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Research paper

Applying Agile Concepts from Software Development into the Design of Flood Disaster Management Framework

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Abstract

Managing complex environment often requires flexibility in its processes. This is evident in flood management where the factors that determine the success of it is uncertain. A flexible flood management requires an agile frame-work that allows flexibility to respond to any possible event during a disaster. The concept of agile methods used in software development help to provide values that is used as a basis in offering agility in managing flood complexity. These values are observed during field studies of Standard Operating Procedures (SOP) implementation in managing flood impact at selected flood sites in Malaysia. This study aim to identify the key values of agility in developing a framework based on the review of agile methods combined with factors identified from study of successful flood management. The developed framework is aligned with uncertainties mitigation by dividing the disaster areas into small sub-areas, improving communication, and empowering on-site response team with clear leadership.

Keywords: *Kemaman SOP; Dynamic Flood Management; Community Participation; Flood Governance*.

1. Introduction

Managing flood is a critical process that requires dynamic planning due to the fact that disasters are unique in nature and that their process are extremely complex [1]. Flood studies in Malaysia is considered to be complex based on the characteristics of the disasters' environment: its unpredictability, time pressure, dealing with media, operational demand, interagency conflict and the requirement of supporting technology [1], [2]. In dealing with the complexity and the need to be dynamic, management of the flood disaster must be addressed with discipline and at same time, allow the disaster to be managed with agility [3], [4], [5].

There are two main factors in allowing flexibility in managing flood that are discipline and agility. "Discipline" is the foundation to the successful endeavor by creating memories well arranged through history and experience and "agility" is the counterpart of discipline which strengthen, provides release of agility and invent [2]. The agility applies memory and history to adjust, react and adapt to new environment, whilst taking advantages of unexpected opportunities [6]. Hence, this study aims to review the concept of agile (dynamic planning) on the complex processes from different domain but within the same perspective (complex environment/process).

Research in Software Development methods have established the environment and activities surrounding the development of software-based systems as being highly complex and have proposed agile methods to suitably manage the dynamic processes required. This research aims to apply the suitability of adopting aspects of agile software planning and development into the governance and management of flood.

2. Background Study

The concept of agile was introduced in the unstable, frequently changing environment such as in Software Development (SD) due to the numbers of changing requirements from the customers before, during and after the development process [7]. This was created to help the developer and engineers deal with the unpredictable failures because agile method allows opportunities for any directional changes and promote quick response toward changing environments.

The concept of agility in software development domains is being attempted in the domain of Disaster Management (DM), which applies the agile concept in managing the process to improve the communication, collaboration and coordination (3C) of emergency response. The adaptive planning, rapid and flexible coordination, and sensitive to context are the key factors that shared by both SD and DM [8]. Lack of local knowledge and weakness of actual practice that is not aligned with the ideal coordinating emergency response are among the causes of which are agile seen as the best solution [8].

To overcome the problems, the new approach of agile methodologies seems to be helpful in the complex environment as the process are frequently changing. The success of a flood management requires a clear structure response management, combining both agility and discipline [3], [4], [8]. Both are needed for the improvement of the diagnosis and remedial work of the actual practices during a flood. Case studies and literature review were conducted to understand the implementation and process of agile in the complex environment of SD and DM. Table 1 below shows the information on agile implementations in the software development.

Table 1: Review of Agile Implementations in Software Development

Paper Title	Main Focus of Paper
Review of Agile Methodologies in Software Development. [7]	The paper discussed on several agile methodologies used in software development such as Extreme Programming (XP), Agile Modeling, SCRUM, Crystal methodologies family, Feature-Driven Development and Adaptive Software Development and the implementation of agile within the areas. The key value of every agile methodology were highlighted. The focus of the paper was on the appropriateness of agile methods implementation can only exist if there are exist of strong **communication** between developer and customer, and strong skilled man-power in the development team.
A study of the Agile Software Development Methods, Applicability and Implications in Industry. [9]	This article studied on agile methodologies: crystal methodologies, Dynamic Software Development Method (DSDM), Feature driven development, Lean software development, SCRUM and Extreme Programming (XP). The aim of the paper was to gain understanding on type of agile methodologies used on particular companies which concluded **large projects should be broken down into smaller projects.** It is to allow more flexibility and easier management of a large project.
Adopting Agile Software Development: Issues and Challenges [10]	This article identified the issues of changing and implementing agile concept from the traditional method in the development of software engineering. Among the points highlighted in the study are: (1) Missing the Agile Master Role, (2) The overzealous teams, (3) The Absence of a Pilot Project, (4) Scrum Implementation, (5) Current Work Pressure, (6) Upper Management Concerns, (7) Government Bureaucratic System and (8) Documentation requirements.
Review of Agile Software Development Methodologies. [11]	This article represented the review on three of Agile Software Development Methodologies in the Software Engineering fields which are Extreme Programming (XP), SCRUM and Feature-Driven Development. Process involved in every model were discussed in general for the developer to have better understanding and review on agile method while choosing model for their projects. The study highlighted the **difficulties** faced during the implementation of Agile methods. Among that are (1) Developer's fear of Skill-Deficiency Exposure, (2) Broader skill sets for developers, (3) Increased Social Interaction, and (4) Understanding Agile principles.

Table 2 below highlighted the common key values and issues in adopting an agile method into the management process in the areas of SD and DM. Based on studies conducted on agile implementation within the field SD and DM, it has proven that agile has increased the effectiveness and efficiencies of the management for both domain by introducing a more systematic planning. Agile is considered suitable to be explored and extended in disaster management specifically in Flood Management (FM). This consideration was made as the concept of agility that been used in in the process of managing software development is widely accepted and implemented. The complexity of the processes that involve the frequent changes in requirement before, during and after the development in SD has made agile methods viewed as the best solution for the management to produce the best result.

Both disaster management and software development has similar factors in sharing the same experience and the complexity of environment due to the rapid changes of the situation. In DM, the changes caused by the unpredictable heavy raining and river overflow that will affect victims and infrastructures. Flood management is expected to have a better discipline and agility in ensuring a better success in providing relief to victims. The study identified the enabling agile characteristics are embedded in communication, technology and empowerment of key personnel's.

Table 2: Review of Agile Implementation in Disaster Management

Paper Title	Main Focus of Paper
Towards an Integrated Framework for Applying the Agile Project Methodology to Manage Task Uncertainty in Disaster Management [3]	The main issue discussed the disaster management is an actual coordination between numerous agencies in providing the services or/and information. Lacks coordination may cause resources wasted. Thus, task uncertainty must be addresses with the proper assessment and mitigation to achieve project success. Adoption of SCRUM allow flexible development framework to foster unexpected changes during the process. This can be done by identifying characteristics of task uncertainty. The outcome of the study is to propose a framework for **applying agile methodology to mitigate task uncertainty.**
The Role of Agile Practices in Disaster Management and Recovery: A Case Study [4]	The crisis management and business continuity require careful analysis in continuing daily operation. The adoption of agile practices in general and SCRUM processes more than five years had helped an infrastructure life-cycle recover from the unexpected disaster in an offshore agile development context. It supported the agile culture that resulted in self-empowered teams (self-motivating, self-managing and self-directed), strong peer-to-peer communication modality, short and iterative nature of agile process and role played by the SCRUM Master. The outcome was **a better recovery of unexpected disasters**.
Agile & User Centric SOA Based Service Design Framework Applied in Disaster Management [5]	The user needs in the development process were considered based on the combination of agile characteristics and principles, user-centered design (UCD) and service oriented architecture (SOA). The aim was to improve the human actors' involvement in the design project and to offer the possibilities to accept any changes along the process to produce the usable SOA based services. The comparative studies on SOA, UCD, and Agile development process was conducted that resulted a novel design framework combining agile, UCD and SOA approaches. Later, it was applied to an earthquake management where **it allow highly flexible and agile software method that able to meet rapidly changing business needs.**
Towards More Relevant Research on Humanitarian Disaster Management Coordination [12]	Humanitarian Disaster Management (HDM) seek a responsive and agile respond toward the improvement over the processes and activities during the disaster. The major challenge of effective HDM is to coordinating the activities including the people, policy, information and system. The performance of response are based on knowledge integration, situation awareness and adaptation capabilities where it may allow the support decision making and support reassigning decision power to improve agility. The use of Interoperability System, Big Data, Collaborative Business Processes and Agile Coordination System **may improve the processes and activities during the disaster.**

The review of agile in both domains will be discussed in the next section where suitable characteristics from SD agility will be identified. Those characteristics will later be adopted into the Flood Disaster Management in the discussion section.

3. Research Methodology

In this paper, agile issues and implementation in System Development (SD) and Disaster Management (DM) were reviewed and common agile characteristics were identified. These characteristics were then compared with a benchmarked flood management practice in Malaysia. The study is keen on the characteristics prevalent in software development due to the complex nature of the development as well as the maturity of research being done in the domain [7], [9], [10], [11]. Based on the latest flood incident in Malaysia, the Kemaman flood management standard operating procedure was applauded as being the most successful practice [15][16]. Hence, the study has chosen the Kemaman as benchmark to compare with existing DM and SD characteristic to highlight an agile factor for flood management. Result then compared with the Flood Management SOP, to identify the similarities of the factors. Specifically, characteristics that are suggestively agile in nature are analyzed. The research design of the study can be seen below in Figure 1.

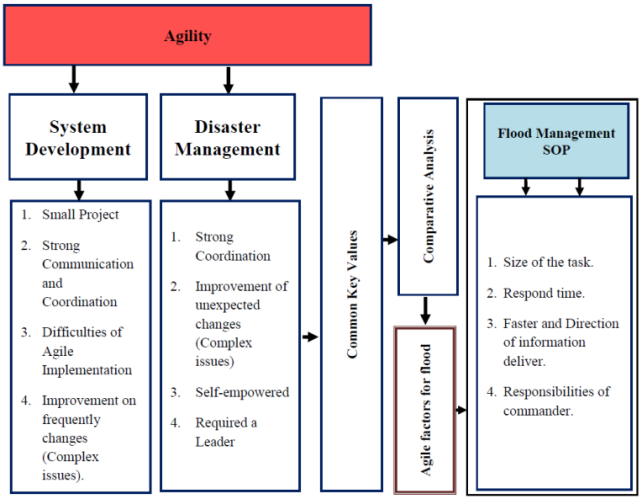

Fig. 1: Research Design of the Study

4. Findings

The District of Kemaman has been successful in reducing the impact of the flood in 2014, based on three grounds: marked reduction of impact compared to its previous occurrence; much milder impact compared to other districts undergoing similar disaster; and the 2014 flood was recorded as the worst flood in 30 years [13].

Kemaman relied on technology in managing its annual flood, including web application and forecasting system. Magiswary et al. [2] pointed out that the success of using systems in disaster depends on Situational Quality (SitQ) which include the unique characteristics of disaster contexts which seeks different types of response associated with values and attitudes of individual or groups involved in the flood activities [2]. Kemaman manages flood using three elements, which are technology, communication and engagement of locals across the entire flood phases. These three elements were the key strengths of Kemaman that helped in reducing the impact of the 2014 flood.

4.1 Technology

Kemaman owned an Integrated Flood Disaster Management Portal, which was developed by the Malaysian Communications and Multimedia Commission (MCMC). The portal is managed by the District of Kemaman, and allows three ways communication among authorities, disaster agencies and victims. All related information regarding the victims and agencies was recorded in the system for the easy access and monitoring by the authorities. Any agencies involved in the disaster can obtain information on the strength and capacity of other agencies, including available resources such as personnel and asset. This information can be utilized in strategizing for the best relief efforts during the disaster.

4.2 Communication

The study has identified two categories of communication which are: (1) communication among flood responding parties including the agencies, authorities and local heroes on the flood activities and planning and (2) communication between flood authority and the community. This can further be refined into three phases which dictate different nature/tone that can extended to the development of following:

- Communication before flood – This is targeted towards preparing the community for possible flood which may reduce the impact of flood to the victims.
- Communication during flood – This aims at informing and instructing parties during flood and pro-motes relief to save life.
- Communication after flood – This aims at restoring the community to normal situation with the help and support from the authorities and agencies.

Communication during flood is most complex as instruction will be adaptive to the progression of flood. This phase contains the most dynamic activities which must correspond and adapt to changes and uncertainties.

4.3 Engagement of Local

The involvement of chief of village and communities from flood-free areas in the flood management had brought a positive feedback to the Kemaman experience of 2014 flood. Kemaman had fully utilized the opportunities and skills of the local heroes by transforming them into moral agent in managing the 2014 flood. Moral agent is someone that could provide dynamic action toward the unpredictable situation based on the experience and knowledge of flood. The moral agents were given priorities to manage and lead the process, mostly at the evacuation centers and during the search and rescue. Before the disaster happen, moral agent firstly been identified by the authorities for the purpose of sharing information, simulation, expose on flood management processes and search and rescue activities and other several flood practices. This is for the preparation phases before facing real flood disaster.

On the other hand, the awareness of the authorities in making sure that all the prone area was listed with the detail information and well mapped for the monitoring and control activities. Flood that hit Kemaman on 2014 had shared the similar serious impact with Kelantan. However, the management process was classified as the best practices among others which one of it is the well mapped on speed of river water to reach the main road prepared by assemblyman of Air Putih, Terengganu.

The three elements stated earlier carried the agile characteristics, which it can adapt and suit the nature of the flood based on the knowledge and experience of the authorities, agencies and victims involved. The next section will discuss on the nature of agility that can be suited to flood.

5. Discussions

Agile methodologies that originated from SD can be adapted in managing flood, where the concept of Agile Flood Management (AFM) was introduced. AFM is adapted into Dynamic Flow Plan (DFP), combining discipline and agility where discipline is the lesson learnt and well-arranged memories from the history of event and experience [6] and agility is allowing flexibilities and

changes of unexpected opportunities. Using the concept of DFP in flood can be advantageous as flood is considered as a dynamic event that can rapidly change in terms of its magnitude and frequency. Flood that start small in magnitude, easily managed can change into bigger and unexpected situation due to continuous rains that cause dams or rivers to overflow. The drastic change can make flood management becoming increasingly difficult, combined with other factors such as different type of skilled man-power (people), rigid documentation (policy), overflow of information (information) and lack in technology support (system). Hence, agile process introduced into disaster management can promote quick respond to the challenge of an unpredictable environments, by reducing the maintenance cost and number of affected victims or infrastructure by relying on people and their creativity to overcome the problems rather than on processes [9].

The characteristics of having agility that have accommodated the complexity in the software development are also prevalent in the Standard Operating Procedure of Kemaman. These characteristics that utilized the strength of technology and people have improved communication in the times of turmoil. The engagement of the local people with the authorities has enable easier communication as both entities can obtain and supply information that assist in all phases of the disaster. However, for AFM to be successfully implemented in flood, some key value need to be addressed. The following point will discuss the identification of the key values for a successful AFM.

5.1 Agile for Small Project.

Flood is a complex disaster that involves many processes throughout its four standard phases; prevention, preparation, response and recovery, and many stakeholders including agencies, people and infrastructure. The management of flood was assisted through the use of guidelines and SOP in ensuring proper actions are being carried out. However, SOP developed by NSC was considered as general guidelines that only provide basic explanation of every agencies roles and responsibilities. In actual flood, some agencies that do not have their own SOP will follow the guidelines, to know their roles and responsibilities during the flood.

Implementation of an agile framework to manage the work flow of flood can be adopted in all three level of disas-ter management with the consideration of smaller scope of work so that it can easily be managed and monitored. Since flood involves of many activities, a activity or process request shall be divided into smaller part. This is to ensure that the processes can be managed by a small team of people that allow more flexibility for quick responses and improved processes. Hence, any guideline developed or used by agencies should be extended and be more specific for each type of disaster, allowing for agility in the whole processes of disaster management. In example, during the flood, the areas of search and rescue must be less, so that the assistance can be reach easily and reduce the time to rescue.

5.2 Agile Need Quick Respond

Agile can also be defined as request for quick respond over the process based on the situation. However according to the Kaushal and Anju [11], quick respond in agile can be categorized as mentally quick and physically quick. Mentally quick is able to think rapidly and clearly, while physically quick able to move your body quickly and fluently. To be physically quick, strong skill man-power is required. Strong skill man-power is someone that knowing what to do and how to do it correctly, at a correct time, with a correct knowledge and execution process. Strong skill man-power should have the exact knowledge and understanding of the situation in dealing with flood in choosing the best solution for the problems. Knowledge can only be converted into understandable information when it became as part of our experience and memories, either to serve as onsite committee during the flood or experience it as one of the victims or experience it by own self.

5.3 Agile Seek for Strong Communication and Coordination

Researches on disaster management have emphasized on the need of better agile implementation in facilitating strong communication between the authority-to-authority and authority-to-victims. Creating a smaller project or team is for easier communication among the team members, which is a critical need in disaster management as stakeholders in disaster consists of different agencies, authorities and even public. Communication can be made either direct communication involving of face-to-face, or writen communication such as email, website, messages, or any other medium that able to deliver information to the team. According to Ather and Imran [4], communication richness can be achieved through face-to-face meeting compared to written communication. During a meeting, team can deeply understand the information shared by asking clarification on any uncertain questions related to their jobs. Agile allow two ways of communication, from the authority to the victims and it can bring more precise information. This is possible since the victims is the local people that experience the flood, and they possess the knowledge and experience to reduce the costs and risk or delay in the process. A better communication in disaster management can be achieved when management start to implement systematic coordination.

Coordination in the contact of FM is the relationship and interaction among different actors, shared information, standard policy and interoperability system that allow centralized access when it is required. A centralized coordination among the parties involved in managing the flood may resulted in maximum positive impact of the entire processes. As discussed by Lynn et al. [14] relating to governance structure for disaster management for Australia, they shared the same framework as Malaysia by involving all levels of government as highlighted in Directive No.20 for the purpose of centralized coordination. Both frameworks have several tiers of managing disaster and this showed that it is important to have proper coordination in all aspects including all the agencies, assets, financial, human resources and information while dealing with the DM to get better result. A strong coordination among the teams and other aspects may provide unexpected advantages toward managing the disaster since all the actors know their own responsibilities on what to do and how to do it with the support from the team and management groups.

One way to improve and develop better coordination is through conducting daily short meeting to update on the current progress and situation by the person-in-charge (PIC). This is for the team to acknowledge and understand the current issues and for the PIC to share and exchange information and seek for future explanation and solution on issues that need more clarification.

5.4 Rule of Agile Master

Agile Master (AM) is another important key value to improve the management for the disaster. Basically, during the disaster, it is required to have one leader who will manage and coordinate all the activities and process among the team. This person known as agile master where his job are to gather all the required information's regarding the disaster and management from the teams, to communicate the current situation to the team members, to start making alternative plan if the situation become worst, to make sure the important asset is get out from the location if the disaster has spread up to the office, to make sure all the assets and infrastructures are in place and to help the teams remove the

unique and varied type of obstacles. Agile master is the main person and had given the authority to make the decision based on the current situation and the effect from the disaster where it allows changes before, during and after the process.

6. Conclusion

As conclusion, agile methodologies as common practices in system development for managing the frequently changes in development process has bring more advantages to the developer and management team. The same concept of agile can be applied in other domain like disaster management, which has adopted agile methodologies in the management processes specifically for flood. For agile method to be successfully implemented, several key values should be addressed and monitored such as the size of the task, the respond time, the amount of time taken and direction of information delivered and changes and the responsibilities of commander. However, future re-searches may explore in finding more key value of agile in achieving better and maximum advantages of agile methodologies to be implemented in flood disaster management.

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References

[1] O. Marini, N. A. Mohamad, S. Azizah, H. A. Noor and S. M. Siti, "COBIT Principles to Govern Flood Management," International Journal of Disaster Risk Reduction, vol. 9, pp. 212-223, 30 May 2014.

[2] D. Magiswary, R. Murali and K. Maniam, "Evaluating CEMAS in Simulated Environment to Support Disaster Management Challenges," in Proceedings of the 11th International ISCRAM Conference, USA, 2014.

[3] G. B. Jayson and A. C. Dr., "Towards an Integrated Framework for Applying the Agile Project Methodology to Manage Task Uncertainty in Disaster Management," in Proceedings of the Nineteenth Americas Conference on Information System, Chicago, 2013.

[4] N. Ather and A. Z. Imran, "The Role of Agile Practices in Disaster Management and Recovery: A Case Study," in In Proceedings of 2009 Conference of the Center for Advanced Studies on Collaborative Research, -, 2009.

[5] Karima, I. Djilali and K. Christophe, "Agile & User Cen-tric SOA Based Service Design Framework Applied in Disaster Management," in The 1st IEEE International Conference on Information and Communication Technologies for Disaster Management, Algeria, 2014.

[6] Barry and T. Richard, "A Guide for the Perplexed," in Balancing Agility and Discipline , vol. 7, New York, Addison-Wesley, 2004, pp. 25 - 57.

[7] H. Malik and H. O. Siew, "Review of Agile Methodologies in Software Development," International Journal of Research and Review in Applied Sciences, vol. 1, no. 1, pp. 1-8, October 2009.

[8] W. Lisa, B. Monika, V. V. Bernard and V. S. Sander, "Agile Response and Colloborative Agile Workflows," International Journal of Information System for Crisis Response and Management, vol. 5, no. 3, pp. 1-3, 1-19 July-September 2013.

[9] N. R. Kuda, K. N. G. and C. Praneeth, "A Study of the Agile Software Development Methods, Applicability and Implications in Industry," International Journal of Software Engineering and Its Applications, vol. 5, no. 2, pp. 35-45, April 2011.

[10] H. Hassan and S. T. Al, "Adopting Agile Software Developmet: Issues and Challenges," International Journal of Managing Value and Supply Chains (IJMVSC), vol. 2, no. 3, pp. 1-10, September 2011.

[11] P. Kaushal and S. Anju, "Review of Agile Software Development Methodologies," International Journal of Advance Research in Computer Science and Software Engineering, vol. 3, no. 2, pp. 270-276, February 2013.

[12] L. S. Laura, L. Matthieu, C. Tina and V. d. W. Bartel, "Towards More Relevant Research on Humanitarian Disaster Management Coordination," in In Proceedings of the 12th International Conference on Information Systems for Crisis Response and Management, Kristiansand, 2015.

[13] Y. Mashitoh, Banjir dan Alam Sekitar: Kalau Takut dilambung Ombak, Jangan Berumah di Tepi Pantai, Malaysia: UKM Cetak, 2015.

[14] C. Lynn, L. Craig and B. Bhishna, "Building Capability for Disaster Resilience," in 28th Annual Conference of Association of Researchers in Construction Management, Edinburgh Scotland, 2012.

[15] Bernama, "Terengganu Flood Management to be SOP for all, says Najib," New Straits Times, 31 December 2014. [Online]. Available: https://www.nst.com.my/news/2015/09/terengganu-flood-management-be-sop-all-says-najib. [Accessed 12 March 2018].

[16] Bernama, "Bernama: 6 Jan 2015: Flood Management Plan In Kemaman Improved To Become National Model," Kementerian Komunikasi dan Multimedia Malaysia, 6 January 2015. [Online]. Available: http://www.kkmm.gov.my/latest-news/8197-2015-01-08-01-14-26. [Accessed 20 April 2018].