extracted (AVE) displayed in the diagonal.

In another factor analysis (Table 4), since the dimensions of TTF, task-support, extended task-support, ease of use/training, and compatibility load on single factor with overall composite reliability of 0.859 for TTF construct, it confirms TTF as a second order construct. The results presented in Tables 2 and 4 provide support for the validity of measurement scales used in this study. To validate a factor structure, the correlation between each factor pairing must be less than the square root of the average variance extracted for each factor. As shown in Table 3 and 5, our model constructs confirm that the factor structure is valid.

<table>
<thead>
<tr>
<th>Construct</th>
<th>Items</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>Composite Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Task-Technology-Fit</td>
<td>TS</td>
<td>0.039</td>
<td>0.315</td>
<td>0.764</td>
<td>0.859</td>
</tr>
<tr>
<td></td>
<td>ETS</td>
<td>0.200</td>
<td>0.303</td>
<td>0.709</td>
<td></td>
</tr>
<tr>
<td></td>
<td>EOU</td>
<td>0.349</td>
<td>0.450</td>
<td>0.631</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CMP</td>
<td>0.267</td>
<td>0.177</td>
<td>0.640</td>
<td></td>
</tr>
<tr>
<td>Nature of IS use (NU)</td>
<td>NU1</td>
<td>0.137</td>
<td>0.652</td>
<td>0.000</td>
<td>0.857</td>
</tr>
<tr>
<td></td>
<td>NU2</td>
<td>0.074</td>
<td>0.749</td>
<td>0.024</td>
<td></td>
</tr>
<tr>
<td></td>
<td>NU3</td>
<td>0.081</td>
<td>0.816</td>
<td>0.057</td>
<td></td>
</tr>
<tr>
<td>Performance impacts of IS (PI)</td>
<td>PI1</td>
<td>0.825</td>
<td>0.097</td>
<td>0.003</td>
<td>0.910</td>
</tr>
<tr>
<td></td>
<td>PI2</td>
<td>0.739</td>
<td>0.258</td>
<td>0.289</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PI3</td>
<td>0.790</td>
<td>0.016</td>
<td>0.070</td>
<td></td>
</tr>
</tbody>
</table>

Table 4: Factor loadings for key constructs
Table 5. Correlations between constructs (*significant at p < 0.05. Average variance extracted (AVE) displayed in the diagonal.

<table>
<thead>
<tr>
<th>Path Name</th>
<th>Path Coefficient</th>
<th>t Value</th>
<th>P value</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete Model</td>
<td></td>
<td></td>
<td></td>
<td>0.601</td>
</tr>
<tr>
<td>TTF-IS Use</td>
<td>0.524</td>
<td>15.56</td>
<td>&lt;0.001</td>
<td>0.274</td>
</tr>
<tr>
<td>IS Use-Nature of IS Use</td>
<td>0.425</td>
<td>9.17</td>
<td>&lt;0.001</td>
<td>0.181</td>
</tr>
<tr>
<td>TTF-Performance Impacts of IS</td>
<td>0.545</td>
<td>10.66</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>IS Use-Performance Impacts of IS</td>
<td>0.112</td>
<td>2.76</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td>Nature of IS Use-Performance Impacts of IS</td>
<td>0.234</td>
<td>5.94</td>
<td>&lt;0.01</td>
<td></td>
</tr>
</tbody>
</table>

Table 6. PLS Results

6.2 Structural Properties: Model Validation

We used the partial least squares (PLS) (PLSGraph, Version 3.0, Build 1126) method to validate the integrated model. PLS relates measures to latent constructs and permits construction of a system of equations to maximize the variance explained among the endogenous constructs. PLS uses a series of OLS regressions to estimate structural parameters. PLS is more “flexible” when analyzing exploratory models (Chin, 1998). We chose PLS over structural equation modeling (or covariance structure modeling) because our prime focus in this study is to analyze the explanatory power of the model as opposed to just validating the structural relationships.

Our results (Table 6) indicate that the integrated model does reasonably well (R² = 0.60) in explaining the variance in performance impacts of IS compared to technology-to-performance chain model of Goodhue and Thompson (1995) that explained only 16% of the variance in the performance impacts. Further, these results confirm the statistical significance of all the hypothesized relationships in the model.

7 DISCUSSION

We validated our integrated model by studying individuals’ usage of the spreadsheet application. Given that the spreadsheet is a general purpose and widely used application, our study results can be generalized to the general class of office productivity software. Our results showed support for the relationships that we had hypothesized. These were: (a) There is a positive relationship between IS use and performance impacts of IS; (b) There is a positive relationship between task-technology-fit and performance impacts of IS; (c) There is a positive relationship between task-technology-fit and IS use; (d) There is a positive relationship between nature of IS use and performance impacts of IS; and (e) There is a positive relationship between IS use and nature of IS use. In addition to overall support for the research model, there were several findings that were interesting – some that were consistent with past research and others that were specific to this research. In the remainder of this section, we discuss the scientific contributions and implications of our work.

Our work makes several important contributions to IS research. Developing the nature of IS use construct, modifying the TTF construct and demonstrating their relationship with performance impacts of IS is a key contribution. In general, we hope that this work serves as an important step in adding to the emerging body of research in post-adoption domains incorporating performance impacts of IS. In terms of the overall model, our model explains 60.1% of the variation in performance impacts of IS. This is significantly high compared to the 16% reported by Goodhue and Thompson (1995). The difference in R² between Goodhue and Thompson (1995) and our research can be explained by the
fact that we are using a specific individual level application and relating it to individual productivity. In the process of developing this enhanced model we modified the TTF construct and developed the conceptualization and scales for a new construct - nature of IS use. The results in Tables 2 to 5 provide evidence regarding the generalizability of these constructs. While the hypothesized relationship between IS Use and Performance Impacts of IS came out to be significant, it should also be noted that the path weight associated with it was also the smallest – compared to the relationships between PI and the two other independent variables (NU and TTF). This implies that increasing usage does not result in as higher performance impacts as would if we varied NU and TTF.

Based on the regression results (Table 6), we can see that TTF and Nature of IS use have a significant influence on Performance Impacts of IS. TTF and NU can be considered to be the structural and operational determinants, respectively, of Performance Impacts of IS. We say this because the level of TTF is typically established before an application is installed in an organization – either by choosing the right technology or by ensuring the right work processes for a given technology or by a combination of both. TTF can, of course, be adjusted later, its level depends on institutional decisions – typically manifested in decisions like which spreadsheet to buy for the organization, what kind of training to provide to users, or what types of tasks to encourage users to take up using spreadsheets. Nature of IS use, however, is a far more user-centric concept. The locus of control for recalibrating NU lies with the user. As a result, we consider it to be more post-implementational in character compared to TTF.

Importantly, the relationship between TTF and IS use emerged as significant in our study. This is at variance with the result reported by Goodhue and Thompson (1995) who did not find the relationship between these two variables significant. This results is consistent with the technology acceptance research tradition that if a technology is useful (in this case, compatible with the work and work process, as measured by TTF), the user is inclined to use the technology more than if there is a dissonance between the technology in place and the task at hand. The significant relationship between NU and IS use is consistent with our hypothesis that individuals who use the information system more tend to be more sophisticated users. IS use is an important antecedent of nature of IS use. It goes to show that a user enhances her capability to leverage a given information system better, by using the system more intensely compared to others.

From a practitioner’s perspective, our results have many implications. The relationship between TTF and IS use should tell managers that as information systems get more sophisticated, users’ jobs and tasks must be continuously reconfigured and enriched so as to preserve the resonance between task sophistication and technology functionality. Given that IS use is necessary, but not sufficient to delivering performance impacts of IS, TTF becomes an important managerial tool that can be leveraged not only at the time a technology is introduced but also recalibrated at regular intervals by enhancements to technology as well as user tasks and associated work processes. The practical value of the significance of the relationship of NU and PI lies in ensuring that IS users work smarter and not necessarily harder. When juxtaposed with the smaller path coefficient between IS use and PI, more time spent using an IS (in this case a spreadsheet) does not necessarily leads to greater PI. On the other hand, working smarter may lead to sustainable performance impact patterns.

8 CONCLUSIONS

This study has added to the literature on post-adoptive IS use by linking TTF, NU and IS use to performance impacts of IS. The study has shown the importance of TTF as a structural variable and NU as a process variable. By recasting the TTF instruments that is relevant for a specific application, our research approach and results have provided useful implications for theory as well as practice. The primary theoretical implication of our focus on the outcome variable, performance impacts of IS, lies in framing a process theory oriented (Soh and Markus, 1995; Crowston, 2000) approach to technology enabled productivity. It is this very process-based view of IS use than can be used to derive incremental value by manipulating the IS use process.
References


Appendix A: Instrument Items

<table>
<thead>
<tr>
<th>Task Support</th>
<th>Extended Task Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spreadsheets provide significant support for my daily tasks</td>
<td>Spreadsheets are very versatile so that I can put them to different uses in my daily tasks</td>
</tr>
<tr>
<td>My job does not require the use of spreadsheets</td>
<td>Spreadsheets provide features that sometimes help me outside my routine tasks</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ease of Use/Training</th>
<th>Compatibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>My earlier experience makes it easier for me to use spreadsheets in my daily tasks</td>
<td>Spreadsheets allow me to manipulate things the way I want</td>
</tr>
<tr>
<td>I find spreadsheets easier to use in my daily tasks because of my training in using them</td>
<td>Spreadsheets provide for easier integration with other productivity software</td>
</tr>
<tr>
<td>Nature of IS Use</td>
<td>Performance Impacts of IS</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>My use of spreadsheet is more sophisticated</td>
<td>Spreadsheets have significant positive impact on my effectiveness</td>
</tr>
<tr>
<td>I use features in spreadsheets to do things differently</td>
<td>Spreadsheets have a significant positive impact on my productivity in my daily tasks</td>
</tr>
<tr>
<td>I try new features in spreadsheets</td>
<td>Spreadsheets improve my ability to complete tasks in time</td>
</tr>
</tbody>
</table>