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# Exploring the Influence of Job Characteristics: A Comparison between Open Source and Proprietary IS Development

Research-in-Progress

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## ABSTRACT

Open source development (OSD) of software is becoming increasingly desirable for individuals and organizations alike. Organizations that heavily resisted this new way of developing software are now actively participating in this process. Participation of developers in the OSD environment has been a focal point of research in the information systems (IS) domain that has examined various reasons developers participate in project development. Our study goes beyond participation and looks at engagement of developers in the OSD environment. Using the job characteristics model (JCM), we conduct a comparative analysis of how job characteristics influence engagement of IS developers in open source and proprietary environment. Job characteristics have been found to play a very important role in driving individual work outcomes such as engagement and job satisfaction. Our study is expected to enrich the open source literature, extend JCM. The study will also provide new insight to organizations that are currently investing in OSD or planning to do so in the near future.

## Keywords

Open source, participation, engagement, job characteristics, job satisfaction, information systems development.

## INTRODUCTION

Open source development (OSD) of information systems continues to be a dominant trend that is becoming increasingly popular with individuals and organizations. For instance, SourceForge, one of the most popular OSD platform, has facilitated more than 430,000 software projects in its platform (SourceForge 2018). Linux Foundation, a pioneer of OSD, claims that more than a million IS professionals have participated in its open source drive that resulted in an estimated sixteen billion dollars' worth of software projects (Linux Foundation 2018). It is not surprising that renowned firms such as IBM, Google, and Microsoft are heavily involved in OSD (Ho and Rai 2017). Even government organizations such as the US Department of Defense have been exploring OSD for software development (August et al. 2017). Data.gov, a US government sponsored website that makes thousands of datasets available to the general public, has been using GitHub as an OSD platform for its infrastructure (Data.gov 2018). OSD is a new frontier of software development that will require project managers to understand the dynamics of this environment for organizations to utilize its full potentials. Our research attempts to provide new insights for project managers and project management researchers.

Volunteer participation is at the heart of the success of the OSD development model. However, it has been found that a lack of voluntary participation affects a large percentage of OSD projects (Fang and Neufeld 2009). Even after a decade of that finding how to increase voluntary participation remains an important question for IS researchers (e.g., Ho and Rai 2017). While the existing literature on OSD has looked at various individual and project attributes that drive engagement of IS professionals, we are yet to see an examination of the nature of the job of an IS professional. In other words, what does this mean to work as a software developer in the OSD environment and how is it different from working in the proprietary environment. The existing literature acknowledges that working in the OSD is primarily voluntary while the other is primarily based on a financial contract (e.g., Lerner and Tirole 2002) but does not provide a nuanced comparative analysis of the IS professional's job in the two environments. We address this gap. Our study goes beyond participation and looks into engagement that has deeper psychological meaning. We use the job characteristics model as the overarching theoretical framework.

Job characteristics model (JCM) has been used as a theoretical lens to examine how these characteristics influence work outcomes in the proprietary software development (PSD) environment (e.g., Tripp et al. 2016). Job characteristics is defined as a composite construct in the IS and organization literature by five distinct constructs (Morris and Venkatesh 2010) that explains five different characteristics of a job: task significance, task identity, skill variety, autonomy, and feedback. In this study, using the JCM, we plan to compare IS professional's job in the OSD and PSD environments and examine. The comparison will provide us insights on how these job characteristics can potentially influence the developer's engagement and other downstream work outcomes. One of the most useful qualities of JCM is that it does not include the payment factor in the model and therefore presents a readily available theoretical lens that can be used in the OSD environment where IS professionals are primarily volunteers. Working for monetary compensation is not the norm in IS domains, as many IS professionals are working in the OSD environment for non-monetary gains. These works in the OSD environment also have similar job characteristics such as task significance or skill variety. To understand the dynamics of voluntary participation, we compare how the job characteristics influence the OSD and PSD engagement differently.

Once completed, this study is expected to enhance both the OSD and PSD literature by providing a comparison of the influence of job characteristics on developer's engagement between the two environments. The study is also expected to enhance the IS literature by extending the JCM in the OSD context. There is a tremendous interest in organizations to explore and utilize the OSD for software development (Ho and Rai 2017). Understanding the role of job characteristics in the OSD and how that is different from PSD environment should also help IS project managers designing projects that can leverage such knowledge and ultimately help numerous organizations that have already invested or planning to invest in the OSD. At the time of writing this research-in-progress paper, we have completed some data collection from the PSD environment, and after briefly discussing the literature and presenting our proposed research model we will discuss our preliminary findings from the PSD environment.

## BRIEF LITERATURE REVIEW

IS researchers have explored various factors that can influence participation of IS professionals in the OSD environment. Earlier research found that participation in the OSD is an outcome of a combination of intrinsic and extrinsic motivations (Alam and Campbell 2017; Hars and Ou 2002; Herter et al. 2003). Prior collaboration ties have been found to be one of the significant factors that influence the developer's decision to join a new OSD project (Hahn et al. 2008). Besides personal attributes and aspiration, project attributes can also drive engagement of developers in the OSD. Project attributes such as quality control and project type have been found to influence continued voluntary participation (Ho and Rai 2017). Participation of developers is crucial in OSD because it is related to performance. Roberts et al. (2006) found that developers' participation is positively related to their performance in OSD software projects. Table 1 below lists a few notable studies that have looked at the question of participation IS developers in open source projects. We go beyond participation to examine engagement.

Reference	Independent Variables	Dependent Variables
Alam and Campbell 2017	Intrinsic motivation, extrinsic motivation	Volunteer participation in cultural crowdsourcing work
Bagozzi and Dholakia 2006	Social identity, identification, emotions, attitudes, experience with the platform	Participation intentions
Blanchard and Markus 2004	Feelings of membership and influence, integration and fulfillment of needs and shared emotional connection	The sense of virtual community
Fang and Neufeld 2009	Situated learning, identity construction	Long-term voluntary participation
Faraj and Johnson 2011	Direct reciprocity, indirect reciprocity, preferential attachment	
Faraj et al. 2011	Tension resulting from the fluidity	Participation
Hahn et al. 2008	Cohesion cues and status cues based on developer's past collaboration	Join
Hann et al. 2004	Social-psychological functions (normative, values, understanding, career concerns, and ego enhancement)	participation
Hars and Ou 2002	Self-determination, altruism, community identification, future rewards, personal need	Participation

Herter et al. 2003	Valence, instrumentality, self-efficacy, and trust	Participation
Ho and Rai 2017	Quality control, type of project, tenure in the project	Volunteers continued participation intention
Lerner and Tirole 2002	Career concern incentive, ego gratification incentive	Participation
Ma and Agarwal 2007	Perceived identity verification, satisfaction	Knowledge contribution
Nambisan and Baron 2010	The sense of responsibility to community and company, expectations of self-image and expertise enhancement, identification with community and company	Contribution
von Hippel and von Krogh 2003	Private-collective model of innovation (Private rewards)	Contribution

Table 1. Participation Research in Open Source Development

## THEORETICAL BACKGROUND AND PROPOSED RESEARCH MODEL

In this section, we define our constructs and present our proposed research model.

### Construct Definitions

The core sets of the constructs in our research model include developer's engagement, development environment, job characteristics, and the developer's job satisfaction. We define a *developer's engagement* as the investment of physical, cognitive, and emotional resources of a developer to achieve the goal of his or her role in the project. We draw developer's engagement from Saks (2006) who identified two distinct dimensions of employee engagement – job and organization engagement. Engagement has been a topic of great interest in social science studies for almost three decades. Table 2 lists a few notable studies that examined engagement in various contexts.

Reference	Dimensions Studied	Relationships Tested	Theory Used
Anthony-McMann et al. 2017	Physical, Emotional, Cognitive, Social, affective, intellectual	Burnout, Stress	Conservation of Resources theory
Halbesleben 2006	Disengagement (burnout)	Social Support	Conservation of Resources
Harter et al. 2002	Employee Engagement	Business unit outcomes	N/A
Harter et al. 2013	Employee Engagement	Profitability	N/A
Kahn 1990	Personal Engagement and Personal Disengagement	Psychological Meaningfulness, safety, and availability	Theory of personal engagement at work. Extended Person-in-role research with personal engagement and disengagement (started with the work of Goffman 1961)
Kahn 1992	Personal engagement	Work elements, elements of social systems	Theory of engagement Job Characteristics Theory
Rich et al. 2010	Physical, Emotional, Cognitive	Performance	Khan' Theory
Saks 2006	Job and Organization	Job Satisfaction, OCB, Turnover, Organizational commitment	Social Exchange Theory
Schaufeli et al. 2002	Vigor, dedication, absorption	Burnout	Khan's theory
Shuck et al. 2011	Employee Engagement	Job Satisfaction	Khan's theory
Soane et al. 2012	Intellectual, social, affective	OCB, Performance, Turnover Intentions	Khan's Theory

Table 2. A Brief Overview of Engagement Studies

We define the *development environment* as a binary variable that divides software development into two categories: proprietary and open source. OSD environment is defined as the development environment in which a developer is not paid for his/her role in the IS project while PSD environment is the environment where the developer is directly or indirectly employed and paid by the owner of the project (e.g., an organization).

We adapt the definitions of the five JCM constructs from Morris and Venkatesh (2010) while limiting the scope of the job characteristics on a specific project that a developer has worked to facilitate our comparison of JCM in the different software development environments.

*Task significance* is defined as the perception of the developer as to how significant the IS project is in relations to society or organization. *Task identity* is defined as the portion of the project the developer has been involved with. *Skill variety* is defined as the variation in skillset that is utilized by the developer to accomplish his or her task in the project. *Autonomy* is defined as the degree of freedom enjoyed by the developer in deciding on how to accomplish his or her task in the project. Feedback is defined as the extent of information provided by other parties in the project that help the developer to determine the quality of his or her input in the project.

Job satisfaction is a well-established construct in the psychological, organizational behavior, and IS literature. We adapt our definition from previous IS (Tripp et al. 2016; Morris and Venkatesh 2010) and engagement literature (Rich et al. 2010). *Developer's job satisfaction* in this study refers to the degree of positive emotional response generated by a developer's assessment of the experience gained due to the role in the IS project. The literature on job satisfaction in the OSD environment is still at its nascent stage, but research is emergent in the domain (e.g., Casalo et al. 2009; Gerede et al. 2018).

### Research Model

Our research model attempts to achieve two goals. First, we attempt to examine the relationship between job characteristics and engagement in two different IS contexts: OSD and PSD. The influence of job characteristics on work outcomes is of great interest to IS and organizational researchers. Job characteristics have been studied as antecedents to employee engagement in various organizational studies (e.g., Saks 2006; Rich et al. 2010; Christian et al. 2011). However, no study in the IS literature has so far attempted to study this relationship. Context can change the relationship in various ways (Johns 2006). Johns (2006) defined "context as situational opportunities and constraints that affect the occurrence and meaning of organizational behavior as well as functional relationships between variables. Context can serve as a main effect or interact with personal variables such as a disposition to affect organizational behavior" (p. 386). OSD and PSD regarding approaches (voluntary vs. non-voluntary) and economics (the availability of the source code) have been established to be fundamentally different (Hars and Ou 2002) and therefore represent two unique contexts of IS development. Therefore, we argue that the development environment type will have a profound impact on how job characteristics impact a developer's engagement in his or her project.

The direct influence of job characteristics on job satisfaction is well-established in the IS literature (Goldstein and Rockart 1984; Specht 1986; Kaplan and Duchon 1988; Igbaria et al. 1994; Morris and Venkatesh 2010; Bala and Venkatesh 2013). However, engagement has been found to play a mediating role in the relationship between job characteristics and job satisfaction in the non-IS literature (e.g., Saks 2006; Rich et al. 2010), to the best of our knowledge, these relationships have never been studied in the context of open source development. Thus, the second goal of our research model is to test the mediating effect of engagement between job characteristics and job satisfaction. In line with recent IS studies of JCM (e.g., Tripp et al. 2016; Morris and Venkatesh 2010; Venkatesh et al. 2010), we utilize the job characteristics proposed by Hackman and Oldham (1980). Figure 1 depicts our proposed research model.

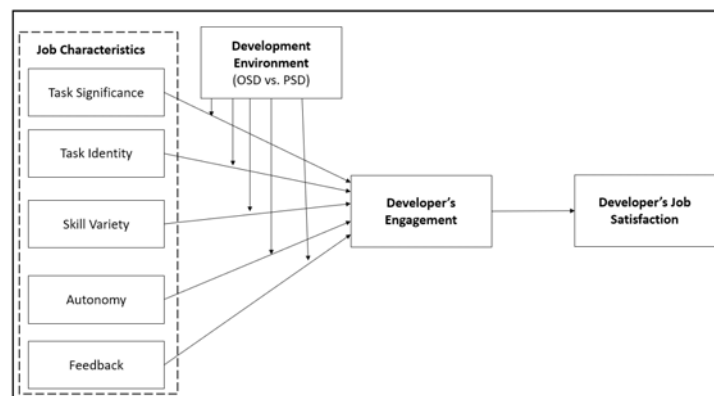


Figure 1. Proposed Research Model

## METHOD

The data collection in the PSD environment that is completed so far was conducted using a cross-section survey design. The survey included established measures from the information systems and engagement literature. Email requests were sent to corporate IT contacts in various organizations. Authors contacted only one individual from any given company even though the authors may have known multiple individuals in a company. When the authors knew multiple people, only the highest-ranking person in the company was contacted to increase the chance of getting accessibility. The corporate contacts were requested to share a website survey link with their employees in their respective IT departments. The potential participants were requested to complete the survey within one month of receiving the website link. A follow-up email was sent to each corporate contact to remind their IT professionals to complete the survey as we neared the deadline to collect data. The participation was completely voluntary, and data collection was fully anonymous.

Survey requests were sent to sixteen different Industry partners group at the authors' university. We received responses from thirteen out of the twenty-eight organizations which represent roughly 46% organizational response rate. The organizations represented the following industries: telecom, insurance, IT, food and beverage, e-commerce, energy, healthcare, transportation, retail, and federal and state organizations. We only sent requests to the corporate contacts who confirmed to have at least 10 or more employees in their respective IT departments. We received a total of 85 usable responses that included 74 unique projects. Our study participants included 67 males and 18 females. Majority of the respondents reported having 3–5 years of tenure at the time of response.

To measure the constructs in our study, we searched for appropriate and already validated scales in the existing literature. All of the measurement items used in this study were collected from existing literature to operationalize the constructs. Measurement items for the JCM and job satisfaction were adapted from Morris and Venkatesh (2010), and the items for engagement were adapted from Saks (2006). Participants provided their responses to measurement items for all of the focal constructs using Likert-type scales with anchors strongly disagree to agree strongly.

## RESULTS

Following standard practice, we first tested the reliability and validity of various scales and then tested our proposed research model using the PSD data sample without the interaction effect of the development environment.

### Measurement Model Assessment

We tested our data for any multicollinearity issues using variance inflation factors (VIF). The VIF values were well below the acceptable threshold of ten indicating that there was no serious multicollinearity issue (Gruber et al. 2010; Petter et al. 2007). Our factor analysis confirmed the convergent and discriminant validity of all the measurement items. Since the scales used in our study are well-established and the results are consistent with previous findings, we do not provide any further details of the results to conserve space. Cronbach's Alpha (CBA) was used to assess the reliability of the measures. Cronbach alphas for all constructs were larger than the established threshold of .70 which establishes the reliability of the scales for these constructs.

### Testing the Effect of Job Characteristics on Engagement and Job Satisfaction

For our preliminary analysis, we used the ordinary least square method to test our proposed research model (without the interaction effect of the development environment as we are yet to collect the data from the OSD environment). We used linear regression to test the effect of job characteristics on engagement and job satisfaction. The regression results are presented in Table 3. The regression results in Table 3 show that for this sample from the PSD environment, the effect of job characteristics on engagement is statistically significant.

To test the mediation effect of the developer's engagement between the job characteristics and job satisfaction, we apply the Baron and Kenny (1986) approach, one of the most well-recognized method for testing mediation effect. To examine mediation, the Baron and Kenny (B&K) approach involves three steps of regression. The first step involves finding that the independent variable has a significant effect on the mediator. Table 3 shows that job characteristics significantly influence the developer's engagement.

The second step in the B&K mediation analysis is to show that the independent variable has a significant effect on the dependent variable. As we can see in Table 3 that job characteristics appear to have significant effect on a developer's job satisfaction even when tested with few individual and project characteristics.

The final step in the B&K mediation test is that the mediator must significantly affect the dependent variable while tested along with the independent variable. As it is shown in Table 3, the developer's engagement indeed appears to have a significant effect on a developer's job satisfaction. However, since job characteristics also appears to have significant effect on a developer's job satisfaction in the second regression, according to the B&K approach, we have partial mediation.

	Developer's Engagement	Developer's Job Satisfaction	
		Main effects	Mediation effect
Gender	-.0133	.0198	.0252
Age Group	-.0089	.0695*	.2079*
Organization Tenure	-.0033	.0620	.0286
Project Duration	.0816	.1215	.0917
Project Team Size	-.0004	-.0014	-.0012
Job Characteristics	.2325**	.3150**	.2201*
Developer's Engagement			.4084*
R <sup>2</sup>	.2080	.4142	.4835
* p-value < .05; **p-value < .005			

Table 3. Regression Results

## DISCUSSION AND CONCLUSION

The goal of this research-in-progress is two-fold. First, we explore the relationship between job characteristics and engagement of IS professionals and how that varies in OSD and PSD environment. So far, from the data collected in the PSD environment, we find that job characteristics have significant effect on IS professional's engagement. We are, however, yet to test how these relationships will vary in the OSD environment and plan to explore these relationships once we finish collecting data from the both PSD and OSD environment. The second goal of this study is to explore whether engagement plays a mediating role in the relationship between job characteristics and job satisfaction. Our finding so far corroborates this proposition that engagement does play a mediating role, however, the mediating role is partial in nature. The partial mediation is in line with the findings in the IS research domain that job characteristics is indeed a very important factor of influence for individual work outcomes such as job satisfaction in the work life of an IS professional. The mediation result also provides a strong support for our argument that engagement of IS professionals is an important factor and should be studied in relations to individual work outcomes of IS professionals.

Managing IS project is always a challenge. The IS professionals are usually highly skilled and well paid. Software development in the OSD adds another complex attribute of project development for the IS project managers. Researchers are looking at various factors that trigger and stabilize participation of IS professionals in OSD projects (e.g., August et al. 2016; Hahn et al. 2008; Ho and Rai 2017). Once completed, our study is expected to enrich this stream of literature by showing that we can utilize the JCM theoretical lens to further understand this phenomenon. JCM has helped us understand how various work outcomes can be influenced by job characteristics in the PSD environment (e.g., Morris and Venkatesh 2010; Tripp et al. 2016). We believe this study will show that JCM can also provide valuable insights about IS professionals in the OSD environment. Finally, the JCM model that has been highly studied in the IS domain (e.g., Morris and Venkatesh 2010) shows a direct effect of job characteristics on job satisfaction. Once completed, we expect this research to enrich the IS domain by extending JCM model by adding the moderating effect of the development environment and the mediating effect of engagement.

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