Technology's Role:
Personified ERP System as a Social Actor
Influencing IS Resistance

By
Pam J. Schmidt
and
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Technology's Role: Personified ERP System as a Social Actor Influencing IS Resistance

Research Paper

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Abstract

This novel enterprise systems research conceptualizes the Enterprise Resource Planning (ERP) system as a social actor. A personified ERP system is described and hypothesized as an element in the user’s transactive memory system (TMS). Characteristics of this personified ERP are identified from prior research. This experimental study addresses influences on IS Resistance using a new measure of Task Interdependence on ERP, modeled on the measure of Task Interdependence on others (Sharma & Yetton, 2007). Specifically, effects of the new measure of Task Interdependence on the ERP system, Task Interdependence on teammates and Perceived Technological Complexity and their impact on IS resistance are evaluated. IS Resistance is best explained by a three-way interaction. Across all conditions, individuals with the highest task inter-dependency on teammates were generally found to have lower IS resistance. The lowest IS Resistance was found when all three independent variables are at their highest levels.
Introduction

The primary goal of this study is to investigate ERP’s role as a personified technology in a transactive memory system, and to explore the team’s interdependency as antecedents of Resistance to an ERP system. Prior calls for ERP research state “There is a growing need to examine how resistance to ERP and ERP workarounds change over time, what actions management can use to counteract them, and how these ERP workarounds impact management control.” (Grabski et al. 2011). More particularly, this study investigates what factor(s) exacerbate and mitigate the resistance to ERP through the IS Resistance construct. Specifically, this study focuses on how task interdependence on team members may help diminish IS Resistance (and therefore accelerate ERP use). This study finds that individual users benefit from team member assistance in utilizing the ERP system.

Transactive Memory Systems (TMS) is a knowledge management practice whereby team members differentiate their knowledge by specializing in different expertise domains. Team members then collaborate interdependently to share expert knowledge with others as needed. These collaborations provide each team member with a larger memory, through collaborative transactions, than individual memory alone retains. This practice expands the expertise available to each team member by expanding their domain of expert knowledge.

Social psychology and team research have repeatedly demonstrated that a TMS is influential in improving performance in small teams. This research introduces the concept of viewing IT systems, specifically an ERP system, as an additional source of expert knowledge and therefore a transactive memory (TM) element. In other words, it conceptualizes an ERP system as a knowledge resource alternative to the expertise of team members. Learning how to better utilize ERP as a part of a TMS could expand the team expertise and improve process execution.

A challenge faced by new ERP users is that utilizing ERP-based knowledge requires both the ability to navigate the ERP system as well as a clear understanding of the business process steps, interactions and dependencies. Effectively communicating with team members (in a TMS) requires inter-personal communication skills. Effectively using a complex ERP system additionally requires the individual development of technical and process knowledge before the ERP system can become a viable member of the TMS. These skills should be multidisciplinary and include both declarative and tacit knowledge structures (Freeze et al. 2015). This process is similar to the TMS team member introducing themselves to their teammates, becoming comfortable with their domain of expertise and sharing their domain of expertise. The activity of learning ERP serves in the creation a TMS directory entry about the knowledge and location of expertise. With greater ERP skills comes the effective use of an ERP as a ‘full and valuable’ member of the TMS.

This study departs from the typical IT application acceptance research approach and instead views technology from a social cognition perspective. Prior research (Schmidt et al. 2014) shows that it is not enough for individuals within a team to interact with team members, but it is important that users utilize high quality knowledge sources in their workplace social network. To perform well, users should seek knowledge sources of high quality to support both the process conceptual knowledge as well as accurate and timely business data. The use of an ERP is presented as the choice of each individual who could alternatively communicate directly with a team member. This positions the choice of using ERP or team interaction as alternative information sources during operations of a time-sensitive business process. The following research questions are the focus of this study:

- Research Question #1 – To what degree can interdependence on a personified ERP be detected?
- Research Question #2 - How do individuals vary in reliance on their virtual TM element (personified ERP) and their human TM element in a fast paced, dynamic work environment?
- Research Question #3 – Do varying levels of interdependence on personified ERP and on human team members reduce IS resistance by a new user?

By investigating the technology from this perspective, fundamental cognitive concepts related to knowledge management and ERP use will be better understood. Special focus is placed on two cognitive areas: a) how perceptions of high complexity produces mental workload that inhibit use of ERP (i.e. IT Resistance) and b) how technology vs. human team members are viewed within a close, interdependent work team as it...
performs demanding, dynamic business processes. The remainder of the paper begins with the theoretical research associate with the personification of IT followed by a review of Transactive Memory Systems. The theoretical background section concludes with a review of IT Resistance and Technostress theory. The research model and resulting hypothesis will be presented with a concluding discussion of the three-way interaction that is the focus of this study. Next, the experimental setup and data collection methods will be reviewed, followed by an analysis of the results. Finally, the contributions and conclusions of this study will be reviewed along with the limitations and future research.

Theoretical background

This research builds on transactive memory systems (TMS) theory by positing the ERP system as an element of the transactive memory available to all team members assigned to jointly perform interdependent business processes. Therefore, the ERP system, as a TM element (ERP/TM), is considered an extended part of the TMS definition. The ERP/TM element could be custom developed to directly support the team or project, could be commercially purchased for project use, or could be an external knowledge resource. All of these types of IT can be considered as IT/TMs if they are incorporated into the knowledge differentiation resources of the team’s TMS.

Personification of IT

It is hypothesized that the personified ERP system acts as a team member in a Transactive Memory System (TMS). Viewing the ERP system as a personified member of the team leads to an interpretation whereby greater reliance on any team member can result in reducing the cognitive demands inherent in performing interdependent tasks to achieve the common goal of a business process. In more detail, this study asks the question "How do Task Interdependence, ERP Interdependence and Technical Complexity influence Resistance to ERP?" More specific questions are: Does interdependence on team mates and/or on ERP (as social actor, i.e. team member) decrease IS Resistance to ERP? How does the perception of ERP complexity influence resistance to ERP?

As an ERP/TM, the ERP system provides valuable information and performs valuable activities such as a) sharing stored master data reflecting past policies and decisions enacted by management (e.g. suppliers from which to purchase, materials to utilize in production, credit limits for customers); b) providing real time status information collected and used in the performance of business transactions, and c) 'monitors' and 'enforces' the necessary steps and conditions required in performance of each business process.

For purposes of defining the full team involved in executing ERP-based business processes, it is valuable to include the ERP system as a personified team member. Just as various co-worker personalities and work-styles will impact a team, the ERP system exerts a large influence on how co-worker's interact with it due to the tight coupling among inter-dependent tasks in an ERP environment. Since the ERP system imposes many factors on the team, this study finds it beneficial to consider the ERP system as a team member and part of the TMS. To better understand the nature of a personified ERP, characteristics of an ERP system are listed in Table 1 - Personified ERP Characteristics. This approach to defining a personified ERP as a team member is based on CASA (Computers are Social Actors) (Nass et al. 1994; Nass et al. 1996). Prior research has shown that strong social bonds can form between human and computer accelerated by simply labeling them as a 'team' (Nass et al. 1995). There is also support for simple forms of technology to be personified. One study found that personification of technology does not require that the technology have any form of artificial intelligence (Nass et al. 1995).
<table>
<thead>
<tr>
<th>ERP Characteristic</th>
<th>References</th>
<th>Definitions and Descriptions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integrated, less flexible User Interface</td>
<td>(Xu et al. 2002)</td>
<td>Requires the end user to adhere to a highly integrated user interface (inflexible and non-adaptive in communication style as a human team mate would be).</td>
</tr>
<tr>
<td>Strict Business Processes (high task interdependence)</td>
<td>(Morton et al. 2008; Sharma et al. 2007; Kang et al. 2003)</td>
<td>Requires all steps in the process be properly executed before work can proceed to a successful conclusion. Cannot skip data inputs or steps.</td>
</tr>
<tr>
<td>Internal controls, Management policy</td>
<td>(Chapman et al. 2009; Grabski et al. 2007; Grabski et al. 2011)</td>
<td>Internal controls enforce management policy by ERP restrictiveness.</td>
</tr>
<tr>
<td>Panoptic monitoring</td>
<td>(Spears et al. 1994; Kayas et al. 2008; Elmes et al. 2005)</td>
<td>In a panopticon, employees exercise self-discipline because they know they are or can be monitored.</td>
</tr>
<tr>
<td>Panoptic empowerment versus Panoptic Control (data visible across organization)</td>
<td>(Elmes et al. 2005; Sia et al. 2002)</td>
<td>Panoptic-based empowerment is mainly based on employees readily accessing information previously unavailable or accessing new forms of valuable task information. ERP is effectively omniscient with regard to business data held in the corporate database.</td>
</tr>
<tr>
<td>Discipline by enforcing processes, Reflective conformity</td>
<td>(Elmes et al. 2005; Pearsall et al. 2006)</td>
<td>Reflective conformity: ERP can contribute to less reflection by employees due to embedded processes, but it requires more reflection about how processes inter-relate and how the system supports them, to achieve operational and control benefits.</td>
</tr>
</tbody>
</table>

Table 1 - Personified ERP Characteristics

In the case of an ERP system, the processes and practices enforced by the system are said to reflect industry 'best practices'. The internal controls, such as user access controls based on roles and authorizations represent internal control mechanisms based on policies of upper management. So, with this view, by interacting with a personified ERP, individuals are responding rationally to a computer as a 'human-made artifact'.

**Personified ERP Characteristics**

Based on extant ERP literature and the Computer as a Social Actor (CASA) approach, a set of ERP characteristics has been assembled which is interpreted as the ERP personality within the team. These ERP personality characteristics have an impact on other team members. These characteristics are based on observations and findings in prior ERP research. Each characteristic is named, along with its referencing source and followed by a short definition or description (Table 1). A majority of ERP studies point out that the leading purpose of an ERP is to implement generally accepted 'best practices' and to integrate business processes (resulting in high task interdependence). The nature of a highly integrated business process is to restrict user actions by enforcing a very specific sequence of business tasks and to require a complete and correct set of inputs and interactions before allowing the business process to proceed to the next step. Such requirements provide consistency and correctness in the system. However, human actors may find such restrictiveness and strictness to be oppressive.

ERP systems lead to inherent contradictions because they are both a mechanism for management to exert outcome and process control, while simultaneously enabling increased employee empowerment by providing early access to information and pushing down operational decision-making. Two concepts which capture the inherent contradictions – panoptic empowerment and reflective conformity were identified (Elmes et al. 2005). Panoptic empowerment refers to the greater visibility of information provided by the common shared database of an ERP that empowers workers to do their work more efficiently and effectively, but which also makes them more visible to others throughout the organization who can then more easily exercise process and outcome control. Reflective conformity describes how the integrated
nature of the ERP with its embedded rules and procedures for organizational processes leads to greater employee discipline while simultaneously requiring them to be highly reflective as well in order to achieve organizational benefits from the ERP. Both of these concepts help explain how enterprise systems exert organizational control based on disciplinary power rather than a traditional management oversight and administrative bureaucracy.

**Transactive Memory Systems (TMS)**

A transactive memory system is a collection of differentiated knowledge sources called transactive memories (TM) of experts on a team who share information via interactions (i.e., transactions) between these same interdependent individuals. The existence of TMSs were first identified studying couples and how they differentially stored knowledge and experiential memories in support of interdependent goals (Wegner et al. 1991; Wegner D. M. 1986). A TMS operates based on a shared understanding of 'who knows what' in the group. The structure of a TMS has been defined as consisting of two main elements of a set of transactive memories (TM) and a shared TMS directory (Lewis 2003; Lewis 2004). A TM element is a member that is influenced by knowledge about the memory systems of other persons.

A TMS directory is often thought of as a shared understanding of the knowledge contained in individual TMs across the group. In other words, the directory is a shared mental model of 'who knows what' in the TMS. A more or less similar copy of the directory is known by each individual within the group. This directory is created by interactions during the team formation process and is continually updated and adjusted throughout the lifetime of the team. This as the directory update process and include the TMS processes of information allocation and retrieval coordination (Wegner D. M. 1995). Information allocation is the process that handles new information as it comes into the group and is communicated to the appropriate TM to facilitate encoding and storage. Retrieval coordination is the enactment of a retrieval plan for a specific topic and includes identification and selection of an appropriate TM from the directory, as well as the interactions needed to retrieve knowledge. A TMS allows for varying levels of integrated or differentiated knowledge across the group.

Study of TMS is often focused on task-oriented information. TMS advantages build on shared training (Moreland et al. 2002), memories of shared experiences (Wegner D. M. 1986) and knowledge regarding external resources (Austin 2003). The existence of a TMS has been repeatedly shown to positively influence productivity in small groups, as has been demonstrated in married and dating couples (Wegner et al. 1991) and other dyads as well as in small interdependent teams (Moreland et al. 2002; Borgatti et al. 2003).

**IT Resistance**

User resistance to IT is defined as an adverse reaction, or opposition of users to perceived change related to new IS implementation (Markus 1983). For organizations to maximize the benefits of technology, especially a business process efficiency-oriented system such as an ERP, the users need to accept and become proficient at its use. The main antecedents of resistance to IT were integrated from three different literature bases including that of technology acceptance, user resistance and 'status quo bias' (Kim et al. 2009). While they did study ERP system usage, the Enterprise system technology studied was quite a modest system (few modules, did not include major/core ERP capabilities for large companies such as MRP, SCM or finance). While their findings did not support that 'Favorable colleague opinion has a negative effect on user resistance' there were many other direct and indirect effects that act as important mitigators of IT Resistance. In their study, switching benefits operate through perceived value which reduces resistance.

**TechnoStress Theory**

In IS literature, a concept closely related to IS Resistance is TechnoStress. TechnoStress is defined as a modern condition of adapting to, and being heavily dependent on, the use of Information and Communication Technologies (ICTs) (Tarafdar et al. 2007). It is considered to be the lack of ability to cope with new technologies in a healthy manner and as a state of arousal seen in some employees who are very dependent on computers in performing their work tasks (Arnett et al. 1997). The model contains TechnoStress Creators which reduce outcomes including Job Satisfaction, except when occurring in the presence of TechnoStress Mitigators. TechnoStress Creators include Techno-Complexity and Techno-
Overload. *Techno-complexity* describes cases where the ICT complexity causes users to feel inadequate about their computer skills and forces them to extra spend time and effort in learning ICTs. *Techno-overload* describes situations where ICTs pressure users to work faster and harder. Among TechnoStress Inhibitors, "Technical support provision" describes activities related to end-user support that reduce the effects of technostress by solving users' ICT problems relating (Ragu-Nathan et al. 2008). These include an emphasis on team work and knowledge sharing in dealing with new technology problems. Technical complexity was classified as a TechnoStress Creator, whereas, Technical support provision and Literacy Facilitation were considered TechnoStress Mitigators.

**Research Model and Hypotheses**

The research goal is to investigate the effects of independent variables of Perceived Technical Complexity (TC) and Task Interdependence on teammates (TI) associated with reducing IS resistance that has been presented in prior research (Sharma et al. 2007). We have additionally posited that the personified nature of the ERP system as a team member can be captured with the adapted factor of Task Interdependence on ERP (TI-ERP) which is derived from the TI construct. This TI-ERP variable introduces another possible moderation variable that interacts with the variables of Task Interdependence and perceived Technical Complexity to help further illuminate the understanding of factors that impact IS Resistance. The commonly accepted conceptual understanding of moderation (Baron et al. 1986) is followed with two-way interactions hypothesized between each pairing of independent variables. With the priority of understanding the interactions among these three variables (TI, TC and TI-ERP) the model ultimately leads to a possible three-way interaction influencing IS Resistance. The research model is presented in Figure 1.

![Research Model](image)

**Figure 1 - Research Model**

**Hypothesis H1: TI by TI-ERP**

**High TI-ERP Conditions**

Due to the highly integrated nature of ERP systems, individuals who heavily use an ERP system will find themselves deeply involved in an integrated process. The ERP facilitates their job task and results in a high level of TI-ERP. High TI-ERP improves the individual's familiarity with the ERP user interface and over time gains them a greater understanding of the business process. These individuals with a high level of TI-ERP who also exhibit a high TI (i.e., interacting with other team members in the organization) do so to jointly achieve the organizational objectives which would result in very low levels of IS resistance. These individuals interact with team members that enhance a knowledge flow concerning the ERP system thus reducing the level of IS resistance which leads to hypothesis H1A.

On the other hand, without a lot of interaction with team mates (i.e. in the case of low TI), the focal individual is lacking the opportunity to gain knowledge about ERP interface, lacks access to coordinated process execution strategy, and is also cut off from inter-dependent problem solving (Kang et al. 2003). These actions lead to an increased IS resistance and hypothesis H1B.

- **H1A:** High TI and High TI-ERP results in Low IS Resistance
- **H1B:** Low TI and High TI-ERP results in High IS Resistance
Low TI-ERP Conditions
Also a result of the highly integrated nature of ERP systems in supporting end-to-end business processes, individuals who seldom use ERP will find themselves less involved in an integrated process as tracked and enabled by the ERP system. Coupled with a low interaction with teammates, this could indicate that the individual is cut-off from both the overall goals and strategy of the business process, and also has limited access to others in the process. The lack of task interdependence on the ERP system along with reduced interaction with other team members provides less opportunity to engender a resistance to the use of the ERP system and results in hypothesis H1C.

Though less interdependent on ERP, utilizing other team members in a business process (high TI) is beneficial to an individual as proficient ERP users are more knowledgeable than tech support about the how best to apply ERP transactions to accomplishing the business process. Interactions between users, super users, and technical support in a new system implementation have confirmed greater benefits to users from interacting with expert users (Santhanam et al. 2007). This low TI-ERP user who has high interaction with team mates could get both positive opinions (high perceived value) about the system and additional usage insight in future ways to use the ERP system effectively. It has been found that users can be influenced by a team mates who’s a) favorable opinion has a positive effect on switching benefits, b) articulated switching benefits has a positive effect on perceived value, and c) perceived system value has a negative effect on resistance (Kim et al. 2009). High TI can lead to lowering resistance to ERP even though the user is not currently an interdependent ERP user, and results in Hypotheses H1D.

H1C: Low TI and Low TI-ERP results in Low IS Resistance
H1D: High TI and Low TI-ERP results in Low IS Resistance

H1 Summary
A summary of all H1 hypotheses has been provided in Table 2 - Hypothesis H1.

<table>
<thead>
<tr>
<th>Interdependence on ERP</th>
<th>Interdependence on Team Mates</th>
</tr>
</thead>
<tbody>
<tr>
<td>LOW</td>
<td>H1C: Low Resistance</td>
</tr>
<tr>
<td>HIGH</td>
<td>H1B: High Resistance</td>
</tr>
<tr>
<td></td>
<td>H1A: Low Resistance</td>
</tr>
</tbody>
</table>

Table 2 - Hypothesis H1

Hypothesis H2: TI by TC

Low TI Conditions
Within a highly integrated system, many job functions can be affected simultaneously by execution of a single interdependent task. Within a hierarchical model of a workflow system (Kang et al. 2009), the highest level of knowledge includes interdependent problem solving. Based on the difficulty inherent in these integrated systems, individuals operating autonomously with low interdependence on team members, and who simultaneously perceive the ERP system as having high technical complexity, can easily feel overwhelmed or frustrated leading to experiencing a high level of IS Resistance. This is the basis for our H2A hypothesis. When, the perceived technical complexity is much lower and the user is operating autonomously, the user would have less peer support and also has less apprehension about using the system. In such a case, their initial resistance is lower (but is likely subject to change based on future actual attempts at use in isolation from supportive team mates). With little interdependence on team mates and low perceived technical complexity, an individual does not increase their level of IS Resistance which leads to hypothesis H2B.

H2A: Low TI and High TC results in High IS Resistance
H2B: Low TI and Low TC results in Low IS Resistance

High TI Conditions
Users participating in a highly interdependent environment get great benefit from interacting with expert users and others using the same system for a similar business purpose (Santhanam et al. 2007). The help of team mates in solving complex interdependent problems associated with a highly integrated workflow system, such as an ERP system, overcomes obstacles and mitigates frustration that could precipitate into a negative emotional response to the system. Higher levels of help and support from team members in
instances of both low and high levels of perceived technical complexity would tend to mitigate resistance to system use. This supports hypotheses H2C and H2D.

\[ H2C: \text{High TI and Low TC results in Low IS Resistance} \]
\[ H2D: \text{High TI and High TC results in Low IS Resistance} \]

**H2 Summary**
A summary of all H2 hypotheses has been provided in Table 3 - Hypothesis H2.

<table>
<thead>
<tr>
<th>Perceived Technical Complexity</th>
<th>Interdependence on Teammates</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOW</td>
</tr>
<tr>
<td>LOW</td>
<td>H2B: Low Resistance</td>
</tr>
<tr>
<td>HIGH</td>
<td>H2A: High Resistance</td>
</tr>
</tbody>
</table>

Table 3 - Hypothesis H2

**Hypothesis H3: TI-ERP by TC**

**High TI-ERP Conditions**
When a new user first encounters an ERP system, the individual rarely has prior experience with a highly integrated system that imposes a rigorous process and offers many detailed options to the user. For new users whose job role requires heavy use of the ERP, the user's dependence on ERP is heightened. For such a new user, many factors such as their prior business process experience and comfort level multi-user technology would inform the perception of ERP's technical complexity. Those perceiving ERP to have high technical complexity will likely experience the Technostressor Creators of Techno-Complexity and Techno-Overload (Ragu-Nathan et al. 2008). In their study, higher technostress leads to low job satisfaction unless there exist sufficient Technostress Inhibitors such as Technical Support to off-set the technology stressors.

Here, it is expected that the combined effects of TechnoStress Creators and TechnoInhibitors combine to inform a single assessment of IT Resistance. ERP users with high interdependence on ERP who perceive low technical complexity will experience in low technostress which should inform an outcome of low IS resistance leading to Hypothesis H3A. While ERP users with high interdependence on ERP who perceive high technical complexity appear to experience much higher Technostress Creators with less off-setting Technostress Inhibitors. This leads to an expectation of high IS resistance and results in hypothesis H3B.

\[ H3A: \text{High TI-ERP and Low TC results in Low IS Resistance} \]
\[ H3B: \text{High TI-ERP and High TC results in High IS Resistance} \]

**Low TI-ERP Conditions**
Even though an individual may have a low task interdependence with ERP, there could still be a higher perceived level of technical complexity associated with an ERP system. Complexity is a factor that reflects a person's comfort and understanding of the ERP system as it relates to their own experience (Kim et al. 2009). The lower level of task interdependence with the ERP system does not allow an individual to learn the associated processes that could increase the familiarity with the system and therefore provide a lower IS Resistance. With a low level of task interdependence with an ERP system, the perceived technical complexity provides the overriding factor in determining the individual's resistance to IS and leads to hypothesis H3C and H3D.

\[ H3C: \text{Low TI-ERP and High TC results in High IS Resistance} \]
\[ H3D: \text{Low TI-ERP and Low TC results in Low IS Resistance} \]

**H3 Summary**
A summary of H3 hypothesis is provided in Table 4 - Hypothesis H3.

<table>
<thead>
<tr>
<th>Perceived Technical Complexity (TC)</th>
<th>Interdependence on ERP (TI-ERP)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>LOW</td>
</tr>
<tr>
<td>LOW</td>
<td>H3C: High Resistance</td>
</tr>
<tr>
<td>HIGH</td>
<td>H3D: Low Resistance</td>
</tr>
</tbody>
</table>

Table 4 - Hypothesis H3
Hypothesis H4: TI-ERP by TC by TI

Interacting little with the ERP system (low TI-ERP) and little with human team members (low TI), the new user fails to develop an effective TMS system to support them in performing their job tasks. In isolation from helpful team mates (low TI), failing to utilize the information depth of ERP (low TI-ERP) and failing to grasp the expansive functionality of the ERP system (low TC), the individual will lack the knowledge resources of a TMS to support performance of their tasks. This lack of a TMS leads to a higher level of IS resistance. This isolated user may dwell on the more negative aspects of the ERP system (Table 1) such as its restrictive controls (Grabaki et al. 2007), rigid process enforcement (Morton et al. 2008) and panoptic monitoring (Sia et al. 2002) as impediments which lead to resistance. Such a user may not utilize the vast set of real time information accessible via ERP and may not see ERP as enabling panoptic empowerment (Elmes et al. 2005). Not interacting with ERP or with teammates, the user avoids engaging in the reflection needed to understand inter-dependent processes (Elmes et al. 2005). Failing to enter into the rich TMS offered by the teaming of human and personified ERP, the individual with low TI-ERP, low TI, and low TC is isolated from knowledge and assistance. This user is expected to experience high IS resistance when performing job tasks. This leads to Hypothesis H4A (Low-Cubed).

By interacting more with the ERP system, the heavy user teaming (high TI-ERP) with the personified ERP system and their human team members (high TI) in the TMS develops the necessary interdependent process views and recognizes the technical complexity (high TC) of the ERP system. Technical support has historically provided knowledge in dealing with new technology problems, but typically lacks the business process knowledge for effective use. A high TI with team members provides both the technical and process oriented knowledge to new users. An ERP system is considered to be complex compared with many other technologies. For new users, TechnoTress creators include TechnoComplexity and TechnoOverload (Ragu-Nathan et al. 2008). The user’s familiarity and proficiency with their ERP System use can be facilitated by both their high degree of interaction utilizing their team mate’s knowledge of the ERP system. This knowledge exchange within the TMS will facilitate the lowest IS Resistance and provides the final hypothesis H4B (High-Cubed).

H4A: The three-way interaction of Low TI-ERP, low TI and low TC results in the Highest IS Resistance
H4B: The three-way interaction of High TI-ERP, High TI and High TC results in Lowest IS Resistance

Experimental Setup

Data collection was accomplished in undergraduate business courses during the Fall semester of 2014 and Spring of 2015. The experiments were performed in 24 different classes at three different locations. No prior ERP training was provided to any of the participants. Each of the courses were chosen based on the inclusion of content that would provide instruction on enterprise resource planning system concepts. The exercise consisted of a business simulation (ERPsim – Distribution) in which teams compete for customers by purchasing and reselling water bottles (Leger et al. 2007). The participants had no transactional knowledge of the SAP (ERP) particular interface at the start of the experiment.

Each experimental engagement had between four and eight teams. The data analyzed in this study is limited to teams with two or three members where the need to cover four business roles resulted in a need for task coordination and boundary-spanning. Initial instruction included outlining the market context and describing the overall operation of the businesses. Organizational success was defined as the highest net income for their organization. All participants were instructed on basic navigation and each task described by stating its primary decision function along with introducing its transactions and relevant reports.

The simulation consisted of three rounds of 20 virtual days and lasted approximately 20-25 minutes per round. The time between each round was used to field general questions and review the financial standings of the organizations. Questions concerning both report interpretation and decision making transactions were fielded while the simulation was operating. It should be noted that only operational questions were answered. Questions about team strategy were not answered directly but left as team decisions.
With an ERP system, a main benefit is availability of real-time information to all organizational members. Training for the two and three person teams consisted of potential ways to perform the information-seeking and decision-enacting activities. The teams were allowed to develop naturally during the three rounds of the experiment as team members worked toward their shared goal of maximizing the team’s net profit.

Data Collection

Data collection used items from previous literature. This study included the published measures for independent variables of Technical Complexity (TC) (Sharma et al. 2007), Task Interdependence (TI) (Sharma et al. 2007), and the dependent variable factor of IS Resistance (Resist) (Kim et al. 2009). The new measure for personified ERP system on a team, referred to as Task Interdependence on ERP (TI-ERP), was based on 3 items of the measures for Task Interdependence (Sharma et al. 2007). The pre-survey was administered to participants immediately prior to commencing the engagement and the post-survey was administered immediately following the experiment’s conclusion.

This study includes two prominent personal traits that contribute to technology. Well-established items are used to measure Computer Self-Efficacy (SE) (Compeau et al. 1991) and Personal Innovativeness with Information Technology (PIIT) (Agarwal et al. 1998) in the pre-survey. The variables of Self-Efficacy with Technology (SE) and Personal Innovativeness with IT (PIIT) are indicators of a person's general approach and ability to utilize new technology. These variables control for an individual’s tendency to readily accept new technologies, as this trait could lead to lower resistance to a new system. The remaining factors in the study (Resist, SE, TC, TI, TI-ERP) were measured in the post-survey. The mean and number of items for each factor is summarized in Table 5.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Abbreviation</th>
<th>Mean</th>
<th># of Items</th>
</tr>
</thead>
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<tr>
<td>Resistance to IS</td>
<td>Resist</td>
<td>2.54</td>
<td>4</td>
</tr>
<tr>
<td>Personal Innovativeness with IT</td>
<td>PIIT</td>
<td>4.15</td>
<td>4</td>
</tr>
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<td>Self-Efficacy</td>
<td>SE</td>
<td>4.66</td>
<td>4</td>
</tr>
<tr>
<td>Task Interdependence</td>
<td>TI</td>
<td>4.87</td>
<td>6</td>
</tr>
<tr>
<td>Task Interdependence on ERP</td>
<td>TI-ERP</td>
<td>4.81</td>
<td>3</td>
</tr>
<tr>
<td>Technical Complexity</td>
<td>TC</td>
<td>3.68</td>
<td>3</td>
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</table>

Table 5 - Factors

Analysis

Assessment of the regression model was performed using the SAS Enterprise Guide 7.1 statistical software package by creating interaction terms from the independent variables’ summative measures. A graphical representation for the significant three-way interaction influence on IS Resistance was created and used for interpretation of the interaction results (Cohen et al. 2003). The use of interactions in regression equations has been noted to be problematic, but these problems benefit from centering the predictor variables by eliminating nonessential multicollinearity (Marquardt 1980). This allows a more direct interpretation of the interactions and the predictor variables in the regression equation. Centering the predictor variables is accomplished by subtracting each participant’s result by the mean value of the factor (Table 5).

The model analysis progressed through assessing the factor correlation matrix (Table 6 - Correlation Matrix), a review of the Centered regression model results (Table 7 - Model Results) and review of the regression variable coefficients (Table 8 - Regression Variable Coefficients). While not presented due to space limitations, the model characteristics were compared starting with a main effects only model, then the 2nd order model (two way interactions) and finally the 3rd order model (three way interaction). These model results are provided in Table 9 - Model Comparison.

Correlation Matrix

The correlation matrix (Table 6) indicates a significant correlation at $\alpha < .001$ confidence level between the dependent variable Resist and the independent variables of TI, TI-ERP and TC. Resist is also correlated with PIIT at $\alpha < .05$ confidence level. In addition, the independent variable of TI, TI-ERP and TC are all significantly correlated at $\alpha < .001$ with each other. The independent variables measured in the pre-survey, PIIT and SE, are significantly correlated with each other at $\alpha < .001$. All statistical tests use a minimum p-value of 0.05 (or better) for significance as indicated in Table 6.
Regression Models

The regression analysis for the three-way interaction resulted in a model that was significant at an $\alpha < .001$ confidence level (Table 7). This model provided an adjusted explained variance of 32% ($r^2_{adj} = .32$) which is within the typical range for publications in top IS journals (Mani et al. 2010; Tian et al. 2015). The significance of the variable coefficients (Table 8) are indicated in accordance with the $p$-values stated in Table 6. The Variance Inflation Factor (VIF) is a test that determines any problems with multicollinearity. A typical value for VIF with respect to multicollinearity is 10 (Cohen et al. 2003). Centering the variables as recommended, in order to address the nonessential multicollinearity (Marquardt 1980), resulted in the VIF for the higher order variable is well below the suggested value at 2.9 (Table 9).

While this study focused on interaction effects among the independent variables, the final regression model contains first order (direct) effects as well as two-way and three-way interactions of independent variables on IS resistance. The inclusion of all lower order effects is required for proper regression model results. Analysis was done for three models: the base model of main effects only, with two-way interaction effects added and finally with the three-way interaction effect added. The three models used centered summative measures (labeled as Main only, Two Way Interactions and Three Way Interaction) and all three models were statistically significant (Table 9).

**Interpretation of Findings**

In the transaction-based model of Technostress (Ragu-Nathan et al. 2008), the set of Technostress creators and the set of Technostress inhibitors jointly influence job satisfaction. In this current study, the antecedent constructs (of task interdependence on teammates, interdependence on ERP and perceived technical complexity) interact such that these variables’ three-way interactive effect is the significant predictor of IS Resistance. This three-way interaction effect was significant even though no individual first-order factor and no specific two-way interaction was itself found to be significant (although those models were significant). Based on the third-order regression findings, the extreme outcomes for IS Resistance are best explained by the all Low conditions in the three-way interaction (referred to as Low-Cubed condition) and by the all High Conditions (referred to as High-Cubed condition). Therefore, it appears that the mix of these

<table>
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<tr>
<th>Variables</th>
<th>df</th>
<th>Parameter Estimate</th>
<th>Standard Error</th>
<th>t Value</th>
<th>Pr &gt;</th>
<th>VIF</th>
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<td>Intercept</td>
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<td>-26</td>
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<td>-0.15</td>
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<td>0.12</td>
<td>-4.95</td>
<td>&lt;.001***</td>
<td>3.3</td>
</tr>
<tr>
<td>TI-ERP</td>
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<td>0.36</td>
<td>-1.96</td>
<td>.05</td>
<td>30.5</td>
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<tr>
<td>TC</td>
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<td>0.50</td>
<td>-0.82</td>
<td>.42</td>
<td>36.0</td>
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<tr>
<td>TI*TI-ERP</td>
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<td>.76</td>
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</tr>
<tr>
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<td>-0.12</td>
<td>0.06</td>
<td>-2.19</td>
<td>.04</td>
<td>2.9</td>
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Table 8 - Regression Variable Coefficients
three variables interact closely to alternately 'tip the balance' of the overall influence on the IS Resistance outcome. An interpretation is that these three variables act in concert so that their combined effects shift the total TechnoStress effects between dominance by Technostress creators or dominance by Technostress inhibitors.

Graphing the results of the three-way interaction (Figure 2), it becomes possible to interpret the interactions at different levels of each independent variable. The first general interpretation of the results of the three-way interaction graph, reveal that low interdependence on teammates (the four left plot point locations in the graph) serves to be a possible Technostress creator (or possibly it is too weak of an inhibitor) for all combinations of TI-ERP and TC. In other words, for every one of the four graphed lines (each representing a specific combination of TI-ERP and TC conditions) the low TI condition consistently results in higher levels of IS Resistance when compared with high TI condition. Most of the slopes are noticeably steep except for the High TI-ERP and Low TC (line 2) which exhibits a moderate slope but in a consistent direction with other slopes. Specifically, in the instance of low levels of TI-ERP, TC and TI (Low-Cubed, the left filled square point of line 4 in Figure 2), we find support for our study target hypothesis H4A in which a low level of all three independent variables within the three-way interaction (Low-Cubed Condition) results in the highest IS Resistance outcome. Therefore, Hypothesis H4A is supported.

On the right side of the graph of three-way interactions, another notable finding is that high interdependence on teammates serves (based on plotted levels showing low IS resistance for each line) to

<table>
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<th>Variables</th>
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<th>Two Way Interactions</th>
<th>Three Way Interaction</th>
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</thead>
<tbody>
<tr>
<td>Model Adj R²</td>
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<td>.3048</td>
<td>.3175</td>
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<td>F Value</td>
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<td><strong>.0001</strong></td>
</tr>
<tr>
<td>Intercept</td>
<td>2.54</td>
<td><strong>.0001</strong></td>
<td><strong>.0001</strong></td>
</tr>
<tr>
<td>PITT</td>
<td>-.04</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>SE</td>
<td>-.06</td>
<td>ns</td>
<td>ns</td>
</tr>
<tr>
<td>TI</td>
<td>-.41</td>
<td><strong>.0001</strong></td>
<td><strong>.0001</strong></td>
</tr>
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<td>TI-ERP</td>
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<td>TC</td>
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<tr>
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<td>ns</td>
<td>.02</td>
</tr>
<tr>
<td>TI*TC</td>
<td>-.20</td>
<td>ns</td>
<td>-.14</td>
</tr>
<tr>
<td>TI-ERP*TC</td>
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<td>.16</td>
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<tr>
<td>TI<em>TI-ERP</em>TC</td>
<td></td>
<td>-.12</td>
<td></td>
</tr>
</tbody>
</table>

Table 9 - Model Comparison

![Three Way Interaction Results](image)

Figure 2 - Three Way Interaction
be a strong Technostress inhibitor for all combinations of TI-ERP and TC. In other words, for every one of the four graphed lines (each representing a specific combination of TI-ERP and TC conditions) the High TI condition (on the right side of the graph) consistently results in lower levels of IS Resistance when compared with Low TI condition (on left side of graph). This finding is supported by investigation of the slopes for each two-way interaction plot, as discussed previously in discussion of H4A.

In the instance of high levels of TI-ERP and high TC (line 1 in Figure 2), in concert with the condition of High IT (lower rightmost graphical point on line 1) shows support for the hypothesis H4B in which a high level of all three independent variables (High-Custed Condition) of the three-way interaction results in the lowest IS Resistance outcome. Therefore, Hypothesis H4B is supported.

The three-way interaction graph also informs our interpretation of the two way hypotheses. A further review of Figure 2 can provide insight into interpreting the two way hypotheses (H1 through H3) by using the relative location of plot points on the graph and by interpreting both the slope of each plotted line and the relative locations of each line. Some interpretations regarding two-way interaction hypotheses follow.

The two-way hypothesis of H1A states that the combination of High TI and High TI-ERP is predicted to result in Low IS Resistance. Looking at the three-way interaction plots in figure 2, hypothesis H1A corresponds to both diamond symbols as TC level is not specified (white and black diamonds represent High IT-ERP with High TC; and High TI-ERP with Low TC, respectively) in the far right of graph, the area of High TI. To interpret an interaction term, one can use the average of the two end points as an overall value for conditions (Cohen et al. 2003). Here, the average value between the two rightmost diamonds exhibits the lowest levels of IS resistance for conditions of High TI-ERP with High TI, thereby supporting H1A.

The two-way hypothesis of H1B states that the combination of Low TI and High TI-ERP is predicted to result in High IS Resistance. Looking at the three-way interaction plots in figure 2, hypothesis H1B corresponds to both diamond symbols on the far left of the graph, the area of Low TI. Both leftmost diamond points are used as TC level is not specified (white and black diamonds represent High IT-ERP with High TC; and High TI-ERP with Low TC, respectively). To interpret an interaction term, one again uses the average of the two end points as an overall value for conditions (Cohen et al. 2003). Here, the points are very similar but the average value between the two leftmost diamonds still exhibits a higher level of IS resistance (as compared with rightmost High TI condition) for conditions of High TI-ERP with Low TI, thereby supporting H1B.

**Contribution and Conclusions**

A primary contribution of this study is to view ERP as an inter-dependent team member of the individual user who is simultaneously interacting with an inter-dependent team of co-workers. Thus, ERP performs a role as a personified team member filling an important central role on the work team. Further, this study offers a construct for a personified ERP system and provides measures that differentiate interdependency on the ERP team member from other team members. Findings indicate that all human and personified ERP team members need to collaborate and coordinate efforts towards a common organizational goal, and that most significantly, that human team members are vital to minimizing resistance. The graph of three-way interaction among interdependence on ERP, interdependence on Team members and perceived technical complexity provides evidence that is interdependence on human team members which has the greatest and most consistent (across conditions) effect in reducing IS Resistance.

Automation is increasing and integrated business processes increasingly require collaboration between 'human and machine'. As business continues to introduce increasing amounts and variety of technology into the workplace, it is important to avoid resistance of new technology. TMS cognition research combined with CASA/personification of technology have potential to inform IT research. This study seeks to extend the use of TMS theory beyond a focus on human teams and to include ERP-oriented business teams. The broader impacts of this research are to improve utilization of ERP in supporting innovation, knowledge work and education.
Future Research and Limitations

Addressing three-way interactions is complex as the results are impacted in ways not easily discerned. In addition, there is limited prior research using the lens of 'computer as social actor' with respect to an ERP system. While following leading methodological resources (Cohen et al. 2003) to provide guidance on standard practices for interpreting three-way interaction in a regression equation. Initial steps of future research include conducting hypothesis tests with respect to whether IS Resistance is significantly different for each of the conditions represented in Figure 2. A second set of hypothesis testing can be conducted on each of the slopes for when the TI levels move from low to high and can answer the question of "what starting conditions are most important to increase the levels of TI?". Future research might address the question of "what antecedents are most influential to increasing levels of TI?". With the means and slope tests of the two way interactions, greater insight into the 2nd order hypothesis can be accomplished.

This initial study needs to be augmented to deconstruct and better understand how the combination of independent variables that may alternatively perform as TechnoStress creators or inhibitors. In this respect, this initial study is taking a new approach into understanding actual ERP usage in a small team setting. Future research includes conducting hypothesis tests with respect to whether IS Resistance leads to significantly different team performance outcomes for each of the conditions represented in Figure 2.

A limitation is that the CFA was not as clear and distinct as desired due to some cross-loadings so a SEM measurement model is underway to investigate the measurement model in more depth. Also, a larger data set should be used in future analysis. While a significant model for small teams of 2 or 3 members has been shown in this study, the experiment and future analysis should include data from teams of 4.

References