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Towards an Integrated Framework for Applying the Agile Project Methodology to Manage Task Uncertainty in Disaster Management

Completed Research Paper

Jayson G. Brown
Texas A&M University – Central Texas
jayson.brown@ct.tamus.edu

Dr. Anitha Chennamaneni
Texas A&M University – Central Texas
anitha.chennamaneni@ct.tamus.edu

ABSTRACT

Natural and man-made disasters are a constant threat to cultural civilizations and pose various risks to the basic foundations of our known existence. Not only do these situations occur at any time and place; they have various unknown determinants until the tragedy exists. Task uncertainty remains a critical factor in disaster management. This research study examines different facets of task uncertainty and develops an integrated research framework that applies the agile project methodology, in particular Scrum, to properly manage the impact of task uncertainty in disaster response, coordination, mitigation and recovery. Our framework provides insights to researchers and practitioners alike and offers guidelines for effective management of task uncertainty in projects. Implications for future research and practice are discussed.

Keywords

Agile Methodology, Scrum, Disaster Management, Task Uncertainty, Project Management

INTRODUCTION

The effect(s) of a disaster whether it is natural or man-made can be devastating to the victims and the rest of the world. The economic, social, physical and mental impact that these disasters will register can be substantial in qualitative and quantitative measures. A few examples of such disasters include floods, tornados, earthquakes, nuclear attacks, biological attacks, chemical leakage, fires, explosions and cyber-attacks. The continuation after any of the above or other disasters to prior conditions could take years or a few days depending on the severity. A reported 43% of businesses never reopen after a disaster and a 93% business failure rate occurs following a significant data loss (Cumbie, 2007). Disaster management efforts focus on mitigating these potential losses and provide prompt responses to target the population in an effective manner. However, an effective and efficient response to a disaster is often threatened by uncertainty, sudden unpredictable developments, high time pressure, urgency, high risks, enormous losses and disruptions in communication infrastructure. Additional factors that make it difficult to respond to disasters in a timely and effective manner include coordination between multiple authorities, infrastructure interdependencies and task uncertainty.

Failure to respond effectively to disasters such as the 9/11 attack, Hurricane Katrina and so forth are extensively documented in the extant literature (Townsend, 2006). Identifying key factors and enablers that support successful disaster management is much warranted to deepen our understanding of the factors and practices that contribute to effective disaster management. Our recent analysis of research in disaster management shows that extant literature on how to effectively manage projects that deal with disaster response is scant. The few works that deal with disaster management focus on technical designs of emergency information systems (Turoff, 2002) or a case study on the applications of the agile methodology to a specific disaster (Nawaz and Zualkeman, 2009). There is a lack of profound discussion on how and what project management techniques can be used for effectively managing disasters. Although, it is commonly agreed that it is nearly impossible to completely counteract all negative impacts resulting from a disaster, appropriate methods can be used to mitigate their impacts. In this regard, effective project management is a key element to successful disaster management. A disaster has several characteristics such as size, periodicity, circumstances, information and knowledge, task uncertainty, communications, and so forth (Kumar, 2000). While each of these characteristics is equally important, this research study

being only a fraction of a whole series of future studies will focus on one such characteristic and that is task uncertainty. These future studies will investigate other characteristics of disasters to improve overall coordination and responses.

The objectives for this research study are two folds: First, we examine the different dimensions of task uncertainty which in the past has proven to be a hindrance in disaster management. Task uncertainty has five dimensions: task novelty, task un-analyzability, the task information amount, task urgency and task impact (Rocha, Becerra-Fernandez, Xia and Gudi, 2009). Each of these factors plays a vital role in the development and planning of the coordination tasks. Second, we draw upon extant literature to derive an integrated research framework for applying the agile project methodology, in particular Scrum, to manage task uncertainty in disasters from a public project management perspective. The framework provides insights to researchers and practitioners alike and offers guidelines for effective management of task uncertainty not only in disaster management, but also in any large scale projects. The rest of this research article proceeds as follows. The next section briefs different characteristics of disaster and task uncertainty in particular. Following that, we review agile methodologies and highlight the differences between the traditional and agile practices. The section on suitability of agile project management to disaster management discusses why agile practices, in particular Scrum is a good fit for handling task uncertainty in disaster management. Following it, we describe an integrated framework for applying the agile project methodology to manage task uncertainty in disaster management. We also illustrate the framework with a well-worked-out example in disaster management. Finally, we conclude with a discussion on the research article's contributions and implications.

CONCEPTUAL BACKGROUND

One of the top priorities in disaster management is the actual coordination between the numerous agencies that become part of the conundrum of rendering services and/or information. For example, the federal government has over one hundred agencies for disaster recovery, but lacks coordination between these response systems causing resource waste. Coordination relationship is one of the most important factors to ensure cohesive and efficient emergency coordination process (Comfort, Ko and Zagorecki, 2004). The indecisive nature of disasters that has differing characteristics such as size, periodicity, circumstances, task uncertainty, information and knowledge puts dramatic pressures on the agencies involved in dealing with disaster coordination (Kumar, 2000). The first few hours of a disaster is the most important time to assist and optimize these factors for improved responses and task uncertainty will deter this critical time allotment. Therefore, task uncertainty needs proper assessment and mitigation to achieve project success.

Task uncertainty can be broken down into five different parts which include task novelty, task un-analyzability, task information amount, task urgency and task impact (Rocha et al., 2009). Task novelty is the first of the five parts in this context. This segment resembles when projects are new or uncommon. Some procedures to overcome the situation are to hire experts, study research, and obtain external recommendations from forums or other similar methods. An example comes from the Japan tsunami disaster when IBM's forum effort created possibilities for external solution assistance (Muller and Chua, 2012). Next, task un-analyzability is the second part to the mix and becomes affected by the previous task novelty. This factor represents the ability to analyze the situation and come up with a successful solution. In the British Petroleum Deepwater Horizon disaster, task un-analyzability was a major hindrance since many experts didn't know how to analyze the situation and come up with a proper solution from lack of past experiences, study or exchanges. The third portion of task uncertainty is the information amount. This states how much information is in the project and filtering through all the data to provide crucial knowledge while removing unnecessary data to the project. Some common procedures are the usage of data mining techniques such as classification, clustering, prediction and associations. Failure to control this variable will result in information overload which will burden the project management with unnecessary hindrances. The fourth factor is the urgency of the task. This plays a vital role in emergency situations and can be life threatening. In business projects, the urgency of the task may rely on milestones or other necessary implementations to continue the project's funding. An example includes the same British Petroleum disaster where task urgency was a high priority to plug the underwater well leak and stop damaging the ecosystem. The fifth and final piece is task impact. This relates to the overall impact of the disaster, which will affect coordination due to limited resources and instigates the need to maximize resources available for the best optimization.

AGILE METHODOLOGY

The previous discussion iterated over the facets of disasters and task uncertainty specifically for a proper conceptual review and to stress the degree of involvement of task uncertainty and the effect from this variant that can occur in any type of project management. Next, we will review agile methodologies. The agile methodology is a common approach to developing and maintaining software and is becoming the new de facto for many information technology organizations to reduce overhead and achieve higher output (Durdik, 2011). Previous iterations of methodologies were more systematic in their approach including the traditional method which involves the complete requirements and design stages before the actual implementation stage begins (Niinimäki, Piri, Hynninen and Lassenius, 2009). This traditional methodology is highly

valuable in situations that require in-depth analysis of business constraints and requirements, but tends to be cumbersome in the design stage and follows the waterfall progression as the life cycle matures which negates the ability to change. The addition of task uncertainty to the already existing mix of variables will create additional hardships for traditional methodologies and will not allow the ability to implement new details when critical information appears into the project during implementation with relative ease.

To highlight the crucial differences between the two methodologies, one can state that agile is incremental, has strong customer involvement, and drives from the current needs of a project (Durdik, 2011). A second prominent aspect of the agile methodology is that it allows for sudden changes in the project life cycle which are very abundant in disaster responses (Durdik, 2011). A third difference between traditional and agile is that in traditional methods, the managerial decisions are part of the project during the conceptual stage and after the final implementation of the system. In contrast, the agile method allows feedback to be an integral part in the entire process and can accommodate changes as soon as possible (Vanderburg, 2005). Numerous variations of the agile methodologies have come to exist over the last few decades and some of these include eXtreme programming (XP) and Scrum (Cho, 2007). Each of these variations has their own management process in the life cycle and adjusts to the situation(s) for the maximum potential yield of beneficial return. Scrum remains one of the most popular agile methodologies in the practitioner and researcher community for the last ten to fifteen years (Pries-Heje and Pries-Heje, 2011). This is because Scrum has the ability to adapt to changing requirements, has lower error rates, shorter development cycles and provides higher satisfaction.

SUITABILITY OF AGILE PROJECT MANAGEMENT METHODOLOGY TO DISASTER MANAGEMENT

There are several factors that make agile project management better suited to disaster project management. In the circumstances of disaster response, there is a mandatory need for the procurement of information while implementing a changeable prototype in the meantime. High quality information is necessary to reduce the impact of the disaster for an effective coordination response. Poor information quality is to blame for various problems in recent large-scale disaster response activities, such as the 9/11 terrorist attack and the 2004 Asia tsunami (Bharosa, Lee, Janssen and Rao, 2009). Thus, fast but accurate information is necessary for an overall effective solution. The usage of the agile methodology can provide the guidelines for a higher optimization level and the ability to gather the details of the information during its life cycle. The agile methodology, also, assists in responding quickly and effectively to changes (Bonner, Teng and Nerur, 2010). The agile manifesto focuses on individuals and their interactions over processes and tools, having working software rather than the actual documentation, customer collaboration instead of contractual obligations, and allowing change instead of following one plan for the entire life cycle (Beck, Beedle, van Bennekum, Cockburn, Cunningham, Fowler, Grenning, Highsmith, Hunt, Jeffries, Kern, Marick, Martin, Mallor, Shwaber and Sutherland, 2001). The manifesto aligns very well with the necessary considerations for successful disaster management.

Why Scrum?

Scrum is iterative and incremental and allows a flexible development framework to incur changes and faster transitional tasks. This will help in disasters since changes are inevitable and tasks need to occur rapidly due to time constraints. In a usual Scrum build, a Scrum master coaches the different individuals to maximize productivity and various other administrative duties at that level (Pries-Heje and Pries-Heje, 2011). The Scrum master ensures that each individual is on track and knows what the next steps are in the entire project. However, Scrum masters are not necessary since Scrum teams have the ability to self-manage and each individual can focus on a specific task that mirrors their expertise. In addition, each of these Scrum teams consists of a few experts in each specialty and will iterate to different groups during the entire project. The teams consist of members that are able to accommodate each part of the sprint task while not taking extra individuals that may be necessary for other sprint teams. The sprint duration needs to be appropriate for each task which differs depending on the intensity. The daily meetings that are 15-30 minutes occur with each sprint team to assess the current progress in the sprint cycle. The general purpose of these short meetings is to identify shortfalls and keep colleagues predictive (Cho, Kim and Olsen, 2006). There is another type of meeting that is between all of the Scrum masters from all the teams and the project manager/stakeholder(s). This higher level meeting, called the Scrum-of-Scrums, facilitates all of the sprint leaders together and brings an update on the current progression of the project (Cho et al., 2006). This meeting is an excellent time to suggest changes to the overall requirements, which allows every team leader to have knowledge of the new change(s) (Kim, 2007). This helps integrate the autonomous units together and optimizes efficiency. The above features of Scrum make it ideally suited for managing disaster response and coordination.

APPLYING THE AGILE METHODOLOGY TO MANAGE TASK UNCERTAINITY IN DISASTER MANAGEMENT

Figure 1 presents the different facets of task uncertainty and describes the flow of the entire process using the agile methodology. The first step in this process is to develop a brainstorming session with the stakeholder(s). This first sprint planning will iterate on the development of the list of conceptual requirements at the start of the life cycle. Compliance requirements, new technology capabilities, competing priorities and other challenges are a few of the forces that influence this disaster strategy plan. One of the major intentions of the meeting will be determining the task novelty of the situation. The British Petroleum Deepwater Horizon spill represents a task novelty situation since a leak at that depth of the ocean was not common and pre-existing solutions was not abundant or reliant. Task uncertainty will develop when the disaster is new to the committee and if the individuals are unsure on how to fix the situation from lack of expert knowledge. The lack of expertise and experience will cause additional task novelty and un-analyzability factors which will hinder the progression of the sprints and will cause lack of productivity. Proper integration of experts, forums or reviewing another situation's solution to the same problem might prove viable in this condition. Task un-analyzability will usually occur when the situation is new, but may happen when resources are not in supply or other blockades exists that affects the development of a proper solution. Adding these two impacts together creates the beginning of the overall task impact and will place undue stress and complicate the development of an efficient project backlog. Fast and efficient planning is necessary to lower the time of development and allow the release of resources to start implementation and recovery procedures.

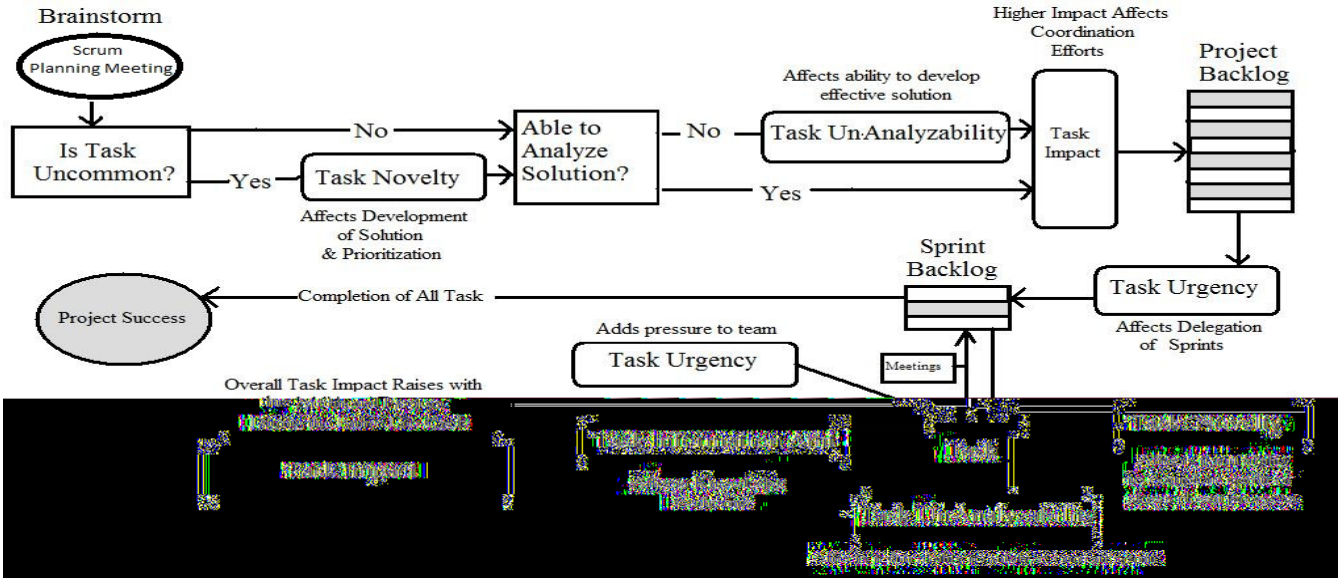

Figure 1: Conceptual Model Illustrating Different Facets of Task Uncertainty

After the brainstorming session, the product backlog of all the conceptual planning will exist for each of the sprint teams to start processing. The introduction of task urgency will affect the delegation of these sprints. In the previous development of the product backlog, prioritization of the different tasks was applied since some tasks have more importance and impact. Each disaster sprint team will have a different set of skills and abilities that will facilitate the topic of their respective sprint. Each of these sprint backlogs will have their own prioritization, as previously noted, to determine their executing order with respect to the amount of participating individuals. Task urgency will even put undue stress on the team members and may cause exponential harm to their mental mindset and reduce productivity. Coordination is a major factor in the implementation of multiple Scrum teams and must adhere to specific conditions. There are several methods to accomplish coordination in an agile project such as the Scrum group meetings, psychological factors, and reducing cultural differences (Chen, Sharman, Rao and Upadhyaya, 2007). Upon completion of each sprint cycle, then the product owner(s) can review the current implementation and make additional changes to the project. This allows modification to the project which is vital to the strategic coordination of disaster response. Keep in mind that there are several sprint cycles, depending on the different facets and conditions, in large projects and that these individuals can proceed to the next available sprint in the prioritized product backlog. If the sprint seems ready, then the team can move to the next stack thread and start its process until all tasks are complete. The inclusion of various task uncertainty facets raises the overall task impact factor by incremental values during the entire agile project life cycle.

A Conceptual Framework for Applying the Agile Methodology to Mitigate Task Uncertainty

This framework is conceptual, but represents a viable solution to successfully mitigate the impact of the five facets of task uncertainty in the previous figure and offers guidelines on how to manage task uncertainty successfully in a disaster situation or any other management situation. Figure 2 depicts how applying agile methodology will reduce the overall impact of task uncertainty and raise the effectiveness and success of the solution. These actions can be tailored with respect to each customized situation, but the general concept is pertinent to all contexts.

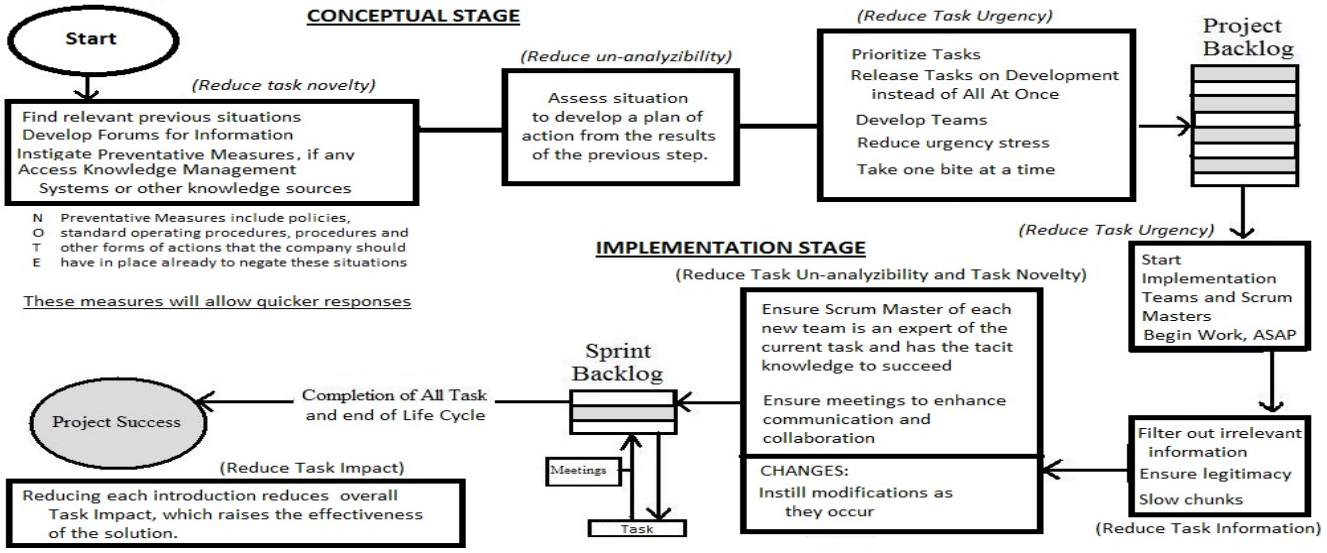

Figure 2: A Framework for Applying Agile Methodology to Mitigate Task Uncertainty

An example is worked-out in Figure 3 to illustrate the previous framework in a disaster situation. The following diagram is only a small example of all the procedures that an organization can take at each level due to size and room constraints. However, this should facilitate the necessary knowledge to utilize the agile project management methodology in disaster response, coordination and management. Mitigating task uncertainty is a large factor in improving the efficiency, effectiveness and success of any project. The bottom line is that knowing what to do and implementing proper procedures /techniques quickly will resolve these issues and lower task uncertainty.

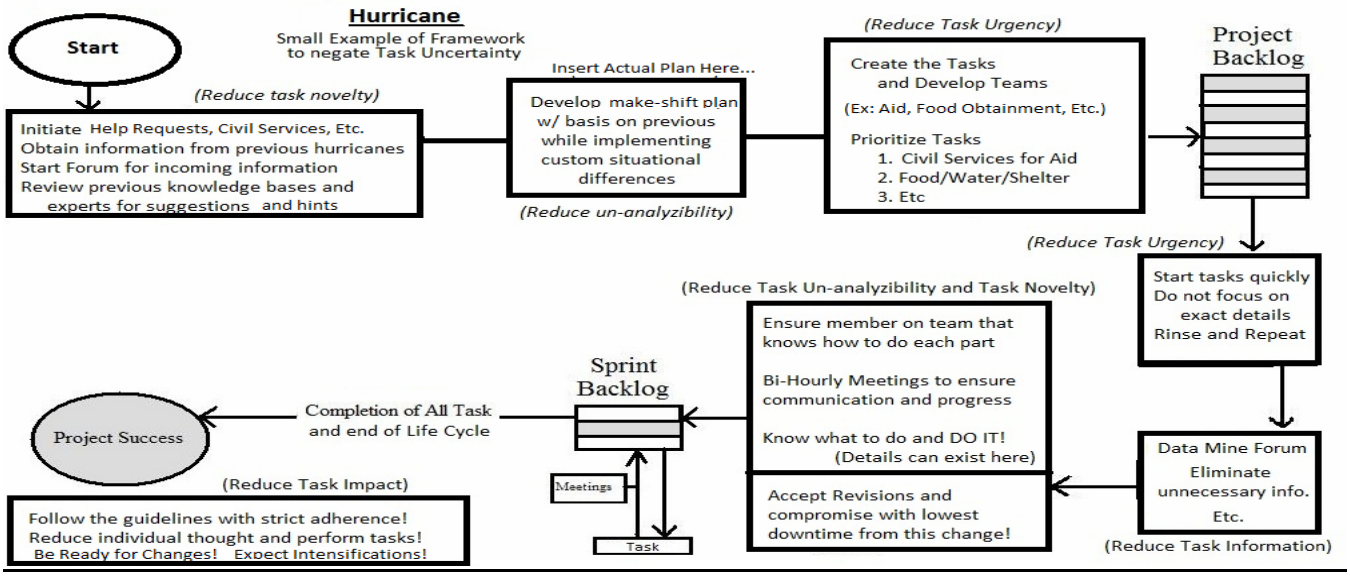

Figure 3: Illustration of the Framework with a Worked-out Example in a Disaster Context

CONTRIBUTIONS AND IMPLICATIONS

The contributions of this research study are manifold. First, it expands our fundamental understanding of different facets of task uncertainty in disaster situations. Second, it contributes to the agile project methodology and disaster management literature by proposing an integrated approach to disaster management using agile methods which appears to be neglected to a large extent in the extant disaster management literature. Third, it offers guidelines and comprehensive recommendations to concerned authorities for dealing with task uncertainty in emergency contexts. Fourth, this framework is generalizable and can be applied in any distributed and / or other large scale projects. Additionally, the research framework serves as another building block for further research on this topic.

CONCLUSION

In the past, agile methods such as Scrum, eXtreme Programming and the Dynamic System Development Method have been effectively applied to small-scale and dynamically evolving software development projects with success. These methods are known to support teams in responding effectively to the uncertainty of the task. Task uncertainty remains a critical factor in disaster management. This research study examines different facets of task uncertainty and develops an integrated research framework that applies the agile project methodology, in particular Scrum to manage task uncertainty in emergency contexts. We illustrate the framework with a well-worked-out example in disaster management. Our research framework provides insights to researchers and practitioners alike and offers guidelines and recommendations for effective management of task uncertainty in projects that deal with natural or man-made disasters.

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