

**Duration, Frequency, and Intensity of Knowledge Contribution:
Differential Effects of Job Characteristics**

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Abstract

Even though knowledge repositories typically seek to capture the knowledge employees acquire from working on their jobs, little consideration has been given to the influence of job characteristics. This study proposes a job knowledge contribution model that details the influence of different job characteristics on the duration, frequency, and intensity of knowledge contribution through their influences on different knowledge characteristics. The model was assessed with a survey of 255 employees working in knowledge-intensive industries. Identifying the knowledge mechanisms explaining the impact of job characteristics has implications for the theoretical development of knowledge contribution and indicates new directions for research.

Keywords: Knowledge contribution, job characteristics, perceived value of knowledge, knowledge renewal, knowledge breadth

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Introduction

Since the early days of organizational knowledge management (KM), electronic repositories have been commonly used to collect, organize, and improve accessibility to employees' knowledge. A recent study of KM in knowledge-intensive organizations highlights that building and maintaining a centralized, searchable repository remains a best practice for supporting knowledge-intensive activities such as product development (APQC 2012). Appropriate knowledge repository architecture facilitates the accumulation of knowledge stock and resources, which has been shown to improve organizational efficiency (Miranda et al. 2011). Nevertheless, much of the success of repositories is predicated on employees' willingness to contribute their knowledge. If employees do not actively provide content, dissemination and reuse of knowledge in repositories cannot occur and the benefits attainable would be limited (Huang et al. 2013; Kankanhalli et al. 2005). The importance of knowledge contribution has motivated many studies on its antecedents. To date, antecedents identified include those related to cost and benefit considerations, contributor characteristics, social and cultural factors, and system characteristics (e.g., He and Wei 2009; Kankanhalli et al. 2005; Muller et al. 2005; Watson and Hewett 2006). Even though knowledge repositories typically seek to capture employees' knowledge which is largely acquired from working on their jobs (Schmidt et al. 1986), much less consideration has been given to the influence of job characteristics.

The few studies that examined job characteristics have focused on the relationships between job characteristics and intrinsic and extrinsic motivations (e.g., Foss et al. 2009; Pee 2012). They have provided insights into the motivational mechanisms through which job characteristics influence knowledge contribution. However, the potential effects of job characteristics on employees' knowledge accrual and knowledge contribution (that is, the knowledge mechanisms) have not been explored. Motivated thus, this study proposes a model that describes the relationships among job characteristics, knowledge characteristics, and knowledge contribution behavior, while controlling for the influences of intrinsic and extrinsic motivations. The proposed job knowledge contribution model conceptualizes knowledge characteristics in terms of perceived value (of knowledge), knowledge renewal, and knowledge breadth to account for the effects of different job characteristics. Overall, the model seeks to enrich our understanding of the effects of job characteristics on knowledge

contribution by detailing the underlying knowledge mechanisms.

Depending on their knowledge characteristics, employee may behave differently in knowledge contribution. For example, employees whose knowledge is updated regularly may contribute new submissions to repositories more frequently, while those with a broader range of knowledge may tend to contribute to more different topics or categories of knowledge. Time spent/duration, frequency of contribution, and number of unique contributions/intensity have been commonly used to conceptualize and measure knowledge contribution behavior in prior studies (e.g., Durcikova and Brown 2007; Durcikova and Gray 2009; He and Wei 2009; Kankanhalli et al. 2005; King and Marks Jr 2008; Raman et al. 2005; Watson and Hewett 2006). However, the concept of knowledge contribution has mostly been treated as a black box, where different conceptualizations are often treated as interchangeable and selected based on practical considerations (e.g., data availability). This poses a challenge to the aggregation of findings across studies in theoretical development, as studies using different conceptualizations cannot be assumed to be comparable (Bunderson and Sutcliffe 2002) and the significance of antecedents may depend on the conceptualization used.

To the extent that an electronic knowledge repository is a type of information system, research on system use lends support to the need to differentiate among conceptualizations. Specifically, the duration and frequency of system use were found to be predicted by different factors and having a clearer and deeper understanding of system use may facilitate further studies on the different downstream impacts of system use (Venkatesh et al. 2008). As knowledge contribution studies accrue and theory development advances, it becomes necessary to open up the black box of knowledge contribution behavior and better understand the different antecedents and theoretical mechanisms underlying the duration, frequency, and intensity of knowledge contribution. To this end, a study that considers all three conceptualizations in the same research setting is necessary, since variance in results across studies may be a consequence of different research settings rather than (or in addition to) different conceptualizations of knowledge contribution. Furthermore, the comparison needs to be grounded on sound theoretical arguments that make clear why the effects are expected to differ across conceptualizations.

Motivated thus, this study goes beyond treating duration, frequency, and intensity as interchangeable measures of knowledge contribution behavior to examining them as theoretical constructs. We not only identify the job characteristics predicting different

conceptualizations of knowledge contribution, but also identify the knowledge mechanisms by which the effects occurred. In sum, the objectives of this paper are: 1) develop a research model to explain the knowledge mechanisms through which different job characteristics influence the duration, frequency, and intensity of knowledge contribution and 2) statistically assess the proposed research model with empirical data.

Conceptual Background

In this section, the concept of knowledge contribution will first be defined and reviewed. The key characteristics of a job will then be described. This is followed by a discussion of the characteristics of employees' knowledge that are likely to be influenced by job characteristics.

Conceptualizations of Knowledge Contribution

Employees can contribute to electronic repositories by adding knowledge in the form of new documents or posts (Durcikova and Gray 2009; Watson and Hewett 2006), or shaping and revising one's own or others' previous submissions (Majchrzak et al. 2013b; Yates et al. 2010). The focus of this study is on the adding of knowledge, which is critical in enriching a repository to ensure that it captures the new developments in a changing business environment. Our review of studies examining this type of knowledge contribution (see Table 1) reveals that it is commonly conceptualized in terms of duration (Chung and Galletta 2011; He and Wei 2009; Raman et al. 2005), frequency (Durcikova and Gray 2009; Kankanhalli et al. 2005; Kim 2007; Watson and Hewett 2006), and number of unique contributions (Raman et al. 2005; Wasko and Faraj 2005).

Duration of knowledge contribution represents the amount of clock time an employee spends on creating a new submission. Ancona et al. (2001) characterize clock time as being a linear continuum that is divisible into quantifiable units. Duration is the accumulation of the quantifiable units. *Frequency* is the number of times an employee creates new submissions within a defined temporal continuum (Durcikova and Brown 2007). It represents how often an employee contributes knowledge. An employee who contributes more frequently also tends to have a greater number of unique submissions. In order to minimize the conceptual overlap between frequency and the number of unique contributions, we define unique contributions more precisely in terms of the number of unique topics to which an employee contributes knowledge. This conceptualization of knowledge contribution is referred to as

intensity. Content on knowledge repositories is typically organized into topics to help knowledge seekers find the knowledge they need (Gray and Durcikova 2005/6). Employees who have a broad range of knowledge are likely to be better able to contribute to multiple topics. Intensity is distinct and not easily discernible from the duration and frequency of contribution, since spending more time on a submission and contributing knowledge more frequently do not necessarily indicate that one contributes to a wider range of topics. Intensity is an important aspect of knowledge contribution because it determines the richness and breadth of knowledge stored in a repository and enhances its usefulness to users. To the extent that knowledge repository is an information technology system, intensity of knowledge contribution is akin to the intensity of information system use, which refers the extent to which different aspects of a system are used (Moore and Benbasat 1996; Thompson et al. 1991). Since the focus of this study is *knowledge* contribution rather than system use, it is most appropriate to define intensity in terms of the extent to which employees contribute to different knowledge topics.

Study	Conceptualization of Knowledge Contribution	Nature of Measure	Sample
Durcikova and Gray (2009)	- The extent to which one frequently, often, and regularly uses repositories - Actual contribution frequency	Objective and perceptual	118 senior managers in a large American firm
He and Wei (2009)	Usage time spent	Objective	161 employees in an international IT company
Kankanhalli et al. (2005)	The extent to which one frequently, often, and regularly uses repositories	Perceptual	150 senior managers in 10 public organizations in Singapore
King and Marks Jr (2008)	Frequency measured with a scale anchored by "never", "rarely", "some of the time", "a good bit of the time", "usually", "always"	Perceptual	169 employees in a large federal agency in the United States
Raman et al. (2005)	- Time spent - Number of unique, different submissions	Objective	20 students in an information systems and technology school in the United States
Wasko and Faraj (2005)	Volume of contribution	Objective	604 members of a national legal professional association in the United States
Watson and Hewett (2006)	Frequency measured with a scale anchored by "almost never" and "always"	Perceptual	430 employees in a global knowledge services firm

Job Characteristics and Impact on Knowledge Contribution

This study seeks to examine how different conceptualizations of knowledge contribution are

influenced by different job characteristics through their impact on various knowledge characteristics. Hackman and Oldham (1976) identified five core job characteristics that influence employees' in-role and extra-role behaviors at work: task significance, task feedback, skill variety, task identity, and job autonomy.

Task significance refers to the degree to which a job has substantial impact on the lives or work of other people, whether within the immediate organization or in the external environment (Hackman and Oldham 1976). A meta-analysis has shown that employees working in jobs with task significance experience their work as being more meaningful (Morgeson and Humphrey 2006). Task significance may motivate pro-social behavior, which involves the act of freely giving one's knowledge, skills, and time for the benefit of other people, groups, or causes (Grant 2012). *Task feedback* is the degree to which carrying out a job allows the employee to obtain direct and clear information about the effectiveness of his or her performance (Hackman and Oldham 1976). Feedback on performance is an important basis for judging one's level of competence and identifying potential improvements (Anseel et al. 2009). *Skill variety* refers to the degree to which a job requires the employee to use different knowledge, skills, and talents (Hackman and Oldham 1976). Nair and Vohra (2010) found that knowledge workers who perceive their job to lack skill variety are likely to feel alienated and are less likely to put effort into work or care about events at their workplace. de Vries et al. (2006) found that the level of variation in work is positively related to an employee's sharing of knowledge with others. *Task identity* is the degree to which the employee completes a "whole" and identifiable piece of work, that is, doing a job from beginning to end with a visible outcome (Hackman and Oldham 1976). A job with high task identity allows the employee to follow through the main stages to "provide a complete unit of product or service" (Hackman and Oldham 1976, p. 257) instead of just an indistinguishable part. *Job autonomy* refers to the degree of freedom, independence, and discretion in scheduling work and determining the procedures for carrying out activities in a job (Hackman and Oldham 1976). In high-autonomy jobs, job outcome depends more on the employee's effort, initiative, and decisions rather than on the adequacy of instructions from supervisors or adherence to standard operating procedures. High job autonomy offers personal control, which allows employees to manage their environment to make it less threatening and more rewarding (Ganster and Fusilier 1989). In KM research, autonomy has been found to promote cooperative learning in systems development teams (Janz and Prasarnphanich 2003), solution innovation among technical support analysts (Durcikova et al. 2010), as well as knowledge

sharing among employees (Cabrera et al. 2006). More generally, enriching jobs by increasing the levels of all five job characteristics has been found to significantly improve the job satisfaction and task performance of knowledge workers (compared to manual workers; Yan et al. 2011). Overall, these findings suggest that it is relevant to consider the impact of job characteristics on the KM behaviors of knowledge workers, such as knowledge contribution. In support, Arazy and Gellatly (2012) observed that the five job characteristics influenced employees' engagement in corporate Wikis, measured in terms of contributions and edits.

A few studies have looked beyond the direct effects of job characteristics on knowledge contribution to clarify the underlying mechanisms. Thus far, they have mainly focused on motivational mechanisms. Foss et al. (2009) studied job autonomy and task feedback and found that they influenced the intrinsic and extrinsic motivations of employees, which in turn affected their sending of knowledge to colleagues. Pee (2012) observed that job characteristics positively moderated the effect of extrinsic motivation on knowledge contribution. Nevertheless, other than motivation, it has been suggested that job characteristics may influence knowledge contribution by affecting employees' knowledge and skills (Kelloway and Barling 2000). This knowledge-oriented mechanism is important and closely related to the phenomenon of knowledge contribution in that it focuses directly on the knowledge to be contributed. Yet, there has been a lack of studies clarifying the effects of different job characteristics on employees' knowledge accrual and contribution. This study seeks to address this gap by proposing that job characteristics influence employees' perceived value of knowledge, knowledge renewal, and knowledge breadth. These knowledge characteristics are described next.

Characteristics of Employees' Knowledge

Perceived value of knowledge refers to the extent to which one deems his or her own knowledge to be useful, beneficial, and acquired from important sources (Ford and Staples 2006). In organizations, the value of employees' knowledge lies in the production of intellectual capital such as patents and copyrights to help maintain or enhance organizational competitive advantage (Bogdanowicz and Bailey 2002). Therefore, knowledge related to key products and services is typically perceived as valuable. Knowledge that provides benefits, such as creation of new products, also tends to be highly valued (Ipe 2003). In line with this, it has been shown that employees regard knowledge about work procedures and understanding of client needs to be highly valuable, and this knowledge is mainly acquired

from professional education and job experience (Ford and Staples 2006). In contrast, general knowledge (e.g., computer skills) and knowledge that is not job related are seen as less valuable (Ford and Staples 2006). This suggests that employees' knowledge and its perceived value are influenced by working on their jobs. Perceived value of knowledge has also been found to influence individuals' intention to share knowledge with others, since sharing highly valuable knowledge may help one earn respect (Cyr and Choo 2010; Ford and Staples 2006). The potential job characteristic → perceived value of knowledge → knowledge contribution relationship will be investigated in this study.

It is important to note that the value of knowledge is conceptually distinct from the uniqueness of knowledge, in that value focuses on the effectiveness of production rather than the imitability of resource (Lepak and Snell 2002). Uniqueness of knowledge could impede knowledge contribution, since employees are likely to guard unique knowledge to retain any power arising from exclusive resource ownership. Perceived value of knowledge is also different from the more commonly studied antecedent of knowledge self-efficacy, defined as employees' *confidence* in their ability to provide knowledge that is useful to their organizations (Kankanhalli et al. 2005; Lin 2007; Lin and Huang 2010). Our emphasis on knowledge contribution leads us to be principally concerned with the nature of knowledge that arises from employees' job experience rather than employees' personality-based beliefs.

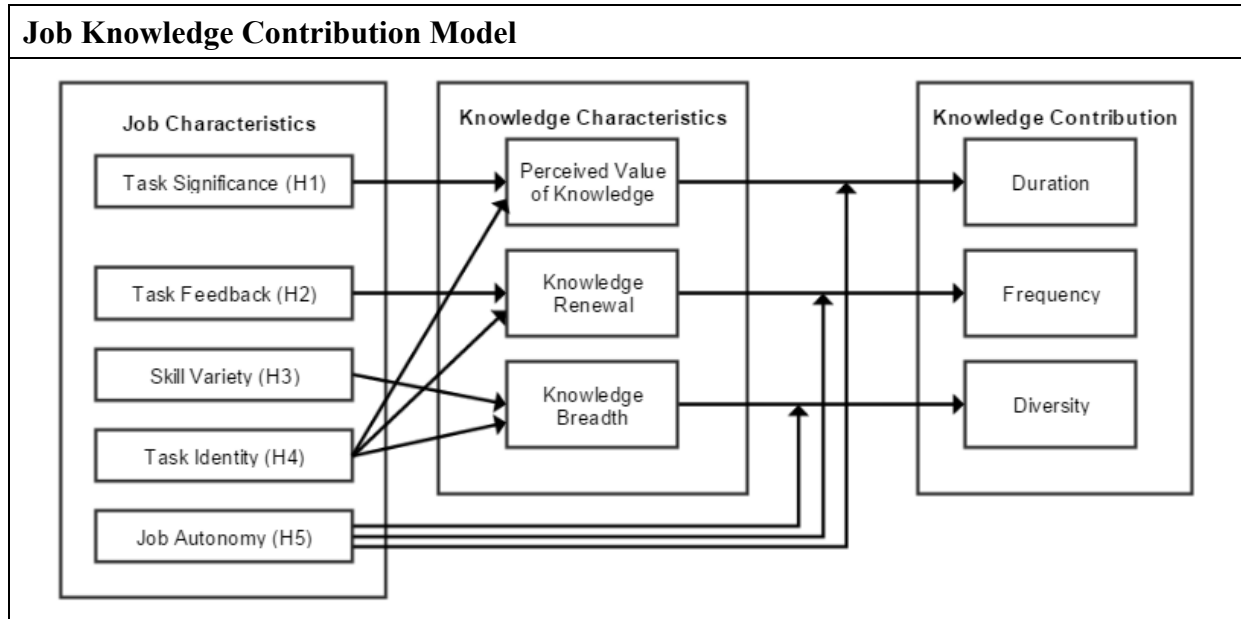
It is crucial that organizations operate and make decisions based on up-to-date knowledge that accurately reflects current developments in the environment. Employees' knowledge renewal is an important way through which organizations keep their knowledge relevant (Argyris and Schon 1978). *Knowledge renewal* involves enhancement, continuous learning, and systematic maintenance of knowledge. It is conceptually distinct from employee learning, knowledge sourcing, and learning orientation in that it focuses on the resultant change in one's knowledge stock rather than the act and mechanism of learning, sources of knowledge, or motivation of learning (Rong and Grover 2009). The knowledge-based perspective is more relevant in this study than the activity-based perspective since knowledge contribution is grounded on knowledge that has been successfully acquired and assimilated. Knowledge renewal also helps individual employees avoid professional obsolescence and remain proficient in their current and near-future job roles. It is mainly driven by the need to improve one's job-related status, such as advancement in professional knowledge and career aspirations (Rong and Grover 2009). Therefore, we expect job

characteristics to influence knowledge renewal.

Knowledge breadth refers to the extent to which one possesses knowledge of multiple domains relevant to his or her organization (Taylor and Greve 2006). Prior studies have mainly examined the breadth of knowledge in teams. Recent research showed that individuals can have different levels of knowledge breadth (Bublitz and Noseleit 2014) and individuals are better at combining and applying different knowledge than teams since they face less coordination problems or interpersonal conflicts that often arise in combining various perspectives in teams (Taylor and Greve 2006). Employees can acquire a broad range of knowledge through high-commitment exposures such as applying knowledge related to multiple domains in a job role (Bublitz and Noseleit 2014; Taylor and Greve 2006). For example, a general manager is likely to develop knowledge of a specific industry, as well as knowledge of different business areas such as marketing and sales, finance, operations, and information technology. Others, such as specialists and entry-level employees assigned to a single role or task, are instead likely to acquire knowledge in only one or a limited number of domains. This suggests that employees' knowledge breadth is likely to be influenced by their job characteristics.

Research Model and Hypotheses

In this section, we discuss how different job characteristics relate to the duration, frequency, and intensity of knowledge contribution. In general, job characteristics are expected to influence knowledge contribution through affecting the knowledge of employees. The proposed mediated model is shown in Figure 1. Unlike other job characteristics, job autonomy is expected to moderate the effect of knowledge characteristics on knowledge contribution. The theoretical bases for the impact of each job characteristic are detailed next.



Employees working on jobs with high task significance produce outputs that have strong, positive impact on others (Grant 2008; Hackman and Oldham 1975). For knowledge-intensive professionals (the target population of this study), knowledge is an important factor of production. Those perceiving high task significance are likely to view their job knowledge to be instrumental in generating the important output and therefore highly valuable in their organizations. When contributing knowledge to repositories, those who perceive their knowledge as important tend to work through the new submission carefully to ensure accuracy, due to the expectation that the contributed knowledge will have significant consequences. This is in line with the concept of prospective metaknowledge (Cress et al. 2007), which suggests that individuals' evaluation of their own knowledge influences the expectation of whether their contributions to repositories will be useful to and needed by others. Contributing knowledge to repositories typically requires the composition of texts to describe one's knowledge on a topic. Composition of texts involves activities such as planning, translating knowledge into texts, and reviewing (Kellogg 1987). Individuals tend to spend more time thinking, editing, and revising texts when they believe that what they write is important (Zamel 1982). This suggests that employees who believe that their knowledge is valuable are likely to spend more time creating a new submission. Accordingly, we hypothesize a mediating relationship that explicates the effect of task significance on the duration of knowledge contribution. Since the concept of task significance is concerned with the importance of tasks, we expect it to influence the perceived value of knowledge but not the other knowledge characteristics of knowledge renewal and knowledge breadth.

H1: Task significance of a job increases the employee's duration of knowledge contribution

through increasing the perceived value of knowledge.

Task feedback is the extent to which an employee obtains direct and clear information about job performance from stakeholders such as supervisors, customers, and co-workers (Hackman and Oldham 1975). Feedback provides information for employees to evaluate whether they meet job expectations and offers a basis for determining the necessary improvements. The need to improve prompts employees to learn new knowledge and skills to close the gap (Kluger and DeNisi 1996). In contrast, employees lacking awareness of performance lag and need for improvement are less likely to recognize knowledge deficit and actively engage in learning (Kulik et al. 2007). Regular task feedback is expected to serve as a stimulus that triggers continuous introspection and learning, which results in employees' frequent knowledge renewal. Employees who acquire new knowledge regularly are likely to contribute knowledge more frequently. Therefore, we posit that the job characteristic of task feedback prompts employees to engage in knowledge renewal regularly and this influences their frequency of knowledge contribution. There is a lack of theoretical basis for expecting that the extent to which employees receive task feedback would influence knowledge characteristics other than knowledge renewal.

H2: Task feedback of a job increases the employee's frequency of knowledge contribution through increasing knowledge renewal.

Skill variety is the degree to which a job requires the employee to draw upon different knowledge and skills (Hackman and Oldham 1975). To succeed in jobs with high skill variety, employees need to acquire a broader set of knowledge and skills and they are therefore likely to develop greater knowledge breadth. In line with this, Oldham and Hackman (2010) suggest that enriching a job by increasing skill variety offers the chance to extend the employee's knowledge and skill set. Employees with a broader spectrum of knowledge are better able to contribute to a more diverse range of topics on repositories. Skill variety focuses on the range of knowledge and it is therefore expected to influence knowledge breadth but not directly influence the other knowledge characteristics of perceived value of knowledge and knowledge renewal.

H3: Skill variety of a job increases the employee's intensity of knowledge contribution through increasing knowledge breadth.

A job with high task identity requires the employee to follow through the delivery of a clearly discernible and recognizable unit of output from the beginning to the end (Hackman

and Oldham 1975). The identifiable output serves as a tangible basis for discerning the value of knowledge that goes into producing the output. Employees working in jobs with high task identity are therefore likely to appreciate the value of their knowledge better. In a similar vein, Jackson and Schuler (1985) suggest that task identity increases employee's awareness of how they fit into the larger organizational scheme. The responsibility for an entire process of production and the visibility of output also instill a greater sense of accountability in the employee (Hackman and Oldham 1975) and this is likely to promote introspection and stimulates learning of new knowledge and skills to meet the accountability demands. In support, a case study observed that employees with greater responsibility and accountability believe that learning would build up their competency (Yang 2004). This suggests that task identity may also increase knowledge renewal. In jobs with high task identity, employees are involved in all the activities undertaken to produce the output, which requires more comprehensive knowledge of the entire process of production. They are therefore likely to develop greater knowledge breadth. For example, an engineer responsible for designing, prototyping, and testing an identifiable car component is likely to have more extensive knowledge than one who is only in charge of testing the component. In sum, we hypothesize that task identity influences all three knowledge characteristics, and in turn, affects the duration, frequency, and intensity of knowledge contribution.

H4a: Task identity of a job increases the employee's duration of knowledge contribution through increasing the perceived value of knowledge.

H4b: Task identity of a job increases the employee's frequency of knowledge contribution through increasing knowledge renewal.

H4c: Task identity of a job increases the employee's intensity of knowledge contribution through increasing knowledge breadth.

While the job characteristics of task significance, task feedback, skill variety, and task identity are expected to influence employees' knowledge, job autonomy is expected to determine whether employees have the opportunity to access knowledge repositories at work. Job autonomy is the extent to which an employee has substantial freedom, independence, and decision latitude in scheduling and carrying out work (Hackman and Oldham 1975). High job autonomy allows employees to determine when, where, and how work is to be done. These employees are able to make flexible arrangements to conduct other activities alongside formal job activities to meet multiple work and non-work demands (D'Abate 2005). Studies have shown that employees with high job autonomy engage in more non-work activities (e.g.,

Garrett and Danziger 2008). This suggests that high job autonomy offers employees more opportunities to participate in activities that are not mandatory to a job, such as knowledge contribution. With the authority to schedule the use of time at work, employees are able to access a knowledge repository any time they want, contribute knowledge as frequently as they like, and spend as much time as they need. In contrast, employees with low job autonomy are expected to follow a predetermined schedule and they are likely to have less opportunity and discretion to access a knowledge repository outside the designated time and routine. Although it may be possible for them to access the knowledge repository after work, they are more likely to use the time for personal activities and leisure rather than knowledge contribution if the personal time is not compensated (Stier and Lewin-Epstein 2003). Therefore, for employees with low job autonomy, their duration, frequency, and intensity of knowledge contribution may be lower even when their perceived value of knowledge, knowledge renewal, and knowledge breadth are favorable. In sum, we expect job autonomy to moderate the effect of knowledge characteristics on knowledge contribution.

H5a: When an employee has high (or low) job autonomy, the perceived value of knowledge has a stronger (or weaker) effect on the duration of knowledge contribution.

H5b: When an employee has high (or low) job autonomy, knowledge renewal has a stronger (or weaker) effect on the frequency of knowledge contribution.

H5c: When an employee has high (or low) job autonomy, knowledge breadth has a stronger (or weaker) effect on the intensity of knowledge contribution.

To determine the significance of job characteristics, it is also important to control for the other known antecedents of knowledge contribution. There has been strong evidence that motivational factors such as intrinsic motivation and extrinsic motivation, and social factors such as pro-sharing norms, and generalized trust have significant effects on knowledge contribution (e.g., He and Wei 2009; Kankanhalli et al. 2005). They were therefore included as control variables in the proposed model. Further, two motivational mechanisms through which job characteristics influence knowledge sharing found in prior research (Foss et al. 2009) were also controlled: job autonomy → intrinsic motivation and task feedback → extrinsic motivation.

Research Method

The proposed model was assessed with data collected in a survey. The development of the survey instrument, data collection procedure, and sample demographics will be described in

this section.

Survey Instrument Development and Pretest

Most constructs in our study were measured with items validated in prior studies, with slight adaptation to suit our context (see Table 2). For knowledge breadth, new measures were developed based on the description of “cognitive intensity” by Taylor and Greve (2006) and “broad expertise” by Bublitz and Noseleit (2014). The items assess the extent to which an employee has knowledge spanning different professional domains, topics, and business functions.

Measures for the control variables of intrinsic motivation, extrinsic motivation, pro-sharing norms, and generalized trust were adopted from the scales validated by Kankanhalli et al. (2005). Among them, the indicators of extrinsic motivation are formative. Unlike reflective indicators, which are affected by an underlying latent construct and therefore expected to covary, each formative indicator captures a different aspect of the construct and cannot be assumed to covary (Henseler and Fassott 2010). Indicators of extrinsic motivation measure the possibility of getting better work assignments, chances for job promotion, higher salary, stronger job security, and more bonus when one contributes knowledge to repositories. They are considered as formative because they tap into different themes and cannot be assumed to be interchangeable.

The proposed survey instrument was refined in a pretest using the unlabeled and labeled sorting procedures proposed by Moore and Benbasat (1991). We also solicited qualitative feedback about the clarity of questions in the pretest. Results were satisfactory, with inter-judge raw agreement scores averaging 0.94, Kappa scores averaging 0.92, and placement of items within the targeted constructs averaging 0.91.

Table 2. Survey Instrument and Source

Construct	Item
Task Significance (SIG)	To what extent does your job...(all items adapted from Morris and Venkatesh 2010) SIG1: have job significance? A significant job means that the results of your work are likely to significantly affect the performance, wellbeing, or lives of other people SIG2: have effect on a lot of other people? SIG3: have job significance and importance in the broader scheme of things
Task Feedback (FEE)	To what extent does your job provides...(all items adapted from Morris and Venkatesh 2010) FEE1: clues about how well you are doing – aside from any feedback that coworkers or supervisors may provide? FEE2: chances for you to figure out how well you are doing your job? FEE3: knowledge of whether you have performed well after you finish a job?
Skill Variety (VAR)	To what extent...(all items adapted from Morris and Venkatesh 2010) VAR1: does your job have variety? Having variety means you are required to do many different things at work, using a variety of your skills and talents VAR2: does your job require you to use a number of complex or high-level skills? VAR3: is your job complex and non-repetitive?
Task Identity (IDE)	To what extent does your job ...(all items adapted from Morris and Venkatesh 2010) IDE1: require completion of a whole and identifiable piece of work? A whole and identifiable piece of work means a complete piece of work that has an obvious beginning and end rather than only a small part of the overall piece of work IDE2: provide chances to completely finish the pieces of work you begin? IDE3: have job arrangements that allow you to do a piece of work from beginning to end?
Job Autonomy (AUT)	To what extent does your job...(all items adapted from Morris and Venkatesh 2010) AUT1: have autonomy? Having autonomy means that you are allowed to decide on your own how to go about doing the work AUT2: give you opportunity for independence and freedom in how you do the work? AUT3: give you chances to use your personal initiative and judgment in carrying out the work?
Construct	Item
Perceived Value of Knowledge (VAL)	To what extent do you believe that your knowledge is generally ...(all item adapted from Ford and Staples (2006) VAL1: useful for your job (<i>strongly disagree – strongly agree</i>)? VAL2: valuable to coworkers and managers? VAL3: acquired from important sources?
Knowledge Renewal (REN)	To what extent do you ...(all items adapted from Rong and Grover (2009)) REN1: possess knowledge of the latest developments in your field of work? REN2: have job knowledge that is current and reflects the present state of affairs in your field of work? REN3: have job knowledge that is up to date?
Knowledge Breadth (BRE)	To what extent is your knowledge ... BRE1: diverse in that it spans many different professional domains (developed based on Taylor and Greve 2006)? BRE2: broad in that it spans many different topics (developed based on Bublitz and Noseleit 2014)? BRE3: varied in that it spans many different business functions (developed based on Bublitz and Noseleit 2014)?
Knowledge Contribution*	DURATION: On average, <u>how much time</u> do you spend on creating each submission to your organization's electronic knowledge repositories (<i>seven-point Likert scale anchored by "less than 30 minutes",..., "more than four hours"</i> ; adapted from Raman et al. (2005))? FREQUENCY: On average, <u>how often</u> do you create new submissions (rather than update existing ones) to your organization's electronic knowledge repositories? (<i>seven-point Likert scale anchored by "rarely"- "several times a month"- "several times a day"</i> ; adapted from Kankanhalli et al. (2005)) DIVERSITY: To what extent do you contribute knowledge to many <u>different topics</u> rather than specific topics on your organization's electronic knowledge repositories (<i>seven-point Likert scale anchored by "very few, specific topics" – "some topics" – "many different topics"</i> ; adapted from Hsu et al. (2007)?)
* All items were measured with seven-point Likert scale anchored by "not at all" – "moderate" – "to a very great extent" unless otherwise indicated in italic parentheses.	

Data Collection

This study examines knowledge contribution to electronic repositories and employees working in organizations that maintain such repositories constitute the target population. Respondents were recruited through a research company that had a panel of 88,856 employees from different organizations and industries. The company randomly selected 553 individuals occupying professional or managerial positions in the knowledge-intensive industries of information technology, healthcare, consulting, and financial services. They were contacted to complete an online survey. The questionnaire began with two filter questions to ensure that only appropriate respondents were asked to complete the questionnaire. The first question requested respondents to indicate the types of information system available for their use in their organizations. The second question asked respondents to specify their job position. Based on these filter questions, employees working in organizations without knowledge repositories (or were not aware of the existence of knowledge repositories) and those occupying non-professional or non-managerial positions were not directed to the main survey questionnaire. Out of the 553 individuals contacted, 46.1% qualified for the survey based on the filter questions and completed the questionnaire, yielding a sample size of 255.

Sample Demographics

The characteristics of the survey respondents are summarized in Table 3. The majority of the respondents are male (64.7%) between 30 to 49 years old (62.7%) and attained a Bachelor degree (72.5%). About half of them were working in professional positions (60.8%) in large organizations with more than 1000 employees (45.9%). Most of them had been with their organizations for more than five years (63.1%).

Table 3. Demographic Analysis (n=255)				
Characteristic	Value	Frequency	Percent*	Cumulative Percent
Gender	Female	90	35.3	100.0
	Male	165	64.7	64.7
Age (years)	20-29	56	22.0	22.0
	30-39	83	32.5	54.5
	40-49	77	30.2	84.7
	50-59	30	11.8	96.5
	>60	9	3.5	100.0
Education	Professional Certificate	44	17.3	17.3
	Bachelor	185	72.5	89.8
	Master	4	1.6	91.4
	PhD	22	8.6	100.0
Job Position	Chief Executive Officer/ President	4	1.6	1.6
	Senior Manager (COO, CFO)	53	20.8	22.4
	Division/ Department Manager	34	13.3	35.7
	Middle Manager	9	3.5	39.2
	Professional	155	60.8	100.0
Characteristic	Value	Frequency	Percent*	Cumulative Percent
Organization Size (person)	51-100	26	10.2	10.2
	101-200	24	9.4	19.6
	201-300	17	6.7	26.3
	301-400	16	6.3	32.5
	401-500	11	4.3	36.9
	501-1000	44	17.3	54.1
	>1001	117	45.9	100.0
Job Tenure (year)	< 1	22	8.6	8.6
	1-2	19	7.5	16.1
	3-5	53	20.8	36.9
	6-9	60	23.5	60.4
	10-15	39	15.3	75.7
	>15	62	24.3	100.0

*Percentages for a characteristic may not sum to 100 due to rounding.

Data Analysis

The data were analyzed using Partial Least Squares (PLS) regression. PLS was chosen over ordinary least squares regression because it allows the simultaneous assessment of the measurement structure and causal paths (in terms of measurement model and structural model). Further, PLS is able to model causal sequence, which is necessary for testing our mediation hypotheses (Bollen 1989). Given the presence of a formative construct in our model (i.e., extrinsic motivation, which is a control variable), PLS is more appropriate than other structural equation modeling approaches because it can analyze reflective and formative constructs jointly occurring in a single model (Henseler and Fassott 2010; Wetzels et al. 2009).

Measurement Model Analysis

The measurement model was assessed in terms of reliability and discriminant validity (Wetzels et al. 2009). To evaluate reliability, Cronbach's alpha and composite reliability were calculated (see Table 4). We found that all values exceeded the requirement of 0.70. Discriminant validity was assessed by calculating average variance extracted (AVE) and item loading. All AVEs exceeded the recommended value of 0.50. Further, for all the constructs, the square root of AVE (diagonal entries in Table 5) exceeded corresponding correlations (non-diagonal entries in Table 5) with other constructs. Additional support for discriminant validity comes through inspection of the cross loadings, which were low compared with the loadings. For the formative construct of extrinsic motivation, these tests are not applicable. Instead, significance of item weights was examined to determine the contribution of items constituting the construct. The results were favorable, with all item weights significant at $p < 0.05$. Multi-collinearity among items was assessed using variance inflation factor (VIF). All VIFs were below the recommended threshold of 3.33 (Cenfetelli and Bassellier 2009).

Construct	Item	Loading*	Construct	Item	Loading*
Task Significance (SIG) $\alpha=0.93$; CR=0.95; AVE=0.87	SIG1	0.95	Job Autonomy (AUT) $\alpha=0.95$; CR=0.97; AVE=0.91	AUT1	0.96
	SIG2	0.93		AUT2	0.95
	SIG3	0.92		AUT3	0.95
Task Feedback (FEE) $\alpha=0.86$; CR=0.92; AVE=0.78	FEE1	0.87	Perceived Value of Knowledge (VAL) $\alpha=0.88$; CR=0.93; AVE=0.83	VAL1	0.96
	FEE2	0.93		VAL2	0.97
	FEE3	0.87		VAL3	0.95
Skill Variety (VAR) $\alpha=0.71$; CR=0.83; AVE=0.63	VAR1	0.90	Knowledge Renewal (REN) $\alpha=0.83$; CR=0.89; AVE=0.75	REN1	0.94
	VAR2	0.87		REN2	0.95
	VAR3	0.85		REN3	0.97
Task Identity (IDE) $\alpha=0.88$; CR=0.92; AVE=0.79	IDE1	0.98	Knowledge Breadth (BRE) $\alpha=0.84$; CR=0.90; AVE=0.79	BRE1	0.93
	IDE2	0.94		BRE2	0.95
	IDE3	0.86		BRE3	0.92

α : Cronbach's Alpha; CR: Composite Reliability; AVE: Average Variance Extracted;
* All item loadings were significant at $p < 0.001$

Common method bias was also assessed considering that all data were collected in a survey. We conducted three different tests: Harman's one-factor test with the confirmatory factor analysis (CFA) setting, calculated goodness-of-fit measures (Wetzels et al. 2009), and partial correlation approach based on the lowest observed correlation (Lindell and Whitney 2001). In the one-factor test, the largest factor extracted did not explain the majority of the variance (only 36.5%), indicating that common method bias was unlikely. The test of goodness-of-fit measures for PLS (Wetzels et al. 2009) showed that the one-factor model had considerably worse fit than the multi-factor model ($GOF_{\text{one-factor}}=0.34$ vs. $GOF_{\text{multi-factor}}=0.55$).

This further supported the conclusion that common method bias was not significant. In the partial correlation approach based on the lowest observed correlation (Lindell and Whitney 2001), construct correlations were compared to partial correlations which were corrected for the correlation with a theoretically-justified construct. We did not observe any change in significance after accounting for the distinct construct. Overall, the three tests indicate that common method bias is minimal.

	Mean	SD	SIG	FEE	VAR	IDE	AUT	VAL	REN	BRE	DUR	FRE	DIV
SIG	3.33	1.34	0.97										
FEE	3.41	1.10	0.36**	0.89									
VAR	3.28	1.15	0.44**	0.37**	0.80								
IDE	3.19	1.16	0.23**	0.31**	0.36**	0.95							
AUT	4.14	1.47	0.22**	0.19**	0.35**	0.25**	0.95						
VAL	4.67	1.58	0.45**	0.23**	0.38**	0.34**	0.26**	0.91					
REN	3.92	1.33	0.31**	0.59**	0.44**	0.37**	0.35**	0.35**	0.87				
BRE	3.85	1.36	0.24**	0.32**	0.56**	0.64**	0.36**	0.45**	0.46**	0.89			
DUR	4.25	1.26	0.23**	0.15*	0.30**	0.21**	0.12	0.40**	0.32**	0.31**	N.A.		
FRE	4.26	1.80	0.30**	0.40**	0.40**	0.27**	0.26**	0.31**	0.56**	0.47**	0.47**	N.A.	
DIV	4.25	1.63	0.36**	0.42**	0.51**	0.35**	0.28**	0.42**	0.49**	0.52**	0.40**	0.47**	N.A.

SD: Standard deviation; *p<0.05; **p<0.01

In addition to ex-post statistical assessment, we employed several ex-ante strategies suggested by Podsakoff et al. (2003) to minimize common method bias. First, the survey questions were measured using only positive values rather than bipolar values (e.g., -3 to +3) to avoid acquiescence bias. Second, respondents were assured of their anonymity and instructed to select the responses that best described their situations and perceptions rather than the “correct” response. Third, survey questions were pretested to ensure that the wording was clear to respondents. Combining multiple statistical and methodological strategies is expected to minimize common method bias more effectively than employing only one of them (Craighead et al. 2011).

Structural Model Analysis

We conducted two complementary tests of the mediating effects in hypotheses H1 to H4, following Rai et al. (2006). First, the full-mediation model was compared with the partial-mediation model (which includes both direct and mediated effects). The full-mediation model explained 23% of the variance in duration, 39% of the variance in frequency, and 38% of the variance in intensity, while the partial-mediation model explained 30% of the variance in duration, 40% of the variance in frequency, and 44% of the variance in intensity. The change

in variance explained was assessed by computing pseudo-F statistics (Rai et al. 2006). We found that the additional direct paths did not significantly add to the variance explained in duration ($F=2.43$, $p=0.12$), frequency ($F=0.07$, $p=0.79$), and intensity ($F=2.79$, $p=0.10$). This suggests that the knowledge characteristics fully mediated the effects of job characteristics on various conceptualizations of knowledge contribution.

Second, we assessed the significance of the mediation effects by computing Z statistics based on the path coefficients and standard errors of direct paths among job characteristics, knowledge characteristics, and different conceptualizations of knowledge contribution (Rai et al. 2006). We found that all Z statistics were significant at $p<0.05$ (see Table 6), indicating that all the mediation effects were significant. yield a z-statistic of 2.75, which is significant at $p < .01$.

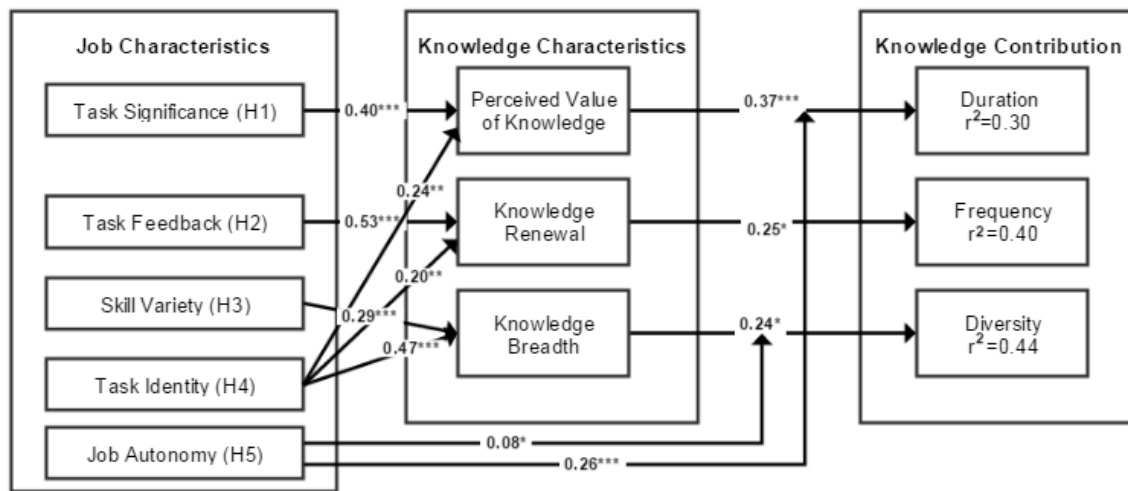
To test the hypotheses involving job autonomy, the interaction terms were added to the full-mediation model. The moderating effects were modeled using the product-indicator approach (Henseler and Fassott 2010), where product terms were created using the mean-centered indicators of the latent independent variable and the mean-centered indicators of the latent moderator variable. These product terms served as indicators of the interaction terms in the structural model. Path coefficients of the moderated model are shown in Table 6 and Figure 1. We found support for both H5a and H5c. The plots of the significant moderating effects (see Figure 2) show that perceived value of knowledge and knowledge breadth have much stronger effects on knowledge contribution when job autonomy is high. However, hypothesis H5b was not supported – job autonomy did not significantly moderate the effect of knowledge renewal on the frequency of contribution.

Several control variables had significant effects: knowledge contribution duration was influenced by gender, job position, job tenure, and intrinsic motivation; frequency was influenced by job position, intrinsic motivation, and extrinsic motivation; intensity was influenced by education level and extrinsic motivation. It was observed that the control relationships of job autonomy \rightarrow intrinsic motivation and task feedback \rightarrow extrinsic motivation were significant, supporting the findings of a prior study (Foss et al. 2009). Interestingly, employees working in managerial job positions spent less time contributing knowledge and did so less frequently. Those who were more highly educated tended to contribute to fewer topics (i.e., lower intensity). This may reflect the subject/major concentration prevalent in higher education. The implications of these and other findings will be discussed next.

Table 6. Path Coefficient and Result of Hypothesis Testing						
Construct and Hypothesis	Mediating Effect	Main Effect Model		Moderating Effect Model		Result
	Z-Statistic	Path	T-Statistic	Path	T-Statistic	
Task significance → Perceived value of knowledge	3.56**	0.39	7.24***	0.40	7.52***	H1 is supported
Perceived value of knowledge → Duration of contribution		0.29	4.12***	0.37	5.55***	
Task feedback → Knowledge renewal	2.64**	0.54	8.35***	0.53	8.02***	H2 is supported
Knowledge renewal → Frequency of contribution		0.25	2.80**	0.25	2.28*	
Skill variety → Knowledge breadth	2.70**	0.30	5.66***	0.29	4.50***	H3 is supported
Knowledge breadth → Intensity of contribution		0.19	3.12**	0.24	1.74*	
Task identity → Perceived value of knowledge	2.89**	0.25	4.17***	0.24	4.06***	H4a is supported
Task identity → Knowledge renewal	2.12*	0.19	3.46***	0.20	3.62***	H4b is supported
Task identity → Knowledge breadth	2.87**	0.47	7.75***	0.47	7.53***	H4c is supported
Job autonomy * Perceived value of knowledge → Duration	Not Applicable (N.A.)	N.A.	N.A.	0.20	4.15***	H5a is supported
Job autonomy → Duration		-0.05	0.67	-0.06	1.07	
Job autonomy * Knowledge renewal → Frequency		N.A.	N.A.	-0.01	0.21	H5b is not supported
Job autonomy → Frequency		0.01	0.11	0.01	0.12	
Job autonomy * Knowledge breadth → Intensity		N.A.	N.A.	0.08	1.93*	H5c is supported
Job autonomy → Intensity		0.01	0.19	0.01	0.02	

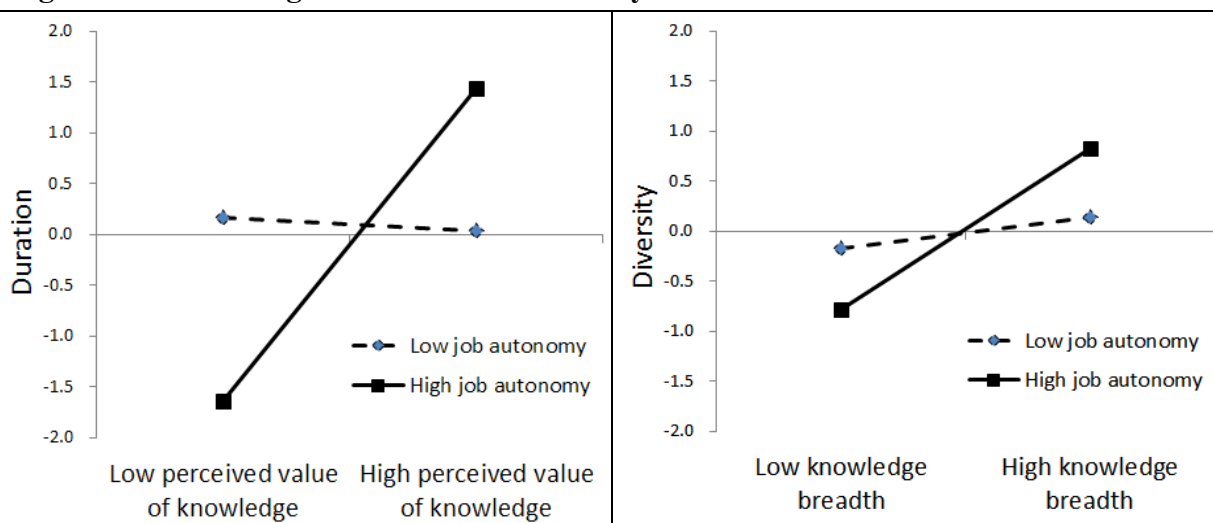
*Significant at $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 1. Significant Relationships in the Structural Model



*Significant at $p<0.05$; ** $p<0.01$; *** $p<0.001$

Figure 2. Moderating Effects of Job Autonomy



Note: High = +2 SD; low = -2 SD; constructs standardized

Discussion of Findings and Implications

This study developed and empirically assessed a research model that details the knowledge mechanisms through which different job characteristics influence the duration, frequency, and intensity of employees' knowledge contribution. Understanding the effects of job characteristics is relevant and important as employees acquire much valuable knowledge while working on their jobs and capturing this knowledge is the main goal of knowledge repositories. This is one of the earliest studies to examine the job characteristics → knowledge characteristics → knowledge contribution relationship. We found that task

significance increases employees' perceived value of their knowledge, which in turn increases the duration of knowledge contribution as they spend more time ensuring the accuracy of each contribution; task feedback promotes knowledge renewal, which results in higher frequency of new contributions; skill variety enhances employees' knowledge breadth, which enables contribution to a greater variety of topics (i.e., intensity); task identity has the strongest overall effect in that it affects employees' perceived value of knowledge, knowledge renewal, and knowledge breadth, which in turn increases the duration, frequency, and intensity of contribution. This suggests that increasing task identity should be the first choice when the goal is to improve knowledge contribution in general. On the other hand, job autonomy has a moderating effect such that those with more autonomy tend to spend more time on a contribution (i.e., duration) and contribute to more topics (i.e., intensity) given a level of perceived value of knowledge and knowledge breadth.

Contrary to hypothesis H5b, we found that the frequency of knowledge contribution was influenced by knowledge renewal but the relationship was not significantly moderated by job autonomy. This indicates that knowledge renewal increases the frequency of knowledge contribution regardless of the level of job autonomy. On one hand, this suggests that employees with low job autonomy contribute as frequently as others as long as their level of knowledge renewal is high. On the other hand, this suggests that increasing job autonomy is not useful for encouraging those with high level of knowledge renewal to contribute more frequently. Alternatively, the frequency of knowledge contribution can be boosted by increasing task feedback, which drives knowledge renewal (as hypothesized in H2).

Controlling for the motivational mechanisms identified in prior research (i.e., job autonomy → intrinsic motivation and task feedback → extrinsic motivation), we found that the proposed knowledge mechanisms are significant in explaining the effects of job characteristics. This indicates that job characteristics have a multifaceted influence on knowledge contribution and the knowledge mechanisms should be taken into account in the theoretical development of knowledge contribution and management of knowledge repositories. The theoretical and practical implications of this study are discussed next.

Implications for Theoretical Development

This study contributes to theoretical development in several ways. First, the proposed model clarifies the differential effects of job characteristics on employees' knowledge contribution.

KM research is beginning to recognize the salience of job characteristics (e.g., Foss et al. 2009; Kelloway and Barling 2000; Pee 2012). Although job autonomy and task feedback have been found to influence intrinsic and extrinsic motivations differentially (Foss et al. 2009), the distinctive effects of the other job characteristics have not been examined. We advance this line of inquiry by providing a more comprehensive account of how all five job characteristics influence knowledge contribution, based firmly on their theoretical conceptualizations.

The second contribution of this study is introducing knowledge characteristics to explain the effects of job characteristics on knowledge contribution. We found that job characteristics influence employees' contribution behavior through affecting their knowledge. The knowledge-oriented mechanisms identified enrich our understanding of job characteristics' impact. Distinguishing among different knowledge characteristics also extends prior research which has mainly focused on knowledge self-efficacy as a general knowledge-related characteristic influencing knowledge contribution. Our work indicates that a more fine-grain conceptualization of knowledge characteristics is useful for clarifying the impacts of different knowledge contribution antecedents and the duration, frequency, and intensity of contribution. Exploring deeper into different knowledge characteristics is critical given that knowledge is the key entity of interest in knowledge contribution. Even if employees are motivated by rewards and social norm to participate in knowledge contribution, they are unlikely to be able to do so if their knowledge is inadequate. This study serves as a call to further investigate how employees' knowledge develops in the context of their work, social, and organizational environments. Other knowledge characteristics that may be interesting to examine in future include familiarity with knowledge, complexity of knowledge, and durability of knowledge. Understanding the antecedents and effects of specific knowledge characteristics is also necessary for identifying effective interventions for improving employees' ability to contribute knowledge.

Third, we showed that a more refined conceptualization of knowledge contribution in terms of duration, frequency, and intensity enhances theoretical understanding by allowing relevant antecedents for different knowledge contribution behaviors to be identified. Researchers have noted that diverse measures for knowledge contribution behavior exist (Liang et al. 2008) and emphasized the importance of using valid measures (e.g., Yi 2009). It is critical to tie the measurement of knowledge contribution to its conceptualization, and

ensure that the conceptualization is relevant to the antecedents and consequences of interest. Being more careful and explicit in conceptualizing knowledge contribution should lend confidence to the validity of findings and facilitate theoretical development by allowing the results to be interpreted and integrated in light of the theoretical relationship between the selected conceptualization of knowledge contribution and antecedents/consequences. We believe that distinguishing among duration, frequency, and intensity is an important step towards advancing knowledge contribution research. Our findings suggest that in studies where the interest is knowledge contribution as a single construct, the construct may be operationalized using a multi-dimensional and *formative* measure. More importantly, this study indicates that there is great potential in studying knowledge contribution in terms of different constructs capturing different conceptualizations. Other than specifying the pertinent antecedents for each conceptualization as done in this study, future research may also examine the downstream consequences of knowledge contribution. For example, the effects of different knowledge contribution behaviors on outcomes such as quality of knowledge repositories, knowledge seeking from repositories, and knowledge reuse can be examined to identify the most valuable form of knowledge contribution and the nature of value generated.

Implications for Practice

Promoting knowledge contribution remains a challenge in organizations' use of electronic repositories despite much research into the topic. This may be partly attributable to the lack of clarity in the conceptualization of knowledge contribution and the relevant predictors of each conceptualization. It is important for managers to identify the nature of knowledge contribution that is most pertinent to their context and encourage knowledge contribution by focusing on the appropriate predictors. In practice, it is also necessary for the predictors to be amenable to managerial intervention. This study expands the range of practical approaches available to purposefully promote knowledge contribution in organizations. Specifically, if it is desirable that employees spend more time composing new posts to knowledge repositories (i.e., duration), it will be most effective to enhance employees' perceived value of knowledge by increasing employees' understanding of their task significance. In cases when organizations would like to increase the frequency of knowledge contribution, it will be most useful to drive knowledge renewal by increasing task feedback. In organizations where the intensity of knowledge contribution is important, employees' knowledge breadth can be augmented by increasing their jobs' skill variety and task identity. If an organization intends

to promote knowledge contribution in terms of duration, frequency, as well as intensity, increasing task identity will be the most helpful since our findings indicate that it significantly influences all knowledge characteristics. These specific suggestions help managers direct their effort and limited resources effectively to address their particular KM needs.

When possible, employees should be provided with more job autonomy since it allows employees to arrange work such that they have opportunities to access knowledge repositories. Job autonomy enhances the effect of perceived value of knowledge and knowledge breadth and it is thus useful in contexts where the extent to which task significance, skill variety, and task identity can be increased is limited. For example, in cases where task significance and subsequently perceived value of knowledge cannot be adjusted, increasing job autonomy can be a complementary approach to help organizations attain the desired knowledge contribution duration.

In organizations where it is desirable to increase knowledge contribution in general (i.e., duration, frequency, and intensity), such as when new knowledge repositories are implemented, the measures for knowledge characteristics validated in this study can be useful for identifying specific managerial interventions. The measures can be used to gauge employees' perceived value of knowledge, knowledge renewal, and knowledge breadth, identify inadequacies in knowledge, and pinpoint the job characteristics that should be enhanced to address the inadequacies.

Limitations and Suggestions for Future Research

A limitation of this study is that we could not measure actual knowledge contribution to repositories because the respondents were from different organizations. The duration, frequency, and intensity of knowledge contribution were measured using single-item scales. Such measures cannot yield accurate estimates of internal consistency reliability. While the measures clearly capture the largely concrete, singular, and one-dimensional constructs of duration, frequency, and intensity, more studies that use objective knowledge contribution data are needed to further validate the findings. It is important to note that collecting objective knowledge contribution data is likely to limit the study to one or a few specific organizations' repositories and affect the generalizability of findings. Therefore, we believe that both types of studies are needed to ascertain the effects of job characteristics.

Conducting a longitudinal study that measures the predictors and knowledge contribution behaviors at different times can offer stronger evidence for the causal relationships in our research model. A longitudinal study also provides opportunities to advance our research model by incorporating temporal mechanisms. For example, it will be interesting to examine whether employees' perception about job characteristics changes over time and how the change modifies their knowledge contribution behavior.

The generalizability of our findings can be further improved by studying other knowledge-intensive industries such as those providing legal and research and development services. A more interesting extension of this study is to examine knowledge contribution on social media (e.g., Wikis, microblogging)*. There has been increasing use of social media tools to facilitate the sharing of knowledge broadly throughout an organization. Social media provides unique affordances for employees to engage in ongoing organization-wide communal knowledge conversations (Majchrzak et al. 2013a). It may be fruitful to study whether job characteristics interact with the social media affordances in affecting employees' knowledge contribution behaviors.

Another avenue for future research is to look beyond the duration, frequency, and intensity to examine other knowledge contribution behaviors such as shaping, in which individuals contribute by reorganizing already posted contributions to ensure readability, reduce redundancies, and co-develop a more organized artifact (Majchrzak et al. 2013b; Yates et al. 2010). Kane et al. (2014) identified different patterns of co-production in online communities and observed that contributors self-selected and transiently enacted the roles they preferred. Future studies may examine whether job characteristics influence the contributors' behavior in knowledge shaping and co-production.

Conclusion

As set out in the research objectives, this study has identified the knowledge mechanisms through which different job characteristics influence the duration, frequency, and intensity of knowledge contribution. The proposed model has expanded the nomological network of knowledge contribution in several ways. This is one of the few studies to look beyond personal, cultural, and social factors to examine the influence of job characteristics. This is also one of the first studies to distinguish among different conceptualizations of knowledge contribution and identify the relevant predictors for each conceptualization. The significant

** We thank the reviewers for suggesting the literature that inspired these research directions.

effects of job characteristics imply that knowledge contribution can be incorporated into and driven by employees' work rather than simply added on top of existing job tasks. This study sheds light into the black box of knowledge contribution and highlights new directions for research, while providing practical and specific suggestions for promoting knowledge contribution in organizations.

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