MIS Quarterly

RESEARCH ARTICLE

# CHANGES IN EMPLOYEES' JOB CHARACTERISTICS DURING AN ENTERPRISE SYSTEM IMPLEMENTATION: A LATENT GROWTH MODELING PERSPECTIVE[1]

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*Enterprise system implementations often create tension in organizations. On the one hand, these systems can provide significant operational and strategic benefits. On the other hand, implementation of these systems is risky and a source of major disruptions. In particular, employees experience significant changes in their work environment during an implementation. Although the relationship between ES implementations and employees' jobs has been noted in prior research, there is limited research on the nature, extent, determinants, and outcomes of* ***changes*** *in employees' job characteristics following an ES implementation. This paper develops and tests a model, termed the* ***job characteristics change model*** *(JCCM), that posits that employees will experience substantial changes in two job characteristics (i.e.,* ***job demands*** *and* ***job control****) during the shakedown phase (i.e., immediately after the rollout) of an ES implementation. These changes are theorized to be predicted by work process characteristics, namely* ***perceived process complexity****,* ***perceived process rigidity****, and* ***perceived process radicalness****, that in turn will be influenced by technology characteristics (i.e.,* ***perceived technology complexity****,* ***perceived technology reconfigurability****, and* ***perceived technology customization****). JCCM further posits that changes in job characteristics will influence employees'* ***job satisfaction****. Longitudinal field studies conducted in two organizations (N = 281 and 141 respectively) provided support for the model. The scientific and practical implications of the findings are discussed.*

**Keywords**: Enterprise systems, business process, work process, job characteristics, job demands, job control, job satisfaction, latent growth modeling, process characteristics, technology characteristics

## Introduction

Implementation of enterprise systems (ESs), which are comprehensive commercial software packages with embedded industry best practice business processes, has increased significantly over the years as organizations continue to deploy these systems to improve operational efficiency and achieve strategic advantage (Gregor et al. 2006; Seddon et al. 2010; Volkoff et al. 2007). About 88 percent of organizations in the United States have either implemented ESs or evaluated ESs for implementation (Liang et al. 2007; Wailgum 2009). The global market for enterprise resources planning (ERP) systems, the most widely used type of ESs, has been projected to reach about US $50 billion by 2015 (Martens and Hamer-

[1]Shirley Gregor was the accepting senior editor for this paper. Elizabeth Davidson served as the associate editor.

The appendices for this paper are located in the "Online Supplements" section of the *MIS Quarterly*'s website (http://www.misq.org).

man 2011). ES implementations are challenging because they require radical changes to existing business processes and deployment of new technologies to support the new business processes (Markus and Tanis 2000; Morris and Venkatesh 2010). Employees often resist an ES, fearing that their jobs will be radically different after the implementation (Boudreau and Robey 2005; Morris and Venkatesh 2010; Sykes et al. forthcoming). In fact, organizations' inability to understand and manage employees' perceptions of changes during ES implementations has been recognized as a key reason for implementation failures (Cohen 2005; Jasperson et al. 2005; Markus 2004). Therefore, an understanding of the nature, magnitude, and causes of changes in employees' perceptions of their jobs during an ES implementation is important for its success.

There is a rich body of research that has examined different facets of ES implementations: (1) implementation processes in organizations (e.g., Hong and Kim 2002; Liang et al. 2007; Robey et al. 2002; Soh et al. 2000), (2) employees' reactions to a new ES (e.g., Boudreau and Robey 2005; Volkoff et al. 2007), and (3) the impacts of ES implementations on firm performance (e.g., Cotteleer and Bendoly 2006; Gattiker and Goodhue 2005). Although prior research has provided rich insights on different aspects of ES implementations, there has been limited research on employees' perceptions of *changes* in their job characteristics during an ES implementation. A notable exception is Davis and Hufnagel (2007) who studied employees' perceptions of changes at various levels of work conditions (i.e., organizational, task, process, and role) following a new ES implementation. The recent work of one or both authors of this paper has extensively focused on ES implementations (e.g., Morris and Venkatesh 2010; Sykes and Venkatesh forthcoming; Sykes et al. forthcoming; Venkatesh et al. 2010; Venkatesh et al. 2011), with some work specifically focusing on the role of job characteristics (Morris and Venkatesh 2010; Venkatesh et al. 2010). However, these studies did not particularly focus on changes in job characteristics following an ES implementation.

Further, prior research that has examined employees' perceptions of changes in jobs during information systems (IS) implementations used cross-sectional data or at most two waves of data to understand change (e.g., Majchrzak and Cotton 1998; Millman and Hartwick 1987). We suggest that changes in employees' jobs during an IS implementation are dynamic, such that some employees may feel more changes immediately after the implementation and some employees may change their perceptions rapidly after the implementation (i.e., intra-individual variability), some employees may perceive greater change than others (i.e., interindividual variability), and employees may enact different adaptation strategies based on how much change they experience (Beaudry and Pinsonneault 2005; Boudreau and Robey 2005; Volkoff et al. 2007). Hence, there is a need to understand the longitudinal trajectory of employees' perceptions of changes in their job characteristics during an ES implementation.

Against this backdrop, we conducted a longitudinal field study of an ES implementation in two organizations to accomplish two objectives. Our first objective was to examine the nature and extent of changes in employees' perceptions of two important job characteristics from the job strain model (JSM)—namely, *job demands* and *job control* (Karasek 1979)—during the *shakedown phase* of an ES implementation. We focused on the shakedown phase because most of the changes, disruptions, shock, and negative reactions that result from an ES implementation can be expected during this phase (Hakkinen and Hilmola 2007, 2008; Markus et al. 2003; Markus and Tanis 2000; Morris and Venkatesh 2010). Although it has been suggested that, with the passage of time, employees may overcome the disruptions and changes, and organizations may recoup productivity reduction, many organizations abandon ESs due to the inability to manage changes during the shakedown phase (Hakkinen and Hilmola 2008; Markus et al. 2000; Markus and Tanis 2000). Our second objective was to examine the determinants and outcomes of changes in job demands and job control. Given that an ES implementation typically entails deployment of new technologies (i.e., software and hardware) and business processes (Morris and Venkatesh 2010; Sykes and Venkatesh forthcoming; Sykes et al. forthcoming), we identified a set of technology and process characteristics from employees' perspectives and theorized them as determinants of changes in job demands and job control. We also examined the impact of changes in job demands and job control on an important job outcome: *job satisfaction.* The longitudinal studies strongly support our research model. In particular, we found that employees indeed perceived overall changes in job demands (increase) and job control (decrease) during the shakedown phase. These changes were predicted by perceived process characteristics that in turn were predicted by perceived technology characteristics.

This research is expected to make key theoretical contributions. First, it offers a nomological network that integrates ES implementations with employees' jobs. The scope of this model is the shakedown phase, which has been suggested to be the most critical phase of an ES implementation. The model incorporates key technology characteristics of an ES that influence employees' perceptions of work processes and, subsequently, perceptions of changes in two important job characteristics. Second, we offer possible explanations for employees' negative reactions to an ES during the shakedown phase by theorizing the nature of change in two aspects of their jobs and the impacts of this change on a key job outcome, namely, job satisfaction. Third, this work extends JSM, one of the most influential models of job stress, by offering determinants of job demands and job control in the context of a radical organizational change—here, an ES implementation. Finally, this work is expected to help organizations better manage change during ES implementation projects by offering insights on the nature, extent, determinants, and outcomes of changes in employees' job characteristics following an ES implementation.

## Theoretical Background

### *Enterprise Systems Implementation: The Shakedown Phase*

Prior research has proposed four phases of an ES implementation, also known as the ES experience cycle: *chartering*, *project*, *shakedown*, and *onward and upward* (Markus and Tanis 2000). The shakedown phase is the period of time from the point the system is functional and accessible by employees (going live or rollout) to the point when normal operation or routine use has been achieved (Markus and Tanis 2000). During this phase, organizations mandate the use of the new software and business processes. Markus and Tanis (2000) indicated that the shakedown phase is the first phase in which end users (i.e., employees) are fully involved in the ES experience cycle as key actors. They further noted that some of the common errors and/or problems of this phase are business disruptions, maintenance of old procedures or manual workarounds, underuse or nonuse of the system, and failure to achieve normal operations. Measuring employees' job quality and stress has been suggested as an important performance metric of the shakedown phase (Markus and Tanis 2000).

Prior studies have indicated that the duration of the shakedown phase may range from three months to a year (or more) depending on various factors, such as the type of ESs being implemented, magnitude of changes in business processes and technology platforms, and the nature of implementation, for example, the number of modules being implemented and number of employees being affected (Gattiker and Goodhue 2005; Hakkinen and Hilmola 2007, 2008; Morris and Venkatesh 2010; Wei et al. 2005). Regardless of the duration, there are typically two possible outcomes of the shakedown phase: (1) termination of the project due to severe problems in the shakedown phase, such as disruption of business, poor technical performance, bugs and errors, and (2) achievement of normal operation, with routine use of ESs leading to operational and strategic benefits (Markus and Tanis 2000). As noted earlier, there are numerous cases of implementation failure and project termination in which organizations failed to achieve the normal operation that marks the end of the shakedown phase, thus underscoring the key role of this phase in an ES implementation (Hakkinen and Hilmola 2007; Markus et al. 2000; Markus and Tanis 2000).

### *Job Strain Model (JSM): Job Demands and Job Control*

JSM, also known as the job demand-control (JDC) model, is one of the most influential theories of job stress since the 1980s (de Lange et al. 2003; Van der Doef and Maes 1999). In its basic form, JSM postulates that two broad work conditions—*job demands* and *job control*—can vary independently in the work environment and lead to job strain, a stress outcome reflected in mental and physical health problems of employees (Fox et al. 1993; Karasek 1979). Job demands are defined as the degree to which an employee perceives that he or she is required to work fast and hard, and has much work to do, often in a short time (Karasek 1979). Job control is defined as the degree to which an employee perceives that he or she has the ability to exert some influence over his or her work environment with respect to the method, timing, and boundary of his or her work (Ganster and Fusilier 1989; Wall et al. 1990). Note that these are primarily psychological demands and control and not necessarily physical ones (Fox et al. 1993).

The central tenet of JSM is that job demands and job control interact to cause psychological strain and different physiological outcomes. JSM makes two major predictions with respect to this interaction: (1) job stress and health-impairing outcomes, such as hypertension and high blood pressure, occur in *high strain jobs* that are simultaneously high in demand and low in control, and (2) positive outcomes, such as satisfaction, motivation, and healthful regeneration, occur in *active jobs* that are high in both demands and control (Karasek 1979). The theoretical rationale underlying these predictions is that although job demands put an employee into an aroused or motivated state, this arousal or motivation will not be released in the normal execution of the job if it is accompanied by low control over the job (Fox et al. 1993; Jex and Beehr 1991; Karasek 1979). It is this non-release of arousal or motivated state that leads to negative psychological and physiological consequences (Jex and Beehr 1991). Notwithstanding such rich theoretical predictions related to this interaction, reviews of studies on JSM revealed that although the additive model (i.e., main effects of job demands and job control on psychological and physiological outcomes) was consistently supported, the empirical support for the interaction model was inconclusive (de Lange et al. 2003; de Rijk et al. 1998; Van der Doef and Maes 1999). Nonetheless, the contribution of JSM is undisputed as a key theoretical foundation for numerous studies of job stress and health outcomes in organizational behavior, human resources, and occupational psychology literatures.

We focus on changes in job demands and job control for three important reasons. First, given the influence of ES implementations on various aspects of employees' jobs (Boudreau and Robey 2005; Soh et al. 2000), we expect that the influence on job demands and job control will be more substantial due to the nature of these systems (Devadoss and Pan 2007). Further, given their negative influence on psychological and physiological outcomes, we anticipate that unfavorable changes in these two job characteristics will be a potential source of negative reactions to a new ES and concomitant changes in business processes (Boudreau and Robey 2005; Mullarkey et al. 1997; Wall et al. 1990). Therefore, from a managerial point of view, potential increase in job demands and decrease in job control during an ES implementation are important to understand in order to develop and implement effective change management interventions and strategies during an implementation.

Second, prior research on IS implementations has not focused on changes in these two important aspects of employees' jobs. Although some studies have focused on the influence of ES implementations on job characteristics from the job characteristics model (JCM; Hackman and Oldham 1980; see Davis and Hufnagel 2007; Morris and Venkatesh 2010; Venkatesh et al. 2010)—that is, skill variety, task identity, task significance, autonomy, and feedback—there has been limited empirical research on whether and how an ES implementation can influence perceptions of changes in job demands and job control. Understanding changes in these two aspects of employees' jobs will help unearth the disruptive nature of ESs suggested in prior research (Boudreau and Robey 2005; Markus et al. 2003; Robey et al. 2002; Volkoff et al. 2007). Finally, although research on job demands and job control is rich and has spanned over 30 years (de Lange et al. 2003), it has primarily focused on the dimensions and outcomes of these two job characteristics (Fox et al. 1993; Karasek 1979; van Yperen and Hagedoorn 2003; Wall et al. 1990) and limited research has focused on the antecedents of changes in job demands and job control. As noted earlier, we address this gap by identifying and conceptualizing antecedents of changes in job demands and job control applicable to the context of ES implementations.

### *Employee Perceptions of Changes During ES Implementations*

JSM suggests that environmental and situational conditions in the workplace play a major role in the formation of employees' perceptions of job demands and job control (Ganster 2005; Ganster and Fussilier 1989; Hambrick et al. 2005; Karasek 1979). Hambrick et al. (2005) noted that if a work environment consists of numerous variables and contingencies, imposes considerable information processing demands, and enforces high performance requirements, it engenders a high degree of task and performance challenges for employees. Employees are more likely to appraise such an environment as demanding (Ganster 2005; Hambrick et al. 2005). Further, if a work environment allows fewer elements of choices with respect to the order, pace, and amount of work, employees are more likely to appraise it as less controllable (Ganster and Fussilier 1989). Employees thus develop a stable appraisal of job demands and job control over time based on their experiences in the work environment. However, when there is a change in the work environment, employees experience a variation in the existential state of job demands and job control, thus leading to a shift in their appraisal of these two job characteristics. Prior research has suggested that organizational change events, such as a new technology implementation, process redesign, organizational restructuring, and mergers and acquisitions, are potential sources of changes in employees' appraisal of job demands and job control (Ganster 2005; Parker et al. 1997).

Prior research has found that employees experienced significant disruptions in their work environment following an ES implementation (Boudreau and Robey 2005; Markus and Tanis 2000; Morris and Venkatesh 2010; Robey et al. 2002; Sykes and Venkatesh forthcoming; Sykes et al. forthcoming; Volkoff et al. 2007). Given that employees first experience an ES during the shakedown phase, we expect that they will experience major changes in their environment during this phase. Research on organizational routines has suggested that employees like to maintain stable routines that they have developed over time and found to be successful (Feldman and Pentland 2003). They will have a strong tendency to persist with these stable routines (Gersick 1991). During the shakedown phase, as employees try to orient themselves with an ES, they are most likely to find their previous, stable routines obsolete (Volkoff et al. 2007). This feeling of obsolescence will be triggered by the introduction of redesigned business processes and much uncertainty and confusion associated with the new technology components, such as software and hardware (Morris and Venkatesh 2010). Hence, consistent with prior research (Volkoff et al. 2007), we suggest that employees will experience changes in their jobs due to the impact of an ES on their routines or work processes during the shakedown phase. In particular, they are more likely to reappraise their perceptions of job characteristics if they experience disruptions and unforeseen changes in their work processes or routines following an ES implementation.

Building on research on organizational routines and business processes, we conceptualize a work process as a sequence of interrelated tasks performed by an employee to accomplish his or her job duties (Basu and Blanning 2003; Davenport 1993; Pentland 2003). Although perceptions related to work processes following an ES implementation will likely influence perceptions of changes in job characteristics, we suggest that perceptions of technology characteristics of an ES will shape how employees assess their work processes in the first place. We offer the theoretical rationale for these relationships in the next section. We identified technology and process characteristics in two complementary ways.

First, we reviewed the ES implementation and business process change literatures to identify aspects of employees' perceptions of an ES and their work processes. Although there may be many different technology and process characteristics related to an ES, we sought to identify a manageable set of characteristics that (1) would be most salient to employees as they start using an ES during the shakedown phase, (2) would help us understand employees' perceptions of changes in their job characteristics, and (3) would represent the work environment perceived by employees during the shakedown phase. Therefore, we focused on prior research that offers insights on employees' reactions to an ES and process changes immediately after an implementation. We also examined macro-level research that offers characteristics of ESs and business processes that are potentially relevant to employees.

Second, we conducted multiple sessions of moderated focus groups of employees of a Fortune 500 manufacturing firm that had implemented ESs for supply chain and product development purposes. The comments from these focus groups were content analyzed to identify employees' perceptions of technology characteristics of an ES and their work process characteristics (Stewart et al. 2007). We include illustrations from these focus groups in footnotes when we define these characteristics in the next section. From these two complementary approaches, we identified three technology characteristics—perceived technology complexity, perceived technology reconfigurability, and perceived technology customization—that we expected would influence employees' work process characteristics. We also identified three work process characteristics—perceived process complexity, perceived process rigidity, and perceived process radicalness—that we expected would predict changes in job characteristics. Note that these characteristics were conceptualized as employees' perceptions rather than objective characteristics of ESs and work processes (see Table 1). We further discuss these constructs in the next section.

## Theory Development

Figure 1 presents the research model that we term the job characteristics change model (JCCM). JCCM posits that during the shakedown phase, employees will perceive an overall increase in job demands and an overall decrease in job control. It further postulates that these changes will be predicted by employees' work process characteristics experienced during the shakedown phase. Further, employees' perceptions of technology characteristics of an ES will influence the work process characteristics. Finally, increase in job demands and decrease in job control will influence employees' job satisfaction.

### *Changes in Job Demands and Job Control*

We offer three theoretical reasons to justify why employees will experience an increase in job demands during the shakedown phase. First, when employees start using an ES, they have to spend a significant amount of time learning the new software and business processes and, at the same time, performing their day-to-day work (Boudreau and Robey 2005; Robey et al. 2002; Sykes forthcoming). The simultaneous need for learning and performing will increase their workload. Second, employees will have an intense urge to quickly routinize the new software and business processes to reduce the uncertainty and unpredictability in their work environment during the shakedown phase (Lassila and Brancheau 1999). In doing so, employees are likely to make mistakes when using the new ES to execute their work processes. Correcting these mistakes will increase their workload, thus increasing their job demands. Finally, many organizations keep both the old and new software and business processes in parallel to support certain legacy applications or external stakeholders, such as customers and suppliers. In such a situation, employees have to perform extra work to go back and forth between the new and old software and business processes. For example, Davidson and Chismar (2007) found that pharmacists and nurses experienced extra work because they had to follow both old and new processes. Although it may be that job demands will eventually go down over time as employees gain experience with an ES, we suggest that during the shakedown phase, employees will perceive an overall increase in job demands.

**Table 1. Employees' Perceptions of Technology and Process Characteristics**

| Characteristics | Definitions | Prior Research Examples |
|---|---|---|
| Perceived technology complexity | The extent to which an employee perceives an ES to be relatively difficult to understand and use. | Boudreau and Robey (2005); Devadoss and Pan (2007); Robey et al. (2002); Venkatesh (1999, 2000) |
| Perceived technology reconfigurability | The degree to which an employee believes that an ES is implemented in such a way that it supports modifications of features and functionalities during the course of use. | Boudreau and Robey (2005); Devadoss and Pan (2007); Robey et al. (2002); Soh et al. (2000); Volkoff et al. (2007) |
| Perceived technology customization | The degree to which an employee believes that an ES is tailored in such a way that it closely fits with his or her needs for data, functionality, and outputs to accomplish tasks. | Brehm et al. (2001); Robey et al. (2002); Soh et al. (2000); Volkoff et al. (2007); Wang et al. (2006) |
| Perceived process complexity | The degree to which an employee believes that elements of his or her work processes (i.e., activities, information and resource requirements) are difficult to understand and act upon. | Gebauer and Schober (2006); Pentland (2003); Volkoff et al. (2007) |
| Perceived process rigidity | The degree to which an employee believes that elements of his or her work processes (i.e., activities, information and resource requirements) cannot be modified or circumvented during the course of executing the work processes. | Boudreau and Robey (2005); Gebauer and Schober (2006); Robey et al. (2002); Soh et al. (2000, 2003); Volkoff et al. (2007) |
| Perceived process radicalness | The extent to which an employee believes that there is a certain degree of newness in the elements of his or her work processes (i.e., activities, information and resource requirements). | Hong and Kim (2002); Pentland (2003); Stoddard and Jarvenpaa (1995); Volkoff et al. (2007) |

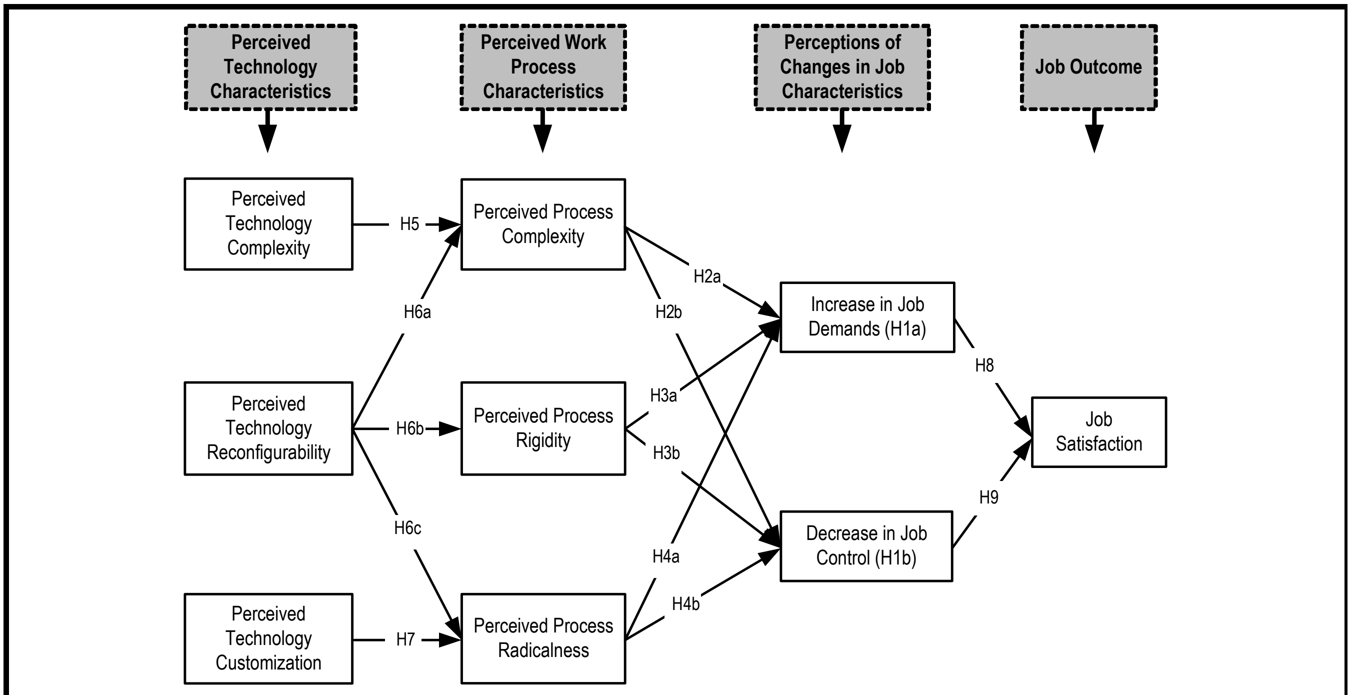


**Figure 1. Job Characteristics Change Model (JCCM) in an ES Implementation Context**

*H1a: Employees will perceive an overall increase in job demands during the shakedown phase of an ES implementation.*

We theorize that employees will experience a decrease in job control during the shakedown phase. According to JSM, appraisal of job control depends on two key reasons: (1) ability of employees to learn and use their skills, and (2) ability of employees to have some say or authority in the work method. When employees first start using an ES during the shakedown phase, both these reasons will be at play. Given that employees will not have enough experience with the new software and business processes during the shakedown phase, they may feel that they do not have the necessary skills to perform their tasks using the ES (Boudreau and Robey 2005). Moreover, ESs are different from other types of IS that employees may have used before (Devadoss and Pan 2007). These systems come with new business processes, which are industry-specific best practices, that are likely to be very different from existing business processes of an organization (Markus and Tanis 2000). When employees discover this difference, they may not be able to leverage their existing skill sets and may perceive a loss of control over their jobs. Further, given that the use of ESs is typically mandatory in organizations, employees may feel that they no longer have the freedom to decide their pace and amount of work. As noted earlier, employees have a tendency to persist with their stable routines to perform tasks or solve a problem (Gersick 1991). However, in the shakedown phase, they may have to change their established routines that were developed and optimized over a long period of time, learn new work methods, and develop new routines (Volkoff et al. 2007). Consequently, they may feel that they have less control over how they perform their jobs.

*H1b: Employees will perceive an overall decrease in job control during the shakedown phase of an ES implementation.*

## Predicting Changes in Job Characteristics

Although we hypothesize that employees, on average, will perceive an increase in job demands and a decrease in job control, we expect that these perceptions will vary among employees depending on their differences in perceptions of work process characteristics. Here, we develop hypotheses regarding the influence of work process characteristics on changes in job demands and job control.

### Influence of Perceived Process Complexity

Prior research on process modeling has suggested that work processes encompass at least three key elements: (1) sequence of interdependent and coordinated tasks or activities, (2) information, and (3) resources needed to perform these tasks (Basu and Blanning 2003; Malone et al. 1999; Pentland 2003; Stoddard and Jarvenpaa 1995). Following an ES implementation, employees may have to follow a new work sequence, spend time thinking about how to execute tasks, and actively search beyond readily available procedures. If an ES makes it difficult for employees to understand their work sequences, and to access the information and resources they need to perform their tasks, it is more likely that employees will find their overall work processes to be more complex than they (work processes) were before the implementation.[2] We conceptualize *perceived process complexity* as an important aspect of employees' work processes and define it as the degree to which an employee believes that elements of his or her work processes (i.e., activities, information and resource requirements) are difficult to understand and act upon.

According to JSM, job demands increase when employees are required to work fast and hard, and have much work to do, often in a short amount of time (Karasek 1979). When an employee perceives that his or her work processes have become complex, such that the sequence of tasks is difficult to understand and execute, and information and resources needed to accomplish the tasks are difficult to understand and gather, it is more likely that the employee will have to work harder and spend more time to understand various elements of his or her work processes. The perception of process complexity will be salient during the shakedown phase as employees have limited knowledge of how different elements of their work processes will shape up over time. In the context of an electronic medical records (EMR) system, Lapointe and Rivard (2005) found that physicians and nurses felt that they had to work extra hours due to the complexity of their new work processes. Perceived process complexity will thus increase job demands because employees may have to spend more time figuring out what tasks to perform, when to perform them, how to perform them, and what information and resources are needed for their tasks. Although employees need to spend time to understand different elements of their work processes, they may still feel the pressure to accomplish their tasks on time as mandated by their supervisors, which in turn will lead to greater workload. In some cases, employees may need more time to accomplish some tasks and have less time available to accomplish some other tasks. This may also lead to a feeling of a higher workload (Karasek 1979).

[2]During our focus group sessions, some participants expressed their concerns about increased difficulty in understanding their work processes following the ES implementation in their organization. For example, an employee working in a new product development team mentioned that although there was no change in the total number of tasks she performed, there were significant changes in the sequence of her tasks and the information needed for the tasks.

*H2a: Employees with higher perceived process complexity will exhibit a greater increase in perceptions of job demands during the shakedown phase of an ES implementation.*

Employees will feel decreased job control when they believe that they do not have the ability to influence their work environment (Ganster and Fusilier 1989). Consistent with our arguments in H2a, when employees have difficulty in understanding the elements of their work processes during the shakedown phase, they are more likely to feel that they do not have the ability and/or resources to execute their work processes and have less discretion over the work environment. This can be further explained using Bandura's (1997) self-efficacy theory, which suggests that if individuals do not believe that they have capabilities to perform their tasks, they are more likely to feel less control over their jobs. Complex work processes can make employees feel that they may not have the ability to perform their jobs as they have difficulties in understanding various elements of their work processes. For example, a credit analyst may feel that he or she has less control over the job because of the lack of understanding of and mastery over a new loan approval process that came into being after an ES implementation.

*H2b: Employees with higher perceived process complexity will exhibit a greater decrease in perceptions of job control during the shakedown phase of an ES implementation.*

### Influence of Perceived Process Rigidity

When organizations change their business processes to fit with vendor-recommended best practices as part of an ES implementation, it is possible that such standardization will make employees' work processes rigid (Volkoff et al. 2007). For example, if a customer service representative who used to follow up with customers via phone has to conform to a certain new communication protocol when using a CRM system and the other options are not allowed in the process, the representative is more likely to find his or her work processes to be rigid. It is well documented in the ES implementation literature that ESs make work processes rigid by restricting the ways employees perform their tasks and enforcing certain information and resource requirements (Volkoff et al. 2007). Such rigidity prompts employees to attempt to workaround and/or improvise their work processes (Boudreau and Robey 2005; Robey et al. 2002; Soh et al. 2000, 2003).[3] We define *perceived process rigidity* as the degree to which an employee believes that elements of his or her work processes (i.e., activities, information and resource requirements) cannot be modified or circumvented during the course of executing the work processes.

We argue that a work process perceived as not offering sequential variety, allowing improvisations, and supporting flexibility will lead to perceptions of increasing job demands. The inflexibility of ES-enabled processes may place an additional cognitive burden on employees, as they have to be more alert in following the sequence of tasks and other business rules associated with their new work processes. Prior research has noted that employees will find the system-enforced processes to be rigid when they first start interacting with an ES (Boudreau and Robey 2005; Volkoff et al. 2007). ESs are designed to have a certain degree of process rigidity in order to reduce process variations throughout the organization. During the shakedown phase, when employees start using an ES, they will have to break their old habits to execute and become familiar with the new system-defined work processes (Robey et al. 2002; Volkoff et al. 2007). Consequently, they may feel that their workload has increased, as they are not able to use the shortcuts and workarounds they have developed over time (Robey et al. 2002).

*H3a: Employees with higher perceived process rigidity will exhibit a greater increase in perceptions of job demands during the shakedown phase of an ES implementation.*

Given that a rigid work process does not allow employees to have much discretion over the elements of their work processes, employees are more likely to feel that they have less control over their jobs. An important element of job control is the choice among task alternatives (Ganster and Fusilier 1989). During the shakedown phase, when employees have limited experience with an ES, they may perceive that they do not have a choice with respect to how they accomplish their tasks. Therefore, consistent with our arguments in H3a, we suggest that the salience of process rigidity will intensify the perceptions of decreasing job control during the shakedown phase. Using the earlier example of the credit analyst, if the analyst finds that the steps in the ES-enabled work process of loan approval are inflexible and require him or her to follow a fixed sequence of steps and use a specific and unchangeable set of information or resources, he or she may develop a sense of a lack of control over the job due to the lack of choice among task alternatives, information, and resources needed to perform tasks.

*H3b: Employees with higher perceived process rigidity will exhibit a greater decrease in perceptions of job control during the shakedown phase of an ES implementation.*

[3] Rigidity of work processes was mentioned by some of our focus group participants who commented that they did not have the flexibility to perform tasks at their own pace and sequence following the ES implementation.

### Influence of Perceived Process Radicalness

The concept of radicalness is central in the innovation and technology implementation literature, as well as in the business process change literature (Aiman-Smith and Green 2002; Green et al. 1995; Stoddard and Jarvenpaa 1995). Radicalness refers to the degree of newness, lack of experience, or departure from existing knowledge and practices (Green et al. 1995). Given that an ES implementation typically involves significant business process changes and/or reconfiguration, an employee may feel that his or her work processes are radically different from what he or she previously performed. The employee may feel that he or she has to perform a new set of tasks that require new information and resources. Employees may develop such feelings for two reasons (Volkoff et al. 2007): *substitution* (i.e., employees no longer perform a work process that they used to perform before the new system, or they perform a completely new work process) and *alteration* (i.e., employees perform an old work process in a new way).[4] We conceptualize these perceptions of changes as *perceived process radicalness*, which we define as the extent to which an employee believes that there is a certain degree of newness in the elements of his or her work processes (i.e., activities, information and resource requirements).

As noted earlier, an ES implementation is a radical change that disrupts employees' previous routines and makes their work environment ambiguous and unstable (Boudreau and Robey 2005; Volkoff et al. 2007). Given that employees first experience an ES during the shakedown phase, they are more likely to perceive a greater degree of change in their work processes during this phase. In an attempt to reduce the radicalness and associated ambiguity, employees will work hard and exert more physical and mental effort to understand, learn, execute, and routinize these new work processes. In contrast, if employees find that the work processes are not radically different following an ES implementation, it is likely that they will not have to exert significant effort to understand different elements of the processes. They will find it rather easy to execute their work processes using the new ES.

*H4a: Employees with higher perceived process radicalness will exhibit a greater increase in perceptions of job demands during the shakedown phase of an ES implementation.*

Consistent with our arguments in H4a, when an employee first realizes that the tasks to be performed are different from what he or she did before an ES implementation, he or she is more likely to feel less control over the job and work environment. If a work process is radically new, employees may lose their sense of mastery over it. According to Bandura's self-efficacy theory, when individuals do not feel a sense of mastery in a domain, they tend to believe that they cannot achieve a desired performance level due to a perceived lack of control. During the shakedown phase, when organizations typically struggle with the transition to a new ES, employees are more likely to perceive a lack of structure to perform their tasks. Markus et al. (2000) found that during the shakedown phase, many organizations still kept old business processes in parallel to the new processes to ensure seamless business operations. Consequently, some employees may become confused with respect to which work processes to follow. This lack of structure creates a sense of urgency to regain stable routines that were in place before the ES implementation. Although it is possible that employees may eventually adapt to the new work processes, the perception of decreasing job control will prevail due to the perceived radicalness of these new work processes during the shakedown phase.

*H4b: Employees with higher perceived process radicalness will exhibit a greater decrease in perceptions of job control during the shakedown phase of an ES implementation.*

## *Linking Technology and Work Process Characteristics*

JCCM posits that employees' perceptions of technology characteristics of an ES will influence their perceptions of post-implementation work process characteristics. We suggest that when employees first start using an ES, their perceptions of technology characteristics will dominate their initial responses toward the ES. Boudreau and Robey (2005) noted that employees' initial reactions toward an ES and their post-implementation work processes were shaped by technology characteristics, such as complexity. Robey et al. (2002) and Hakkinen and Hilmola (2008) found that employees developed perceptions of technology characteristics, such as complexity of pulling data from an ES, when they first started using an ES. We suggest that when employees start using an ES (i.e., during the shakedown phase) to execute their work processes, they will take into consideration their perceptions of technology characteristics as they form perceptions of post-implementation work process characteristics. For instance, if employees find the new software to be difficult to understand and use (i.e., high technology complexity), they are more likely to find it difficult to execute their work processes. In this section, we theorize how and why technology characteristics of an ES will drive employees' perceptions of work process characteristics.

[4]During our focus groups, participants commented that although their day-to-day tasks essentially remained the same, they had a different work sequence from what they followed before the ES implementation.

### Influence of Perceived Technology Complexity

ESs are typically considered more complex than other types of IS that employees use (Devadoss and Pan 2007; Markus and Tanis 2000). Effective use of an ES requires substantial knowledge about how it handles various aspects of a business process. For example, creating a purchase order in SAP ERP 6.0, one of the most widely adopted ESs, requires an employee to access five to eight different screens to provide or retrieve information pertinent to the order (Magal and Word 2011). Accessing and navigating different screens and options, and understanding the information needed for each of these screens and options, may add enormous cognitive burden to an employee as he or she tries to accomplish tasks. Indeed, prior research has found that employees typically perceive ESs to be complex, thus leading to negative reactions, user resistance, and ineffective use of these systems (Boudreau and Robey 2005).[5] We conceptualize *perceived technology complexity* as a key characteristic of an ES and define it as the extent to which an employee believes that an ES is relatively difficult to understand and use, which is consistent with the definition and drivers of perceived ease of use in the prior literature (e.g., Venkatesh 1999, 2000; Venkatesh and Bala 2008; Venkatesh and Davis 1996).

During the shakedown phase, as employees start using an ES, they quickly discover the complexity of the system and find it to be more complicated than the previous technologies or other methods used to perform the same or similar tasks (Aiman-Smith and Green 2002; Boudreau and Robey 2005; Devadoss and Pan 2007). Further, due to limited experience with the new software, employees may not be able to find and use different features and functionalities to execute their work processes effectively and efficiently. Consequently, employees will experience much uncertainty related to the execution of their work processes using the software. Further, they may feel that because of the complexity of the system, they now have more tasks to do in their work processes, as they are not only learning the features of the new software, but also using these features to perform their work processes. They may also feel that due to high technology complexity, they may not be able to figure out what tasks to perform, what information is needed, and how to access this information using the software.

*H5: Perceived technology complexity will positively influence perceived process complexity during the shakedown phase of an ES implementation.*

### Influence of Perceived Technology Reconfigurability

Prior research has suggested that in order to reduce variations and errors in business processes, organizations tend to implement an ES in such a way that employees are not able to experiment with or modify its features and functionalities (Devadoss and Pan 2007; Markus and Tanis 2000). Nevertheless, employees still engage in significant workarounds and improvisation when they use an ES (Boudreau and Robey 2005). Some employees attempt to *tweak* and execute *workarounds* to modify certain aspects of an ES to fit with their pre-implementation routines (Robey et al. 2002). Others will attempt to find ways to fit the ES with their task requirements (Volkoff et al. 2007). Overall, a reconfigurable ES will help employees reduce any possible misalignment between the ES and their work environment (Soh et al. 2000; Strong and Volkoff 2010).[6] We conceptualize *perceived technology reconfigurability* as an important characteristic of an ES and define it as the degree to which an employee believes that an ES is implemented in such a way that it supports modifications of features and functionalities in the course of its use.

During the shakedown phase, we expect that employees will actively attempt to reconfigure the software component of an ES to reduce the gap between the software functionalities and their needs (Boudreau and Robey 2005; Soh et al. 2000). They will start exploring the ES to find efficient ways to leverage features and functionalities to execute their work processes (Tyre and Orlikowski 1994). For example, some ESs allow users to create customized reports, forms, templates, and shortcuts to access certain screens. If employees are able to do these reconfigurations, it is more likely that they will develop a better understanding of how the software can be used to execute their work processes (Boudreau and Robey 2005; Robey et al. 2002). They will be able to find information and functionalities from the system to accomplish their work processes effectively. As a result, employees may develop a feeling of mastery over their work processes, and perceive that their work processes are less complex in terms of the number of tasks to be performed and the amount of information and resources needed.

*H6a: Perceived technology reconfigurability will negatively influence perceived process complexity during the shakedown phase of an ES implementation.*

Consistent with the arguments for H6a, we suggest that during the shakedown phase, if employees find the software component of an ES to be reconfigurable, it is more likely that

[5]Our focus group participants frequently mentioned the complexity of the user interface and the navigation difficulty as hindrances to the accomplishment of their tasks.

[6]Several of our focus group participants noted the importance of reconfigurability, such as the ability to store data in different formats and create reports that did not conform to the system-generated report templates.

they will attempt to modify the software to reduce rigidity of their work processes. Boudreau and Robey (2005) found that employees used workarounds to make their work processes less rigid. Although the actual level of rigidity may not be reduced, employees will perceive that some aspects of their work processes are less rigid, as they are able to modify different features of an ES to accomplish tasks in their preferred ways. They will try to find various shortcuts and configure various functionalities of the system that will help them reduce process rigidity (Robey et al. 2002). For example, employees may find shortcuts to retrieve data from an ES and use the data to perform certain tasks in their work processes.

*H6b: Perceived technology reconfigurability will negatively influence perceived process rigidity during the shakedown phase of an ES implementation.*

We suggest that if employees perceive that the software component of an ES is reconfigurable, it is more likely that they will leverage this capability to make their work processes less radical. Employees typically find their work processes to be radically different during the shakedown phase because they have limited experience with the new ES (Volkoff et al. 2007). Therefore, if they are able to modify certain aspects (e.g., interface, reports) of the ES to meet their needs and fit with their work processes, they are likely to feel that they have a greater control over how they execute their work processes using the ES. Further, if employees can reconfigure an ES, they will be able to influence the sources of work process radicalness, such as new task sequences, information requirements, and resource requirements, by altering certain features of the system. For example, employees may find ways in an ES to retrieve data in a certain format or generate reports in a certain way to perform work process tasks in their preferred ways.

*H6c: Perceived technology reconfigurability will negatively influence perceived process radicalness during the shakedown phase of an ES implementation.*

### Influence of Perceived Technology Customization

Wang et al. (2006, p. 268) suggested that ESs are essentially "configuration technology" that can be customized to fit with an organization's "specific market, structure, and operational requirements." Prior research and trade press articles have suggested that when organizations implement an ES, there are two major approaches: (1) the system can be customized to fit the existing business processes, or (2) the existing business processes can be redesigned to fit the system features and functionalities (Hong and Kim 2002; Markus and Tanis 2000). Although the latter approach is generally recommended by vendors and consultants, most organizations adopt a middle ground. Organizations customize certain aspects of ESs, such as module selection, table configuration, screen masks, interface development, and package code modifications, to reduce misfits between an ES and user requirements with respect to data, features, functionality, and output (Brehm et al. 2001; Davenport 1998; Hong and Kim 2002; Soh et al. 2000). Through training and other direct or indirect sources, such as user participation in the implementation process and initial hands-on use, employees typically develop an understanding of the extent to which an ES was customized to fit with their needs (Gattiker and Goodhue 2005; Sykes forthcoming; Volkoff et al. 2007).[7] We conceptualize *perceived technology customization* as a critical aspect of an ES implementation and define it as the degree to which an employee believes that an ES is tailored in such a way that it closely fits with his or her needs for data, functionality, and outputs to accomplish tasks.

We suggest that if employees perceive that an ES was configured to fit with their needs for data, features, and functionalities, they are more likely to believe that they will be able to get the necessary data, use the features, and access the functionalities that they need to execute their work processes. As discussed earlier, employees typically want to avoid uncertainty and unpredictability in their work environment. During the shakedown phase, if employees feel that an ES was customized to fit with their needs, they will perceive that the system will not be a source of uncertainty and ambiguity in their environment. Employees will develop a sense of confidence regarding the fit the new system has with their needs (Hong and Kim 2002). We suggest that the perception of customization will reduce employees' perceptions of process radicalness during the shakedown phase as employees will feel that they can get the data and use the features and functionalities that they need to execute their work processes. They will have a greater understanding of how the new system can be used to execute their work processes and may perceive their work processes not to be radically different after the implementation of an ES.

*H7: Perceived technology customization will negatively influence perceived process radicalness during the shakedown phase of an ES implementation.*

## Impacts of Changes in Job Characteristics

Prior research on JSM has suggested that job demands have a negative influence on job satisfaction and job control has a

[7]Although a few of our focus group participants felt that the ES was adequately configured to meet their requirements in their organization, many of them expressed their frustration about the lack of customization that adversely affected their task performance.

positive influence on job satisfaction (de Lange et al. 2003; Fox et al. 1993; Parker et al. 1997; Van der Doef and Maes 1999). Although examining the impacts of changes in job characteristics on job satisfaction is not the central focus of this research, we included these hypotheses to demonstrate the predictive validity of our principal constructs (criterion validity), namely increase in job demands and decrease in job control.

Consistent with the JSM and prior research on job stress, we suggest that increasing job demands, such as increase in time pressure, workload, and long working hours, following an ES implementation will create a stressful and strain-evoking work situation. Prior research has suggested that in such a work situation, employees will exhibit various fatigue symptoms, such as disturbed mood and cognitive impairment (Karasek 1979; Sonnentag and Zijlstra 2006). Consequently, employees will be less satisfied with their jobs.

*H8: The increase in job demands during the shakedown phase of an ES implementation will negatively influence job satisfaction.*

Job control has been suggested as one of the most important motivational aspects of work in job design theory (Ganster and Fussilier 1989; Parker et al. 1997). Karasek (1979) noted that increases in decision latitude in employees' work processes (i.e., job control) could reduce employees' mental strain and increase their job satisfaction. When employees feel that their control over their jobs decreases following an ES implementation, they will be less motivated to perform their tasks. Further, given that it is likely that employees will feel that they had more job control before the implementation, it is more likely that they will be less satisfied about their jobs following the implementation. Parker et al. (1997) found that following an organizational change event (i.e., strategic downsizing), increased levels of job control had significant positive influence on employees' job satisfaction.

*H9: The decrease in job control during the shakedown phase of an ES implementation will negatively influence job satisfaction.*

## Method

### Research Sites

We conducted longitudinal field studies in two organizations implementing two modules of SAP ERP systems—Human Capital Management (HCM) and Financials—to test JCCM. The SAP HCM module is a comprehensive human resource management (HRM) solution that provides three main functionalities and supports related business processes: (1) talent management, (2) workforce process management, and (3) workforce deployment. SAP Financials is a widely used financial management system that supports business processes in the following areas: (1) financial and management accounting, (2) financial supply chain management, and (3) corporate governance.

The two organizations from which we collected data were both manufacturers of electronic components and in turn suppliers of a major telecommunication firm. We gained access to these organizations through our contacts in the telecommunication firm. The telecommunication firm recommended the implementation of SAP to its key suppliers with the objective of improving process efficiency, reducing process variations, and increasing the effectiveness of business-to-business transactions. It provided financial and technological support to its suppliers to implement SAP modules. The two organizations were of medium size, with approximately 3,100 (organization A) and 2,400 (organization B) employees respectively. Given that both organizations were in the same industry and manufacturing similar products, they had fairly similar organizational structures, cultures, and employee backgrounds, thus holding constant some situational and organizational factors.

### Participants

In both organizations, data were collected from employees who used SAP HCM and/or Financials on a daily basis as a part of their jobs. These employees were from multiple business units, such as finance and budgeting, administration, accounting, sales, customer accounts, purchasing, and human resources. The participating employees were in the middle and operational levels of the organizational hierarchy, and were primarily accountants, account managers responsible for supply chain activities, and HRM employees. Employees from the engineering departments who were involved in sales and customer services had to use the SAP Financial module regularly and were thus also included in the study.

In organization A, we received a list of 837 employees who were identified by the project manager as potential users of one or both of the SAP modules. These employees participated in a 5-day onsite training program conducted by the consulting firm that implemented the SAP modules. We invited these 837 employees to participate in the first wave of survey before they participated in the training. Given that the study duration was 6 months with 4 points of measurement, it was not feasible to have all invited employees participate throughout the study. A total of 281 employees provided usable responses at all 4 points of measurement (34% response rate). Of the 281 participants, 182 were men (65%) and the average age was 44.45, with a standard deviation of 13.12. Similarly, in organization B, a total of 342 employees

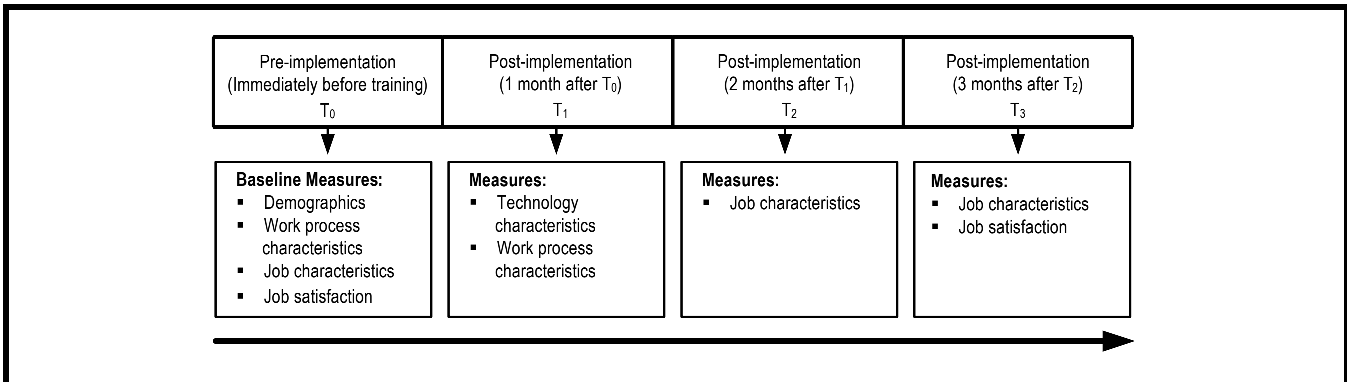


**Figure 2. Data Collection Procedure**

participated in a 5-day onsite training program. In organization B, we had 141 usable responses (41% response rate) at all 4 points of measurement. Of the 141 participants, 93 were men (66%) and the average age was 44.06, with a standard deviation of 12.66. These response rates were consistent with studies that have used a similar research design (Bentein et al. 2005). In addition to nonresponse, there were a few different reasons for the attrition. One reason was that during our study period, some employees were promoted and/or transferred to different business units. Another reason was that some employees switched to different job assignments within the same business unit; we did not include responses from these employees. Both organizations provided employees with the four most common forms of support: onsite training, help desk, online manuals, and change management (Sykes forthcoming), thus making the implementations fairly typical.

## Research Design

### Data Collection Procedure

An ES implementation is a complex and lengthy process that typically takes multiple years to complete. Given our focus on the shakedown phase, we collected data immediately before and 6 months after the ERP modules went live (after rollout) in both organizations. As noted earlier, the shakedown phase typically has a duration between 3 months and a year after the rollout, depending on the size of the organization and the scope of implementation (Gattiker and Goodhue 2005; Morris and Venkatesh 2010; Sykes forthcoming, Sykes and Venkatesh forthcoming; Sykes et al. forthcoming). For example, in Gattiker and Goodhue's (2005) study, the duration of this phase was about a year in organizations implementing ESs in multiple plants. Morris and Venkatesh (2010) considered this phase to be 8 months for an ES implemented in an organization with about 3,500 employees; likewise, Sykes and Venkatesh (forthcoming) and Sykes et al. (forthcoming) were studies conducted in a single business unit of approximately 200 employees during the shakedown phase, which lasted about 6 months. Considering the size of our organizations and the number of potential users (less than 1,000 in both cases), we believe that 6 months was a reasonable duration for the shakedown phase in both organizations. Moreover, project leaders in both organizations confirmed that activities that are typical for the shakedown phase, such as bug fixing, hardware and software configurations, and performance tuning, were completed in the first 6 months after the rollout.

We requested that project leaders in both organizations provide us a schedule of system deployment, training programs, and a list of participating employees. Based on the schedule, we requested business unit managers to send an initial e-mail about the survey to employees from their respective units who were going to participate in the training program. Following this e-mail, we sent a customized invitation e-mail to each employee with a unique link to a web-based survey. When an employee clicked the link, the survey software was able to detect the employee and generated a unique ID for the employee. We used a Microsoft Excel-based tool to match the responses from the subsequent surveys. A reminder was sent to each participant after 7 days from the initial invitation day. Employees were given 15 days to participate.

Figure 2 presents our data collection timeline. Data were collected at four points in time: $T_0$ (i.e., immediately before training), $T_1$ (i.e., within a month of training), $T_2$ (i.e., 3 months after $T_0$ or 2 months after $T_1$), and $T_3$ (i.e., 3 months after $T_2$). Data on demographic variables, pre-implementation work process characteristics, job characteristics, and job satisfaction were collected at $T_0$. At $T_1$, data on technology characteristics and post-implementation work process characteristics were collected. Given that process radicalness reflects the extent of novelty in work processes experienced by employees after an ES implementation, it was measured only at $T_1$, after the implementation of the new ES. Job characteristics data were again collected at $T_2$ and $T_3$. Job satisfaction was again collected at $T_3$. We did not measure job demands and job control at $T_1$ because employees might not be able to provide an accurate assessment of their job characteristics immediately after an ES implementation due to much confusion and uncertainty in their work environments and job roles (Boudreau and Robey 2005).

In order to test for response biases and to determine whether attrition had any effect on our results, we first examined whether there were any demographic differences (i.e., age, gender, and organizational tenure) among members of the following five groups of employees who participated: (1) only at $T_0$ (i.e., 767 in organization A and 306 in organization B); (2) only at $T_1$ (i.e., 611 in A and 267 in B); (3) only at $T_2$ (i.e., 486 in A and 228 in B); (4) only at $T_3$ (i.e., 373 in A and 182 in B); and (5) at $T_0$, $T_1$, $T_2$ and $T_3$ (i.e., 281 in A and 141 in B). We then examined whether there were any mean differences in job demands and job control within each point of measurement between those who participated at the next measurement occasion and those who did not participate at the next point of measurement. For example, we compared the mean differences in job demands at $T_0$ between those who only participated at $T_0$ and those who participated at $T_2$. We did not find any significant differences in any of these comparisons.

### Measures

We adapted measures from prior research whenever possible (see Table 2). We used a seven-point Likert agreement scale ("strongly disagree" to "strongly agree") to measure the constructs. Perceived technology complexity was measured using four items adapted from Aiman-Smith and Green (2002), Venkatesh (1999, 2000), and Venkatesh et al. (2003). Items for perceived technology customization were adapted from Gattiker and Goodhue (2005) and Hong and Kim (2002). Perceived process complexity was measured using items that were adapted from Wood (1986), who developed measures for task complexity. We adapted these items to capture employees' perceptions of how difficult it is to understand and use different elements of their work processes, such as tasks, information, and resources. Job demands and job control were operationalized using four items from van Yperen and Hagedoorn (2003). Job satisfaction was measured using an established, extensively used three-item scale by Camman et al. (1983) that was used by Morris and Venkatesh (2010) in the IS literature.

We developed scales for three constructs—perceived technology reconfigurability, perceived process rigidity, and perceived process radicalness—following the procedures outlined by DeVellis (2003) and Hinkin (1998). We conducted a pilot study among executive MBA students (N = 94) to examine psychometric properties of these scales. Based on item-level exploratory and confirmatory factor analyses we included four items per construct, which is considered to be sufficient for validity and reliability (Hinkin 1998), in our final surveys to keep the length of the survey manageable without sacrificing content validity. Given the longitudinal nature of our study, such a manageable length was important to maximize the response rate in each of the waves of data collection. The items we included had the highest factor loadings in the pilot study and represented the content domain well (Venkatesh et al. 2003). The internal consistency reliabilities (ICRs) were greater than .80, with there being four items for all scales.

## Data Analysis Approach

Given that understanding changes in employees' perceptions of their job characteristics during an ES implementation is the focus of this research, we needed a data analytic approach that would allow us to measure changes in latent variables, such as job demands and job control. Although there are several data analytic approaches, such as change scores, *t*-test, ANOVA, MANOVA, and lagged regression, to assess change in a variable over time, latent growth modeling (LGM) has recently been suggested as a powerful and integrative approach to assess change in latent variables. LGM overcomes many of the limitations of traditional approaches (Lance, Meade, and Williamson 2000). It helps us not only measure change in a latent variable over time, but also validate causal models to predict the change and assess the effect of change on outcome variables within a single structural model (Chan 1998; Duncan et al. 2006; Lance, Meade, and Williamson 2000).

Following the guidelines of Chan (1998), Lance, Meade, and Williamson (2000) and exemplars from prior research (e.g., Bentein et al. 2005; Lance, Vandenberg, and Self 2000), we employed a three-step approach to conduct the LGM analysis (see Appendix A for more details on the LGM analysis). Particularly, we conducted multiple-indicator LGM (MLGM), also known as second-order factor (SOF) LGM, analysis (Bentein et al. 2005; Chan 1998). In the first step of the analysis, we tested for the measurement invariance of change variables (i.e., job demands and job control) to establish whether the same latent constructs were measured over time. This step helped us examine whether job demands and job control measured at $T_0$, $T_2$, and $T_3$ were invariant so that we could provide an unambiguous interpretation of change (Lance, Vandenberg, and Self 2000). The objective of the second step was to find out the nature and magnitude of change in job demands and job control. We tested four different models, namely a no-growth model, a linear growth

**Table 2. List of Items***

| Constructs | | Items | Source |
|---|---|---|---|
| Perceived technology complexity (TCOMP) | 1 | I find it time consuming to get the system to do what I want it to do. | Adapted from Aiman-Smith and Green (2002); Venkatesh et al. (2003) |
| | 2 | Working with the system is so complicated that it is difficult to understand what is going on. | |
| | 3 | Interacting with the system requires a lot of my mental effort. | |
| | 4 | In general, the system is more complex than what I used to work on. | |
| Perceived technology reconfigurability (TRCNF) | 1 | Some system features can be adjusted during use to carry out certain tasks. | New items |
| | 2 | Some system features can be changed during the course of use. | |
| | 3 | Some system settings can be altered during use to accomplish some tasks. | |
| | 4 | The system allows the users to modify some settings to perform certain tasks. | |
| Perceived technology customization (TCUST) | 1 | When the system was being implemented, the package was changed to better meet the local needs, including mine. | Adapted from Gattiker and Goodhue (2005); Hong and Kim (2002) |
| | 2 | The system was altered during implementation to improve its fit with the local needs, including mine. | |
| | 3 | Specific changes were made to the system during implementation to fit my requirements. | |
| | 4 | The system was configured during implementation to align with my needs. | |
| Perceived process complexity (PCOMP) | 1 | It is often difficult to understand what resources I may need to execute my core work processes. | Adapted from Wood (1986) |
| | 2 | There is no understandable sequence of steps that can be followed in doing my core work processes. | |
| | 3 | It is often difficult to understand what information I may need for my core work processes. | |
| | 4 | It is often difficult to predict the steps of my core work processes. | |
| Perceived process rigidity (PRGDT) | 1 | My core work processes are so inflexible that I have to follow a fixed set of steps. | New items |
| | 2 | There is no variation in the sequence of my core work process tasks. | |
| | 3 | My core work processes are not flexible. | |
| | 4 | Overall, my core work processes are very rigid. | |
| Perceived process radicalness (PRDCL) | 1 | After the implementation of the new system… …My core work process tasks are now very different from what I used to perform. | New items |
| | 2 | …The tasks of my current work processes are radically different. | |
| | 3 | …I need resources for my tasks that I never needed before. | |
| | 4 | …Overall, my work processes are now radically different. | |
| Job demands (JDEM) | 1 | I have to work fast. | Adapted from van Yperen and Hagedoorn (2003) |
| | 2 | I have too much work to do. | |
| | 3 | I have to work extra hard to finish a task. | |
| | 4 | I work under time pressure. | |
| Job control (JCON) | 1 | I plan my own work. | Adapted from van Yperen and Hagedoorn (2003) |
| | 2 | I can vary how I do my work. | |
| | 3 | I decide when to finish a piece of work. | |
| | 4 | My job allows me to organize my work by myself. | |
| Job satisfaction (JSAT) | 1 | All things considered, I am satisfied with my job. | Adapted from Camman et al. (1983) |
| | 2 | In general, I don't like my job. (Reverse coded) | |
| | 3 | In general, I like working here. | |

*Seven-point Likert-type agreement scale was used for all items.

**Table 3. Operationalization and Use of Constructs in LGM Analysis**

| Construct | Measurement Occasion | Use in LGM Analysis |
|---|---|---|
| Job satisfaction (JSAT) | $T_0$: before training and ES use<br>$T_3$: after 6 months of system use | The $T_0$ measure was used as an exogenous control variable to partial out the effects of pre-implementation job satisfaction. The $T_3$ measure of job satisfaction was modeled as an endogenous variable and an outcome of changes in job demands and job control. In LGM analysis, it is possible to predict a static outcome of a change variable (Lance, Vandenberg, and Self 2000). |
| Increase in job demands (JDEM) | Job demands were assessed in:<br>$T_0$: before training and ES use<br>$T_2$: after 3 months of ES use<br>$T_3$: after 6 months of ES use | Increase in job demands was assessed as a difference among employees' perceptions of job demands in $T_0$, $T_2$, and $T_3$. In LGM analysis, the measure of the same construct at three (or more) different time periods allows the estimation of the trajectory of change or growth over time, such as no change, linear change, or complex change (e.g., nonlinear and quadratic changes). |
| Decrease in job control (JCON) | Job control was assessed in:<br>$T_0$: before training and ES use<br>$T_2$: after 3 months of ES use<br>$T_3$: after 6 months of ES use | Decrease in job control was assessed as a difference among employees' perceptions of job control in $T_0$, $T_2$, and $T_3$. In LGM analysis, the measure of the same construct at three (or more) different time periods allows the estimation of the trajectory of change over time, such as no change, linear change, or complex change (e.g., nonlinear and quadratic changes). |
| Perceived process complexity (PCOMP) | $T_0$: before training and ES use<br>$T_1$: 1 month after training and ES use | The $T_0$ measure was used as an exogenous control variable to partial out the effects of pre-implementation perceived process complexity. The $T_1$ measure was used as an endogenous variable in the LGM analysis. |
| Perceived process rigidity (PRGDT) | $T_0$: before training and ES use<br>$T_1$: 1 month after training and ES use | The $T_0$ measure was used as an exogenous control variable to partial out the effects of pre-implementation perceived process rigidity. The $T_1$ measure was used as an endogenous variable in the LGM analysis. |
| Perceived process radicalness (PRDCL) | $T_1$: 1 month after training and ES use | Used as an exogenous variable in the LGM analysis to predict changes in job demands and job control. |
| Perceived technology complexity (TCOMP) | $T_1$: 1 month after training and ES use | Used as an exogenous variable in the LGM analysis to predict perceived process complexity. |
| Perceived technology reconfigurability (TRCNF) | $T_1$: 1 month after training and system use | Used as an exogenous variable in the LGM analysis to predict perceived process complexity, rigidity, and radicalness. |
| Perceived technology customization (TCUST) | $T_1$: 1 month after training and ES use | Used as an exogenous variable in the LGM analysis to predict perceived process radicalness. |

model, a quadratic growth model, and an optimal growth model, to determine the functional form of change (e.g., whether there were increasing or decreasing trajectories of changes) in these latent constructs. Finally, in the third step, we added the predictors and outcomes of changes in job demands and job control to the model. Table 3 presents a summary of our key constructs and how they were used in the LGM analysis.

## Results

### *Preliminary Analysis*

We used Amos™ 18, a widely used covariance-based structural equation modeling tool, to conduct the data analysis (Arbuckle 2009). We first conducted a preliminary analysis comparing the sample across the two organizations. Given that the two organizations were in the same industry, produced similar products, implemented the same SAP modules, and had employees with similar backgrounds, we expected that the data from two organizations would be similar. The participants across the two organizations were homogeneous in terms of demographic characteristics. We followed the procedure used by Venkatesh et al. (2000) to determine whether the data from the two organizations were statistically equivalent. In particular, we conducted two sets of analyses. First, we tested the model separately with the data gathered from each of the two organizations and found similar results in both organizations. We used the following five widely used and recommended fit indexes to asses model fit (Hu and Bentler 1999): (1) chi-square ($X^2$) goodness of fit test, (2) non-normed fit index (NNFI), (3) the comparative fit index (CFI), (4) the root mean square error of approximation (RMSEA), and (5) the standardized root mean square residual (SRMR). The model fit indexes were acceptable and similar in organization A ($\chi^2 = 1912.04$, $p < .001$; CFI = .96; NNFI = .96; SRMR = .08; RMSEA = .05) and organization B ($\chi^2 = 2129.10$, $p < .001$; CFI = .95; NNFI = .96; SRMR = .07; RMSEA = .05). Second, we tested for statistical equivalence of the descriptive statistics between the two organizations at each point of measurement and did not find any significant differences. For example, there was no significant difference in mean job demands and job control between organizations A and B over time (see Table 4). Similar results were found for all other constructs. Overall, we found that the data from both organizations were statistically similar, suggesting that it was appropriate to pool the data per the guidelines of Pindyck and Rubenfeld (1981) and exemplars in IS research (Venkatesh et al. 2003). In fact, in our case, we found the two samples to be statistically equivalent, giving us greater confidence that we could pool the data. We conducted the subsequent analysis with the pooled data (N= 422).

We followed the guidelines by Fornell and Larcker (1981) to assess construct validity and reliability. Internal consistency reliabilities (ICRs) were greater than .70 for all scales at all time periods. The square roots of the shared variance between the constructs and their measures were higher than the correlations across constructs, supporting convergent and discriminant validity (Fornell and Larcker 1981). Appendix B shows the loadings from a factor analysis with direct oblimin rotation. The loadings were greater than .70 and cross-loadings were less than .35 for all constructs in all time periods. Table 5 presents the correlation matrix and descriptive statistics. In addition to showing changes in job demands and job control means over time, the table shows that perceived process complexity and perceived process rigidity increased and job satisfaction decreased between pre- and post-implementation ($T_0$ vs. $T_1$). Technology and process characteristics were significantly correlated with job demands and job control. We employed both procedural and statistical remedies for common method biases following Podsakoff et al. (2003) and did not find any significant threats of such biases in our study (see Appendix C for more details).

## *Test of Hypotheses about Changes in Job Characteristics*

Tables 6 and 7 present the results related to the hypotheses on changes in job demands and job control (i.e., H1a and H1b). In order to find support for these hypotheses, we need to demonstrate that (1) there are significant changes in job demands and job control during the shakedown phase, and (2) job demands have a positive change score and job control has a negative change score over time. Table 6 shows the LGM results related to the nature of change in job demands and job control. It shows that the optimal growth model for job demands and job control (Model G4b) with a homoscedastic residual structure (i.e., equal error variances over time) had the best overall fit and was significantly better than the no-growth model (Model G1b) and linear growth model (Model G2a) based on a chi-square difference test (see Appendix A for more details about these models). Curvilinearity in the plots of job demands and job control (see Figure 3) also indicates why an optimal change function provided a better model fit than did a strictly linear change function (Lance, Vandenberg, and Self 2000).

Table 7 shows the change scores (i.e., change factor means) for job demands and job control. In the optimal growth model, the unconstrained loadings for the slope factor were estimated at .69 ($p < .001$) and 1.13 ($p < .001$) for job demands and job control respectively. If the changes were linear, these loadings would have been close to 2 (i.e., $T_3$ loading for the slope factor for a linear growth model). This suggests that the increase in job demands and decrease in job control peaked at $T_2$ (3 months after the rollout) and then declined between $T_2$ and $T_3$ (between 3 months and 6 months after the rollout). These loadings can be used as weights of the slope (i.e., change) to determine the overall changes in job demands and job control in the 6-month period of the shakedown phase (Duncan et al. 2006; McArdle and Nesselroade 2003). Following Duncan et al. (2006), we estimated that an employee, on average, in our sample experienced approximately 22 percent increase in job demands in the 6-month period of the shakedown phase.[8] Similarly, on average,

[8] $[(.69 \times .92) \div 2.86] \times 100 = 22.20$, where .69 is the unconstrained slope factor loading, .92 is the mean change in job demands, and 2.86 is the initial status of job demands (see Table 7).

**Table 4. Comparison of Means**

| Constructs | Time | Organization A | | Organization B | | Difference (A-B) | | *t*-statistic | *p*-value |
|---|---|---|---|---|---|---|---|---|---|
| | | Mean | S.D. | Mean | S.D. | Mean | S.D. | | |
| Job demands (JDEM) | $T_0$ | 2.87 | .97 | 2.71 | .95 | .16 | .09 | 1.62 | .11 |
| | $T_2$ | 3.81 | .92 | 3.63 | .98 | .18 | .09 | 1.84 | .07 |
| | $T_3$ | 3.48 | .97 | 3.37 | 1.04 | .11 | .10 | 1.12 | .27 |
| Job control (JCON) | $T_0$ | 3.04 | .94 | 3.00 | .93 | .04 | .09 | .46 | .65 |
| | $T_2$ | 2.62 | .88 | 2.55 | .93 | .07 | .09 | .71 | .48 |
| | $T_3$ | 2.77 | .96 | 2.90 | .95 | -.13 | .09 | -1.27 | .20 |

*Note*: N = 281 (organization A) and 141 (organization B).

**Table 5. Correlation Matrix and Descriptive Statistics**

| | Mean | S.D. | ICR | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TCOMP ($T_1$) | 4.57 | 0.94 | .93 | .89 | | | | | | | | | | | | | | | |
| TRCNF ($T_1$) | 3.96 | 0.89 | .93 | -.42*** | .88 | | | | | | | | | | | | | | |
| TCUST ($T_1$) | 4.17 | 0.94 | .94 | -.53*** | .32*** | .89 | | | | | | | | | | | | | |
| PCOMP ($T_0$) | 3.73 | 1.07 | .95 | .11* | -.20*** | -.22*** | .94 | | | | | | | | | | | | |
| PCOMP ($T_1$) | 4.10 | 0.95 | .93 | .16** | -.25*** | -.23*** | .56*** | .89 | | | | | | | | | | | |
| PRGDT ($T_0$) | 3.37 | 1.04 | .96 | .13** | -.20*** | -.10* | .11* | .12* | .94 | | | | | | | | | | |
| PRGDT ($T_1$) | 4.20 | 0.93 | .92 | .06 | -.36*** | -.18*** | .15** | .17** | .49*** | .89 | | | | | | | | | |
| PRDCL ($T_1$) | 3.90 | 0.94 | .93 | .32*** | -.30*** | -.32*** | .09 | .06 | .12* | .23*** | .90 | | | | | | | | |
| JDEM ($T_0$) | 2.82 | 0.97 | .97 | .29*** | -.28*** | -.26*** | .36*** | .26*** | .29*** | .26*** | .27*** | .94 | | | | | | | |
| JDEM ($T_2$) | 3.75 | 0.95 | .93 | .42*** | -.34*** | -.43*** | .34*** | .41*** | .26*** | .41*** | .49*** | .54*** | .89 | | | | | | |
| JDEM ($T_3$) | 3.45 | 0.99 | .96 | .23*** | -.16** | -.25*** | .25*** | .30*** | .23*** | .27*** | .32*** | .36*** | .64*** | .93 | | | | | |
| JCON ($T_0$) | 3.03 | 0.94 | .98 | -.07 | .02 | -.01 | -.02 | .01 | -.02 | -.05 | -.11* | .05 | -.01 | .01 | .96 | | | | |
| JCON ($T_2$) | 2.59 | 0.89 | .96 | -.13** | .06 | .13** | -.09 | -.17** | -.09 | -.13** | -.26*** | -.04 | -.16** | -.08 | .47*** | .93 | | | |
| JCON ($T_3$) | 2.82 | 0.96 | .97 | -.10* | .06 | .09 | -.06 | -.14** | -.07 | -.11* | -.15** | .02 | -.11* | -.03 | .26*** | .57*** | .95 | | |
| JSAT ($T_0$) | 5.17 | 1.05 | .84 | -.18** | .19** | .17** | -.05 | -.17** | -.19*** | -.22*** | -.20*** | -.22*** | -.25*** | -.24*** | .17** | .20*** | .28*** | .85 | |
| JSAT ($T_3$) | 4.08 | 1.09 | .80 | -.22** | .24*** | .17** | -.15** | -.22*** | -.22*** | -.25*** | -.21*** | -.24*** | -.26*** | -.29*** | .20*** | .26*** | .29*** | .29*** | .87 |

*Notes*:

1. TCOMP: perceived technology complexity; TRCNF: perceived technology reconfigurability; TCUST: perceived technology customization; PCOMP: perceived process complexity; PRGDT: perceived process rigidity; PRDCL: perceived process radicalness; JDEM: job demands; JCON: job control; JSAT: job satisfaction.
2. $T_0$: Immediately before training; $T_1$: 1 month after $T_0$; $T_2$: 2 months after $T_1$; $T_3$: 3 months after $T_2$.
3. ICR: Internal consistency reliability; Diagonal elements are the square root of the shared variance between the constructs and their measures; off-diagonal elements are correlations between constructs.
4. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

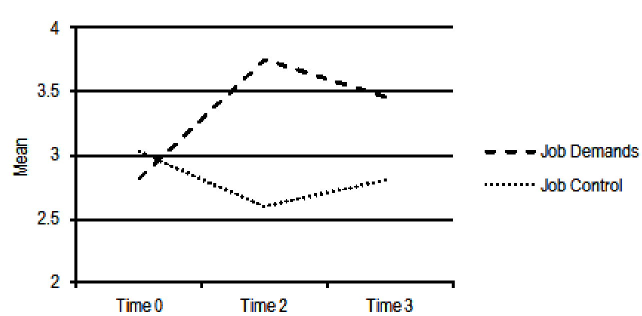


**Figure 3. Plots of Job Demands and Job Control (Pooled Data, N = 422)**

**Table 6. Tests of Multivariate LGM Analysis**

| Model | Change Function | FOF Residual Structure | $X^2$ | df | Model Comparison | $\Delta X^2$ | Δdf | NNFI | CFI | RMSEA | SRMR |
|---|---|---|---|---|---|---|---|---|---|---|---|
| G1a | No growth | Heteroscedastic | 646.63*** | 241 | – | – | – | .97 | .97 | .06 | .06 |
| G1b | No growth | Homoscedastic | 715.30*** | 245 | G1a vs. G1b | 68.67*** | 4 | .96 | .97 | .07 | .08 |
| G2a | Linear growth | Heteroscedastic | 535.08*** | 232 | G1a vs. G2a | 111.55*** | 9 | .97 | .98 | .06 | .05 |
| G2b | Linear growth | Homoscedastic | 544.89*** | 236 | G2a vs. G2b | 9.81* | 4 | .97 | .98 | .06 | .05 |
| G3a | Quadratic growth† | Heteroscedastic | – | – | – | – | – | – | – | – | – |
| G3b | Quadratic growth† | Homoscedastic | – | – | – | – | – | – | – | – | – |
| G4a | Optimal growth†† | Heteroscedastic | 206.37*** | 230 | NA | – | – | .99 | .99 | .00 | .02 |
| G4b | Optimal growth | Homoscedastic | 318.95*** | 234 | G1b vs. G4b<br>G2b vs. G4b | 396.35***<br>225.94*** | 11<br>2 | .99 | .99 | .03 | .05 |

*Notes:* FOF: first-order factor. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. †Models G3a and G3b were unidentified (see Appendix A for details). ††Model G4a failed to converge to an admissible solution.

**Table 7. Growth Parameter Estimates (Optimal Growth Model)**

| Variables | Initial Status (IS) | | Change (CH) | | Covariance (IS-CH) |
|---|---|---|---|---|---|
| | Mean | Variance | Mean | Variance | |
| Job demands (JDEM) | 2.86*** | .43*** | .92*** | .14* | -.02 |
| Job control (JCON) | 3.02*** | .52*** | -.28*** | .36*** | -.21*** |

*Note*: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

an employee experienced approximately 10 percent decrease in job control in 6 months.[9] Overall, these results suggest that there were significant changes in job characteristics (i.e., job demands increased and job control decreased) during the shakedown phase, thus supporting H1a and H1b. Further, these results indicated that, although it was possible that job demands and job control could reach pre-implementation levels at some point in the future as employees would gain more experience with the ES, there was a significant overall increase in job demands and a decrease in job control in the first 6 months after the rollout (i.e., the shakedown phase).

Table 7 also provides important information regarding the nature of changes in job demands and job control. As shown in the table, the mean initial status of job demands was 2.86 and job control was 3.02. These were the levels of job demands and job control employees had on average before the ES implementation. The variances of initial status for both job demands and job control were statistically significant (.43, $p < .001$ for job demands and .52, $p < .001$ for job control), suggesting that systematic individual differences in job demands and job control existed before the ES implementation such that some employees had higher levels of job demands and job control than others. Further, the change variances in both variables (i.e., job demands and job control) were statistically significant (.14, $p < .05$ for job demands and .36, $p < .001$ for job control), indicating that some employees felt a greater increase in job demands and decrease in job control than did others during the shakedown phase. The significant and negative initial status and change covariance (–.21 $p < .001$) for job control indicated that the initial status of job control was negatively associated with its decline, suggesting that employees who had higher levels of pre-implementation job control felt a greater decline in job control (a steeper declining slope) after the implementation than those who had a lower mean level of job control at $T_0$ (pre-implementation).

## Predicting Changes in Job Characteristics

We created a structural model incorporating predictors and outcomes of changes in job demands and job control to test

[9] $[(1.13 \times .28) \div 3.02] \times 100 = 10.48$, where 1.13 is the unconstrained slope factor loading, –.28 is the mean change in job control (we used the absolute value for calculating the percentage decrease), and 3.02 is the initial status of job control (see Table 7).

our model (i.e., H2a, H2b, H3a, H3b, H4a, and H4b). This model yielded a good fit to the data: $\chi^2 = 2285.88$, $p < .001$, CFI =.97, NNFI =.97, RMSEA = .04 and SRMR = .07. In order to test the effect of perceived process complexity and perceived process rigidity on changes in job demands and job control, we controlled for pre-implementation perceived process complexity and perceived process rigidity to partial out their effects on changes in job demands and job control. As Table 8 shows, post-implementation perceived process complexity had a positive influence on the increase in job demands ($\beta = .47$, $p <.001$) and a negative influence on the decrease in job control ($\beta = -.26$, $p <.001$), suggesting that employees with higher levels of post-implementation process complexity felt a greater increase in job demands and a greater decrease in job control than did employees with lower post-implementation process complexity, thus supporting H2a and H2b. We found that pre-implementation process complexity had a significant negative influence on the increase in job demands ($\beta = -.43$, $p <.001$). This finding is particularly noteworthy because it suggests that while employees with higher levels of pre-implementation process complexity perceived an increase in job demands during the shakedown phase (a gradual slope), employees with lower levels of pre-implementation process complexity felt a greater rate of increase in job demands (a steeper slope). In other words, the negative relationship indicates that the lower the pre-implementation level of process complexity, the steeper the slope of increase in job demands.

As shown in Table 8, post-implementation perceived process rigidity had a positive influence on the rate of increase in job demands ($\beta = .31$, $p <.001$) but did not have an effect on the rate of decrease in job control ($\beta = -.06$, $p >.05$), thus supporting H3a but not H3b. Hence, employees with higher levels of post-implementation perceived process rigidity felt a greater increase in job demands during the shakedown phase than did employees with lower post-implementation perceived process rigidity. Like pre-implementation perceived process complexity, we found that pre-implementation process rigidity had a significant negative influence on the increase in job demands ($\beta = -.29$, $p <.01$), suggesting that employees with higher levels of pre-implementation perceived process rigidity felt an increase in job demands (a gradual slope), whereas employees with lower levels of pre-implementation perceived process rigidity felt a greater rate of increase in job demands (a steeper slope). We did not find any such effects on the rate of decrease in job control.

Finally, perceived process radicalness had a positive influence on the increase in job demands ($\beta = .56$, $p <.001$) and a negative influence on the decrease in job control ($\beta = -.24$, $p <.001$), thus supporting H4a and H4b. Employees with higher levels of perceived process radicalness felt a greater increase in job demands and a greater decrease in job control than did employees with lower process radicalness. Perceived process radicalness had the strongest effect on the increase in job demands and perceived process complexity had the strongest effect on the decrease in job control. Overall, perceptions of process characteristics explained 63 percent of the variance in the rate of increase in job demands and 13 percent of the variance in the rate of decrease in job control.

### Predicting Work Process Characteristics

Table 9 presents the results related to the influence of technology characteristics on process characteristics (i.e., H5, H6a, H6b, H6c, and H7). After controlling for the pre-implementation perceived process complexity, perceived technology complexity had no significant effect on post-implementation perceived process complexity, thus not supporting H5. We predicted that perceived technology reconfigurability would have a negative influence on perceived process complexity (H6a), perceived process rigidity (H6b), and perceived process radicalness (H6c). We found support for all three hypotheses ($\beta = -.14$, $p <.01$, $\beta = -.31$, $p <.001$, and $\beta = -.25$, $p <.001$ for perceived process complexity, perceived process rigidity, and perceived process radicalness, respectively). We found that perceived technology customization had a negative influence on perceived process radicalness ($\beta = -.29$, $p <.001$), thus supporting H7. Overall, technology characteristics explained 33 percent, 32 percent, and 19 percent of the variance in perceived process complexity, perceived process rigidity, and perceived process radicalness, respectively.

### Predicting Job Satisfaction

Table 10 presents the results related to the influence of changes in job characteristics on job satisfaction (i.e., H8 and H9). After controlling for pre-implementation job satisfaction, job demands (initial status), and job control (initial status), the increase in job demands had a significant negative influence on job satisfaction, suggesting that employees who felt a greater increase in job demands had lower job satisfaction ($\beta = -.19$, $p <.01$), thus supporting H8. The decrease in job control had a positive influence on job satisfaction ($\beta = .29$, $p <.001$). Given that job control followed a decreasing trajectory of change, the positive sign associated with the effect of change in job control on job satisfaction indicated that the decrease in job control had a negative influence on job satisfaction, thus supporting H9. Overall, the model explained 29 percent of the variance in job satisfaction.

**Table 8. Predicting Changes in Job Demands and Job Control**

| Predictors | Increase in Job Demands | Decrease in Job Control |
|---|---|---|
| *Control variables:* | | |
| Perceived process complexity ($T_0$) | -.43*** | .11 |
| Perceived process rigidity ($T_0$) | -.29** | -.01 |
| *Independent variables:* | | |
| Perceived process complexity ($T_1$) | .47*** | -.26*** |
| Perceived process rigidity ($T_1$) | .31*** | -.06 |
| Perceived process radicalness ($T_1$) | .56*** | -.24*** |
| $R^2$ | .63 | .13 |

*Notes*: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. N = 422. Standardized coefficients are shown.

**Table 9. Predicting Work Process Characteristics**

| Predictors | Perceived Process Complexity ($T_1$) | Perceived Process Rigidity ($T_1$) | Perceived Process Radicalness ($T_1$) |
|---|---|---|---|
| *Control variables:* | | | |
| Perceived process complexity ($T_0$) | .52*** | NA | NA |
| Perceived process rigidity ($T_0$) | NA | .43*** | NA |
| *Independent variables:* | | | |
| Perceived technology complexity ($T_1$) | .07 | NA | NA |
| Perceived technology reconfigurability ($T_1$) | -.14** | -.31*** | -.25*** |
| Perceived technology customization($T_1$) | NA | NA | -.29*** |
| $R^2$ | .33 | .32 | .19 |

*Notes* *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. N = 422. NA = not applicable; standardized coefficients are shown.

**Table 10. Predicting Job Outcomes**

| Predictors | Job Satisfaction ($T_3$) |
|---|---|
| *Control variables:* | |
| Job satisfaction ($T_0$) | .21*** |
| Job demands (initial status) | -.31*** |
| Job control (initial status) | .37*** |
| *Independent variables:* | |
| Increase in job demands | -.19** |
| Decrease in job control | .29*** |
| $R^2$ | .29 |

*Notes*: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$. N = 422. Standardized coefficients are shown.

## Discussion

This work sought to achieve two objectives: (1) to examine the nature and extent of changes in employees' perceptions of their job characteristics during the shakedown phase of an ES implementation, and (2) to examine the determinants and outcomes of these changes. To achieve these objectives, we developed a model of changes in two important job characteristics from JSM (Karasek 1979)— job demands and job control—during an ES implementation. Using LGM, an integrative approach to analyze change, we found that during the shakedown phase, employees in the two organizations that we studied felt a significant overall increase in job demands and decrease in job control. Changes in job demands and job control were predicted by employees' perceptions of their work process characteristics, with perceived process radicalness being the strongest predictor of increase in job demands and perceived process complexity being the strongest predictor of decrease in job control. We found that perceived technology reconfigurability had a significant negative effect on the three work process characteristics: perceived process complexity, perceived process rigidity, and perceived process radicalness. Perceived technology customization had a significant negative influence on perceived process radicalness. Finally, increase in job demands and decrease in job control had a significant negative effect on employees' job satisfaction.

### Theoretical Implications

This work offers key theoretical contributions. First, we present a nomological network that integrates ES implementations with employees' job characteristics and job satisfaction. The scope of this nomological network is the shakedown phase that has been suggested to be the most critical phase of an ES implementation (Markus et al. 2003; Markus and Tanis 2000; Morris and Venkatesh 2010). Although prior research has noted the importance of the relationship between IS and employees' jobs (Davidson and Chiasson 2005; Davis and Hufnagel 2007), there has been limited understanding of the impacts of ES implementations on employees' job characteristics and job outcomes, particularly during the shakedown phase. We identify key technology characteristics of an ES that influenced employees' perceptions of their work processes and, subsequently, perceptions of changes in two important job characteristics: job demands and job control. Our findings not only offer insights on the nature and extent of changes in job demands and job control, but also shed light on the determinants and outcome of these changes. Thus, by identifying and conceptualizing determinants of changes in specific facets of employees' job characteristics, this work complements prior work (Boudreau and Robey 2005; Davidson and Chismar 2007; Davis and Hufnagel 2007; Lapointe and Rivard 2005; Volkoff et al. 2007) that has studied the relationship between IS implementations and employees' jobs. Further, we extend recent research by Morris and Venkatesh (2010) and Venkatesh et al. (2010) that studied the influence of ES implementations on five job characteristics from JCM (Hackman and Oldham 1980)—that is, skill variety, task identity, task significance, autonomy, and feedback—by focusing on a different set of job characteristics from the job stress literature (i.e., job demands and job control) that have been understudied in the IS literature. Although these studies, including ours, offer rich understanding of employees' perceptions of job characteristics following ES implementations, there is still a need for developing an integrative view of employees' perceptions of job characteristics and their impacts on important job and organizational outcomes following an ES implementation. Such a view will be important for both theory and practice related to managing ES implementations in organizations. A mixed methods approach could be particularly suitable for conducting such research that will require extensive synthesis and triangulation (Venkatesh et al. 2010; Venkatesh et al. 2013).

Our second contribution is related to the possible explanations for employees' negative reactions to an ES during the shakedown phase. Prior research has highlighted the challenges that organizations face during the shakedown phase, such as poor system performance, data errors, deterioration of key performance indicators, and negative reactions from stakeholders (Hakkinen and Hilmola 2007; Markus et al. 2000, 2003; Markus and Tanis 2000). Our findings extend this research by highlighting additional challenges related to employees' perceptions of changes that can potentially invoke unfavorable reactions toward an ES. Although our research has suggested changes in job conditions as a possible explanation for these negative reactions (Beaudry and Pinsonneault 2005; Boudreau and Robey 2005; Lapointe and Rivard 2005), there has been little or no research on the changes in specific facets of employees' job characteristics and reasons for such changes. Our findings, which are related to the increasing trajectory of job demands and decreasing trajectory of job control, and to the subsequent negative influence on job satisfaction, offer a plausible explanation of why employees may resist a new ES implementation.

Third, this work extends research related to job demands and job control by offering determinants of these two important job characteristics in the context of a radical organizational change—here, an ES implementation. Given that about 30 percent of organizational change events are, in fact, related to IS implementations (Caldwell et al. 2004) and ESs are increasingly becoming an integral part of organizations, understanding the determinants of changes in employees' job characteristics during an ES implementation is an important contribution to the organizational studies literature. Although prior research has also found that employees perceive changes in job demands and job control following a planned organizational change (e.g., Parker et al. 1997), there has been limited research that identified the determinants of such perceptions. Our findings suggest that if employees' work processes become complex, rigid, and radically different following an organizational change, employees will indeed perceive an increase in job demands and a decrease in job control. These findings offer important insights on how employees appraise job demands and job control following a major change in their workplace. Further, these findings contribute to the work design literature by highlighting the aspects of employees' work processes that become salient as employees assess the impacts of an organizational change on their jobs (Sonnentag and Zilstra 2006).

Perceived process rigidity surprisingly had no significant impact on decrease in job control. Our model explains only a small amount variance in change in job control. We offer the following explanation for these unexpected findings. Although JSM conceptualized job control as employees' overall assessment of how much influence they have over their jobs and work environment, researchers have suggested that job control has different dimensions, such as timing control, method control, and boundary control (Wall et al. 1990). It is possible that an ES implementation does not affect an employee's overall perception of job control but rather affects one or more of these specific dimensions. Understanding the impacts of ES implementations on different dimensions of job control will be a fruitful topic for future investigations.

Fourth, our findings offer insights on the relationship between technology characteristics (i.e., the software components of an ES) and employees' work process characteristics. In particular, we found that technology characteristics explained only a modest amount of variance in work process characteristics, suggesting that there are aspects of employees' work processes that are not enabled and/or supported by the technology (see Sykes et al. forthcoming). We found that perceived technology complexity had no influence on perceived process complexity, indicating that complexity of the technology (e.g., software and hardware components) of an ES does not necessarily make employees' work processes complex. For instance, employees may find an ES to be complex due to the multiplicity of screens, options, and navigational aids. However, these aspects of an ES may not be associated with employees' perceptions of work process complexity that depend on whether employees find that different elements of their work processes (such as activities, information and resource requirements) are difficult to understand and act upon. Technology characteristics, such as perceived technology reconfigurability and perceived technology customization, can help employees better understand the fit between the software and work process components of an ES. Strong and Volkoff (2010) have recently proposed two types of fit in the context of ES implementations: *coverage* (i.e., availability of features that organizations need to operate and that users need to do their work) and *enablement* (i.e., an ES permits and enables the organization to operate more effectively and users to do their work more efficiently than was the case without an ES). We suggest that perceived technology customization and perceived technology reconfigurability will engender favorable perceptions of work processes by enhancing the coverage and enablement fits respectively.

Finally, this study contributes to the change management literature (Caldwell et al. 2004; Herold et al. 2007). Herold et al. (2007) noted that although much is known about organizational change management, such as the importance of communication and employee participation, organizations still fail to effectively manage change. A general model of change management will not be particularly beneficial for research and practice due to the uniqueness of different change events. Therefore, there is a need to enrich our current understanding of change management by theorizing about the change context and its characteristics. Specifically, we theorize and test the impact of changes in job characteristics following an ES implementation. Our research thus contributes to the change management literature by providing insights on the causes of changes in employees' job characteristics during a specific change event—here, an ES implementation.

### Limitations and Future Work

Our findings should be interpreted in light of the limitations of this work. First, data were collected from two organizations that were of similar size and with similar operations in the same industry. Although this helped us control for possible industry differences, it limits the generalizability of our findings. Hence, future research should test the model in other types of organizations and industries. Second, data were collected in the context of a specific ES implementation: a SAP ERP system. It is possible that our results would be different in other ERP systems (e.g., PeopleSoft, Oracle, Microsoft), in the context of other types of ESs, such as supply chain management systems, customer relationship management systems, or healthcare systems (e.g., Venkatesh et al. 2011), and other implementation contexts, such as when an organization does not change its business processes during an ES implementation or changes the business processes and/or system customization to varying extents.

A third limitation is that we only collected data 6 months after the ES rollout. Prior research has suggested that there is a lag before organizations can benefit from an ES (Markus and Tanis 2000). Therefore, it is possible that job demands and job control would go back to pre-implementation levels after several months post-implementation. Indeed, our results also indicate that job demands were gradually decreasing and job control was increasing 3 months after the rollout (i.e., after $T_2$). Given that we had three waves of job characteristics data, we were not able to estimate polynomial growth models for changes in job demands and job control (see Appendix A). A fruitful future research avenue will be to study changes in job characteristics beyond the shakedown phase with four or more waves of data collection to develop additional insights on the nature of changes in different aspects of employees' jobs.

Fourth, although we argued that employees will develop perceptions of technology characteristics before they form perceptions of work process characteristics, we measured technology characteristics and work process characteristics at the same time. Future research should investigate the causal relationship between technology and process characteristics by providing for temporal separation between the measurements. Further, we measured technology and work process characteristics once, early in the shakedown phase. Future research can theorize and test the causal relationship between technology and process characteristics over time, and longitudinally study whether changes in technology characteristics influence changes in process characteristics and, subsequently, changes in job characteristics over time.

Finally, we only examined two job characteristics. There are other aspects of employees' jobs (e.g., motivational, social, work context, and role perceptions) suggested in the job design literature (Humphrey et al. 2007) that should be examined in the future to develop a comprehensive understanding of changes in employees' jobs following an ES implementation and business process changes. Changes in other aspects of jobs, such as interpersonal relationships and job outcomes (e.g., behavioral, attitudinal, and well-being; Humphrey et al. 2007) should also be examined in the context of ES implementations. In keeping with the evolution of the demand–control model that included support (Karasek and Theorell 1990), such as social support, future work could incorporate the role of social support as a critical characteristic using theoretical perspectives, such as social networks (Sykes et al. 2009; Sykes et al. 2011). Other theoretical perspectives, such as task–technology fit, innovation diffusion, anchoring and adjustment, cognitive style and incentive alignment, and user adaptation, can be employed to understand why some employees perceive more changes than others do following an ES implementation.

In addition to addressing the limitations of our study, there are several other fruitful research avenues that build on our model and findings. Future research can attempt to identify other characteristics of the technology and work processes, and examine their impacts on changes in different aspects of jobs and outcomes. A potentially interesting research opportunity will be to conduct a field experiment in which researchers examine the effects of pre-implementation interventions on changes in employees' jobs and outcomes following an ES implementation (Venkatesh and Bala 2008). Further, the methodological approach that we used and consequent insights gained should encourage IS researchers to theorize about change in phenomena and use a longitudinal design to empirically test the change. For instance, using the three-wave longitudinal data that was primarily used to operationalize experience as a moderator, Venkatesh et al. (2003) could have provided additional insights on IS adoption by theorizing and testing changes in employees' perceptions related to new systems over time and outcomes of such changes.

## Practical Implications

Our model not only explains and predicts changes in job characteristics, but also offers insights to help guide design and action related to ES implementations (Gregor 2006). System designers and implementation teams can increase technology reconfigurability and customization so as to favorably influence employees' perceptions of process complexity, process rigidity, and process radicalness. Best practices suggest that organizations should not customize ESs and employees should not be allowed to reconfigure ESs (Markus and Tanis 2000). However, our findings suggest that if ESs are not customized to fit with employees' work processes and do not allow employees to modify certain features or functionalities, employees are likely to perceive an increase in job demands and a decrease in job control, leading to resistance to a new ES. We suggest that IS managers and consultants should find a middle ground between reconfigurability and rigidity and between customization and lack thereof. More importantly, managers should find ways to create perceptions of technology reconfigurability and customization in the mind of the users through different interventions, such as training. At the same time, managers should try to create favorable perceptions of new and/or modified work processes. For example, if employees perceive that their work processes are not radically different, it is more likely that they will feel less change in their job demands. Interventions should be developed to create such perceptions.

Based on our findings, we suggest two types of interventions: pre-implementation and post-implementation (Venkatesh and Bala 2008). Pre-implementation interventions include (1) modifications of design characteristics of new software and business processes to increase the reconfigurability of the new software and decrease the radicalness of work processes, and (2) user participation during the implementation and process change initiatives so that employees can develop more accurate perceptions of technology and work process characteristics. Post-implementation interventions include (1) role-based and simulation-based training for business processes, particularly for employees whose work processes were less complex and rigid before an ES implementation, and (2) support infrastructure for business processes so that employees can get support if they face ambiguous situations when executing their work processes. Organizations can use simulation games (e.g., ERPSim; Léger et al. 2011) and take an experiential learning approach to train employees. Employees can take on different roles in the game consistent with their jobs in the organization and understand how ESs support their work processes.

## Conclusions

Organizations make significant investments in implementing ESs, hoping to improve operational efficiency and gain strategic benefits. Building on prior research that suggests that success of an ES implementation depends on how well organizations manage the shakedown phase of an implementation, we set out to examine the changes in employees' job characteristics during this phase. We identified a set of technology and process characteristics, and theorized that process characteristics would predict changes in job characteristics and that technology characteristics would influence process characteristics. We found that employees experienced substantial changes in their jobs during the shakedown phase. Our findings offer insights on the nature, extent, determinants, and outcomes of changes in employees' job characteristics following an ES implementation, and potential explanations for the strong negative reactions to such systems. As organizations continue to invest in ESs, an understanding of changes caused by such systems is vital to ensuring successful implementations and gaining positive return on investment.

### *Acknowledgments*

This paper stems from the first author's doctoral dissertation. The authors thank his committee: Professors Paul Cronan, Fred Davis, Dan Ganster, and Arun Rai. The paper has benefitted from presentations at Bentley University, Clemson University, Georgia State University, Indiana University, University of Texas at San Antonio, and the International Conference on Information Systems Doctoral Consortium (2007). The authors thank the senior editor, Shirley Gregor, the associate editor, and the three anonymous reviewers for their constructive comments and suggestions that significantly helped improve the paper. The authors also thank Jan DeGross for her efforts in editing and typesetting the paper.

### *References*

Aiman-Smith, L., and Green, S. 2002. "Implementing New Manufacturing Technology: The Related Effects of Technology Characteristics and User Learning Activities," *Academy of Management Journal* (45:2), pp. 421-430.

Arbuckle J. L. 2009. *Amos 18™ User's Guide*, Crawfordville, FL: Amos Development Corporation.

Bandura, A. 1997. *Self-Efficacy: The Exercise of Control*, New York: W. H. Freeman Company.

Basu, A., and Blanning, R. W. 2003. "Synthesis and Decomposition of Processes in Organizations," *Information Systems Research* (14:4), pp. 337-355.

Beaudry, A., and Pinsonneault, A. 2005. "Understanding User Responses to Information Technology: A Coping Model of User Adaptation," *MIS Quarterly* (29:3), pp. 493-525.

Bentein, K., Vandenberghe, C., Vandenberg, R., and Stinglhamber, F. 2005. "The Role of Change in the Relationship Between Commitment and Turnover: A Latent Growth Modeling Approach," *Journal of Applied Psychology* (90:3), pp. 468-482.

Brehm, L., Heinzl, A. and Markus, M. L. 2001. "Tailoring ERP Systems: A Spectrum of Choices and Their Implications," *Proceeding of the 34th Annual Hawaii International Conference on System Sciences*, Los Alamitos, CA: IEEE Computer Society.

Boudreau, M.-C., and Robey, D. 2005. "Enacting Integrated Information Technology: A Human Agency Perspective," *Organization Science* (16:1), pp. 3-18.

Caldwell, S. D., Herold, D. M., and Fedor, D. B. 2004. "Toward an Understanding of the Relationships among Organizational Change, Individual Differences, and Changes in Person–Environment Fit: A Cross-Level Study," *Journal of Applied Psychology* (89:5), pp. 868-882.

Camman, C., Fichman, M., Jenkins, J. D., and Klesh, J. R. 1983. "Assessing the Attitudes and Perceptions of Organizational Members," in *Assessing Organizational Change: A Guide to Methods, Measures, Practices*, S. S. Seashore, E. E. Lawler, P. H. Mirvis, and C. Camman (eds.), New York: Wiley, pp. 71-138.

Chan, D. 1998. "The Conceptualization and Analysis of a Change over Time: An Integrative Approach Incorporating Longitudinal Mean and Covariance Structures Analysis (LMACS) and Multiple Indicator Latent Growth Modeling (MLGM)," *Organizational Research Methods* (1:4), pp. 421-483.

Cohen, D. S. 2005. "Why Change is an Affair of the Heart," *CIO Magazine*, December 1.

Cotteleer, M. J., and Bendoly, E. 2006. "Order Lead-Time Improvement Following Enterprise Information Technology Implementation: An Empirical Study," *MIS Quarterly* (30:3), pp. 643-660.

Davenport, T. H. 1998. "Putting the Enterprise into the Enterprise system," *Harvard Business Review* (76:4), pp. 121-131.

Davenport, T. H. *Process Innovation*, Boston: Harvard Business Press.

Davidson, E., and Chiasson, M. 2005. "Contextual Influences on Technology Use Mediation: A Comparative Analysis of Electronic Medical Record Systems," *European Journal of Information Systems* (14:1), pp. 6-18.

Davidson, E., and Chismar, W. 2007. "The Interaction of Institutionally Triggered and Technology-Triggered Social Structure Change: An Investigation of Computerized Physician Order Entry," *MIS Quarterly* (31:4), pp. 739-758.

Davis, C. J., and Hufnagel, E. M. 2007. "Through the Eyes of Experts: A Sociocognitive Perspective on the Automation of Fingerprint Work," *MIS Quarterly* (31:4), pp. 681-703.

de Lange, A. H., Taris, T. W., Kompier, M. A. J., Houtman, I. L. D., and Bongers, P. M. 2003. "'The *Very* Best of the Millennium': Longitudinal Research and the Demand–Control–(Support) Model," *Journal of Occupational Health Psychology* (8:4), pp. 282-305.

de Rijk, A. E., Le Blanc, P. M., Schaufeli, W. B., and De Jonge, J. 1998. "Active Coping and Need for Control as Moderators of the Job Demand-control Model: Effects on Burnout," *Journal of Occupational and Organizational Psychology* (71:1), pp. 1-18.

Devadoss, P., and Pan, S. 2007. "Enterprise Systems Use: Towards a Structurational Analysis of Enterprise Systems Induced Organizational Transformation," *Communications of the Association for Information Systems* (19), pp. 352-385.

DeVellis, R. F. 2003. *Scale Development: Theory and Applications*, Thousand Oaks, CA: Sage Publications.

Duncan, T. E, Duncan, S. C., and Strycker, L. A. 2006. *An Introduction to Latent Variable Growth Curve Modeling: Concepts, Issues, and Applications*, Mahwah, NJ: Lawrence Erlbaum Associates.

Feldman, M. S., and Pentland, B. T. 2003. "Reconceptualizing Organizational Routines as a Source of Flexibility and Change," *Administrative Science Quarterly* (48:1), pp. 94-118.

Fornell, C., and Larcker, D. F. 1981. "Evaluating Structural Equation Models with Unobservable Variables and Measurement Error: Algebra and Statistics," *Journal of Marketing Research* (18:3), pp. 382-388.

Fox, M. L., Dwyer, D. J., and Ganster, D. C. 1993. "Effects of Stressful Job Demands and Control on Physiological and Attitudinal Outcomes in a Hospital Setting," *Academy of Management Journal* (36:2), pp. 289-318.

Ganster, D. C. 2005. "Executive Job Demands: Suggestions from a Stress and Decision-Making Perspective," *Academy of Management Review* (30:3), pp. 492-502.

Ganster, D. C., and Fusilier, M. R. "Control in the Work Place," *International Review of Industrial and Organizational Psychology* (5:1), pp. 235-280.

Gattiker, T. F., and Goodhue, D. L. 2005. "What Happens After ERP Implementation: Understanding the Impact of Inter-Dependence and Differentiation on Plant-Level Outcomes," *MIS Quarterly* (29:3), pp. 559-585.

Gebauer, J., and Schober, F. 2006. "Information System Flexibility and the Cost Efficiency of Business Processes," *Journal of the Association for Information Systems* (7:3), pp. 122-147

Gersick, C. J. G. 1991. "Revolutionary Change Theories: A Multilevel Exploration of the Punctuated Equilibrium Paradigm," *Academy of Management Review* (16:1), pp. 10-36.

Green, S. G., Gavin, M. B., and Aiman-Smith, L. 1995. "Assessing a Multidimensional Measure of Radical Technological Innovation," *IEEE Transactions on Engineering Management* (42:3), pp. 203-214.

Gregor, S. 2006. "The Nature of Theory in Information Systems," *MIS Quarterly* (30:3), pp. 611-642.

Gregor, S., Martin, M., Fernandez, W., Stern, S., and Vitale, M. 2006. "The Transformational Dimension in the Realization of Business Value from Information Technology," *Journal of Strategic Information Systems* (15:3), pp. 249-270.

Hackman, J. R., and Oldham, G. R. 1980. *Work Redesign*, Reading, MA: Addison-Wesley.

Hakkinen, L., and Hilmola, O. 2007. "ERP Evaluation During the Shakedown Phase: Lessons from an After-Sales Division," *Information Systems Journal* (18:1), pp. 73-100.

Hakkinen, L., and Hilmola, O. 2008. "Life after ERP Implementation: Long-term Development of User Perceptions of System Success in an After-Sales Environment," *Journal of Enterprise Information Management* (21:3), pp. 285-310.

Hambrick, D. C., Finkelstein, S., and Mooney, A. C. 2005. "Executive Job Demands: New Insights for Explaining Strategic Decisions and Leader Behaviors," *Academy of Management Review* (30:3), pp. 472-491.

Herold, D. M., Fedor, D. B., and Caldwell, S. D. 2007. "Beyond Change Management: A Multilevel Investigation of Contextual and Personal Influences on Employees' Commitment to Change," *Journal of Applied Psychology* (92:4), pp. 942-951.

Hinkin, T. R. 1998. "A Brief Tutorial on the Development of Measures for Use in Survey Questionnaire," *Organizational Research Methods* (1:1), pp. 104-121.

Hong, K. K., and Kim, Y-G. 2002. "The Critical Success Factors for ERP Implementation: An Organizational Fit Perspective," *Information & Management* (40:1), pp. 25-40.

Hu, L., and Bentler, P. M. 1999. "Cutoff Criteria for Fit Indexes in Covariance Structure Analysis: Conventional Criteria Versus New Alternatives," *Structural Equation Modeling* (6:1), pp. 1-55.

Humphrey, S. E., Nahrgang, J. D., and Morgeson, F. P. 2007. "Integrating Motivational, Social, and Contextual Work Design Features: A Meta-Analytic Summary and Theoretical Extension of the Work Design Literature," *Journal of Applied Psychology* (92:5), pp. 1332-1356.

Jasperson, J., Carter, P. E., and Zmud, R. W. 2005. "A Comprehensive Conceptualization of Post-Adoptive Behaviors Associated with Information Technology Enabled Work Systems," *MIS Quarterly* (29:3), pp. 525-557.

Jex, S. M., and Beehr, T. A. 1991. "Emerging Theoretical and Methodological Issues in the Study of Work-Related Stress," *Research in Personnel and Human Resources Management* (9:1), pp. 11-365.

Karasek, R. A. 1979. "Job Demands, Job Decision Latitude, and Mental Strain: Implications for Job Redesign," *Administrative Science Quarterly* (24:2), pp. 285-311.

Karasek, R. A., and Theorell, T. 1990. *Healthy Work: Stress, Productivity, and the Reconstruction of Working Life*, New York: Basic Books.

Lance, C. E., Meade, A. W., and Williamson, G. M. 2000. "We Should Measure Change—and Here's How," in *Physical Illness and Depression in Older Adults: Theory, Research, and Practice*, G. M. Williamson and D. R. Shaffer (eds.), New York: Plenum Press, pp. 201-235.

Lance, C. E., Vandenberg, R. J., and Self, R. M. 2000. "Latent Growth Models of Individual Change: The Case of Newcomer Adjustment," *Organizational Behavior and Human Decision Processes* (83:1), pp. 107-140.

Lapointe, L., and Rivard, S. 2005. "A Multilevel Model of Resistance to Information Technology Implementation," *MIS Quarterly* (29:3), pp. 461-491.

Lassila, K. S., and Brancheau, J. C. 1999. "Adoption and Utilization of Commercial Software Packages: Exploring Utilization Equilibria, Transitions, Triggers, and Tracks," *Journal of Management Information Systems* (16:2), pp. 63-90.

Léger, P.-M., Charland, P., Feldstein, H. D., Robert, J., Babin, G., and Lyle, D. 2011. "Business Simulation Training in Information Technology Education: Guidelines for New Approaches in IT Training," *Journal of Information Technology Education* (10:1), pp. 39-53.

Liang, H. G., Saraf, N., Hu, Q., and Xue, Y. 2007. "Assimilation of Enterprise Systems: The Effect of Institutional Pressures and the Mediating Role of Top Management," *MIS Quarterly* (31:1), pp. 59-87.

Magal, S. R., and Word, J. 2011. *Integrated Business Processes with ERP Systems*, Hoboken, NJ: Wiley.

Majchrzak, A., and Cotton, J. C. 1988. "A Longitudinal Study of Adjustment to Technological Change: The Case of Job Transfers from Mass to Computer-Automated Batch Production," *Journal of Occupational Psychology* (61:1), pp. 43-66.

Malone, T. W., Crowston, K., Lee, J., Pentland, B., Dellarocas, C., Wyner, G., Quimby, J., Osborn, C., Bernstein, A., Herman, G., Klein, M., and O'Donnell, E. 1999. "Tools for Inventing Organizations: Toward a Handbook of Organizational Processes," *Management Science* (45:3), pp. 425-443.

Markus, M. L. 2004. "Technochange Management: Using IT to Drive Organizational Change," *Journal of Information Technology* (19:1), pp. 3-19.

Markus, M. L., Axline, S., Petrie, D., and Tanis, C. 2000. "Learning from Adopters' Experiences with ERP: Problems Encountered and Success Achieved," *Journal of Information Technology* (15:4), pp. 245-265.

Markus, M. L., Axline, S., Petrie, D., and Tanis, C. 2003. "Learning from Adopters' Experiences with ERP–Successes and Problems," in *Second Wave ERP: Implementing for Effectiveness*, P. Seddon, G. Shanks and L. Willcocks (eds.), Cambridge, UK: Cambridge University Press.

Markus, M. L., and Tanis, C. 2000. "The Enterprise System Experience: From Adoption to Success," in *Framing the Domains of IT Management*, R. W. Zmud (ed.), Cincinnati, OH: Pinnaflex Educational Resources, pp. 173-207.

Martens, C., and Hamerman, P. D. 2011. *The State of ERP in 2011: Customers Have More Options in Spite of Market Consolidation,* Forrester Research, Inc., Cambridge, MA.

McArdle, J. J., and Nesselroade, J. R. 2003. "Growth Curve Analysis in Contemporary Psychological Research," in *Comprehensive Handbook of Psychology* (Volume 2), J. Schinka and W. Velicer (eds.), New York: Pergamon Press, pp. 447-480.

Millman, Z., and Hartwick, J. 1987. "The Impact of Automated Office Systems on Middle Managers and their Work," *MIS Quarterly* (11:4), pp. 479-491.

Morris, M. G., and Venkatesh, V. 2010. Job Characteristics and Job Satisfaction: Understanding the Role of Enterprise Resource Planning System Implementation," *MIS Quarterly* (34:1), pp. 143-161.

Mullarkey, S., Jackson, P. R., Wall, T. D., Wilson, J. R., and Grey-Taylor, S. M. 1997. "The Impact of Technology Characteristics and Job Control on Worker Mental Health," *Journal of Organizational Behavior* (18:5), pp. 471-489.

Parker, S. K., Chmiel, N., and Wall, T. D. 1997. "Work Characteristics and Employee Well-Being Within a Context of Strategic Downsizing, *Journal of Occupational Health Psychology* (2:4), pp. 289-303.

Pentland, B. T. 2003. "Sequential Variety in Work Processes," *Organization Science* (14:5), pp. 528-540.

Pindyck, R. S., and Rubenfeld, D. L. 1981. *Econometric Models and Economic Forecasts*, New York: McGraw-Hill.

Podsakoff, P. M., Mackenzie, S. B., Lee, J., and Podsakoff, N. P. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies," *Journal of Applied Psychology* (88:5), pp. 879-903.

Robey, D., Ross, J. W., and Boudreau, M.-C. 2002. "Learning to Implement Enterprise Systems: An Exploratory Study of the Dialectics of Change," *Journal of Management Information Systems* (19:1), pp. 17-46.

Seddon, P. B., Calvert, C., and Yang, S. 2010. "A Multi-Project Model of Key Factors Affecting Organizational Benefits from Enterprise Systems," *MIS Quarterly* (32:2), pp. 305-328.

Soh, C., Kien, S. S., and Tay-Yap, J. 2000. "Cultural Fits and Misfits: Is ERP a Universal Solution," *Communication of the ACM* (43:4), pp. 47-51.

Soh, C., Sia, S. K., Boh, W. F., and Tang, M. 2003. "Misalignments in ERP Implementation: A Dialectic Perspective," *International Journal of Human–Computer Interaction* (16:1), pp. 81-100.

Sonnentag, S., and Zijlstra, F. R. H. 2006. "Job Characteristics and Off-Job Activities as Predictors of Need for Recovery, Well-Being, and Fatigue," *Journal of Applied Psychology* (91:2), pp. 330-350.

Stewart, D. W., Shamdasani, P. N., and Rook, D. W. 2007. *Focus Groups: Theory and Practice*, Thousand Oaks, CA: Sage Publications.

Stoddard, D. B., and Jarvenpaa, S. L. 1995. "Business Process Redesign: Tactics for Managing Radical Change," *Journal of Management Information Systems* (12:1), pp. 81-107.

Strong, D. M., and Volkoff, O. 2010. "Understanding Organization-Enterprise System Fit: A Path to Theorizing the Information Technology Artifact," *MIS Quarterly* (34:4), pp. 731-756.

Sykes, T. A. Forthcoming. "Support Structures and Their Impacts on Employee Outcomes: A Longitudinal Field Study of an Enterprise System Implementation," *MIS Quarterly.*

Sykes, T. A., and Venkatesh, V. Forthcoming. "Explaining Post-Implementation Employee System Use and Friendship, Advice and Impeding Social Ties," *MIS Quarterly.*

Sykes, T. A., Venkatesh, V., and Gosain, S. 2009. "Model of Acceptance with Peer Support: A Social Network Perspective to Understand Employees' System Use," *MIS Quarterly* (33:2), pp. 371-393.

Sykes, T. A., Venkatesh, V., and Johnson, J. L. Forthcoming. "System Implementation and Employee Job Performance: Understanding the Role of Advice Networks," *MIS Quarterly*.

Sykes, T. A., Venkatesh, V., and Rai, A. 2011. "Explaining Physicians' Use of EMR Systems and Performance in the Shakedown Phase," *Journal of the American Medical Informatics Association* (18:2), pp. 125-130.

Tyre, M. J., and Orlikowski, W. J. 1994. "Windows of Opportunity: Temporal Patterns of Technological Adaptation in Organizations," *Organization Science* (5:1), pp. 98-118.

Van der Doef, M., and Maes, S. 1999. "The Job Demand–Control (–Support) Model and Psychological Well-Being: A Review of 20 Years of Empirical Research," *Work Stress* (13:2), pp. 87-114.

van Yperen, N. W., and Hagedoorn, M. 2003. "Do High Job Demands Increase Intrinsic Motivation or Fatigue or Both? The

Role of Job Control and Job Social Support," *Academy of Management Journal* (46:3), pp. 339-348.

Venkatesh, V. 1999. "Creation of Favorable User Perceptions: Exploring the Role of Intrinsic Motivation," *MIS Quarterly* (23:2), pp. 239-260.

Venkatesh, V. 2000. "Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model," *Information Systems Research* (11:4), pp. 342-365.

Venkatesh, V., and Bala, H. 2008. "Technology Acceptance Model 3 and a Research Agenda on Interventions," *Decision Sciences* (39:2), pp. 273-315.

Venkatesh, V., Bala, H., and Sykes, T. A. 2010. "Impacts of Information and Communication Technology Implementations on Employees' Jobs in India: A Multi-Method Longitudinal Field Study," *Production and Operations Management* (19:5), pp. 591-613.

Venkatesh, V., Brown, S. A., and Bala, H. 2013. "Bridging the Qualitative–Quantitative Divide: Guidelines for Conducting Mixed Methods Research in Information Systems," *MIS Quarterly* (37:1), pp. 21-54.

Venkatesh, V., and Davis, F. D. 1996. "A Model of the Antecedents of Perceived Ease of Use: Development and Test," *Decision Sciences* (27:3), pp. 451-481.

Venkatesh, V., Morris, M. G., and Ackerman, P. L. 2000. "A Longitudinal Field Investigation of Gender Differences in Individual Technology Adoption Decision Making Processes," *Organizational Behavior and Human Decision Processes* (83:1), pp. 33-60.

Venkatesh, V., Morris, M. G., Davis, G. B., and Davis, F. D. 2003. "User Acceptance of Information Technology: Toward a Unified View," *MIS Quarterly* (27:3), pp. 425-478.

Venkatesh, V., Zhang, X., and Sykes, T. A. 2011. "'Doctors Do Too Little Technology': A Longitudinal Field Study of an Electronic Healthcare System Implementation," *Information Systems Research* (22:3), pp. 523-546.

Volkoff, O., Strong, D. M., and Elmes, M. B. 2007. "Technological Embeddedness and Organizational Change," *Organization Science* (18:5), pp. 832-848.

Wailgum, T. 2009. "ERP Investments Still Top the List for Corporate IT Spending," CIO.com, November 13 (http://www.cio.com/article/print/507663).

Wall, T. D., Corbett, J. M., Clegg, C. W., Jackson, P. R., and Martin, R. 1990. "Advanced Manufacturing Technology and Work Design: Towards a Theoretical Framework," *Journal of Organizational Behavior* (11:3), pp. 201-219.

Wang, E. T. G., Klein, G., and Jiang, J. J. 2006. "ERP Misfit: Country of Origin and Organizational Factors," *Journal of Management Information Systems* (23:1), pp. 263-292.

Wei, J. L., Wang, E. T. G., and Ju, P. H. 2005. "Understanding Misalignment and Cascading Change of ERP Implementation: A Stage View of Process Analysis," *European Journal of Information Systems* (14:4), pp. 324-334.

Wood, R. E. 1986. "Task Complexity: Definition of the Construct," *Organizational Behavior and Human Decision Processes* (37:1), pp. 60-82.

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MIS Quarterly

RESEARCH ARTICLE

# CHANGES IN EMPLOYEES' JOB CHARACTERISTICS DURING AN ENTERPRISE SYSTEM IMPLEMENTATION: A LATENT GROWTH MODELING PERSPECTIVE

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# Appendix A

## An Overview of Latent Growth Modeling (LGM) Analysis

LGM has gained widespread acceptance in organizational research in recent years as an integrative approach to measure change (Bentein et al. 2005; Chan 1998; Jokisaari and Nurmi 2009; Lance, Meade, and Williamson 2000; Lance, Vandenberg, and Self 2000; Ployhart and Vandenberg 2010; Van Iddekinge et al. 2009). Unlike traditional techniques that measure change over two periods of time, LGM measures change over three or more periods of time and suggests a true change pattern and variations over time. Chan (1998) suggested that there are inherent limitations in a two-wave design because it cannot precisely indicate a change in a phenomenon because a trajectory of change cannot be identified and conceptualized from two waves of data. The most complex functional form that can be fitted is a straight line passing through two data points. A two-wave design essentially represents two snapshots of a phenomenon without allowing the assessment of intra-individual change process as it unfolds over time. In contrast, LGM offers precise information on intra-individual change over time by incorporating measurements from three or more time periods. Readers interested in further details related to LGM analyses are encouraged to consult the following articles and books: Chan (1998, 2002), Duncan et al. (2006), Lance, Meade, and Williamson (2000), Lance, Vandenberg, and Self (2000), Meredith and Tisak (1990), Ployhart and Vandenberg (2010), and Willett and Sayer (1994).

LGM overcomes many of the problems associated with traditional approaches to studying change, such as *t*-tests, ANOVA, lagged regression, and difference scores (Chan 1998; Lance, Meade, and Williamson 2000). For example, given that LGM is an SEM-based approach, it creates a latent change construct incorporating individual ratings for each focal construct over time, thus offering a true score for change that is free of measurement error. The traditional techniques, such as *t*-tests, ANOVA, lagged regression, and difference scores, measure change at the aggregate level and are not able to capture individual differences. LGM captures intra-individual change (i.e., change for each individual) by developing a trajectory of change in a focal construct for each individual over time. It also provides each individual's initial status on the construct. Further, LGM supports multivariate analysis of change to examine the interrelationships among changes in multiple focal constructs over time and the effects of change in one construct on the change in another construct. Finally, LGM provides the ability to model predictors and outcomes of change, thus helping us better understand the nature of change in a phenomenon of interest.

Following Chan (1998, 2002) and exemplars from prior research (Bentein et al. 2005; Jokisaari and Nurmi 2009; Lance, Vandenberg, and Self 2000; Van Iddekinge et al. 2009), we followed a three-step process to conduct the LGM analysis. Figure A1 summarizes these three steps.

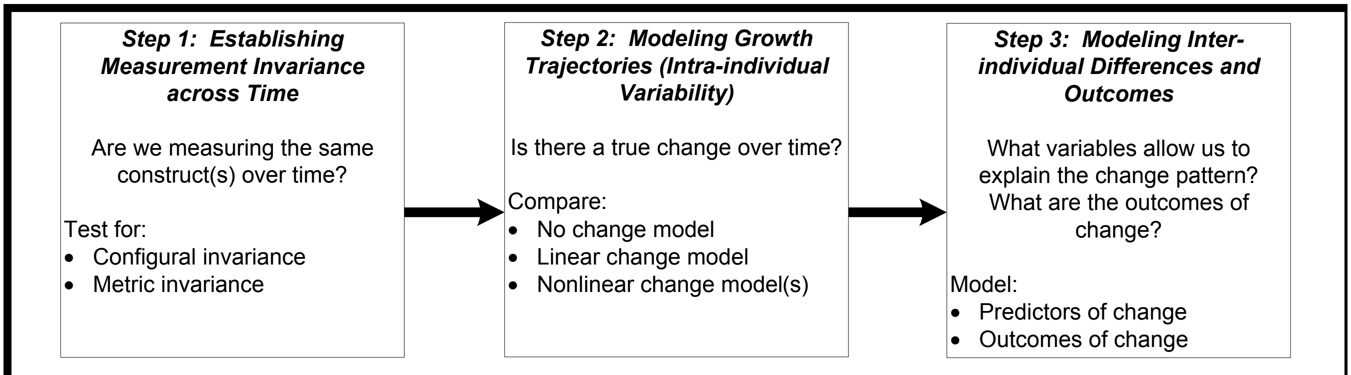


**Figure A1. LGM Analysis Steps**

## *Step 1: Establishing Measurement Invariance across Time*

Given that the primary purpose of LGM analysis is to measure change in a construct over time, the first step is to establish whether we measured the same constructs over time. Measurement invariance is critical for LGM analysis to ensure unambiguous interpretation of change (Lance, Vandenberg, and Self 2000). Bentein et al. (2005) noted that measurement invariance within an LGM context is said to exist if (1) the nature of the construct that is operationalized by a measured variable remains unchanged across measurement occasions, that is, the measures demonstrate invariant construct validity over time, and (2) the relations between measures and their corresponding constructs are invariant across measurement occasions. These two criteria are called configural invariance and metric or factorial invariance, respectively (Bentein et al. 2005; Chan 1998; Lance, Meade, and Williamson 2000). If we have the same number of factors at each time with the same specific factor loadings on each factor, we have configural invariance (Chan 1998). If the factor loadings corresponding to the identical items are equal across time, we can establish metric invariance (Chan 1998).

We strictly followed the procedures outlined in Chan (1998) to test for configural and metric invariance. In particular, we undertook a series of SEM-based confirmatory factor analysis (CFA) nested model comparisons to evaluate various aspects of measurement invariance separately for job demands and job control. We used a k-item × three-occasion variance-covariance matrix, with indicator means as input data. We compared five nested models to establish measurement invariance across time and identify boundaries for possible functional forms of change trajectories in job demands and job control. Model 1 was a three-factor model in which (1) factors corresponded to measurement occasions; (2) items were constrained to load only on the respective measurement occasion factor—for example, $T_0$ items loaded only on the Time 0 factor; (3) the intercept for the first item within each measurement occasion was fixed equal to 0 (zero) to identify the mean of the respective factor; (4) same-item residuals were allowed to covary across measurement occasions to control for correlated specificities—for example, the residual for JDEM1 ($T_0$) was allowed to covary with item JDEM1 ($T_2$); and (5) factor loadings, error variances, factor means, and factor variances were freely estimated. An acceptable fit of Model 1 would indicate the unidimensional factor structure for job demands and job control over time—hence, configural invariance would be established (Chan 1998; Horn and McArdle 1992; Lance, Vandenberg, and Self 2000).

Model 2 was identical to Model 1 except that factor loadings for the same items were constrained to be equal across measurement occasions—for example, factor loading of JDEM1 ($T_0$) = factor loading of JDEM1 ($T_2$) = factor loading of JDEM1 ($T_3$). Given that Model 2 was nested within Model 1, the difference in chi-square values was used to test if there was any statistically significant change (i.e., reduction) in model fit from Model 1 to Model 2. If Model 2 did not differ significantly from Model 1, metric invariance was established because a significant worsening in fit would indicate inequivalence of factor loadings over time. Although Models 1 and 2 helped us establish configural and metric invariance, we tested three other models to identify the functional forms of change trajectories that would help us in steps 2 and 3 of the LGM analysis.

Given that Model 2 was a more constrained (parsimonious) model, it was preferred over Model 1 and the subsequent models were compared against it. Model 3 was equivalent to Model 2 except for error variances for the same items that were constrained to be equal across measurement occasions—for example, error variance for JDEM1 ($T_0$) = error variance for JDEM1 ($T_2$) = error variance for JDEM1 ($T_3$). Model 4 was equivalent to Model 2 except that it constrained all factor means to be equal across time. If Model 4 did not have a significant reduction in fit, it would indicate that there are no changes in factor means (i.e., no growth) for job demands and job control over time. Finally, Model 5 was equivalent to Model 2 except that Model 5 constrained the three factor variances to be equal across measurement occasions. Equal factor variances would indicate that individuals did not differ systematically in their individual slopes. Chan (1998, p. 434) noted that Models

| Table A1. Tests of Measurement Invariance for Job Characteristics | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Models | Job Chars. | $X^2$ | df | Model Comparison | $\Delta X^2$ | Δdf | NNFI | CFI | RMSEA | SRMR |
| Model 1: Free factor loadings, error variances, factor means, factor variances | JDEM | 32.7 | 39 | – | – | – | .99 | .99 | .01 | .02 |
| | JCON | 46.42 | 39 | – | – | – | .99 | .99 | .02 | .04 |
| Model 2: Equal factor loadings, free error variances, factor means, factor variances | JDEM | 39.21 | 45 | 1 vs. 2 | 6.51 | 6 | .99 | .99 | .00 | .02 |
| | JCON | 50.68 | 45 | 1 vs. 2 | 4.26 | 6 | .99 | .99 | .02 | .04 |
| Model 3: Equal factor loadings, error variances, free factor means, factor variances | JDEM | 579.48*** | 53 | 2 vs. 3 | 540.27*** | 8 | .92 | .93 | .15 | .04 |
| | JCON | 415.51*** | 53 | 2 vs. 3 | 364.83*** | 8 | .94 | .95 | .13 | .06 |
| Model 4: Equal factor loadings, factor means, free error variances, factor variances | JDEM | 322.12*** | 47 | 2 vs. 4 | 282.91*** | 2 | .95 | .97 | .12 | .10 |
| | JCON | 134.27*** | 47 | 2 vs. 4 | 83.59** | 2 | .98 | .99 | .07 | .09 |
| Model 5: Equal factor loadings, factor variances, free error variances, factor means | JDEM | 42.40 | 47 | 2 vs. 5 | 3.19 | 2 | .99 | .99 | .00 | .02 |
| | JCON | 54.96 | 47 | 2 vs. 5 | 4.28 | 2 | .99 | .99 | .02 | .04 |

*Notes*: *p < 0.05, **p < 0.01, ***p < 0.001. JDEM = Job Demands; JCON = Job Control.

1 and 2 were sufficient to establish measurement invariance in LGM, and the other models have more stringent requirements for measurement invariance which are "extremely demanding, and most researchers recognize that it is unrealistic to expect such extreme invariance to hold in actual data."

Table A1 presents the results of the tests of longitudinal measurement invariance for job demands and job control. The table shows five models corresponding to those discussed earlier. Consistent with Chan (1998), we used the chi-square difference test ($\Delta X^2$) to compare the fit of two nested models. If the difference is not significant (i.e., there is no significant reduction in fit), the nested model is accepted because it is more parsimonious. Models 1 and 2 had acceptable fit for both job demands and job control—hence, configural and metric invariance were established for both job characteristics. Model 5 was the most parsimonious model—hence, the constraints in Model 5 were kept in place for the next step of LGM analysis.

### *Step 2: Modeling Growth Trajectories*

Step 1 of the analysis provided us a basic growth model that adequately and parsimoniously described the form of change over time. In step 2, we conducted a multivariate LGM analysis in which we simultaneously modeled growth trajectories for job demands and job control.[1] Given that job demands and job control are from a single theoretical model (i.e., JSM), a multivariate LGM analysis was deemed appropriate as opposed to a univariate analysis in which growth trajectories for job demands and job control would be modeled separately. We created four second-order latent variables—two for each of the job characteristics. These second-order factors (SOFs) represented two important attributes of a variable's change trajectory: the intercept and the slope (Chan 1998). The intercept corresponded to the initial status of job demands and job control at $T_0$ (i.e., the true score of job demands and job control before the implementation of the SAP modules), and the slope corresponded to the changes in job demands and job control (i.e., the rate of increase or decrease of job demands and job control over time). We created six first-order factors (FOFs) representing the repeated latent variables (i.e., job demands and job control) over three periods of time. These were the factors used in step 1 for assessing measurement invariance.

Following Chan (1998) and Lance, Vandenberg, and Self (2000), we estimated models for four change functions (i.e., no-growth, linear growth, quadratic growth, and optimal growth) to determine for the nature of growth trajectories in job demands and job control (see Table 6 in the

[1]We also conducted univariate LGM analysis for job demands and job control separately and found virtually identical results, suggesting that there were no anomalies in the results when univariate models were combined (Bentein et al. 2005).

"Results" section). Here, the no-growth model is nested under the linear growth model, the linear growth model is nested under the quadratic and optimal growth model, and the optimal growth model is nested under the quadratic growth model. We also examined two FOF residual structures: (1) homoscedastic (i.e., error variances associate with FOFs are homogeneous over time), and (2) heteroscedastic. The homoscedastic structure models are nested under the heteroscedastic structure models. Model G1a and G2a indicated there were no changes in job demands and job control over time (no-growth model). In these models, the intercept had a fixed value of 1 for factor loadings across the measurement occasions because it is a constant for any given individual across time. The rest of the model was identical to the Model 5 that we developed in step 1. Per Table 6, Model G1a (no growth, heteroscedastic residual structure) had a better fit because there was significant reduction in fit for Model G1b (no growth, homoscedastic residual structure).

Models G2a and G2b were positive linear growth models. These models were equivalent to Models G1a and G1b respectively except that the slope factors were added for job demands and job control, and the factor loadings for the slopes were fixed as 0, 1, and 2, representing three equally spaced measurement occasions. This provided us a linear change trajectory. As shown in Table 6, the chi-square difference between Models G1a and G2a was significant, suggesting that the linear growth model (G2a) had a better fit, and there were at least linear growth trajectories in job demands and job control. Between Models G2a (linear growth, heteroscedastic residual structure) and G2b (linear growth and homoscedastic residual structure), Model G2a had a slightly better fit ($\Delta X^2 = 9.81$, $\Delta df = 4$, $p < .05$). However, fit indexes were identical (see Table 6). Given that Figure 3 shows curvilinearity in both plots, we continued our analysis to model nonlinear growths in job demands and job control.

Models G3a and G3b were quadratic growth models. In these models, two factors corresponding to the quadratic term were added for job demands and job control and the factor loadings for these quadratic factors were fixed as 0, 1, and 4 (squaring the slope factor loadings) to find a positively accelerated quadratic trajectory. These models were unidentified because adding the quadratic term increased the number of parameters to be estimated and the models did not have enough degrees of freedom because of three measurement occasions. Following Duncan et al. (2006), it was possible to have a perfectly identified model by constraining the FOF error variances to be zero. However, this would create an unrealistic growth model because it would be unlikely that there were no variances in individuals' assessment of job demands and job control. Further, we found in step 1 that error variances associated with job demands and job control were indeed significant ($p < .001$) across time.

In fact, polynomials (with squared or other higher-order terms) are not the only way to model nonlinear growth functions (Chan 1998; Duncan et al. 2006; Lance, Vandenberg, and Self 2000). It is possible to create an optimal growth model by freely estimating the slope factor loadings for the latter measurement occasions. This will allow us to determine the nature of the growth based on the empirical data. For instance, for three waves of data collection, the FOF's loadings for the first two measurement occasions on the slope factor can be set to 0 and 1 and the loadings for the third measurement occasion on the slope factor can be freely estimated (see Figure A2). The first two measurement occasions' FOF loadings need to be fixed as reference points to identify the proportionality of measurement intervals (Lance, Vandenberg, and Self 2000). If this model fits well and is better than the linear growth model, the freely estimated loading is used as a weight of the slope to determine the overall change in the latent variable during the study duration (Duncan et al. 2006; McArdle and Nesselroade 2003). More details about the optimal growth model can be found in prior exemplars: Bentein et al. (2005), Jokisaari and Nurmi (2009), Lance, Vandenberg, and Self (2000), and Van Iddekinge et al. (2009).

Models G4a and G4b were optimal growth models in which the first two factor loadings on the slope factors for job demands and job control were fixed at 0 and 1 (for the first two time periods) and the third one (for the third time period) was freely estimated (L1 and L2 in Figure A2). Model G4a (optimal growth, heteroscedastic residual structure) failed to converge to an admissible solution. Hence, we compared Models G4b (optimal growth, homoscedastic residual structure) and G2b (linear growth, homoscedastic residual structure) and found that Model G4b had the overall best fit, suggesting a nonlinear growth trajectory for both job demands and job control. These findings are further discussed in the "Results" section.

## *Step 3: Modeling Predictors and Outcomes of Growth Trajectories*

In step 3, we added the predictors and outcomes of the latent change constructs to the optimal growth model created in step 2. In particular, we added (1) technology characteristics and pre-implementation process characteristics as predictors of post-implementation work process characteristics, (2) pre-implementation process characteristics and post-implementation process characteristics as predictors of changes in job demands and job control, and (3) pre-implementation job satisfaction and changes in job demands and job control as predictors of post-implementation job satisfaction. A pre-implementation measure of perceived process radicalness was not included because perceived process radicalness was measured only post-implementation to capture the degree of newness of post-implementation work processes. The rest of the model and constraints was identical to the model developed in step 2. Findings from step 3 are reported in the "Results" section.

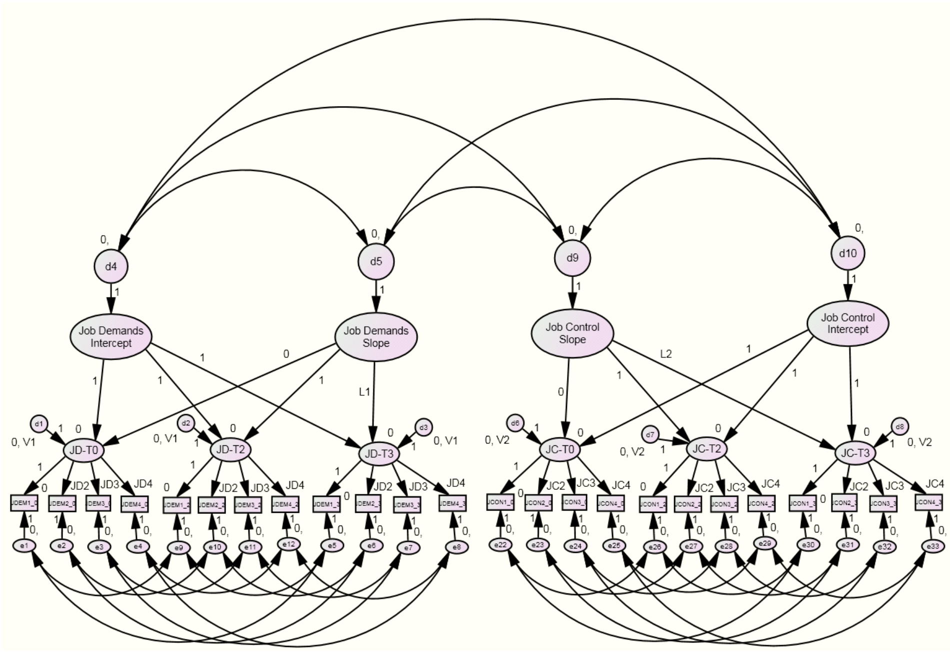


**Figure A2. Optimal Growth Model Estimation in LGM**

## References

Bentein, K., Vandenberghe, C., Vandenberg, R., and Stinglhamber, F. 2005. "The Role of Change in the Relationship between Commitment and Turnover: A Latent Growth Modeling Approach," *Journal of Applied Psychology* (90:3), pp. 468-482.

Chan, D. 1998. "The Conceptualization and Analysis of a Change over Time: An Integrative Approach Incorporating Longitudinal Mean and Covariance Structures Analysis (LMACS) and Multiple Indicator Latent Growth Modeling (MLGM)," *Organizational Research Methods* (1:4), pp. 421-483.

Chan, D. 2002. "Latent Growth Modeling," in *Measuring and Analyzing Behavior in Organizations: Advances in Measurement and Data Analysis*, F. Drasgow and N. Schmitt (eds.), San Francisco: Jossey-Bass, pp. 302-349.

Duncan, T. E, Duncan, S. C., and Strycker, L. A. 2005. *An Introduction to Latent Variable Growth Curve Modeling: Concepts, Issues, and Applications*, Mahwah, NJ: Lawrence Erlbaum Associates.

Horn, J. L., and McArdle, J. J. 1992. "A Practical and Theoretical Guide to Measurement Invariance in Aging Research," *Experimental Aging Research* (18:3-4), pp. 117-144.

Jokisaari, M., and Nurmi, J.-E. 2009. "Change in Newcomers' Supervisor Support and Socialization Outcomes after Organizational Entry," *Academy of Management Journal* (52:3) pp.527-544.

Lance, C. E., Meade, A. W., and Williamson, G. M. 2000. "We Should Measure Change—and Here's How," in *Physical Illness and Depression in Older Adults: Theory, Research, and Practice*, G. M. Williamson and D. R. Shaffer (eds.), New York: Plenum Press, pp. 201-235.

Lance, C. E., Vandenberg, R. J., and Self, R. M. 2000. "Latent Growth Models of Individual Change: The Case of Newcomer Adjustment," *Organizational Behavior and Human Decision Processes* (83:1), pp. 107-140.

McArdle, J. J., and Nesselroade, J. R. 2003. "Growth Curve Analysis in Contemporary Psychological Research," in *Comprehensive Handbook of Psychology* (Volume 2), J. Schinka and W. Velicer (eds.), New York: Pergamon Press, pp. 447-480,

Meredith, W., and Tisak, J. 1990. "Latent Curve Analysis," *Psychometrika* (55), pp. 107-122.

Ployhart, R. E., and Vandenberg, R. J. 2010. "Longitudinal Research: The Theory, Design, and Analysis of Change," *Journal of Management* (36:1), pp. 94-120.

Van Iddekinge, C. H., Ferris, G. R., Perrewé, P. L., Perryman, A. A., Blass, F. R, and Heetderks, T. D. 2009. "Effects of Selection and Training on Unit-Level Performance Over Time: A Latent Growth Modeling Approach," *Journal of Applied Psychology* (94:4), pp. 829-43.

Willett, J. B., and Sayer, A. G. 1994. "Using Covariance Structure Analysis to Detect Correlates and Predictors of Individual Change Over Time," *Psychological Bulletin* (116:2), pp. 363-381.

# Appendix B

## Item Loadings

| Construct | Items | $T_0$ | | | $T_1$ | | | $T_2$ | | | $T_3$ | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Org. A (N = 281) | Org. B (N = 141) | Pooled (N = 422) | Org. A (N= = 281) | Org. B (N = 141) | Pooled (N = 422) | Org. A (N = 281) | Org. B (N = 141) | Pooled (N = 422) | Org. A (N = 281) | Org. B (N = 141) | Pooled (N = 422) |
| Perceived technology complexity (TCOMP) | TCOMP1 | – | – | – | .91 | .85 | .89 | – | – | – | – | – | – |
| | TCOMP2 | – | – | – | .89 | .95 | .91 | – | – | – | – | – | – |
| | TCOMP3 | – | – | – | .86 | .84 | .87 | – | – | – | – | – | – |
| | TCOMP4 | – | – | – | .90 | .82 | .88 | – | – | – | – | – | – |
| Perceived technology reconfigurability (TRCNF) | TRCNF1 | – | – | – | .89 | .92 | .90 | – | – | – | – | – | – |
| | TRCNF2 | – | – | – | .86 | .91 | .88 | – | – | – | – | – | – |
| | TRCNF3 | – | – | – | .84 | .90 | .87 | – | – | – | – | – | – |
| | TRCNF4 | – | – | – | .89 | .83 | .87 | – | – | – | – | – | – |
| Perceived technology customization (TCUST) | TCUST1 | – | – | – | .92 | .88 | .91 | – | – | – | – | – | – |
| | TCUST2 | – | – | – | .89 | .84 | .88 | – | – | – | – | – | – |
| | TCUST3 | – | – | – | .89 | .88 | .91 | – | – | – | – | – | – |
| | TCUST4 | – | – | – | .86 | .87 | .85 | – | – | – | – | – | – |
| Perceived process complexity (PCOMP) | PCOM1 | .95 | .92 | .94 | .92 | .89 | .91 | – | – | – | – | – | – |
| | PCOM2 | .91 | .90 | .91 | .88 | .87 | .88 | – | – | – | – | – | – |
| | PCOM3 | .92 | .89 | .92 | .87 | .88 | .88 | – | – | – | – | – | – |
| | PCOM4 | .90 | .84 | .88 | .76 | .72 | .75 | – | – | – | – | – | – |
| Perceived process rigidity (PRGDT) | PRGDT1 | .93 | .93 | .94 | .84 | .87 | .85 | – | – | – | – | – | – |
| | PRGDT2 | .94 | .92 | .94 | .86 | .83 | .83 | – | – | – | – | – | – |
| | PRGDT3 | .94 | .91 | .93 | .90 | .90 | .90 | – | – | – | – | – | – |
| | PRGDT4 | .93 | .92 | .93 | .89 | .92 | .91 | – | – | – | – | – | – |
| Perceived process radicalness (PRDCL) | PRDCL1 | – | – | – | .91 | .92 | .92 | – | – | – | – | – | – |
| | PRDCL2 | – | – | – | .85 | .95 | .87 | – | – | – | – | – | – |
| | PRDCL3 | – | – | – | .89 | .84 | .86 | – | – | – | – | – | – |
| | PRDCL4 | – | – | – | .88 | .88 | .88 | – | – | – | – | – | – |
| Job demands (JDEM) | JDEM1 | .91 | .91 | .93 | – | – | – | .88 | .88 | .87 | .92 | .91 | .92 |
| | JDEM2 | .92 | .94 | .95 | – | – | – | .90 | .91 | .90 | .95 | .93 | .93 |
| | JDEM3 | .90 | .95 | .94 | – | – | – | .88 | .90 | .89 | .93 | .92 | .93 |
| | JDEM4 | .89 | .94 | .95 | – | – | – | .89 | .90 | .89 | .93 | .93 | .92 |
| Job control (JCON) | JCON1 | .95 | .96 | .93 | – | – | – | .93 | .94 | .94 | .95 | .95 | .92 |
| | JCON2 | .97 | .96 | .96 | – | – | – | .93 | .92 | .93 | .94 | .94 | .95 |
| | JCON3 | .94 | .94 | .94 | – | – | – | .93 | .93 | .93 | .94 | .93 | .94 |
| | JCON4 | .96 | .97 | .96 | – | – | – | .92 | .93 | .93 | .96 | .95 | .95 |
| Job satisfaction (JSAT) | JSAT1 | .86 | .83 | .84 | – | – | – | – | – | – | .86 | .85 | .85 |
| | JSAT2 | .84 | .84 | .85 | – | – | – | – | – | – | .88 | .84 | .86 |
| | JSAT3 | .85 | .86 | .86 | – | – | – | – | – | – | .89 | .86 | .88 |

*Note*: All cross loadings were less than .35.

# Appendix C

## Controlling Common Method Biases

| Techniques | Actions Taken |
|---|---|
| **Procedural Remedies** | |
| Temporal, proximal, psychological, or methodological separation of measurement | We measured the key dependent variables (i.e., job characteristics) separately from the independent variables. For instance, job characteristics were measured at $T_0$, $T_2$, and $T_3$, and technology and work process characteristics were measured at $T_1$. |
| Protecting respondent anonymity and reducing evaluation apprehension | We informed the participants that their responses would be confidential, assured them that there were no right or wrong answers, and requested that they answer questions as honestly as possible. |
| Counterbalancing question order | We counterbalanced the items by randomizing them within each survey block. We also randomized the survey blocks. For example, items within technology characteristics were randomized, and the blocks for technology characteristics and work process characteristics were randomized. |
| Improving scale items | We used pre-validated reliable items (see discussion of measurement) and provided definitions and examples for potentially unfamiliar terms. |
| **Statistical Remedies** | |
| Harman's single factor test | The Harman's single factor test indicated that there was no single factor that explained most of the variance. The first factor explained only 26% of the variance. |
| Partial correlation procedure (e.g., marker variable technique) | Given that we did not include any constructs that were completely theoretically unrelated to one or more constructs in our model to reduce the survey length, we, following Pavlou et al. (2007), used a construct that was not part of our model and was weakly related to other constructs in the model—namely, *organizational tenure*. We compared the correlation between organizational tenure and other constructs in the study and did not find any significant correlations. The average correlation was .09, thus indicating that there was no evidence of common method bias. |
| Controlling for the effects of an unmeasured latent methods factor (i.e., single-common-method-factor approach; Podsakoff et al. 2003) | We did not find a good fit for the models when we used the single-common-method-factor approach. For example, the model fit indexes at $T_0$ were: $\chi^2 = 441.64$, $p < .001$, CFI = .82, NNFI = .72, SRMR = .18, RMSEA = .22. |

### *References*


Pavlou, P. A., Liang, H., and Xue, Y. 2007. "Understanding and Mitigating Uncertainty in Online Environments: A Principal–Agent Perspective," *MIS Quarterly* (31:1), pp. 105-136.

Podsakoff, P. M., Mackenzie, S. B., Lee, J., and Podsakoff, N. P. 2003. "Common Method Biases in Behavioral Research: A Critical Review of the Literature and Recommended Remedies," *Journal of Applied Psychology* (88:5), pp. 879-903.