2009

A case study of risk management in agile systems development

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Abstract

A principal objective of agile development methods is to reduce risk thereby resulting in more successful and effective information systems. However, while there is an extensive body of academic literature on risk management, very little research has attempted to rigorously apply this as a lens to study risk management in agile development projects. The purpose of this research was to ascertain the extent to which risk management practices are incorporated into agile development projects. A case study was conducted involving a change management consultancy firm whose main business involved the deployment of agile approaches. The study found that while there is a perception that risk management practices are not carried out in agile environments, the extent to which risk management is conducted on these projects is in some cases just as substantial to that carried out on traditional projects. In fact, in this case it appeared that the teams were more rigorous in their risk management than is often the case.

1 INTRODUCTION

In ISD, the rapidly growing use of agile methods shows the urgency of organisations to adapt to change at a more speedy and efficient pace where practitioners have "developed methodologies and practices to embrace, rather than reject higher rates of change" (Williams and Cockburn, 2003). Many agile methods have emerged in recent years to address this issue e.g. *eXtreme Programming (XP)* (Beck, 1999), the *Dynamic Systems Development Method (DSDM)* (Stapleton, 1997), *Scrum* (Schwaber and Beedle, 2002), *Crystal* (Cockburn, 2001), *Agile modelling* (Ambler, 2002), *Feature Driven Design (FDD)* (Coad, de Luca et al., 1999), and *Lean Software Development (LSD)* (Poppendieck, 2001), along with variants of each e.g. *XP-Lite* (Aveling, 2004). Agile methods are known for their use of iterative development, active user involvement and their acknowledgement of the need to incorporate changing system requirements and "focus on generating early releases of working products using mostly collaborative techniques" (Reifer 2002). This is a stark contrast to the traditional model for systems development which promotes "elicitation and freezing of requirements in advance" (Fitzgerald 2000) with no overlap between project phases of analysis, design and implementation (Walters, Broady et al. 1994).

A principal objective of agile methods is to reduce well-known risks associated with common ISD project failures by for example, accepting that requirements will change. The first "truly agile method" (Abrahamsson, Warsta et al. 2003) is known as the Dynamic Systems Development Method (DSDM) which promotes the idea that "instead of fixing the amount of functionality in a product and then adjusting time and resources to reach that functionality, it is preferred to fix time and resources and then adjust the amount of functionality accordingly" (Abrahamsson, Warsta et al. 2003). This highlights the element of flexibility in DSDM with regard to adjusting system functionality where system requirements are open to change. However, no matter what the nature of change, there will always be associated risks involved be it either a systems development change or a business operational change.

1.1 Motivation For Research

The idea of being proactive to change is becoming increasingly important across all industries due to an increase in project failures. There are infinite examples across the literature of project failures and media reports of "major engineering and development projects running late or exceeding their budget" (Coppendale 1995). Risk management has been described as the "activity of identifying and controlling undesired project outcomes proactively" (Smith and Merritt 2002). One of the main reasons highlighted for the increasing failure in software projects is that "managers are not taking prudent measures to assess and manage the risks involved" in their projects (Keil, Cule et al. 1998). According to Smith and Merritt (2002), a lack of proactiveness with regard to risk management is one of the main reasons for project delays, increased project running costs and/or eventual project failures.

While there is extensive literature on risk management, research in relation to risk management in agile ISD projects is non-existent. This is surprising considering how quickly agile methods are being adopted in ISD. Many books on agile methods "have remarkably little to say about how a development team determines the risks it faces, prioritises them or takes action to negate their effects" (Smith and Pichler 2005). Essentially, agile methods must "tailor conventional risk management approaches meant for years-long projects into a risk driven agile iteration lasting only seven to thirty days" (Smith and Pichler 2005). How agile projects go about doing this remains unknown.

The primary objective of this research was thus to develop a better understanding of risk management practices in agile ISD projects and the level of formality with which these practices are executed. Specifically, this research focuses on three main elements of risk management, namely risk identification, estimation and evaluation.

2 THEORETICAL BACKGROUND

In an ISD context, Barry Boehm highlighted the concept of managing risks and giving them priority as far back as 1988. Ten years later, Hall (1998) described Boehm as being "the father of software risk management." Boehm proposed a move away from the 'staged' SDLC (Systems Development Lifecycle) to a more iterative or incremental process and this proposed concept in software development is an attempt to lower project risks (Powell and Klein 1996). Boehm's aim was to eliminate any software difficulties or risks mainly by deriving "risk-driven documents" and "incorporating prototyping as a risk-reduction option" (Boehm 1988). It resulted in what was called the 'Spiral Model' that essentially created "a risk-driven approach to the software process rather than a primarily document-driven or code-driven process" (Boehm 1988).

Many authors highlight distinct approaches and frameworks for dealing with risk management. The approaches used can be formal or informal. In an informal environment "much risk identification is undertaken by managers and associated staff without any aiding techniques: they rely solely on experience, intellect and imagination to generate a comprehensive risk list" (Powell and Klein 1996). Formal approaches include methods such as brainstorming or Delphi techniques, which can involve numerous stakeholders. In the literature, there is no universally accepted approach to risk management. This however, is a reasonable and understandable finding in that the process of risk management will differ across various industries and projects. As Raz, Shenhar et al. (2002) state "one cannot expect that a single, universal risk management process and its supporting set of tools and techniques would be applicable to all types of projects" and "just as there are different types of projects, we should expect to see different kinds of risk management practice."

Risk management fundamentals however remain the same and are consistent across disciplines. The literature shows similar emphasis on the most important activities in risk management namely, those identified by Rowe (1977) and Charette (1990) - the early practitioners of risk management - who outline the three main elements of risk assessment as (i) Risk Identification, (ii) Risk Estimation and (iii) Risk Evaluation.

2.1 Risk Identification

Risk identification is the reduction of descriptive uncertainty (Rowe 1977) which involves "surveying the range of potential threats" (Charette 1990). This element of risk assessment involves detecting issues which could jeopardise or threaten the success of a project (Coppendale 1995; Grey 1995). Chapman (1998) states that "the risk identification and assessment stages have the largest impact on the accuracy of any risk assessment." As a result, risk identification is the most important stage of the risk management process. Of particular importance to ISD is the early identification of risks where "identifying and dealing with risks early in development lessens long-term costs and helps prevent software disasters" (Boehm 1991). Many software disasters could have been avoided by early identification of any high-risk aspects (Boehm 1991). It is imperative to understand that "the identification of risks carries on throughout the life of a project" (Grey 1995). In other words, risk identification is an ongoing, continuous process that requires regular screening and monitoring.

An important aspect of risk identification is categorising the risks organisations encounter. According to Coppendale (1995), "depending on the size and the complexity of the project there might be between five and fifteen" categories of risk. Categories attempt to group certain types of risk under a particular heading and in doing so "can help you find global risks that can be solved together" (Williams, Walker et al. 1997). Two dominant ways of categorising sources of risk have been identified by Frame (2002). The first way of categorising risk is by function. Schwalbe (2000) identifies these functional categories as Market, Financial and Technological. For example, market risk may be a failure of user-acceptability of a product. The second approach is to categorise risk as internal or external. For the purposes of this research, it was the author's opinion that an analysis of

the literature in relation to internal and external sources of risk would provide a broader examination of the risk identification process.

There are many sources of risk, some of which include senior management, the client or customer, the project team, organisation of the project itself and finally laws and standards which directly impact the project (Mantel, Meredith et al. 2001). These sources can be placed into their respective categories as being either internal or external risk as follows:

	Risk Category	
	Internal	**External**
Sources of Project Risk	Senior Management	Acts of Nature
	Project Team & Management	The Client
	Organisation of the Project	Laws and Standards

Table 1: Categories and Sources of Project Risk

The two most dominant sources of internal risk identified across the literature are Senior/Project Management and Project Team. The dominating external source of risk is the client. All of these were collectively identified by Mantel, Meredith et al. (2001) and are represented in the above table.

Every source of risk can have numerous risk factors. A risk factor is "a condition that forms a serious threat to the completion of an IT project" (Keil, Cule et al. 1998). Some internal risk factors include project conflict and resource boundaries, which can be linked to sources of project team and senior management risk respectively. There are an infinite number of risk factors (even if one was to analyse just one industry) and a study of all these was beyond the scope of this research. The following table however, shows some of the most dominant risk factors identified by Wiegers (1998), who categories these factors by sector:

Project Sector	**Risk Factor**	**% Of Projects at Risk**
MIS	Creeping User Requirements	80
	Excessive Schedule Pressure	65
	Low Quality	60
	Cost Overruns	55
	Inadequate Configuration Control	50
Commercial	Inadequate User Documentation	70
	Low User Satisfaction	55
	Excessive time to market	50
	Harmful competitive actions	45
	Litigation expense	30

Table 2: Most common risk factors for various project types (Wiegers 1998)

On analysing the table, some direct link between sources and risk factors is evident. For example, the sources of 'management' risk or 'organisation of the project itself' could be linked to the risk factor of 'inadequate configuration control' due to a flaw in the project's arrangement and organisation. However, the most interesting correlation is that of the ten risk factors listed in Table 2, at least six of these can be linked to the client as a source of project risk.

Finally, a dominating feature in recent literature deserves recognition where there is strong support among authors that an actual 'source of risk' can provide a 'source of opportunity.' Chapman and Ward (1997) state "it is only once risk is seen as a good thing people begin to look for opportunities." Very few people would acknowledge 'opportunity' as being a facet of risk as naturally there are negative connotations associated with risk. Hillson (2001) however, states "the decision to encompass both opportunities and threats within a single definition of risk is a clear statement of intent, recognising that both are equally important influences over project success, and both need managing

proactively." In a general sense the above ideas represent something we all know and understand about risk and the nature of taking gambles – people and organisations usually undertake risks with the aim of benefiting from potential opportunities (Schwalbe 2000). Taking on any form of risk can be a daunting task but as DeMarco & Lister (2003) state, "if a project has no risks, don't do it."

2.2 Risk Estimation

At this stage it is hoped that the project team have identified all potential risks and they can now move on to estimating those risks. Risk estimation is the reduction of measurement uncertainty (Rowe 1977) where "the values of the variables describing the system are determined, the various consequences of an event occurring are identified" and finally, "the magnitude of the risk is determined" (Charette 1990). According to Charette (1989) "the basic difficulty in estimating software engineering risks is that most prospective project risk estimates being made are unique" because there are so few comparable projects which were conducted in the past. This aspect of estimation is extremely applicable in ISD environments where there are many generic risk occurrences but very few instances of projects operating under similar circumstances. Therefore, future estimates will undoubtedly be different.

Risk estimation attempts to estimate "the chance (or probability) of potential loss" as well as "the exposure to potential loss i.e. the consequences or magnitude of the identified risks" (Charette 1989). The chance of potential loss is essentially the process of attaching a probability of occurrence to any identified risk. As Hall (1998) states "estimation is the appraisal of risk probability and consequence." Probability is categorized as being greater than zero and less than one hundred while consequence is decided relative to cost, schedule and technical goals (Hall 1998). If an event is certain to occur it has a probability of exactly one (McManus 2004) or one hundred percent. Calculating the probability of occurrence of a risk factor means calculating "the likelihood that this risk will actually happen" (McManus 2004). According to McManus (2004) probability data should be used to compute the risk. When no actually data on probabilities exist, estimates by individuals most familiar with the project, its risk factors and overall problems are a good substitute (Mantel, Meredith et al. 2001).

According to Frame (2002) and Hall (1998) addressing the consequences of risk factors can be carried out in two ways – either by qualitative or quantitative risk analysis. Qualitative data involves subjective units such as 'high', 'low' or 'critical' while quantitative data uses numerical units such as 'workdays', 'staff months' or 'monetary units' (Smith and Merritt 2002). Informally, the literature reveals that qualitative analysis is based on subjective risk estimation while quantitative analysis is based on objective risk estimation. For example, Mantel, Meredith et al. (2001) outline how approaches that are qualitative in nature include "subjective assessments based on experience or intuition" while quantitative approaches are "bases on mathematical and statistical techniques" which are objective in nature.

2.3 Risk Evaluation

Risk evaluation is an ambiguous term. Many authors use it to describe the process of evaluating the entire risk management approach while others use it to encapsulate the ideas of risk response. For example, Marchewka (2003) states how "evaluation should consider the entire risk management process." Charette and Rowe however, outline how risk evaluation is the final stage of the risk assessment process where "responses to the risks are anticipated" (Charette 1990). The latter perspective is the stance to which this research has taken. According to Rowe (1977), risk evaluation involves "risk aversive action, which can result in risk reduction or risk acceptance." Risk aversive action is essentially any mission that is undertaken to control a risk (Rowe 1977). At a glance, the purpose of risk evaluation is to amalgamate the results of the risk estimation phase (Chapman and Ward 1997) and then decide the best action(s) to take. This means that risk evaluation requires input from numerous stakeholders including senior management "in proactive reduction of risk" signifying

the importance of risk action either before a project commences or long before a risk becomes uncontrollable (Thomsett 1993).

According to Charette (1989) risk evaluation consists of the following three steps:

- Establish the 'acceptable' level of risk
- Understand how the various risks interact (which may provide a single referral point for the project)
- Determine the action that needs to be taken with the project in relation to these risks

The acceptable level of a risk will depend on "individual propensity to take risks" (Rowe 1977), which lies in the hands of the project manager and as a result is difficult to specify. By avoiding any risk action however, we are eliminating any proactive risk management. This means that if the risk occurs, reactive approaches will be applied such as contingency planning (Frame 2002). Secondly, interacting the various risks to provide a single referral point to the project is a worthwhile exercise as "risks tend to be interrelated with a lot of overlap existing between categories" (McManus 2004). This can make the risk evaluation process more efficient as risk responses can be "grouped according to their intended effect on the risk being treated" (Hillson 2001). Finally, actions that need to be taken will be in the form of risk mitigation, risk avoidance, risk acceptance and risk transfer which are the response options available (Chapman and Ward 1997).

2.4 Incorporating Risk Management into Agile ISD

According to Remenyi (1999) traditional IS developments initially set out to avoid or reduce the changes to a system which is regarded as a huge fallacy and now "the only way forward to a higher degree of success is to identify potential changes as early as possible and to lay down suitable plans for coping with them." This involves carrying out proactive risk management. In ISD some of the most dominant risk reduction techniques include prototyping, benchmarking or surveying (Boehm 1991) where managers tend to carry out risk action alternatives on an ad hoc basis (Powell and Klein 1996). According to Powell and Klein (1996), "prototyping and incremental development is often used to reduce project risks, for example by developing knowledge, by breaking the project into digestible bits, by reducing time between specification and delivery and by reducing the impact of change requests." These concepts have triggered a new wave of development approaches, the most notable of these being agile methods.

The growing prevalence of agile methods has been increasingly documented with the use of such methods as XP, SCRUM, Crystal and DSDM. Organisations are using these methods primarily to assist them in responding to change more rapidly and as risk management is a proactive change mechanism, it makes sense that these two practices should be associated with one another in agile ISD literature. There are several agile methods and a detailed analysis of all these methods was beyond the scope of this research. However, in order to put agile methods into context for the reader, the author will give a brief overview of one of these methods, namely, the Dynamic Systems Development Method (DSDM). The author has chosen this as an example as it is considered to be the first "truly agile software development method" (Abrahamsson, Warsta et al. 2003). It is also a worthy example to use because the method not only focuses on systems development from a coding or technical perspective but also places emphasis on higher-level business perspectives.

2.5 Dynamic Systems Development Method (DSDM)

According to Abrahamsson, Warsta et al. (2003) the main idea behind DSDM "is that instead of fixing the amount of functionality in a product and then adjusting time and resources to reach that functionality, it is preferred to fix time and resources and then adjust the amount of functionality accordingly." The DSDM Consortium advocates that because each organisation is different none of its practices are detailed and the method itself provides complete support over the entire life-cycle phase (Abrahamsson, Warsta et al. 2003). DSDM phases are made up of a functional prototype iteration, design prototype iteration followed by actual implementation with each iteration stage identifying,

agreeing, creating and reviewing the prototypes (Beynon-Davies and Williams 2003). However before any iteration begins, a project will always start with a feasibility and business study. This highlights that that the method is not just focused on technical deliverables but it remembers to place importance on business aspects where the business should always be the driver of technological developments.

DSDM has an active community and is developed and used mainly by its Consortium members and although the method is fully available, access to white papers which outline the specific use of the method is limited to such members (Abrahamsson, Salo et al. 2002). Therefore, the extent to which DSDM incorporates risk management in practice is unknown. Empirical evidence of the method is enclosed in such white papers, which are not publicly available.

For the purpose of this research, a member of the DSDM Consortium who participated in this study, kindly provided the researcher access to information regarding DSDM's fundamental principles for conducting risk management. Without access to these white papers the researcher would not have been able to document the following information in relation to risk management in DSDM whereby its principles are primarily built around the following concepts:

Suitability Risk List → Risk Identification → Risk Log update → Monitor → Alert → Assess

All risk management practices conducted in DSDM projects are driven by the processes outlined above. The suitability risk list determines at the outset how compatible a particular project is for the use of DSDM and outlines its associated risks. The suitability list is analysed as part of the first formal risk management activity. A risk log is then created, maintained and updated throughout the life of the project (DSDM Consortium 2002-2006). It is well known that agile methods like DSDM were mainly introduced to help combat common ISD project failures, which revolved around time or cost overruns, or a failure to meet business needs. This is also clear from what the DSDM Consortium (2002-2006) has stated whereby "systems that meet the needs of the business are delivered through the incremental and iterative approach with its continuous feedback from users" while "cost and time overruns are avoided by the use of timeboxes."

As a result many would propose that methods like DSDM would not need to incorporate a high degree of risk management into their processes because the very reason for their existence is to reduce common risks associated with these well-known project failures. However, it appears from this literature research from the DSDM Consortium, that DSDM itself gives no less consideration to risk management than what has been documented for traditional projects. The extent, understanding and application to which these procedures are applied however, required greater investigation that took the form of a case study analysis detailed in the following sections.

3 RESEARCH METHODOLOGY

This research utilised a single case study to analyse the present levels of risk identification, estimation and evaluation in the well-known agile method, DSDM. The case study focused on an Irish change management consultancy firm that utilise DSDM in their commitment to delivering client value. All participants in the study also had extensive experience using traditional systems development methodologies and could therefore make accurate comparisons between the practice of risk management on both agile and traditional systems development projects.

A qualitative research approach was chosen for this study because of its greater exploratory nature and therefore its applicability to this research domain because it focuses "on gaining familiarity with the subject area" and gains "insights for more rigorous investigation at a later stage" (Collis and Hussey 2003). This was essential in light of this study because there is very little research conducted in the area of risk management in agile ISD. The researcher's aim was to fully understand, determine and describe the existing situation of risk management in agile ISD, which goes beyond purely scientific restricting research. Therefore an interpretive stance was taken.

3.1 Data Collection

There were a variety of options available for collecting research information in this study however due to the fact that there was little pre-existing theory on the phenomena being studied (Bonoma 1985) and as the researcher needed to focus on a qualitative methodology, the data collection technique needed to "emphasise meanings and experiences related to the phenomena" under investigation (Collis and Hussey 2003). As such, for the purpose of conducting primary research the author decided to use semi-structured, personal one-to-one interviews, which were carried out with the company founder and managing director as well as four of its key consultants and analysts. Each interview had a duration of approximately one hour. The researcher felt that in choosing this approach it ensured maximum quality and reliability of data as all interviews were tape-recorded and therefore allowed for subsequent accurate analysis of the data. The semi-structured interviews ensured that the researcher maintained control over each interview, without discouraging the discussion of any valuable, additional information.

3.2 Company Background

The company involved in this case study was an Irish change management consulting firm with operations throughout Ireland. It focuses on delivering technologies to clients through the utilisation of DSDM. The managing director has over twenty five years experience of project management and has participated in many change-management initiatives varying from traditional techniques to agile development techniques. The dominating feature of this company was its great success and confidence in utilising and deploying the ideas of agile development to deliver client value. In 2006, the company were also one of the 1666 members of the global Agile Alliance.

4 FINDINGS AND ANALYSIS

The company involved in this study is an active member of the DSDM Consortium and conformed to the principles of risk management outlined by the Consortium, which was discussed previously in section two. Each interviewee expressed how the practice of managing risk can never be curtailed whether the project is agile or traditional based. In fact, one of the consultants interviewed emphasised how in their experience there is a greater level of exposure of the importance of managing risk on agile projects due to high-level stakeholder involvement and collaboration. Strong emphasis on stakeholder collaboration improves the degree of managing risk in agile methods such as DSDM. The managing director explicitly stated:

"Techniques of agile methods themselves are about reducing the risks of project failures and no matter what the nature of the agile method, a risk management framework will always be in place"

This interviewee also expressed how in their experience, due to the turbulent nature of business environments that "risk management has become progressively better because of project environments and the large amount of project failures." Therefore, risk management procedures are gradually being considered with greater importance in ISD, regardless of the method being agile-based or otherwise. Such statements are important to consider for the remaining findings relating to risk identification, estimation and evaluation as all participants in this research have transitioned from traditional roles to agile but the extent to which their experience of risk management has progressed is relative to the progression of risk management in project environments over time. An experienced workshop facilitator and consultant with the company noted how they bring DSDM risk management practices into traditional project environments, which reinforce any risk methodologies already in place by the client. As stated by this interviewee, because risk management is incorporated into DSDM "it highlights the need for it even when the client does not have a strict risk management methodology."

4.1 Risk Identification in DSDM

It became evident from all interviews that risk identification is an integral part of the risk management process for the successful completion of a DSDM project. The interviewees generally spoke about three main aspects of their risk identification process, which revolved around an early suitability filter; ongoing workshops and risk log updates. Their comments showed strong association with the formal practices outlined in section two. One interviewee explained that before commencing a project, the suitability filter aims to identify how appropriate DSDM is for a proposed project. The very existence of this suitability filter is a strong indication that DSDM clearly recognises the potential for associated risks when using the method on incompatible projects. Furthermore the managing director noted how even in a scoping workshop they "try and very quickly identify risks from all stakeholder perspectives" and later they would conduct more "formal risk assessment, which may be part of another workshop." This conveys how risks are considered with importance even at the very early stages of DSDM projects.

As indicated in section two, continuous risk identification is an important aspect throughout a project's life cycle. Interview participants predominantly referred to the risk log as their main medium for continuous monitoring and updating of risks. Again, one interviewee working as an analyst explained how "risks would be reviewed on a weekly or fortnightly basis in conjunction with status reports that are carried out. What's outstanding on the risk log would be included in the status report." The researcher was given access to one of the organisations risk logs which contained a risk number, category, description, colour code (for high, medium or low risks), assignment of risk, date, proposed action and follow-up control.

In section two, client risk involving scope creep was documented as being the main source of project risk across literature. This however, was not the main finding in this research where all interviewees strongly declared how "resourcing" would be their most dominant risk across projects. In particular, obtaining and retaining key personnel in a given project is the single biggest risk across all projects encountered in this case study where a key consultant stated how "resourcing availability is the classic risk we encounter because there are so many competing projects in operation across the organisation." This risk is associated with the project team risk documented in section two. With regard to overcoming client risk, this consultant stated how:

"In a DSDM project you actually manage scope creep. There are specific DSDM techniques such as prioritisation of requirements and timeboxing, which helps you to manage it. Within each timebox you set the scope upfront and agree that you're not going to go outside the breadth of what you have at that point."

In terms of risk categorisation, the literature revealed two main ways of categorising risks – either by function or as being internal or external (section two). The findings in this study revealed that in DSDM risks are typically categorised according to function and "according to the project team stream that owns the risk because effectively this is how the risk gets allocated and it determines who has ownership of the risk."

Finally, in section two the author discussed a relatively new feature in literature, which promoted aspects of opportunity in risk identification whereby a source of risk can often be a source of opportunity. When all respondents were questioned about this they expressed how they would never associate risk with opportunity in this way. However, when discussing this with the managing director a very interesting concept was put forward whereby:

"Risk management is really another way of identifying a business requirement. You can take a risk approach to develop more business requirements because mitigation of a risk is something that you actually have to do to develop the product so it becomes part of requirements."

The researcher found this to be a very interesting and valid viewpoint in that if the resolution of an identified risk results in an additional needed requirement, a project might easily find itself embracing

an opportunity by fulfilling this requirement. However, based on this interviewee's experience these requirements are more often a necessary feature required to make the project work instead of an innovative idea bringing about opportunity.

4.2 Risk Estimation in DSDM

The DSDM Consortium (1999-2003) outlines how the 'level of risk' is equal to the likelihood of its occurrence multiplied by the severity of impact, which supports literature in relation to risk estimation. The process was also evident in this case study where risks would be prioritised on this basis. An experienced workshop facilitator stated how their "main mechanism for prioritising risks would use a probability by impact approach." In contrast however, the managing director stated that they would prioritise a risk relative to the prioritised requirement to which the risk effects. The researcher concluded that while some respondents referred to the main concepts of risk estimation, the nature to which they believe risks are prioritised was extremely dependent on each interviewee's project role and experience. For example, the most junior team member stated how they would "prioritise risks and identify which are actual show-stoppers but estimating risk probabilities or allocating percentages to the impact on a project is something I haven't had experience of." Finally, the approach adopted for risk estimation in this case study showed that both quantitative and qualitative estimation techniques are used and are project dependent and vary from client to client.

4.3 Risk Evaluation in DSDM

A general consensus emerged in this study in that it is not considered feasible to carry out action for all risks because as a leading consultant stated "it just wouldn't be practical and in some cases this may be more expensive to the project than what it would have to endure if the risk actually occurred." However, all respondents agreed on one important point when discussing responsive actions and this involved the importance of responding to the highest prioritised risks in the same manner as they would respond to the prioritised 'must-have' requirements in specific timeboxes. The researcher noted something important about this level of clarity in that the principles set down by the Consortium for requirements prioritisation and timeboxing have been made applicable to the approaches taken for managing and responding to risks. As one interviewee stated:

"Procedures or actions would not be carried out for all identified risks but only those which have the appropriate priority in the same way as a 'should-have' requirement would not be an immediate necessity as would a 'must-have' requirement. When actions are taken however, they may include risk reduction, transfer or contingency planning."

5 CONCLUSIONS & FURTHER RESEARCH

This research was based on the concept of managing risk where the researcher sought to discover the extent of risk management practices in agile ISD projects utilising DSDM. This analysis involved a decomposition of the primary elements of risk management namely risk identification, estimation and evaluation. An analysis of the literature revealed little evidence on the extent of use of risk management practices in agile methods. However, it is widely recognised that agile methods themselves were introduced to combat well-known risks associated with ISD project failures such as scope creep, cost overruns and schedule pressures. Their use of incremental development and active user involvement is an attempt to combat such risks.

Nevertheless, the findings of this research shows that the extent to which risk management is conducted in DSDM is in no way inferior to that carried out on traditional projects. In fact, DSDM shows a strong presence of risk management activities and in some instances shows more rigour for managing risk that what has been documented for traditional projects. The DSDM Consortium have specified the need for formal risk management procedures involving the use of an early suitability filter for example, which specifies project fit with DSDM as well as ongoing use of a formal risk log.

In addition, the research participants involved in this study showed a clear appreciation for the importance of managing risk on projects outlining how the insistence which DSDM places on stakeholder collaboration has a huge impact on risk management as it promotes the formal management of business risks, improves overall awareness of risk management among the project team, increases the number of risks identified throughout the project and ensures logical ownership of risks.

While the research produced many interesting findings there is much scope for further research as follows:

- Given the diversity with which methods are adopted across organizations, a large-scale quantitative study may identify more generalisable themes regarding the adoption and deployment of risk management practices across a large number of projects.
- The case adopted in this research focused solely on one agile method, namely DSDM. Given the diversity that exists across the agile method family, there is a need to examine the extent to which risk management is facilitated by other methods.
- A final potential area for further research may be a comparison between the existing state of risk management in agile project environments and traditional project environments. This form of research may produce interesting findings in relation to risk management maturity over time.

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