IT'S ABOUT TIME: INVESTIGATING THE TEMPORAL PARAMETERS OF DECISION MAKING IN AGILE TEAMS

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Abstract The emergence and widespread adoption of agile methodologies is often explained by the need to improve time management in Information Systems Development (ISD). Indeed, a growing body of evidence supports the view that agile methodologies are an effective means of delivering productivity gains through time savings. That is to say, agile methodologies can be used to increase speed and efficiency in ISD projects. In addition, lightweight agile methodologies are designed, by definition, to minimise wastes in the design and delivery of Information Systems and can therefore be used to support sustainability in IS projects (cf. Schmidt *et al.*, 2009). However, the impact of agile methodologies on ISD project outcomes is less clear. In addressing this question, this research-in-progress paper uses a combination of existing literature and empirical data to construct a conceptual framework to explain how three different temporal aspects of agile methodologies (time pressure, polychronicity and periodicity) impact upon decision quality, thereby affecting ISD project outcomes. It is envisaged that this framework will be used to shed light on how agile methodologies impact upon project effectiveness or velocity, which is defined in this context as movement in the 'right' direction.

Keywords: Agile systems development; decision making; temporal dynamics

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1 Introduction

The only reason for time is so that everything doesn't happen at once – Albert Einstein

Time is an inherent quality of human life (Hassard, 1999). All human knowledge and understanding is fundamentally shaped by the temporal nature of our being in this world. For thousands of years, philosophers and scientists have engaged in active debate on the nature of time, our experience of time and its association with causality (Hassard, 1999, p. 327). Heidegger (1927, p. 437) asks "does *time* itself reveal itself as the horizon of *being*?" The notion of time pervades everyday language: "time is of the essence": "timing is everything": something can be "just in time" and "a stitch in time saves nine". In work situations, we try to "save time" or not "waste time": "time is money" and we are "on the clock". Yet time remains an abstract notion (Jacques, 1982): it is a "hidden dimension" (Das, 2001; Hall, 1966) and remains one of the most elusive concepts related to work (Saunders, 2007; Sarkar and Sahay, 2004; Massey *et al.*, 2003; Orlikowksi and Yates, 2002; Cooper & Rouseau, 2000).

Contemporary Western culture is characterized by a pervasive desire to maximise the temporal ordering and synchronisation of activities that dates back to Taylor's famous Time and Motion studies (Orlikowski and Yates, 2002). In this context, time is primarily viewed as an objective, chronological (Sarkar and Sarkar, 2004) and material commodity that is scarce, valuable, homogenous, linear and divisible (Sahay, 1997). In today's increasingly high velocity business environment, effective time management is incredibly important. As a result, there is renewed interest in the subjects of time and timing in organisational studies (cf. Orlikowski and Yates, 2002; Ancona *et al.,* 1996; Sahay, 1997).

Nevertheless, an overwhelming proportion of projects are delayed beyond estimated completion time in most industries (Toxvaerd, 2006). This is problematic given that project outcomes are typically judged on whether time deadlines are met (Sarkar and Sahay, 2004). In Information Systems Development (ISD), projects have consistently been plagued by delays and late deliveries (Toxvaerd 2006; Baskerville and Pries-Heje, 2004; Blackburn and Scudder, 1996; Van Genuchten, 1991; Abdel-Hamid and Madnick, 1989). In response to this problem, contemporary systems development methodologies (e.g. Agile and/or Lean methods) are designed to avoid cumbersome and time-consuming processes that elongate the development process (Fitzgerald *et al*. 2006; Fowler and Highsmith, 2001) and have been shown to deliver tangible cost/time savings to organisations (Fitzgerald *et al*. 2006). In particular, lightweight agile methodologies are argued to represent an opportunity to support sustainability in IS projects as they are designed, by definition, to minimise wastes in the design and delivery of Information Systems (cf. Schmidt *et al*., 2009). Yet while time savings are a key feature of agile methods, very little research has explored the temporal dynamics of software development in general (Nan and Harter, 2009) or agile software development in particular.

This research-in-progress paper uses a combination of existing literature and empirical data to construct a conceptual framework to explain how three different temporal aspects of agile methodologies (time pressure, polychronicity and periodicity) impact upon decision quality, thereby affecting ISD project outcomes. It is envisaged that this framework will be used to shed light on how agile methodologies impact upon project effectiveness or velocity, which is defined in this context as movement in the 'right' direction.

2 Managing Time in ISD

In the main, IS development is thought to be "essentially programmable" and is commonly viewed from a "software factory" perspective (Nandhakumar, 1999). Thus, time management is typically based on mechanistic project management techniques (such as PERT), where time is primarily perceived as measurable clock time (Nandhakumar, 1999) and productivity is measured in "lines of code per person month" (e.g. Blackburn and Scudder, 1996).

Yet IS development projects appear to have been poorly served by traditional time management techniques. This is evidenced by frequent late delivery problems in the software industry (Sauer, 1993) and the fact that an overwhelming proportion of ISD projects are delayed beyond estimated completion time (Toxvaerd, 2006, 2004; cf. Van Genuchten, 1991; Abdel-Hamid and Madnick, 1989).

This phenomenon is at least partly explained by considering the complexity of temporal dynamics in ISD projects. It is, for example, well established that time units are not homogenous: segments of time are not necessarily equivalent (Lee, 1999). In iterative projects, for example, progress tends to accelerate across iterations as teams gain experience of projects and of each other (stabilise). Similarly, different individuals tend to expend time at different rates in accordance with skill and experience levels. Thus, Nandhakumar (2002, p. 257), reports that ISD team members' work is marked by a flux of interwoven activities and multiple temporalities:

> *Team members' work was marked by significant changes of pace in which periods of relative inactivity, such as waiting for a colleague to become available to complete some joint task, were matched by intensive efforts as deadlines for projects approached… many different activities were competing for team members' limited time resources and had to be fitted into, and interwoven with, the stream of their other activities… there were many interruptions to team members' work… [and] team members were often simultaneously engaged in several different 'projects… switch[ing] between different activities during the day…*

In light of these observations, McLeod and Doolin (2012) suggest that it is appropriate to adopt Markus and Robey's (1988) "emergent process" perspective on IS development, viewing it as a "dynamic, multi-dimensional process, in which a development outcome emerges unpredictably from complex and reciprocal interactions between people and technology within an organisational context".

In today's software industry, excessive budget and schedule compression have become the norm (Nan and Harter, 2009). This serves to exacerbate already significant time management problems in ISD. Further, the need for short cycle development has become more pressing with the advent of Internet Time (Baskerville and Pries-Heje, 2004).

The emergence and widespread adoption of agile methodologies (Conboy, 2009; Tan and Teo, 2007) is at least partly explained by the need to improve time management in ISD: one of the main aims and purported benefits of Agile Systems Development methodologies is that they deliver productivity gains through time savings (Begel and Nagappan, 2007). In fact, the concept of agile software development has become more-or-less synonymous with short cycle time development (Baskerville and Pries-Heje, 2004; Wetherbe and Frolick, 2000). As a result, ISD project outcomes are most often judged on whether deadlines are met (Sarkar and Sarkar, 2004).

Despite these assertions, there remains a paucity of research on the temporal dynamics ISD in general (Nan and Harter, 2009) and ASD in particular. Indeed, Sanders (2007) indicates that "in more cases than not, time is a silent visitor" in IS research (p. iii). Thus, there is very little to challenge the dominant perspective of time that permeates existing literature on ISD. This research-in-progress is designed to address this gap.

3 The temporal dynamics of Agile Systems Development

This section identifies three arguments in favour of investigating the temporal dynamics of ASD. First, the concept of agility is inextricably bound up with a number of related temporal concepts such as speed, velocity and flexibility. It is well understood that speed refers to rapidity of movement and that velocity refers, more specifically, to speed in a given direction. However, agility also relates to the concept of flexibility or the capacity to "adapt within a given time frame" (Conboy, 2009)[†].

Thus, agile methods are inherently temporal in nature: agile methods call for the creation of organic, flexible and empowered teams, who work in close collaboration with customers over a series of rapid development iterations. ASD teams work under extreme time pressure to deliver working software in short iterations (Fitzgerald *et al.*, 2006; Fowler and Highsmith, 2001) with frequent, short-term

[†] Volberda (cited in Conboy, 2009) observes that flexibility measurable in terms of absolute speed of change; one must instead take into account both time taken to adapt to change and the variety of that change

decisions (Drury *et al.,* 2012). In this context, high-speed release cycles significantly compress development time frames (Baskerville and Pries-Heje, 2004).

From this perspective, the introduction of agile methods in ISD is seen to typify a phenomenon known as "temporal structuring", whereby people (re)produce (and occasionally change) temporal structures to orient their ongoing activities (cf. Orlikowski and Yates, 2002). In particular, the project iteration can be viewed as a deliberate attempt to displace well-established Western views of linear time with more circadian rhythms. In Scrum, for example, software is developed incrementally in a series of short development phases, called 'sprints' where teams initially prioritise and then freeze tasks at the start of each sprint (Baskerville and Pries-Heje, 2004). Similarly, projects based on eXtreme programming, projects are divided into sequences of self-contained, one- to three-week iterations (Baskerville and Pries-Heje, 2004).

Finally, Kumar (1995) indicates that a variety of techniques have been used to deliver significant time compression in the context of agile manufacturing (e.g. concurrent engineering, group technology principles (e.g. variant process planning), design for manufacturability and assembly, design and process optimization through Taguchi methods). Taken together, this arsenal of techniques well illustrates Hassard's (1999, p. 342) argument that synchronization, sequence and rate are critical factors when we want to distribute time so that activities consume it in the most efficient manner (Hassard, 1999, p. 342). An investigation of the temporal dynamics of ASD may reveal new insights in relation to the application of these and other techniques in software supply chains.

In order to facilitate the development of a nuanced understanding of the role of temporal dynamics of ASD, this study adopts a decision making lens in order to investigate the impact of the temporal dynamics of ASD on project outcomes. This is also an opportunistic approach as it represents an opportunity to address repeated calls for research on decision making in agile setting (Drury *et al*., 2012;; McAvoy and Butler, 2009; Maurer and Zannier, 2007).

4 Building a conceptual framework

The purpose of this section is to develop a conceptual framework of the temporal parameters that have a bearing on decision making in the context of ASD. This framework is based on a multidisciplinary review of literature and is informed by a semi-structured focus group that was carried out in December, 2011, to probe scrum master issues. This focus group was attended by seven scrum masters (representing three companies) and six researchers (including the focus group chair). The session focused on three focal areas: Issues, Recommendations, and Resolutions and flip charts and audio recordings were made to capture proceedings.

4.1 Time Pressure in Agile Decision Making: Need for Speed

It is well established that schedule constraints have a critical impact on software development outcomes (Nan and Harter,, 2009). Problems arise, for example, when developers who feel that they are under pressure to meet task deadlines decide to take shortcuts in dealing with unanticipated complications (Austin, 2001). Thus, time pressure is an often-cited source of quality problems in technological systems (DeMarco 1993; Brooks 1975).

Time compression has become the norm on today's software industry (Nan and Harper, 2009). Thus, agile methods have emerged in response to the inefficiency of existing software development methods (Wang *et al.,* 2012; Highsmith, 2002). Agile methods are designed to achieve software quality under time pressure and in unstable requirements environments (Huo, 2004). In particular, agile methods represent an opportunity to support sustainability in IS projects as they are designed, by definition, to minimise wastes in the design and delivery of Information Systems (cf. Schmidt *et al.*, 2009). Agile teams work under extreme time pressure to deliver working software in short iterations (Fitzgerald *et al.,* 2006; Fowler and Highsmith, 2001). They are required to follow fine-grained time planning and time reporting procedures and their progress is explicitly, continually and publically measured.

As a result, agile decision-making processes are significantly more challenging than when traditional development approaches are used (Conboy *et al.,* 2009. Agile decision making is frequent and short-term (Fowler and Highsmith, 2001) and time and resource constrained (Drury *et al.,* 2012). In agile projects, decision makers are frequently called upon to manage ongoing uncertainty in the face of severe time pressure. In these situations, decision makers' information load – the "the amount of data to be processed per unit of time" (Wright, 1974) – is increased. As a result, decision outcomes can be compromised in agile teams as a result of time pressure (Drury *et al.*, 2012) as decision makers must maximize their ability to rapidly acquire and process information (Fiedler, 1986).

In these contexts, high velocity (Eisenhardt, 1989) or hyper-vigilant (Janis and Mann, 1977) decision making patterns are commonly used. The difficulty is that these patterns are characterized by (a) a nonsystematic or selective information search, (b) consideration of limited alternatives, (c) rapid evaluation of data, and (d) selection of a solution without extensive review or reappraisal (Johnston *et al.* 1997). In this equation, the caliber of the information available to decision makers is crucially important. One participant explained that "*when you're in sprints, you've got a bit of pressure to deliver… you're not analysing what you're doing… you're skipping over it because you know you've deadlines to achieve*".

At the same time, it is acknowledged that decision makers build up a body of knowledge and familiarity about particular decision scenarios over time and can leverage that knowledge and experience to make more effective decisions at speed.

Proposition 1: Time-pressure is negatively associated with decision quality in agile teams; this association is most pronounced in the earliest stages of projects and in the earliest stages of project iterations but has the potential to be moderated if information quality can be improved

4.2 Synchronisation, polychronicity and timeliness

Under industrial capitalism, efficient organisation became synonymous with detailed temporal assessment of productivity (Hassard, 1999, p. 329) and the time period replaced the task as the focal unit of production (cf. Mumford, 1934, p.14). In this context, the clock is the epitome of chronological time (*chronos*) and is the basis upon which functionally segmented parts and activities are temporally coordinated or synchronized.

Similarly, ASD methodologies are based on a linear (or iteratively linear) view of time and assume that events and tasks can be monochronically ordered. That is to say, it is assumed that events and tasks will manifest in an organized temporal way and follow a predetermined or at least predictable sequence (cf. Schein, 1992, p 114). However, the lived reality of agile practitioners is often polychronic: regardless of previous planning decisions, events and tasks frequently occur in an unexpected temporal way; they are irregular, sporadic, uneven, and do not follow a fixed schedule (cf. Schein, 1992, p. 114). Given that agile methods are designed to ensure flexibility, it is important that agile teams maintain what Hassard (1999, p. 333) refers to as "flexible, event-based trajectories". Nevertheless, excessive polychronicity in agile teams results in what one respondent referred to as '*drag*'. In this case, "*everybody just has to stop what they're doing and go fix things*". As a result, momentum or velocity is either lost or it is not achieved in the first place. In this context, more sophisticated temporal structures are needed to manage and coordinate organisational processes (Hassard, p. 329). The challenge is one of *kairos*, or appropriate timing (Williams, 1990, p. 57), rather than *chronos*.

From a decision making perspective, a rich variety of dynamic decision-making studies has revealed much about the flaws in people's abilities to manage dynamic complexity (Diehl and Sterman, 1995). In agile settings specifically, excessive polychronicity impairs planning decisions as agile teams are forced to engage in "*poker planning*": *we have to cost things [in terms of time, but] the plan changes two hours later. We build insurance into the sprint, knowing that we'll lose people or knowledge from the team.*

Thus, we propose that:

Proposition 2: Excessive polychronicity is an indicator of environmental uncertainty in agile teams; it is negatively associated with decision quality but this association can be moderated if decision-making timeliness can be improved

4.3 The agile iteration: periodicity and decision making

The project iteration is one of the hallmarks of ASD. It helps to ensure that potential problems are detected as soon as possible. By breaking time into digestible fragments, it reduces temporal uncertainty (Hassard, 1999, p. 338), improves synchronisation within and across teams, and increases productivity by minimising the effects of Parkinson's Law (1962)[‡]. Whilst it has been established that decision making in agile teams is dynamically complex (McAvoy and Butler, 2009), the impact of the project iteration on decision quality in agile teams is not well understood.

The project iteration may increase susceptibility to immediacy bias (Van Boven, 2012) whilst reducing risk aversion (cf. Lopes, 1996; Read *et al.*, 1999) as it reduces the apparent implications of a particular decision to the time frame of a given iteration: it is always possible, in theory at least, to undo a particular decision in a subsequent iteration. At the same time, empirical studies indicate that agile decision speed increases over time as decision making is informed by experiences from previous iterations. By the same token, the nature of the iteration is such that decisions made in the early stages of a project may influence subsequent decision making behaviour. The difficulty is that "decision making behaviour at time t is largely predictable from decision making behaviour at time $t-1$ - irrespective of whether this is appropriate" (Huber, 1991). Finally, decision making in early iterations may impose unforeseen constraints on choices available in subsequent iterations as iterative decisions are more likely to be intertemporal in nature (cf. Loewenstein and Thaler, 1995).

Proposition 3: Iterative decision making practices in agile teams are negatively associated with decision quality

4.4 Agile decision making and IT

Finally, information technology (IT) has played a key role in transforming the temporalities of work and in creating temporal symmetry between work-groups (Lee, 1999). The proper use of IT has been identified as a key facilitator of agility in organizations (Baskerville and Pries-Heje, 2004; Newman *et al.,* 2000) as it enables faster information flows and speedier decision making, resulting in time compression in the supply chain (Kumar, 1995). In the context of ISD, automated

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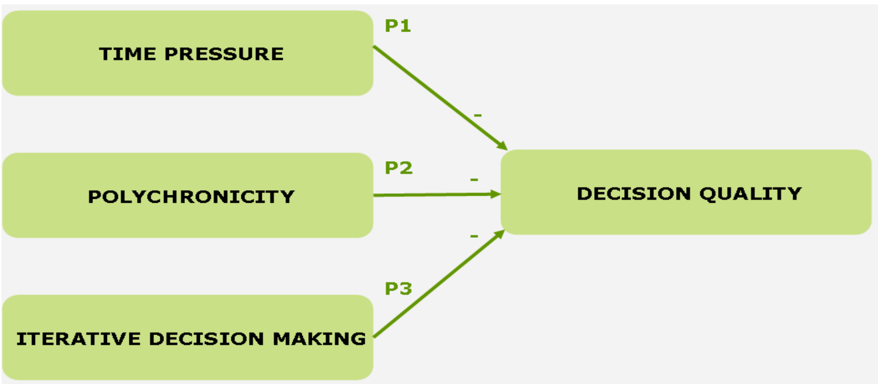
[‡] Parkinson's Law states that work will expand to fill the available time. This law has been formalised by a number of authors (e.g. Abdel-Hamid and Madnick, 1989).

software tools affect the temporal and spatial organisation of work (Sarkar and Sahay, 2004; Orlikowski, 1991) by enabling the surveillance and control of team members' work practices over time–space (Nandhakumar, 2002; Zuboff, 1998). Given the decision making challenges that are inherent in ASD, there is a need to explore the tension between the need for information to aid decision making in ASD and the desire to create minimal documentation in ASD.

5. Conclusions

Figure 1 summarises the conceptual framework of the impact of three temporal parameters on decision making in agile teams developed in this paper.



Proposition 1: *Time-pressure is negatively associated with decision quality in agile teams; this association is most pronounced in the earliest stages of projects and in the earliest stages of project iterations but has the potential to be moderated if information quality can be improved*

Proposition 2: *Excessive polychronicity is an indicator of environmental uncertainty in agile teams; it is negatively associated with decision quality but this association can be moderated if decision-making timeliness can be improved*

Proposition 3: *Iterative decision making practices in agile teams are negatively associated with decision quality*

This framework explores the impact of three temporal parameters on decision making in agile teams and is informed by both existing literature and preliminary data. It serves as a starting point in deconstructing the intertwined concepts of agility, flexibility, uncertainty, and time in the context of decision making and may be used guiding future research in this area. In particular, it is envisaged that understanding the temporal aspects of decision making in agile teams will help to lay a foundation for further studies of the interactions between dynamic complexity and human performance (cf. Diehl and Sterman, 1995).

As such, this research-in-progress paper reports on an ongoing study investigating the temporal parameters of decision making in agile teams. It is part of a growing stream of research that explicitly recognises and calls attention to the concept of temporality in the fields of organisation science, decision making and IS. It also serves to call attention to the capacity of agile methodologies to support sustainability as well as flexibility in ISD.

This research is supported by the Irish Social Sciences Platform (ISSP), funded under the Programme for Research in Third Level Institutions, administered by the HEA and co-funded under the European Regional Development Fund (ERDF), and also supported in part by Science Foundation Ireland grant 10/CE/I1855 to Lero.

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