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Towards an ERP Individual Performance Model

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Abstract
A theoretical model to investigate factors influencing enterprise resource planning (ERP) system users’ performance in the post-implementation stage within organization is developed. The hypotheses were tested using survey data from companies that implemented ERP systems. Results from partial least squares (PLS) analyses suggest that organization climate, absorptive capacity, ease of use and system quality positively and directly affect individual performance. Additionally, the findings highlight the important role of absorptive capacity in mediating the effect of social ties on individual performance and positively impacting ease of use. Results also suggest that strong ties have a negative effect on absorptive capacity. Surprisingly, no support was found for the hypotheses that utilization mediates the effect of social ties, absorptive capacity, organization climate, ease of use and system quality on individual performance.

Keywords
ERP, Individual Performance, Absorptive Capacity, Ease of Use, System Quality, Organization Climate, Ease of Use, Utilization

1. Introduction
AMR Research indicates that the ERP market has seen significant growth over the last decade and predicts considerable growth up to 2009 (Fitzgerald, 2005). ERP implementations require substantial investments and may cost up to US$20M to acquire (Mabert et al., 2001). Notwithstanding the optimistic prediction for the future ERP market, statistics show that more than 70% of ERP implementations fail to achieve their corporate goals (Standish Group, 2004).

In spite of the high failure rate, companies continue to adopt ERP systems with the hope of achieving operational, strategic, managerial, IT infrastructure and organizational benefits (Shang & Seddon, 2000). However, adopting ERP systems is not nearly enough for organizations to achieve expected benefits; ERP systems have to be accepted and utilized by the organization constituents. Kremers et al. (2000, p. 54) point out that “the value of an ES [ERP system] lies not so much in the product itself, but in its effective and efficient usage”.

Given the importance of ERP systems in organizations, a range of measures are sometimes implemented to improve individuals’ performance with these systems. Training programs (Umble et al., 2003) the establishment of competency centres (Eriksen & Markus, 1999) and/or the identification of power users to help their peers adapt (Somers & Nelson, 2004), are some measures implemented by organizations. However, these measures often times do not improve individuals’ performance with the ERP systems.

The lack of improved individual performance (IP) once the ERP system is adopted has been attributed to users’ lacking absorptive capacity (Park et al., 2007), problems with how easy
the ERP system is to understand, the quality and utilization of the ERP system (Kositanurit et al., 2006). While these factors influence IP in ERP system environments, other factors known to influence IP generally are not investigated. The impact of these factors needs to be analyzed in order to enhance our understanding of the ERP phenomenon and to draw useful implications for research and practice.

Empirical studies involving IP in ERP environments are scant. Additionally, a comprehensive model linking key constructs and IP is not available in the literature. There is thus a lack of framework for portraying the relationships among these information systems (IS) variables. The current research seeks to address this gap in the literature by proposing a theoretical model to explain how IP in ERP environments is influenced by social ties, organization climate, absorptive capacity (ACAP), ease of use, system quality and utilization.

The remainder of this paper is organized as follows. The next section develops the theoretical framework. Subsequent sections consecutively develop the research model and hypotheses, describe the data collection method, present the data analysis procedure and the results of the model testing, and discuss the findings and their theoretical and managerial implications. The paper concludes with a discussion about the findings and directions for future research.

2. Theoretical Framework
The theoretical framework is developed by 1) integrating existing theories on IP in the ERP context and 2) extending these theories by including social and situational factors (figure1). Kositanurit et al. (2006) offer three factors – ease of use, system quality and utilization – and Park et al. (2007) offer ACAP. These factors are included in the model in this study. Drawing on the literatures of social network theory and organization climate, social ties and organization climate are also included in the model.

![Figure 1. Theoretical Framework](image)

2.1 Social Network Theory (SNT) and Performance
SNT views social relationships in terms of nodes and ties. Nodes are the individual actors within the networks, and ties are the relationships between the actors. Social ties is defined
as “the interpersonal relationships between individuals which may vary in strength, from weak to strong, depending on the time spent together, the emotional intensity and intimacy of the relation, as well as reciprocal services” (Granovetter, 1973). Members in strong tie relationships are usually motivated to share what they know, provide easy and ready access to information circulating in their network and a ready hand to help (Krackhardt, 1992). However, these members typically only have access to the same resources as others with whom they are closely tied. On the other hand, members in weak tie relationships have access to information and resources circulating in other arenas (Granovetter, 1973). Scholars argue that the structure of the network influences an individual’s ability to get things done (Granovetter, 1973; Jack, 2005). Empirical evidence shows that social ties influence individual performance. For example, Hansen (1999) reported that social ties positively influenced the time taken for individuals to complete projects.

2.2 Organization Climate and Performance
McGregor (1967) argues that the performance of an individual is not only a function of characteristics of the individual but aspects of her environmental situation, such as organization climate. Organization climate is defined as “incumbents’ [employees] perceptions of the events, practices and procedures and the kinds of behaviours that are rewarded, supported and expected in a setting” (Schneider, 1990, p. 384). The relationship between organization climate and performance is supported (Parker et al., 2003). Organization climate has also been found to be important to ERP implementation success (Osei-Bryson et al., 2008).

3. Research Model and Hypotheses
Based on the theoretical framework the research model is developed (figure 2) and hypotheses, grounded in the ERP post-implementation context, are developed.

3.1 IP: The Dependent Variable
The dependent variable in the research model is IP. In this context IP relates to the accomplishment of a portfolio of tasks by an individual. Organizations often adopt technologies in an attempt to achieve higher performance. Higher performance implies some mix of improved efficiency, improved effectiveness and/or higher quality.

3.2 IP Related Antecedents
3.2.1 Social Ties
In the use and maintenance phase of the ERP system the primary objective is to use the ERP in a way that returns expected benefits and minimize disruptions (Esteves & Pastor, 1999). System optimization requests, correction of malfunctions and general systems improvements are activities executed in this phase. Due in part to ERPs’ complexity, ERP users often rely on impersonal sources such as databases, vendor support and user groups, their own memory and power users to help them find information to solve system problems. The relationships between information seekers and information providers usually vary in strength from “weak” to “strong”. Empirical work in the IS and project context demonstrates the importance of weak and strong ties relationships with individual performance. Such weak and strong ties relationships facilitate problem solving by providing access to relevant information than
would otherwise be available (Constant et al., 1996) and facilitate complex knowledge transfer between individuals, ultimately contributing to project success (Hansen, 1999), respectively. Therefore,

**Hypothesis 1a:** Strong ties with known ERP and related users will influence the utilization of the ERP system.

**Hypothesis 1b:** Strong ties with known ERP and related users will influence IP in the ERP environment.

**Hypothesis 1c:** Weak ties with known and unknown ERP and related users will influence the utilization of the ERP system.

**Hypothesis 1d:** Weak ties with known and unknown ERP and related users will influence IP in the ERP environment.

### 3.2.2 Social Ties and Absorptive Capacity

ACAP is the ability of an individual to recognize the value of new, external information, assimilate it, and apply it to new scenarios (Cohen & Levinthal, 1990). It is proposed that social ties is related ACAP. To the authors’ knowledge, this relationship has not been previously investigated. ERP systems are complex, pre-packaged software which embeds business knowledge accumulated from a large number of organizations over many years. ERP systems require sophisticated system and process knowledge for its successful use. The internal logic and the adoption of these systems after implementation remains a challenge for many organizations long after implementation. The literature suggests that social ties facilitate knowledge acquisition and exploitation by affecting the conditions necessary for value creation through the exchange and combination of intellectual resources. Weak and strong ties provide the necessary relationships that facilitate the absorption and exploitation of ERP knowledge necessary to improve user performance and ultimately a return on investment in an ERP system. Thus,

**Hypothesis 2a:** Strong ties with known ERP and related users will influence individual’s ACAP.

**Hypothesis 2b:** Weak ties with known and unknown ERP and related users will influence individual’s ACAP.

### 3.2.3 Organization Climate

Research literature commonly conveys the notion that organization climate influences job performance (Joyce & Slocum, 1982). While recent attention has focused on examining the influence that climate has on ERP implementation (Osei-Bryson et al., 2008), very little empirical attention has been directed towards describing its role in the post-implementation context. Ifinedo and Nahar (2007) findings indicate that organizations that have positive organization climate are better poised to reap the benefits from their investment in ERP systems. Hence, organization climate is highly relevant in understanding IP.

**Hypothesis 3a:** The ERP user perception of the organization climate will influence the utilization of the ERP system.

**Hypothesis 3b:** The ERP user perception of the organization climate will influence IP.

### 3.2.4 Absorptive Capacity

Cohen and Levinthal (1990) found that a recipient’s stock of prior related knowledge determines their absorptive capacity for new knowledge, and deficiencies can render the
recipient unable to successfully exploit new knowledge. Timbrell et al. (2001) found that knowledge recipients absorptive capacity was deficient across ramp-up and integration phases. In order to achieve productivity improvements, process optimization is necessary (Seddon et al., 2003). However, it may be the responsibility of the same deficient knowledge recipients to perform process optimization. Their lack of absorptive capacity may hinder them from successfully exploiting knowledge necessary to perform optimization requests. Hence,

**Hypothesis 4a**: The ACAP of the ERP user will influence utilization of the ERP system.

**Hypothesis 4b**: The ACAP of the ERP user will influence IP.

![Figure 2. Research Model](image)

### 3.2.5 Absorptive Capacity and Ease of Use

Ease of use is theoretically the same as perceived ease of use as defined by Davis (1989). Perceived ease of use is “the degree to which a person believes that using a particular system would be free of effort” (Davis, 1989, p. 320). Since perceived ease of use is the individual’s perception of how easy the system is to use, ease of use is used in this study.

A causal path from ACAP to ease of use is proposed. To the author’s knowledge this relationship has not been investigated in any other study. Researchers have found that a diverse background and prior related knowledge enhances performance, that is, ACAP (Schilling et al., 2003). ERP systems are criticized as being difficult to use and understand. ERP users with prior complex system usage background should perceive ERP systems as easy to use.
**Hypothesis 5:** The ACAP of the ERP user will influence ease of use of the ERP system.

### 3.2.6 Ease of Use

The cognitive load of ERP users is usually high after implementation, leading to the perception that the ERP system is difficult to use. Davis (1989) argues that an application that is perceived to be easier to use than another, all else being equal, is more likely to be accepted by users. Thus, the extent to which users perceive the ERP system as easy to use should influence performance.

**Hypothesis 6a:** Ease of use of the ERP system will influence utilization of the ERP system.

**Hypothesis 6b:** Ease of use of the ERP system will influence IP.

### 3.2.7 System Quality

System quality refers to the performance characteristics of the ERP system. The literature identifies ERP customization as one of the most cited reason for ERP implementation failure. Harris (2000) advises that changes to the software be avoided. This highlights the need for organizations to select a product that “best” fit organizational requirements. Hence, the implemented system characteristics should impact performance.

**Hypothesis 7a:** The system quality of the ERP system will influence the utilization of the ERP system.

**Hypothesis 7b:** The system quality of the ERP system will influence IP.

### 3.2.8 Utilization

Utilization is defined in this study as the extent to which the ERP system is used by individuals to complete tasks. After implementation, the consequences of ERP implementation depend on users’ usage (Pozzebon, 2000). Users unwilling to use the system is one commonly cited reason for ERP failure (Scott & Vessey, 2002). Although individuals are mandated to use an ERP system, the extent of usage and the effort invested in learning about ERP system are largely voluntary.

**Hypothesis 8:** Utilization of the ERP system will influence IP in the ERP environment.

### 4. Research Method and Data

#### 4.1 Research Design

An *ex post facto* design is employed in this study. In *ex post facto* designs, none of the model’s independent variables are controlled or manipulated by the investigator. Of the two types of *ex post facto* designs, a cross sectional survey is used to collect data.

#### 4.2 Construct Operationalization

Constructs in the research model are measured using items that are either adopted or adapted from prior studies to enhance validity (Stone, 1978) or developed based on the assimilation of
relevant literature. A 7-point Likert-like scale is used to measure the observed variables of each latent construct.

Some constructs are operationalized as reflective and others as formative. The observed variables in reflective constructs should reflect the constructs and be unidimensional and correlated (Gerbing & Anderson, 1988). For formative constructs observed variables “cause” the constructs, that is, represent different dimensions of the construct. In the formative construct, observed variables between dimensions are uncorrelated but correlated within dimensions (Chin, 1998).

4.3 Data Collection and Response Rate
A Web-based cross-sectional survey was administered to Jamaican companies. A Web-based survey is suitable because: 1) the electronic technology provides an inexpensive mechanism for conducting surveys; 2) it eliminates item non-responders; and 3) it is usually convenient for participants.

Nine Jamaican organizations were identified as having implemented ERP systems. Of the nine, six participated in the study. Three hundred and fifty invitations were sent and 106 responses received; yielding a response rate of 30%. Of the 106 responses, all were usable because the online survey did not allow respondents to submit the survey with missing items. Respondents were not allowed to complete the survey more than once.

4.4. Data Analytic Method
PLS is chosen as the data analytic technique because it supports reflective and formative constructs. However, PLS cannot handle second-order constructs directly. A two step procedure proposed by Chin and Gopal (1995) was used to assess the second-order constructs. In the first step, the measurements for the first order constructs are entered into PLS directly. Adjacent constructs to first order constructs are also entered. PLS is then executed to obtain the factor scores for the specified first order constructs. The generated factor scores are deemed to “more accurately [reflect] the underlying constructs than any of the individual items by accounting for the unique factors and error measurements that may also affect each item” (Chin & Gopal, 1995, p. 50). In the second step, the factor scores are treated as indicators of the second order constructs and are entered into PLS. Visual PLS (1.04b1) (Fu, 2006) is used for data analysis.

5. Data Analyses and Results
A two-stage PLS analytical procedure as recommended by Gerbing & Anderson (1988) is followed:
- Confirmatory factor analysis to assess the measurement model
- An examination of the structural model

5.1 Measurement Model
The results indicate that convergent and discriminant validity and reliability is achieved for all reflective constructs. Each item loading is greater than 0.7 (Chin, 1998) and p<0.01 for each measurement item (Gefen & Straub, 2005), satisfying the requirements for convergent
validity. Discriminant validity is achieved since each item loads heavily on its own construct than on any other construct and the square root of the average variance explained (AVE) for each construct is larger on itself than the numbers in the same row and column (Gefen & Straub, 2005) and is above 0.5 (Fornell & Larcker, 1981). Reliability is achieved as the Cronbach $\alpha$ values are $>0.7$ (Nunally, 1967) and $\text{AVE} >0.5$.

Traditional construct validity techniques cannot be applied to formative constructs. Petter, et al. (2007) suggest the use of principal component analysis to examine the item weightings for measures and where items are non-significant they can be eliminated or kept to preserve content validity. Additionally, traditional reliability measures are not appropriate. Variance Inflation Factor (VIF) scores should be calculated for each formative measure to establish reliability and should be below 3.3 to avoid multicollinearity problems (Petter et al., 2007).

Construct validity for formative constructs is achieved since most items, except three, were significant at the 0.01 $\alpha$ level. The three items were kept to preserve content validity. Reliability is achieved for formative constructs since all VIF values are well below 3.3.

5.2 Hypotheses Testing

From the results, the $R^2$ value of 0.89 indicates that the model explains a substantial amount of variance for IP. The results show that the following links to IP are significant: organization climate, ACAP, ease of use and system quality. Hypotheses 3b, 4b, 6b and 7b are supported.

Several links to IP were non-significant: strong ties, weak ties and utilization; hence hypotheses 1b, 1d and 8 are not supported.

The results also show that the links from strong ties, weak ties, organization climate and ease of use to utilization, are non-significant (hypotheses 1a, 1c, 3a and 6a are not supported, respectively). However, the links from ACAP and system quality to utilization are significant, supporting hypotheses 4a and 7a, respectively.

Strong and weak ties are significantly related to ACAP, predicting approximately 24% of the variance. However, the coefficient for strong ties is negative, while the coefficient for weak ties is positive. The $R^2$ value of approximately 0.68 indicates that ACAP explains a substantial amount of variance for ease of use.

There were several links in the model that were non-significant. To refine the model the links were removed one at a time and subsequent PLS analyses executed. The results showed no change in the coefficient of determination $R^2$, and no other link that was either significant or non-significant changed, when the links were removed. Based on the results from the follow-up tests, the links from strong and weak ties to utilization and IP were removed. Utilization was also dropped from the model since it failed the tests of mediation as suggested by Baron and Kenny (1986). The revised results show that ACAP mediates the relationships between strong and weak ties and IP. Figure 3 shows the results of the revised model.

6. Discussion

The results show that utilization does not function as a mediating variable. Staples and Seddon (2004) also found that utilization is not a mediating variable under conditions of
mandatory or voluntary use. While utilization is necessary, it is not a sufficient condition to improve performance.

While the findings support the hypotheses that strong and weak ties impacts ACAP, it is surprising that these factors do not impact IP directly. Perhaps because the ability of an ERP user to value, absorb and apply new knowledge to solve problem is a function of their prior related knowledge. Park et al. (2007) reported that ERP users had challenges absorbing and utilizing the knowledge needed to use the ERP system, impacting their performance with the system.

While weak ties have a positive impact on absorptive capacity, strong ties have a negative one. Because ERP systems are complex, usage and maintenance problems often times arise in the post-implementation stage. ERP users may rely (sometimes exclusively) on power users, of strong ties, to assist with resolving problems. This ‘over reliance’ on power users can dull the ERP users’ drive to value new external information, assimilate it and apply it to new scenarios to resolve their problems. In fact, McEvily and Marcus (2000) found that where a firm becomes a ‘captive’ supplier to its lead customer, the drive to innovate and acquire new capabilities may be dulled by the lack of competitive forces.

While the explanation above supports the ACAP of the firm, it is also a plausible explanation for the negative impact of strong ties on individual’s ACAP.

7.1 Theoretical Contributions
This study integrates and extends existing theory on IP in ERP context. The theoretical model also includes factors known to impact performance generally. The results of the study offer a richer, more comprehensive model for investigating ERP users’ performance.

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1 McEvily (2000) used the term ‘acquire’ or ‘acquisition’ to refer to the process by which firms learn about, internalize, and take advantage of new capabilities (the firms absorptive capacity).
New relationships for addition to the nomological net of ERP performance models are suggested: 1) strong ties – ACAP; 2) weak ties – ACAP; 3) ACAP – ease of use; and 4) organization climate – IP.

7.2 Managerial Implications
The findings suggest that management can improve ERP users’ performance by focusing on the following areas:

- **Situational** – Create an organizational climate where users are clear about what they are to accomplish when using the system, provide adequate resources, such as a “Help Desk” to assist with user-related issues and provide incentives, such as promotions or pay increases.
- **Social** – ERP users should be encouraged and given the opportunity to socialize with members from other organizations that they are familiar with and participate in Internet User Groups and attend industry conferences; these types of interactions will give them access to information that can be leveraged to improve future performance.
- **Individual** – It should be made clear to users how the various ERP modules interrelate. Users should be encouraged to apply their knowledge to solve new problems. Where possible, managers should hire individuals with experience with complex system use.
- **System related** – Managers should select an ERP system with the requisite features ERP users need to perform their tasks and invest in high availability infrastructure resources, provide customized training and documentation for users accordingly.

7.3 Limitations and Future Research Directions
There are some limitations to the study. First, other factors excluded from the theoretical model could influence IP. Examples include an individual’s knowledge, motivation, organizational culture and time. Future research could interrogate the influence of these factors on IP. Second, users’ perceptual measures of performance were collected. However, these measures may not correspond to actual performance. In a follow-up study objective measures could be used, but may increase the risk of response bias. Since no support was found for utilization, utilization could be tested for interaction effects in a follow-up study.

8. Conclusions
Drawing broadly on social network and absorptive capacity theories, the extant literature on organization climate, ease of use, system quality and utilization, an IP model was developed and tested in the context of ERP systems. The theoretical framework reconciles the independent contributions of two ERP IP studies and other studies which identified variables impacting performance generally. Analyses based on six Jamaican firms, largely support the hypothesized relationships in the model. This research contributes to the body of knowledge about a special class of IT artifacts (ERP systems), by focusing on its effective management and use in organizations. It confirms that social, situational, individual and system related factors are important for improved IP. This research offers several relationships for the addition to the nomological net of the ERP performance models.
References


