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Locus of Fluctuations: an Examination of Project Disruptions

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ABSTRACT

Project deviations of different types are used to examine the theorized role of Locus of Control on two types of project outcomes: process performance and developer satisfaction. A survey of 315 professional project managers is analyzed with PLS-SEM to quantify the direct effects of requirements fluctuations, staff fluctuations and technology fluctuations as well as the contingent effects from External Locus of Flux. We demonstrate the consequences of deviation events that complicate efforts to maintain situational control. Implications for research and practice are discussed.

Keywords

Project Management, Disruptions, Locus of Control, Developer Satisfaction.

INTRODUCTION

Agile Project Management (PM) advocates claim a motivational and performance advantage when IT project participants are empowered to select their own task assignments and determine how they will accomplish these tasks (Dybå and Dingsøyr 2008). Scholars studying Open Source Software development have identified a similar phenomenon where participation is in part motivated by the ability of developers to "choose their own tasks and set their own schedules" (Bagozzi and Dholakia 2006; Shah 2006, p1007). The advantages of self-determination and control are not limited to software development and have been prominent in general management literature espousing the importance of intrinsic motivation, self-direction and control (Lefcourt 1982; McGregor 1957).

Advocates of team based organizing (Eby and Dobbins 1997), and in particular Agile PM (Kelley 2008), emphasize the value of approaches that shift locus of control from management to individual developers. However, no research examines the ability of these practices to achieve and sustain perceived control that activates the theorized mechanism. Unexpected events that challenge perceptions of individual control are nearly ubiquitous among IT projects (Pavlak 2004; Wearne 2006). Disrupting events can occur within the project team's domain of control or external from the project. As such the source or origin of disruptions may serve as a useful manipulation with which to evaluate locus of control within IT projects. Disruptions with both positive and negative consequences do not discriminate against one particular PM methodology but serve as emphatic reminders that process and outcome control is not fully in the hands of the project team and its members. This study examines the relationship between disruptive events and project outcomes from the perspective of locus of control focused on these research questions:

1. What outcome effects are associated with different types of project deviations?

2. How does source of origin moderate the effects of project deviations?

This paper proceeds in section 2 with an introduction to the literature on locus of control and develops ideas around disruption events. Section 3 follows by developing specific research hypothesis. Section 4 describes a study design with results presented in section 5.

LITERATURE REVIEW

Locus of Control

Locus of Control (LOC) represents the extent to which people believe that outcomes and reward result from their personal actions (Lefcourt 1982), including their workplace actions (Ng and Feldman 2011). Two dimensions of control are internal, where individuals perceive they have determining influence on outcomes, and external, where individuals perceive they lack direct control and perceive the external environment as dictating outcomes. While much research in psychology characterizes LOC as a stable personality trait (Lefcourt, 1982), recent findings identify a mediating role of situational control (Andreassi and Thompson 2007). In the workplace, situational control is characterized by several facets of work autonomy including method, pace and effort (Liang et al. 2015). LOC is largely a cognitive phenomenon whereby an individual who believes s/he has control will accrue certain benefits including higher job satisfaction, self-efficacy, motivation, creativity and ultimately improved performance outcomes (Bizzi and Soda 2011; Joo et al. 2010). Fifty years ago a shift in management philosophy pivoted on the ideas of “Theory Y” that recognized intrinsic motivations within workers who perform best when they have a degree of freedom to direct their own activities (McGreggor 1957).

Post-bureaucratic organizations shape their behavior based on consensual values instead of management by control. Where it occurs this represents a shift in the locus of control from management to the workers who collaborate to establish the means of their own control (Barker 1993). Within the IS project domain advocates of Agile methods emphasize team empowerment, responsibility, authority and autonomy (Beck 1999). Agile Methodologies take advantage of individual preferences for autonomy and self-control (Maruping et al. 2009). Some advocates characterize team autonomy and empowerment as the central mechanism to achieve valued outcomes (Nerur and Balijepally 2007; Kelley 2008) including quality (Chow and Cao 2008), motivation and satisfaction (Tessem 2014). Several studies provide support that developers using Agile methods report higher job satisfaction (Acuna et al. 2009; Dyba and Dingsoyr 2008) and improved project outcomes (Vijayasarathy and Turk 2008), with perceived control singled out as an important factor (Santana and Robey 1995). Some scholars contend that team autonomy within IS projects can be controlled by adhering to certain team practices (Lee and Xia 2010), while others acknowledge that control is situational (Ambler 2005)

Open Source Software (OSS) development represents another model where locus of control is shifted from organization management to individuals and teams. OSS is a community based model in which individuals unaffiliated to any common organization volunteer their contribution to the creation, enhancement and support of software products and systems. OSS developers are drawn to participate in interesting and useful challenges (Shah 2006). OSS tasks and processes satisfy basic human needs for competence, control and autonomy with positive implications for participation and performance (Bagozzi and Dholakia 2006; Roberts et al. 2006). While a degree of skepticism exists about OSS product quality, recent assessments of over 10,000 software projects demonstrate that OSS quality outperforms commercial software quality as objectively measured by defect density (Coverity 2015). The implication is that the mechanism of perceived control plays a significant role in achieving these performance and outcome advantages.

LOC is a broader, more encompassing concept that Autonomy. Autonomy is concerned more with where the authority to make certain decisions rests. Autonomy is related to LOC as individuals who are not empowered to make key decisions will understandably perceive they have less personal control to achieve the desired outcome. However, the loss of control may originate from aspects of the activity space unrelated to decision making authority. While empowerment and autonomy may be contributing factors to individual and group behavioral control, they are not sufficient. Unexamined in existing literature is the possibility that environmental circumstances in the form of unexpected disruptions may often deny individuals and teams the perception of control that analytically justifies these methods.

Deviations and Flux

Managers and teams employ project management methods and processes to provide a framework for executing projects in a predictable and orderly manner. These approaches provide an element of control to the organization and individuals (Kirsch 1997; Bagozzi and Dholakia 2006; Maruping et al. 2009). However, external events that disrupt perceived control can undermine motivation, reduce performance (Leotti et al. 2010) and reduce job satisfaction (Fairbrother and Warn 2001). Deviations are emergent risks that demand action not envisioned when initiating and planning a project (Hallgren and Soderholm 2010; Watson-Manheim et al. 2012).

The term fluctuation or flux is used here to broadly represent the phenomenon of unexpected project events with a disruptive influence on project execution. The disruption represents a deviation from plan and may be either an opportunity with positive implications or a threat with negative consequences (PMI 2009). Fluctuations can emerge from many IS risk domains including the technology, team resources, the host organization and the user/customer environment (Barki et al. 2001; Benaroch et al. 2006). This study operationalizes the distinct impact of fluctuations emerging from three areas easily understood by IS project participants: requirements fluctuation, staff fluctuation and technology fluctuation.

LOC recognizes that individuals and teams perceive that control resides either with themselves or outside themselves. Similarly, fluctuations may originate locally with the individual and team or externally. The Locus of Flux (LOF) is a continuum with fluctuations that arise locally at one end and those that imposed externally at the other. Attention, data gathering, discussion, problem solving and creative exploration are centered on the focal tasks. Deviations arising within the focal activities of the team can be interpreted and understood within the context of intentional activities – they are threats and opportunities caused by the team itself. Deviations arising from beyond the arena of focused attention and actions of the team are more likely perceived as something beyond the project's control. External LOF events may therefore undermine perceptions of control.

When considering project outcomes the most common criteria of project process performance involve the organization objectives of time (schedule), cost (resources), scope (functionality) and quality (Agarwal and Rathod 2006; Jugdev and Muller 2005; Wateridge 1998). These measures relate to standards of performance that may be objectively observed and reported by participants without the need to wait for the emergence of strategic organization benefit. The first three items are commonly used to measure project success (Lee and Xia 2010; Shenhar et al. 2001). Participants making tradeoffs for troubled projects also understand that compromises can reduce quality even as baseline function, cost and time goals are met. Quality is therefore an appropriate supplement for an aggregate reflective construct of project performance (Chandrasekaran and Mishra 2012).

Organizations that depend upon project success will also value job satisfaction and team continuity that has been associated with project performance (Keller 1986). Self-report measures of job satisfaction are common for in the IS literature (Aladwani, 2002; Cheney 1984) with an emphasis on the relationship between job satisfaction and task performance (Goldstein 1989).

RESEARCH FRAMEWORK

In IS projects where individuals and teams attempt to gain perceived behavioral control, fluctuations undermine those efforts. We propose a variance research model depicted in Figure 1 that operationalizes fluctuations as direct determinants of project outcomes in the form of project process performance and member satisfaction. Furthermore, we measure the locus of flux to distinguish fluctuations which originate from within the project team (internal locus of flux) and those that originate outside the project team (external locus of flux).

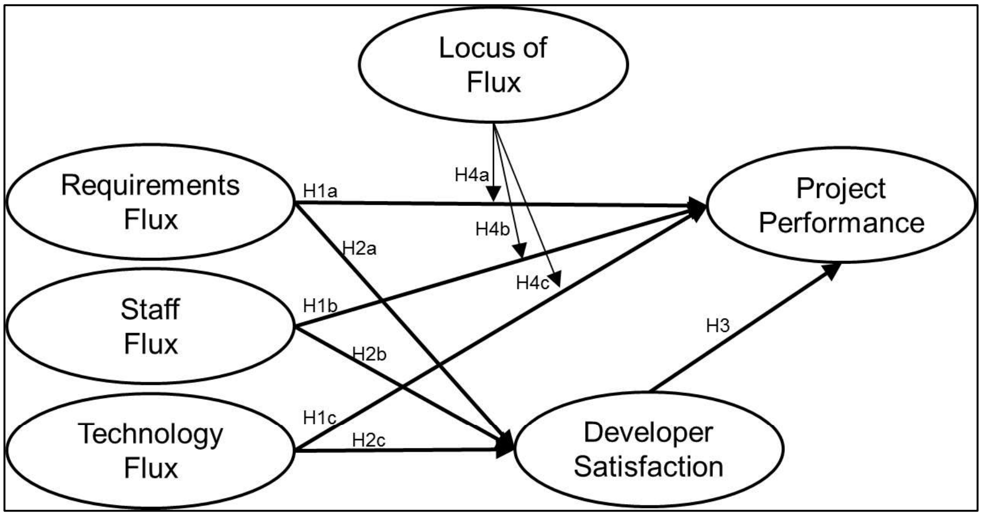

Figure 1: Research Model

Requirements Fluctuations

Requirements fluctuations have been identified by many scholars as a major factor that can impact project performance (Boehm 1991; Keil et al. 1998; Schmidt et al. 2001). Risks in this domain involve frequently changing requirements as well as requirements that are incorrect, unclear, inadequate, ambiguous, or unusable (Liu et al. 2010; Wallace et al. 2004). Requirements risks are a major concern not just during initiation and planning, but throughout an IS project (Yu et al. 2013).

Practitioners recognize the disruptive potential of changing requirements and prescribe a variety of strategies to manage and mitigate these events. Aggressive user engagement with formally approved requirements documents and rigorous change management processes are common among highly structured projects (Abran and Borque 2004; Forsberg et al. 2000). Agile projects employ incremental development and iterative release approaches to integrate requirements changes (Fowler and Beck 1999). Maruping et al. (2009) found that requirements change undermines project quality, particularly in environments with high individual levels of control.

Regardless of the methodological practices employed, requirements fluctuations must be recognized by participants in a timely manner and accommodated. This requires individuals to apply new effort to understand and adjust tasks and activities that are underway. New mental models are needed across members. Effective response involves altered designs, different decisions and new tasks. Shared team mental models about goals and timing motivate the entire collective problem solving, decision making and intellective process (McComb 2008). The direct effect of requirements fluctuations on project process performance is expected to be negative. Therefore:

H1a: Requirements Fluctuations (RF) are negatively associated with IS Project Performance (PERF).

Staff Fluctuations

Staff risks start early in projects where assembling a team with an appropriate mix of skills is often a challenge. Staff risks continue in various forms throughout an IS project (Yu et al. 2013). To an external observer staffing volatility appears as people who are not available when they are needed, and turnover of key participants (Keil et al. 1998; Schmidt et al. 2001). Appearances can be deceiving. Recently both academics and practitioners have begun espousing the virtues of flexible work practices in the form of job sharing, leave programs, flextime and telecommuting as a means to increase employee attitudes and productivity (Beauregard and Henry 2009; Renee Baptiste 2007). What often appears to be volatile staff attendance to an outside observer, may in practice be individuals managing work-life-balance with positive overall performance potential. Similarly staff reconfiguration which may initially appear negatively disruptive, is often pursued for its positive disruptive effect. Agile teams pursue dynamic team reconfiguration as each sprint is initiated to match skills and interests with project needs. Furthermore, organizations exercise functional turnover by replacing poor performers (Allen et al. 2010). The overall effect of both internally and externally instigated fluctuation on project performance is expected to be positive. Therefore:

H1b: Staff Fluctuations (SF) are positively associated with IS Project Performance (PERF).

Technology Fluctuations

Technology fluctuations have been identified by many scholars as a major factor that can impact project performance (Liu et al. 2010; Lyytinen et al. 1998). This risk factor is variously characterized as technology newness (Barki et al. 1993; McFarlan 1981) or novelty and complexity (Gemino et al. 2008; Zmud 1980). Short term tactical problems with technology are central to the specific system being implemented and include software bugs, infrastructure service lapses, connectivity challenges and compatibility problems the project must resolve before completing an implementation. Solutions depend upon acquiring new information, revisiting previous decisions, and applying increased effort to creating new solutions. Increasing the effort required to achieve an objective has a direct negative impact on process performance. The effect of technology challenges can be particularly pronounced during the latter stages of a project when multiple functional affordances are implemented and interacting with each other (Yu et al. 2013). Therefore:

H1c: Technology Fluctuations are negatively associated with Process Performance.

Developer Satisfaction

An area receiving somewhat less attention in the literature relates to the effect of disruptions on project team members. Important learning takes place in the process of trial and error inherent in software development projects (Fong Boh et al. 2007). While organizations benefit from the expanded IT capability nurtured by a series of IS projects, the fruits of this investment are only realized if the technical resources remain both with the organization and motivated. Developer satisfaction is in part a consequence of perceived behavioral control. It also is a significant determinant of project success. Furthermore, employee satisfaction plays an important role in IT worker retention in IT project intensive organizations (McMurtrey et al. 2002; Westlund et al. 2008). Satisfaction is therefore a project outcome with both direct and indirect value to an organization (Aladwani 2002).

Each type of fluctuation discussed above can have an effect of developer satisfaction. Developers can experience frustration when they have to redo design and coding due to unclear or shifting requirements (Procaccino et al. 2006). Late stage requirements change in particular can have a negative impact on developer satisfaction (Burnes et al. 2008). Therefore:

H2a: Requirements Fluctuations are negatively associated with Developer Satisfaction.

Team stability has a direct bearing on many phenomenon that are in turn linked to job satisfaction. Gockel et al. (2012) found that team stability was positiveily related to transactive memory, which was in turn associated with job satisfaction. Dayan and Colak (2008) found that team stability and cohesion was positively related to procedural justice, which in turn supported job satisfaction. Gurtner (2009) found that team stability was positively associated with reflexivity (extent to which members reflect on group objectives, strategies and processes and adapt them to current environmental circumstances), which in turn predicts job satisfaction. Therefore:

H2b: Staff Fluctuations are negatively associated with Developer Satisfaction.

Technology fluctuations may have quite a different effect upon developer satisfactions. Developers as a group value technical skills and are motivated by opportunities to demonstrate and improve their capabilities (Hall et al. 2007). Software developers often acknowledge intrinsic and hedonistic motives as they view the activity as “fun”, “enjoyable” and “cool” (Hars and Ou 2001; Lerner and Triole 2000; Shah 2006). These motivations can be accentuated by status motivations as individuals make important contributions to difficult challenges (Roberts et al. 2006). Therefore:

H2c: Technology Fluctuations are positively associated with Developer Satisfaction.

In addition to the risk of attrition and lost organization capacity that jeopardizes future projects, poor developer satisfaction can also effect performance of the current project. While developers and teams often find and maintain satisfaction despite poor project outcomes (Lindberg 1999; Procaccino et al. 2006), dissatisfied developers adversely affect project and organization outcomes (Koys 2001; Subramaniam et al. 2010). Team effectiveness depends on member satisfaction (Barczak and Wilemon 2001; DeOrtentiis et al. 2013). Therefore

H3: Developer Satisfaction is positively associated with IT Project Process Performance.

Locus of Flux

Teams treat within work system deviations as operational, and expect to address them (Hallgren and Wilson 2007). These challenges are within the locus of control of the team and its members. However, challenges often originate outside work unit boundaries (Chong and Siino 2006) and are beyond the core team's domain of routine and focus of attention. These challenges undermine the perception of control as they are not of the teams making but are externally imposed upon the team. The idea that challenges, uncertainty and change are different when they are internal versus external has been documented by scholars in the related areas of IS investment (Wu and Ong 2008) and construction projects (Sun and Meng 2009). The interaction of fluctuations may also be nuanced, with different types of interruptions having different compounding effects when considering the dynamics of boundary spanning. For example, technology related interruptions have a negative influence on knowledge transfer, whereas change in team structure can positively influence knowledge acquisition (Zellmer-Bruhn 2003).

When considering requirements fluctuations, prospective system users participating directly in a project team bring an evolving understanding of a system through repeated interaction episodes (Highsmith and Cockburn 2001). Close and regular contact with the project allows the team to recognize and respond with change plans in a relatively orderly manner. Externally imposed scope changes, such as might occur with new competitors, represent unexpected events that demand action not envisioned when planning new projects (Wearne 2006). It is therefore expected that requirements fluctuations with an external origin may have significantly larger negative effects. Therefore:

H4a: Locus of Flux (LOF) has a moderating effect on Requirements Flux (RF) such that External LOF amplifies the negative relationship with Performance (PERF).

Arrow and McGrath (1993) found support for the notion that groups react differently to member change depending on who initiates the change. The locus of initiation (internal or external) of team membership change impacts both team cohesiveness and performance, particularly for teams experiencing frequent staff flux. The motive for staff changes may also be important. Replacing poor performing team members with members possessing important new information and skills can have a positive performance impact. Therefore:

H4b: Locus of Flux (LOF) has a moderating effect on Staff Flux such that External LOF amplifies the positive relationship with Performance (PERF).

The source of origin for technology challenges is relevant to project teams focused on a task with an agenda. The focus of attention, data gathering, discussion, problem solving and creative exploration are centered on the primary task. When issues arise within the focal activities of the team, these disruptions can be interpreted and understood in the context of active memory models. When technology challenges arise from beyond the arena of focused attention, the team is faced with multiple challenges that start with recognizing the issue. With attention focused elsewhere, there may be a delay in appreciating the implications of disruptive information. Once the unexpected challenge is recognized, the team must shift a portion of its energies to building a new memory model that assimilates deviations in to the solution. Therefore:

H4c: Locus of Flux (LOF) has a moderating effect on Technology Flux such that External LOF amplifies the negative relationship with Performance (PERF).

RESEARCH DESIGN AND RESULTS

Methodology

Deviations have not been studied in IT projects from the standpoint of locus-of-control that is affected by locus of initiation. As such this study is exploratory as it attempts to demonstrate the applicability of this theoretical perspective. Cross-sectional data and PLS analysis are well suited to this type investigation.

This study employed a web survey to collect empirical data for hypothesis testing. Instruments used in this study were adapted to fit the context of this study from validated scales used in previous research where available. Project performance utilizes a scale employed by Chandrasekaran and Mishra (2012). Requirements flux utilizes a scale from Wallace, Keil and Rai (2004). Staff flux builds an aggregate scale employing measures introduced by Carbonell and Rodgriguez (2006) supplemented by items from Gopal and Gosain (2010). An existing survey scale introduced by Imamoglu and Gozlu (2008) has been adapted for Locus of Flux. Technology Flux has been widely conceptualized as an organization level phenomenon involving emerging and evolving technologies across an industry. These scales are not suitable for this study that examines technology flux at the tactical project level. As a result a new scale has been developed based on an assessment of 16 semi-structured interviews with members of four IS project teams. Several items were reverse coded to maintain motivation and cognitive engagement. In addition to the research variables shown in Appendix A, demographics and controls were included to capture the covariance associated with relevant factors not directly substantive to the proposed theory.

Email requests were delivered to over 3000 IT professionals seeking data for a single self-identified IS project. Responses from 807 IT professionals were filtered to those individuals serving in the role of project manager and who agreed they had “a deep understanding of the projects events and processes”. The usable sample size was 315. Demographic information suggests we captured professionals with substantial experience with over 53% reporting over 10 years in the current role (53% over 10 years, 30% with 5-10 years, 10% with 3-4 years, 4% with 1-2 years and 2% with less than one year). This maturity is also reflected in the age of respondents (less than 1% below age 24, 15% between 25 and 34, 38% 35-44, 30% 45-54, and 17% 55 and over).

The measures and research model were analyzed using the WarpPLS (Kock 2015) implementation of PLS-SEM. All items are treated as reflective indicators of latent variable constructs. Conclusions for hypotheses are assessed at α=0.05 level of significance common for the behavior sciences. A bootstrap resampling technique that is robust where data is not normally distributed is used to calculate the standard error and determine probability levels for hypothesis testing.

PLS-SEM allows simultaneous testing of the measurement and path model. One measure (SF1) was removed due to low indicator reliability. All other measures demonstrate construct validity using criteria and thresholds recommended for IS research (Gefen and Straub 2005). Item loading are above the acceptable threshold of 0.4 for exploratory research and statistically significant at the α=0.05 level (Hair et al. 2012; Urbach and Ahlemann 2010). Internal consistency and reliability is supported by Composite Reliability (CR) scores above 0.7. Convergent validity is supported by average variance extracted (AVE) scores above 0.5. Discriminant validity is supported by a Square-Root of AVE for each latent variable larger than the highest correlation with other latent variables. Appendix A details item level statistics, Appendix B provides latent factor correlations and Appendix C details full path model statistics.

Results

For the structural model, a bootstrapping technique has been used to calculate significance levels for each path coefficient. Results for the inner model are detailed in Table 1. Demographic variables of experience and age do not have a significant relationship with either dependent variable. Control variables for team size, geographic spread of users and geographic distribution of project team members are also not statistically significant.

Hypothesis	Path coefficient	Std.error	p-value	Conclusion	f^2
H1a: RF $\xrightarrow{(-)}$ PERF	-0.216	0.070	0.001	Accept	0.09
H1b: SF $\xrightarrow{(+)}$ PERF	-0.068	0.060	0.130	Reject	0.02
H1c: TF $\xrightarrow{(-)}$ PERF	-0.036	0.064	0.287	Reject	0.01
H2a: RF $\xrightarrow{(-)}$ DSAT	-0.227	0.063	<0.001	Accept	0.09
H2b: SF $\xrightarrow{(-)}$ DSAT	-0.323	0.065	<0.001	Accept	0.14
H2c: TF $\xrightarrow{(+)}$ DSAT	-0.099	0.071	0.083	Reject	0.04
H3: DSAT $\xrightarrow{(+)}$ PERF	0.414	0.066	<0.001	Accept	0.22

H4a: RF * LOF ⟶ PERF	0.042	0.054	0.219	Reject	<0.00
H4b: SF * LOF ⟶ PERF	0.043	0.064	0.247	Reject	<0.00
H4c: TF * LOF ⟶ PERF	-0.150	0.065	0.011	Accept	0.03
RF * TF ⟶ PERF	0.013	0.056	0.405	n.s.	<0.00
SF * TF ⟶ PERF	0.186	0.077	0.009	Significant	0.01
SF * RF ⟶ PERF	-0.226	0.089	0.006	Significant	0.02
Ctrl_Experience ⟶ PERF	0.052	0.048	0.080	*n.s.*	<0.00
Ctrl_Age ⟶ PERF	-0.054	0.046	0.136	*n.s.*	<0.00
Ctrl_TeamSize ⟶ PERF	-0.059	0.051	0.142	*n.s.*	<0.00
Ctrl_UserLoc ⟶ PERF	0.034	0.042	0.246	*n.s.*	<0.00
Ctrl_PrjDuration ⟶ PERF	-0.035	0.059	0.162	*n.s.*	<0.01
Ctrl_Experience ⟶ PERF	-0.065	0.057	0.212	*n.s.*	<0.00
Ctrl_Age ⟶ PERF	0.014	0.062	0.442	*n.s.*	<0.00
Ctrl_TeamSize ⟶ DSAT	0.036	0.047	0.366	*n.s.*	<0.00
Ctrl_UserLoc ⟶ DSAT	0.044	0.053	0.177	*n.s.*	<0.00
Ctrl_PrjDuration ⟶ DSAT	0.070	0.062	0.196	*n.s.*	<0.00

Table 1: Inner Model test statistics

While all three forms of fluctuations (requirements, staff and technology) have negative associations with performance, only Requirements Flux is statistically significant, supporting H1a. The data does not support a direct association between Technology Flux or Staff Flux and performance, leading to rejection of H1b and H1c. When considering Developer Satisfaction, both Requirements Flux and Staff Flux have statistically significant negative associations, supporting H2a and H2b. However, Technology Flux does not have a statistically significant relationship with Developer Satisfaction suggesting rejection of H2c. Overall Developer Satisfaction has a direct positive relationship with Performance supporting H3.

Our examination of perceived control involves the contingent effect of Locus of Flux (LOF) with each form of Flux. Data does not support an interaction between LOF and either Requirements Flux or Staff Flux, suggesting rejection of H4a and H4b. However, the data reveals an interaction effect of LOF and Technology Flux, supporting H4c. These results are summarized in Figure 2.

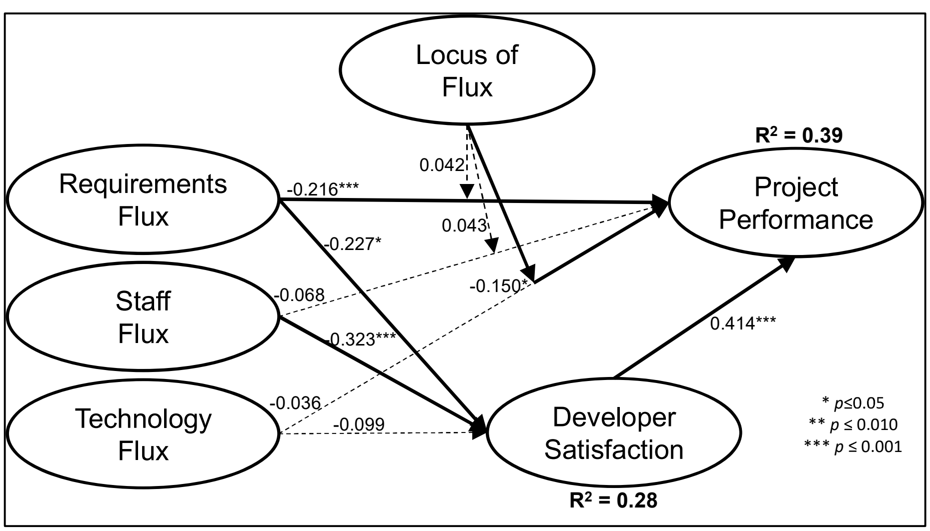

Figure 2: Research Results

DISCUSSION

The findings from this study support the idea that not all project disruptions have the same effect. For this sample of IS projects, only requirements fluctuations have a direct association with project performance. However, both Requirements Flux and Staff Flux have negative relationships with Developer Satisfaction. From this we infer that developers are not be happy about disruptions that coincide with staff and requirements fluctuations. However, the benefits of new ideas and supplemental skills that may occur with team membership reconfiguration are being offset by the negative performance effects of learning curves and team assimilation.

Requirements and staff flux are forms of disruption are outside the direct control of developers, demonstrating that locus of control remains an important factor in project outcomes irrespective of processes and methods employed to establish local control.

Interaction Effects

Findings for Technology fluctuations are particularly interesting. Overall the data reveal the direct effect of technology flux is not statistically significant. This is perhaps not too surprising as software projects inherently involve technical challenges, and this situations often motivates developers to participate in this profession. The contingent effect from LOF indicates that technology problems experienced though the actions of team participants themselves are considered a normal part of the activity. Technology flux has an equivocal or statistically weak relationship with project performance. However, technology fluctuations that originate from outside and imposed on the team change the relationship and reveal a statistically significant negative association with project performance. This effect is plotted in Figure 3. Technology Flux and LOF taken together are a better predictor of performance than Technology Flux alone. External technical challenges may range from hardware service interruptions to bugs in externally provided software libraries. Both internal and external technical challenges appear equivalent to an outsider as features are seen to be inoperable, low quality or performing poorly. From a developer's perspective the differentiating characteristic is the point of origin, suggesting a prominent role for perceived control.

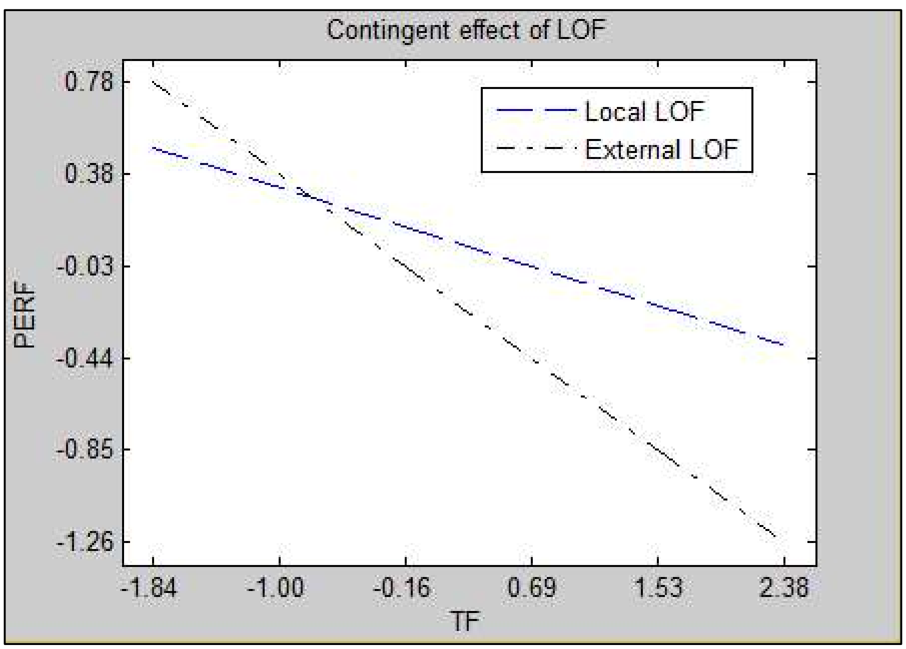

Figure 3: Contingent effect of LOF and Technology Flux

Additional Post-Hoc Analysis

As a post-hoc analysis we also examined the interaction effects of each form of flux with the other forms of flux. The Interaction of Requirements Flux and Technology Flux was not statistically significant (p=0.405). However Staff Flux interacts with both Technology Flux (p=0.009) and Requirements Flux (p=0.006), indicating that interference with project team membership and participation has a compounding effect on these other forms of flux.

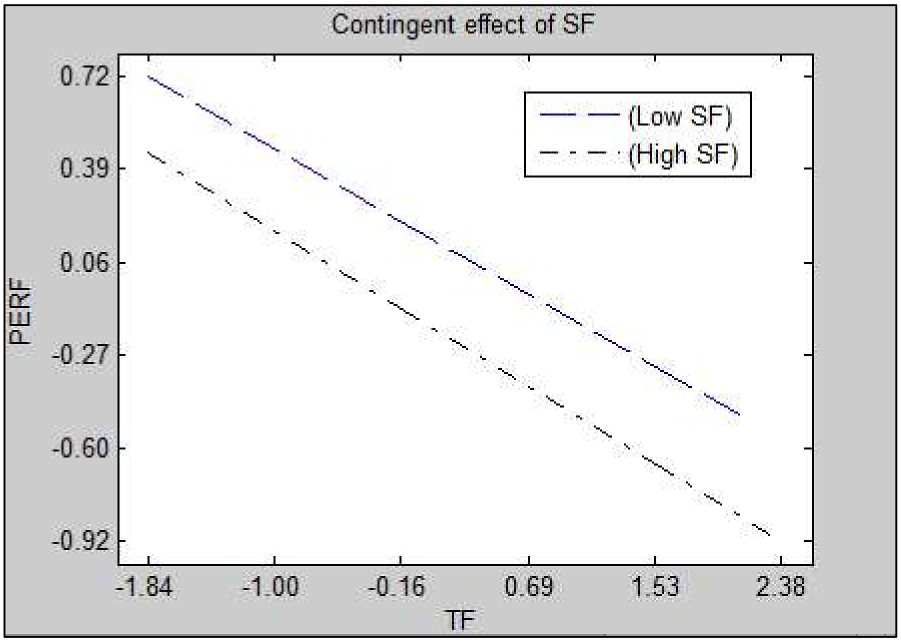

Figure 4: Contingent effect of Staff Flux and Technology Flux

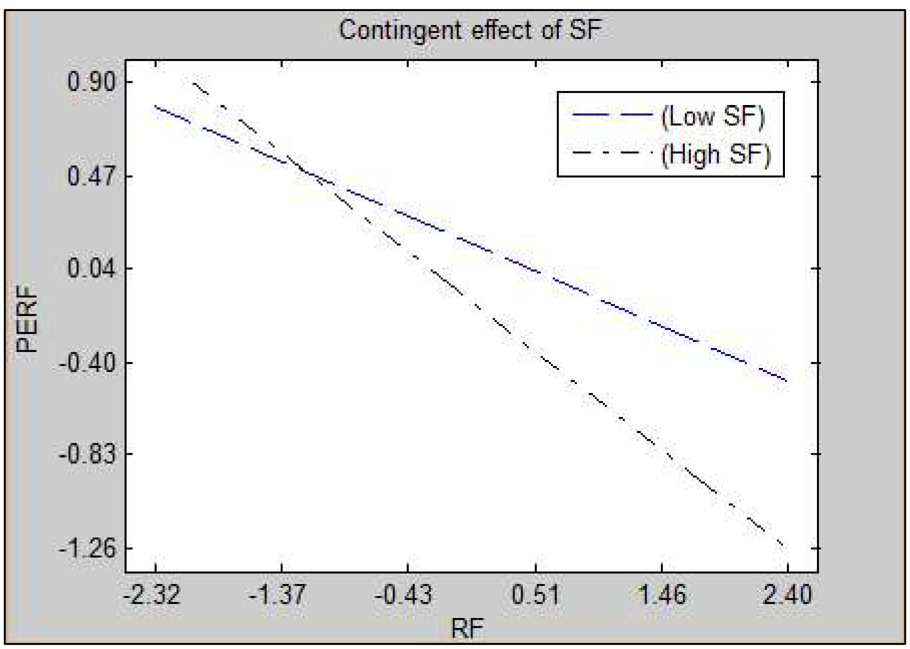

Figure 5: Contingent effect of Staff Flux and Requirements Flux

Implications for Research

In this study we differentiate the sources of project fluctuations to better understand their unique dynamics and impact patterns. Aggregating risk and deviations can hide insights regarding underlying phenomenon. By differentiating types of emergent risk and locus of flux we find empirical evidence that situational locus of control plays a role in project performance and developer satisfaction. This is relevant to the study of project management practices where Agile and OSS are sometimes studied as a manipulation of perceived behavioral control. Our findings suggest that such manipulations will be incomplete and efforts to understand these practices should include situational dynamics. This study also establishes LOF and the point of origin for disruptive events as a contingent factor in IT project performance.

Implications for Practitioners

Agile advocates often highlight the fit of Agile project management to environments where requirements frequently change. This study suggests that staff fluctuations and locus of flux are important contingent factors. Organizations concerned about rapidly changing market conditions that drive requirements fluctuations must also consider how the environment is effecting staff flux and the nature of the technology dynamics as these factors retain their disruptive effects independent of changing requirements.

Limitations

A design decision for this study limited the investigation to three domains as sources of project deviations (requirements, staff and technology). A more complete understanding will come from studies that examine additional areas where fluctuations may emerge including data, organization support or the project processes itself.

A second limitation of this study is the use of proxies and indirect means to assess the theorized effects of perceived control, without attempting to measure the latent phenomenon itself. We are measuring the posited outcomes that are attributable to the theorized phenomenon of perceived control. An opportunity for follow-up study would be to collect data more directly on the phenomenon of perceived control, either through additional survey scales or using a case study approach to triangulate on perceptions of control.

CONCLUDING REMARK

Developers who are drawn to project environments that promise local autonomy and control may be disappointed as their projects continue to experience disruption events that undermine situational control. This empirical investigation demonstrates the negative job satisfaction and project performance impact of various types of project deviations, as well as the compounding and contingent effects involved.

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APPENDIX A: SURVEY ITEMS AND DESCRIPTIVE STATISTICS

		Mean	Std. Dev.	Std. Err.	Load	P-Value	
Performance: (Chandrasekaran & Mishra, 2012) 1-6: Strongly Disagree to Strongly Agree		Mean	Std. Dev.	Std. Err.	Load	P-Value	CR=0.87 ave=0.63
PERF1	This project completed in estimated **time** relative to its goals. (C&M 2012)	4.098	1.493	0.041	0.824	<0.001	
PERF2	This project completed within estimated **cost** relative to its goals. (C&M 2012)	4.251	1.436	0.058	0.756	<0.001	
PERF3	This project completed with **all functionality** relative to its goals. (C&M 2012)	4.571	1.220	0.058	0.801	<0.001	
PERF4	This project completed with **promised quality.** (C&M 2012)	4.708	1.066	0.067	0.800	<0.001	
Developer Satisfaction: (Aladwani, 2002) 1-6: Strongly Disagree to Strongly Agree		Mean	Std. Dev.	Std. Err.	Load	P-Value	CR=0.85 ave=0.66
DS1	Generally speaking, **members** of the project were very satisfied with their work. *(A 2002)*	4.768	0.849	0.082	0.853	<0.001	
DS2	**Team members** were generally satisfied with their role on this project. *(A 2002)*	4.689	0.825	0.058	0.890	<0.001	
DS3r	**Team members** frequently thought of quitting the project. *(A 2002) (rev. coded)*	4.416	1.305	0.055	0.681	<0.001	
Staff Fluctuations: (Carbonell & Rodriguez, 2006; Gopal & Gosain, 2010) 1-6: Strongly Disagree to Strongly Agree		Mean	Std. Dev.	Std. Err.	Load	P-Value	CR=0.81 ave=0.61
SF1	All project team members worked full time on this project, with no other work assignments. *(C&R 2006) (rev. coded)*	4.001	1.597	*Removed, weak indicator reliability (p-value = 0.132)*			
SF2	Member participation level continually changed due to non-project activities. *(new)*	3.794	1.346	0.073	0.598	<0.001	
SF3	Turnover of key project team members was common. *(G&G 2010)*	2.835	1.390	0.044	0.856	<0.001	
SF4	Overall, member changes were highly significant. *(new)*	2.920	1.399	0.041	0.856	<0.001	
Technology Fluctuations: 1-6: Strongly Disagree to Strongly Agree		Mean	Std. Dev.	Std. Err.	Load	P-Value	CR=0.91 ave=0.72
TF1	Technology problems occurred frequently during this project. *(new)*	3.330	1.393	0.033	0.859	<0.001	
TF2	Designs changed frequently to accommodate technology problems. *(new)*	3.235	1.353	0.035	0.882	<0.001	
TF3	Functional capabilities were removed or deferred due to technology problems. *(new)*	3.032	1.356	0.043	0.794	<0.001	
TF4	Overall, technology problems were highly significant. *(new)*	3.130	1.476	0.036	0.861	<0.001	

CR = Composite Reliability; ave = Average Variance Extracted

Requirements Fluctuations: (Wallace, Keil & Rai, 2004a) 1-6: Strongly Disagree to Strongly Agree		Mean	Std. Dev.	Std. Err.	Load	P-Value	
RF1	System requirements were not adequately identified. *(WKR 2004)*	2.937	1.376	0.051	0.765	<0.001	CR=0.85 ave=0.60
RF2r	Requirements never changed during the project. *(rev. coded)*	4.346	1.327	0.068	0.603	<0.001	
RF3	System Requirements frequently needed correction. *(WKR 2004)*	3.321	1.278	0.034	0.844	<0.001	
RF4	Overall, requirements changes were highly significant. *(new)*	3.406	1.456	0.032	0.853	<0.001	
Locus of Flux: (Imamoglu & Gozlu, 2008) 1-6: Not At All to Very Great Extent		Mean	Std. Dev.	Std. Err.	Load	P-Value	
LOF1r	To what extent was the cause of issues and challenges something the project team anticipated? *(new)* *(rev. coded)*	3.124	1.301	*Removed, weak AVE=0.344, weak conceptual alignment*			CR=0.80 ave=0.58
LOF2r	To what extent was the cause of issues and challenges something controlled by the core project team? (I&G 2008) *(rev. coded)*	3.711	1.448	0.044	0.804	<0.001	
LOF3r	To what extent was the cause of issues and challenges something to do with actions or responsibilities within the core project team? *(I&G 2008) (rev. coded)*	4.067	1.398	0.041	0.834	<0.001	
LOF4	To what extent was the cause of issues and challenges something to do with the people or circumstances outside the core project team? *(I&G 2008)*	4.190	1.439	0.074	0.633	<0.001	

Demographic & Control Variables Scale1 [1-6: strongly disagree – strongly agree] Scale2 [1-6: not at all – very great extent]		Mean	Std. Dev.
Team Size	How many members on the core team? *(Scale1)*	19.186	52.751
User Locale	To what extent are users spread across many locations? *(Scale2)*	3.840	1.762
Project Duration	How long did the project last (in months)? *(Scale1)*	15.684	18.964
Experience	Years of experience in your role.	Count	%
	1 = less than 1 year	5	<2%
	2 = 1-2 years	13	4%
	3 = 3-4 years	33	10%
	4 = 5-10 years	95	30%
	5 = 10+ years	166	53%
	Did not answer	*3*	*<1%*
Age	Your Age		
	1 = under 18	0	
	2 = 18-24	1	<1%
	3 = 25-34	48	15%
	4 = 35-44	119	38%
	5 = 45-54	94	30%
	6 = 55+	52	17%
	Did not answer	*1*	*<1%*

APPENDIX B: LATENT VARIABLE CORRELATIONS

	PERF	DSAT	RF	SF	TF	LOF
PERF	**0.796**	<0.001	<0.001	<0.001	<0.001	0.049
DSAT	0.533	**0.813**	<0.001	<0.001	<0.001	0.937
RF	-0.416	-0.391	**0.773**	<0.001	<0.001	0.065
SF	-0.321	-0.435	0.352	**0.779**	<0.001	0.702
TF	-0.364	0.364	0.634	0.431	**0.850**	0.309
LOF	-0.111	-0.004	0.104	-0.022	0.058	**0.762**

Square Root of average variances extracted (AVEs) shown on diagonal
Correlations below the diagonal, p-values above the diagonal

APPENDIX C: PATH MODEL STATISTICS

Latent Variable	Composite Reliability	Cronbach's α	AVE	VIF	R^2	Q^2
PERF	0.873	0.806	0.633	1.660	0.39	0.39
DSAT	0.852	0.737	0.661	1.703	0.27	0.27
RF	0.854	0.769	0.598	2.085	-	-
SF	0.819	0.666	0.607	1.569	-	-
TF	0.912	0.871	0.722	1.915	-	-
LOF	0.804	0.633	0.581	1.145	-	-