

Crowd Sourcing Challenges Assessment Index for Disaster Management

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Crowd Sourcing Challenges Assessment Index for Disaster Management

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ABSTRACT

Emergency agencies (EA) rely on inter-agency approaches to information management during disasters. EA have shown a significant interest in the use of cloud-based social media such as Twitter and Facebook for crowd-sourcing and distribution of disaster information. While the intentions are clear, the question of what are its major challenges are not. EA have a need to recognise the challenges in the use of social media under their local circumstances. This paper analysed the recent literature, 2010 Haiti earthquake and 2010-11 Queensland flood cases and developed a crowd sourcing challenges assessment index construct specific to EA areas of interest. We argue that, this assessment index, as a part of our large conceptual framework of context aware cloud adaptation (CACA), can be useful for the facilitation of citizens, NGOs and government agencies in a strategy for use of social media for crowd sourcing, in preventing, preparing for, responding to and recovering from disasters.

Keywords

Cloud Computing, Crowd Sourcing, Disaster Management, Social Media

INTRODUCTION

Crowd sourcing (Bunker 2011) is a way for emergency agencies (EA) to interact with citizens and non-government organizations affected by a disaster to source, manage and use information to facilitate community self-organization for reaction to and recovery from a crisis. Current traditional approaches (e.g. EA operational systems, TV, radio) for sourcing and disseminating such information come under pressure when a disaster pushes these existing systems to the point of failure. It has been noticed that the crowd sourced information and its use by emergency workers and the general public can be more useful than information which comes from “traditional” official channels in helping people in a disaster scenario. Crowd sourcing of information can be used to build an overall picture of the crisis from the ground up, which is important for informing the community, but also for planning and coordination of EA working teams in reaction to the disaster scenario (Quillinan et al. 2009).

We are currently involved in a project with NSW (New South Wales) Government EA to review crowd sourcing of information and its use during disaster scenarios. EA operate in a complex and highly regulated environment and have shown a significant interest in the use of emerging cloud-based social media such as Twitter and Facebook for “crowd-sourcing” of information in disasters (NSW SES Report 2011). Cloud-based social media are network or internet centric as opposed to desk-top centric computing. There are a number of social media tools that have been deployed in the internet cloud such as Facebook and Twitter. The EA can benefit from the on-demand cloud computing and social computing tools to facilitate the crowd sourcing of information (Gill and Bunker 2011; Gill et al. 2011). It has been suggested that “the mediating and social networking technologies of WEB2.0 e.g. Facebook, wikis, mashups etc, and changing telecommunication infrastructure such as mobile applications and cloud computing are seen as the means to facilitate crowd-sourcing of information and its management and use in disaster scenarios ” (Bunker 2011). The current influx of new technologies and trends such as cloud (Shroff 2010, Bakshi 2011) and social media (Cross et al. 2005, Zandt, 2010) provide both opportunities and challenges to EA in making decisions about the effective use of these technologies. This draws our attention towards the following research question, which is addressed in this paper: What are the potential challenges associated with the use of cloud-based social media for crowd-sourcing of information in a crisis?

This paper presents “Challenge Assessment Index” construct, as a part of our large conceptual framework of context aware cloud adaptation (CACA), to assist EA to understand and strategically plan the assessment of cloud-based social media for crowd sourcing of information for disaster management. The CACA (Figure 1) framework (Gill and Bunker 2011) was

developed in a cloud and social media based business transformation research project. The research was qualitative, which involved the review of practitioners' interviews (Gill et al. 2011), and review of IBM (Behrendt et al. 2011) and NIST (Liu et al. 2011) cloud reference architectures. Our research mainly draws on Actor-Network-Theory (Law and Callon 1988) as a theoretical lens. Actor-Network-Theory (ANT) is used in this research to review qualitative empirical study results and cloud reference architectures in order to identify actor, role, network, intermediary, black box (e.g. Technology Operating Environment) and prescription (e.g. Lifecycle) aspects of the CACA framework layered architecture (Figure 1). The context, self assessment, XaaS (e.g. service requirements analysis: software as a service, platform as a service) and self adoption and improvement are the key constructs of the CACA business transformation lifecycle (e.g. based on complex adaptive systems as discussed in Gill and Bunker 2011). The XaaS construct of the CACA framework has been detailed in (Gill and Bunker 2012). The focus and scope of this paper is to present the crowd sourcing challenges "Self Assessment" (Red box on Figure 1) index construct, which is to be used by EA as a guideline for assessing the challenges of a cloud-based social media for crowd sourcing.

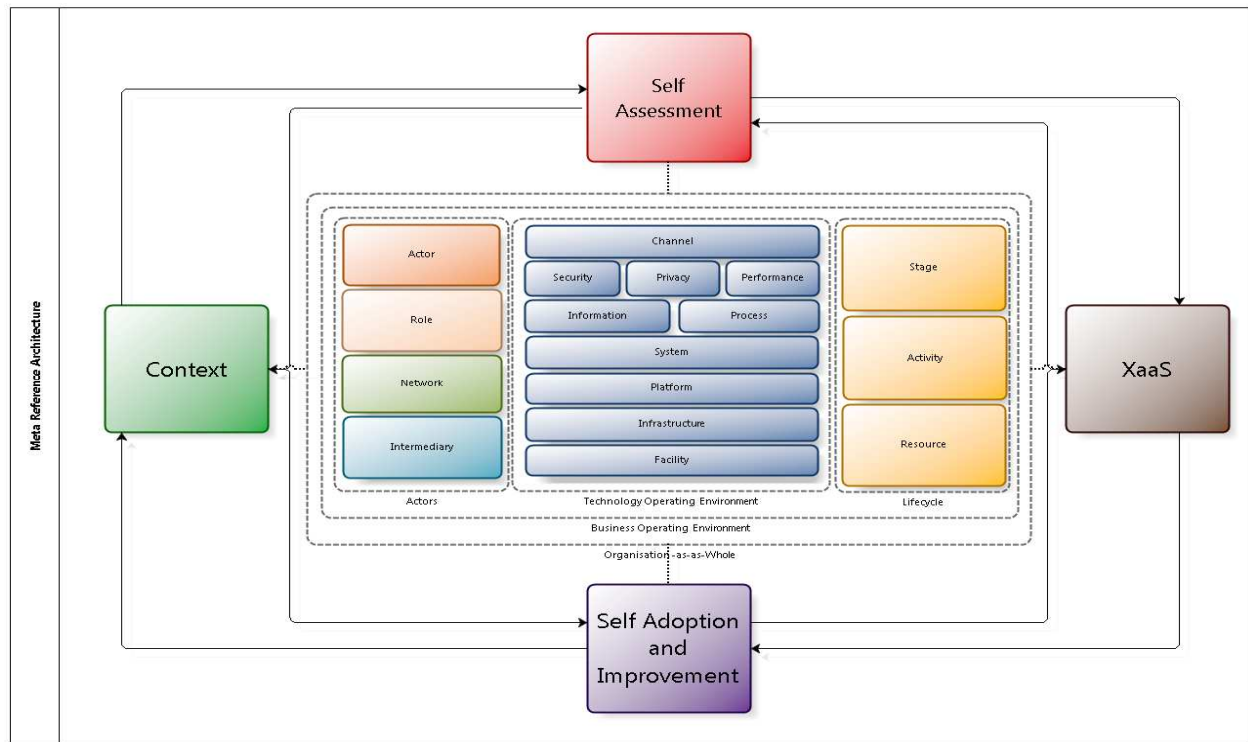


Figure 1: Context Aware Cloud Adaptation Framework – Layered Architecture

The paper is organized as follows. Firstly, it discusses the research method for our study. Secondly, it reviews cloud-based social media and its use for crowd-sourcing by the means of two cases. Thirdly, it presents the key challenges of the use of cloud-based social media for crowd-sourcing. Fourthly, this paper presents a Challenge Assessment Index construct. Finally, it presents future directions for EA and concludes with a short discussion about how the findings of this study can be further used in our current research.

RESEARCH METHOD

This research has been conducted by analysing the cloud-based social media and its use in the context of 2010 Haiti earthquake and 2011 Queensland flood from accounts that have been published in the public domain (as discussed earlier) in order to identify the opportunities or challenges that may hinder the appropriate use of social media for "crowd-sourcing" in a crisis. This research has applied the qualitative analysis process (Rene and Taylor-Powell 2003) combined with design science research (Henver et al. 2004). Qualitative analysis approach seems appropriate (Table 1: Steps 1-3) to identify and categorize the qualitative crowd sourcing challenges. Design science approach seems appropriate (Table 1: Step 4), as the other side of this research, to further analyse the identified challenges in an effort to develop a theoretical construct, which is called here Challenge Assessment Index. The key research process steps are summarized in Table 1.

Research Steps:
<p>Step 0: Overview of cloud-based social media and crowd sourcing</p> <p>Step 1: Literature - Review and Analysis Reviewed literature and identified the cloud-based social media crowd sourcing challenges Identified and labeled the major categories and categories of the “challenges”</p> <p>Step 2: Two Disaster Case (Description Published in Public Domain) - Review and Analysis Used major categories and categories of the “challenges” as a lens to identify the crowd sourcing challenges in 2010 Haiti earthquake and 2011 Queensland flood disaster cases Identified and labeled the additional major categories and categories of the “challenges” Identified the difference between the challenges identified in the literature and two cases</p> <p>Step 3: Self Reflection Based on the overall analysis, challenges at steps 1 and 2, researchers’ own observations and experience in industry, we identified and labeled additional challenges</p> <p>Step 4: Conceptual Construct Development – Design Science Approach Consolidated challenge categories (as identified at steps 1-3). These categories have been analysed and grouped into 15 major categories. The identified 15 major categories have been further analysed and the four key themes of crowd sourcing challenges have been emerged, which have been used to represent the challenge assessment index construct of our CACA framework</p> <p>Step 5: Interpretation Outlined limitations and future research directions</p>

Table 1: Research and Analysis Process

OVERVIEW OF CLOUD-BASED SOCIAL MEDIA AND CROWD SOURCING

Cloud-based social media can be utilized for crowd sourcing information from citizens and organizations during a disaster (Quillinan et al. 2009). This can be described by the means of two recent disaster management scenarios: 2010 Haiti earthquake (Starbird and Palen 2011) and 2011 Queensland floods (Royal Commission Report 2011).

2010 Haiti Earthquake

In the case of 2010 Haiti Earthquake, while the official communication channels were down, social media played an important role in sourcing information from volunteers on the ground to present an overall ongoing operating picture of the earthquake. This operating picture was also used to inform the general public and earthquake victims of the situation as well as to connect them with necessary help (Bunz 2010). For instance, volunteer groups utilized the Ushahidi mapping platform and Twitter to source earthquake related information from the field for crowd mapping and also coordinating the movement of relief workers and supplies. Ushahidi (2011) is an open source platform that allows real-time crowd sourcing (e.g. via multiple channels, including mobile, Twitter and the web), filtering and sense making of crisis information for visual and interactive mapping of geospatial trafficking of humans. Twitter is a cloud-based “communication platform that allows users to broadcast 140-character message (tweets) to groups of other users who subscribe to their accounts (followers). In turn, Twitter users (tweeters) receive tweets from the set of users they select to follow” (Starbird and Palen 2011). It was noticed (e.g. from case study description published in the public domain) that during the Haiti earthquake, Twitter users not only used the Twitter to post the crisis information but also they synthesized information from different tweets and then re-tweeted the synthesized message to their followers – this seemed a new effective use of Twitter which allowed volunteers to self-organize and emerge as “translators” (Starbird and Palen 2011).

2010-11 Queensland Floods

In the case of Queensland floods, Queensland police and some local government councils disseminated flood warnings and information about local conditions via Twitter and Facebook; to/from citizens and their communities (Royal Commission Report 2011). The Australian Broadcasting Corporation (ABC), the Australian Government broadcaster, also experimented in sourcing information from the community and launched an interactive crisis map of the Queensland floods in January

2011. The South Australia Fire and Emergency Commission chief executive mentioned that “in the light of the recent spate of emergencies and disasters, there is an increased need to reinforce the message that there could be possible failures in communication networks, like radio, and that multiple information streams and communication methods should be monitored. With new news media such as Twitter and online news sites, the community expects immediate answers to any query that they may have” (The Advertiser 2011). This initial interest and use of social media and crowd sourcing of crisis information was found to be an attractive way to source and disseminate information.

The 2010 Haiti Earthquake and 2010-11 Queensland flood experiences highlighted the use of social media and supporting technology for real-time crowd sourcing of information from volunteers on the ground to build the overall ongoing operating picture of actual crisis conditions. However, EA need to recognize crowd sourcing opportunities and challenges. The next section discusses the challenges in the context of cloud-based social media for crowd sourcing to address the key research question (as discussed in Introduction).

CLOUD-BASED SOCIAL MEDIA AND CROWD SOURCING CHALLENGES

We have taken the critical view because most of the existing literature is focused around the usage patterns and benefits of social media in disaster and our industry research partner EA operate in a complex and highly regulated environment and they need to be aware of potential crowd sourcing challenges before making any further commitments. Therefore, firstly, we critically reviewed the recent relevant literature, observed (e.g. based on qualitative data analysis), and identified a number of challenge categories by using a qualitative research approach (please see Table 2). Secondly, we used the challenges identified in literature as a lens and critically reviewed recent two cases of 2010 Haiti Earthquake and 2010-11 Queensland Floods, and observed and identified a number of challenge categories in Table 3 (e.g. challenges different from literature). Finally, based on the overall analysis, identified challenges, researchers’ own observations and experience in industry, additional challenges have been reflected and categorized in Table 4. This whole analysis is summarized in Figure 2.

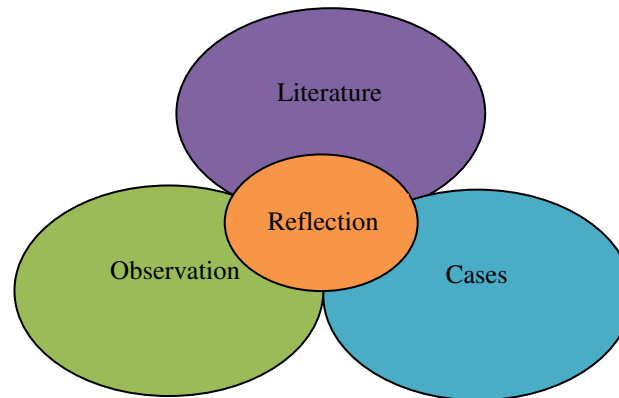


Figure 2: Crowd Sourcing Challenges Extraction

Challenges Derived from Literature

In this section, we present the identified challenge categories based on the recent relevant literature analysis. The identified challenges are summarized in Table 2. First column, we refer to the literature source. Second column, we present our critical observation in the context of EA in order to uncover the hidden challenge. Once the challenge categories had been identified (column three), we grouped them into major categories (column 4). We identified the 9 major categories of challenges (please see Table 2 for details).

Literature Sources	Critical Observations in the Context of EA	Identified Challenge Categories	Major Challenge Categories
The demographics are always changing due to the move of people. Young people need to be approached via social media (The Advertiser (2011)).	Well the challenge is how to determine whether the young people are living in the affected area and whether they know to use the social media?	Changing Demographics	Right People

Literature Sources	Critical Observations in the Context of EA	Identified Challenge Categories	Major Challenge Categories
Mismatch between the social media and legacy systems data feeds frequency Terman (2011).	Mismatch between the social media and legacy systems creates a challenge since most legacy systems are designed to process information in less frequent small chunks than the social media sourced information which is published in real-time streams. There are no clear and defined processes to direct how, when and how often the streaming of crowd sourced data between the social media and legacy system should occur.	Overwhelming Streams of Crowd Sourced Information	Process
Employees forced to use social media, may then struggle to keep up with overloaded information (Cross et al. 2005).	EA staff, if forced to use social media, may then struggle to keep up with overloaded information. This may therefore impact their performance and work practices.	Performance Implications	Human Resources
The location of the physical machine where the information sourced via social networks actually resides may be subject to patriotic law (Gellman 2009; Patriot Act 2001).	Social media providers may change their terms and policies at their own will. There are no clear and defined processes to direct who would monitor and govern cloud-based social media and social media providers – state or local government EA, which one?	Authority Confusion	Authority
A cloud-based social media service provider may shut down their services deliberately or due to regular maintenance during a crisis (Choo 2010; Birmingham 2011).	Victims and workers would not be able to access the information posted via cloud-based social media due to the power failure or loss of mobile phone or internet connection or permanent/temporary service shut down during a crisis.	Information Unavailability	Infrastructure
Unavailability of APIs and unstructured nature of social media information (Choo 2010; Starbird and Palen 2011; Terman 2011).	Lack of APIs and unstructured nature of social media information would hinder cloud-based social media and legacy system relational database integration.	Information Integration	Integration
Social media sourced information lacks well-defined prescriptive micro blogging message syntax and structure (Starbird and Stamberger 2010; Starbird and Palen 2011);	This would hinder information interoperability between the cloud-based social media and legacy system.	Lack of Information Interoperability	Interoperability
Malicious software or mobile apps for crowd sourcing may gain	Malicious software or mobile apps would be able to view and	Malware	Security

Literature Sources	Critical Observations in the Context of EA	Identified Challenge Categories	Major Challenge Categories
control of the cloud-based social media platform (e.g. Apps, OS, hardware) (Price 2008).	modify the crowd sourced information packets without the platform owner knowledge and consent.		
A group of volunteers may use cloud-based social media to launch a brute force attack Choo (2010).	A brute force attack can manipulate the encrypted user social media account information and their broadcasted messages or tweets.	Group Attack	
A distributed denial-of-service situation could arise due to the attack to a specific websites (Ferrer 2009).	An attacker may target specific crowd-sourcing websites by flooding a web server with repeated tweets or messages.	Distributed Denial-of-Service Attack	
Overloaded information cluttered with noise may lead to poor quality information. (Parameswaran and Whinston 2007; Terman 2011)	This may lead to poor quality decision making and increase in the cost of sourcing and cleansing the information	Information Overload	Financial

Table 2: Literature - Cloud-based Social Media Crowd Sourcing Challenges

Challenges Derived from Cases

In this section, we used the challenges identified in literature as a lens to identify challenge categories in recent two cases of 2010 Haiti Earthquake and 2010-11 Queensland Floods in the context of cloud-based social media crowd sourcing. We identified 5 major categories of challenges in these two cases with a different set of challenge categories. However, 2 of the major categories “Right People” and “Human Resources” were the same (marked bold) as we identified during the literature analysis (please see Table 3 for details).

Two Case Studies	Critical Observations in the Context of EA	Identified Challenge Categories	Major Challenge Categories
<p>Community member published inaccurate information on the Western Downs Regional Council Facebook page and a rumour about the failure of Wivenhoe Dam on the Facebook page (Royal Commission Report 2011).</p> <p>2010-11 Queensland Floods</p>	Well the challenge is how to determine whether the crowd sourced information is correct or not?	False Information and Rumours	Right Information
	There is also a challenge that if volunteers maliciously generate a pattern of information to deliberately disturb the crisis planning, response and recovery will be impacted and this may create another crisis during the disaster.	Bad Information Patterns	
	There is also a challenge in determining whether the information source is trustworthy or not?	Information Source Trust	Right People
<p>Raw information translation from different tweets and then re-tweeted to their followers (Starbird and Palen 2011).</p> <p>2010 Haiti Earthquake</p>	Delay in the activity of raw information translation from different tweets and then re-tweeted (of the synthesized message) to their followers may delay the communication to victims and emergency workers.	Information Latency	Right Time

Two Case Studies	Critical Observations in the Context of EA	Identified Challenge Categories	Major Challenge Categories
Deployed additional staff and resources in order to monitor, update, correct and prevent the posting of inaccurate information via social media (Bunz 2010; Royal Commission Report 2011). 2010 Haiti Earthquake 2010-11 Queensland Floods	EA seem to need additional staff or resources 24/7 in order to monitor, update, correct and prevent the posting of inaccurate information via social media	Additional Resources and Supervision	Human Resources
Volunteers used maximum 140 characters tweet to exchange information (Bunz 2010; Starbird and Palen 2011; Royal Commission Report 2011). 2010 Haiti Earthquake 2010-11 Queensland Floods	One tweet allows only a maximum 140 characters, so is that sufficient to disseminate a message? Is it scalable?	Content Constraint	Scalability

Table 3: Disaster Cases - Cloud-based Social Media Crowd Sourcing Challenges

Challenges Derived from Self-Reflection

In this section, we identified 5 major challenge categories, with a different set of challenge categories, based on the overall analysis in the context of cloud-based social media crowd sourcing. However, 2 of the major categories “Process” and “Authority” were the same (marked bold) as we identified during the literature analysis (please see Table 4 for details).

Overall Critical Observations and Reflection in the Context of EA	Identified Challenge Categories	Major Challenge Categories
A clear strategy to use and monitor the social media seems missing at this stage.	Lack of Social Media Monitoring Strategy	Policy
There is a challenge to verify and validate the information sourced via social networks. There are no clear and defined processes/rules to validate the sourced information.	Verification and Validation	Process
There are no clear and defined processes to direct who owns the information residing in the cloud-based social networks - community, social media vendor, emergency services?	Ownership Confusion	Authority
There are no clear and defined processes to direct who has rights to grant permissions to share and secure the information sourced via social media (e.g. who may create or close threads for communication in the social media)?	Unauthorised Information Sharing	
Twitter or Facebook: which one to follow and which thread to follow, and what if someone shutdown the popular thread? There is a need of extra measures to secure and monitor the popular threads of crowd sourced information.	Multiple or Too Many Sources of Information	
There is a possibility of commingling of crowd sourced information of an entirely different crisis if the information for both crises is stored in a single cloud-based multi-tenant environment.	Crowd Sourced Information Comingling	Privacy
The providers of the social media services themselves may suffer due to disasters and people dependent on social media may not be able to access the information posted on the social media site.	Social Media “self-victims”	Resilience

Table 4: Reflection - Cloud-based Social Media Crowd Sourcing Challenges

CHALLENGES ASSESSMENT INDEX AND CONCEPTUAL CONSTRUCT

Based on the analysis presented in the previous Sections (Tables 2-4), we propose a conceptual challenge assessment construct that can be used by EA as a guideline for assessing the challenges of cloud-based social media for crowd sourcing. The challenge assessment index (Table 5) provides a list of 24 consolidated challenge categories (as identified in previous Sections: Tables 2-4). These categories have been analysed and grouped into 15 major categories. The identified 15 major categories have been further analysed and the four key themes of crowd sourcing challenges have emerged. These themes have been used to represent the challenge assessment index construct (Figure 3 and Table 5) of our CACA framework (Figure 1).

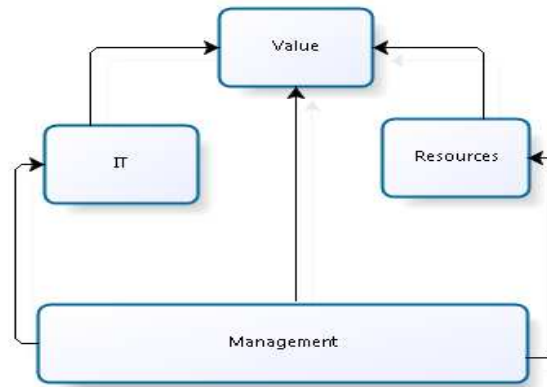


Figure 3: Challenge Assessment Conceptual Construct

Ref.	Conceptual Themes	Major Categories	Key Challenge Categories
01	Value	01.Right Information	1.False Information and Rumours
			2.Bad Information Patterns
		02.Right People	3.Changing Demographics
			4.Information Source Trust
02	Resources	0.3.Right Time	5.Information Latency
		04.Financial	6.Information Overload
		05.Human Resources	7.Additional Resources and Supervision
			8.Performance Implications
03	IT	06.Infrastructure	9.Information Unavailability
		07.Integration	10.Information Integration
		08.Interoperability	11.Lack of Information Interoperability
		09.Privacy	12.Crowd Sourced Information Comingling
		10.Security	13.Malware
			14.Group Attack
			15.Distributed Denial-of-Service Attack
		11.Scalability	16.Content Constraint
04	Management	12.Resilience	17.Social Media “self-victims”
		13.Policy	18.Lack of Social Media Monitoring Strategy
		14.Process	19.Verification and Validation
			20.Overwhelming Streams of Crowd Sourced Information
		15.Authority	21.Authority Confusion
			22.Ownership Confusion
			23.Unauthorised Information Sharing
			24.Multiple or Too Many Sources of Information

Table 5: Consolidated Challenge Assessment Index Construct Matrix

The value for EA is to get the right information from the right people to the right people at the right time in order to make quick effective decisions during a disaster. Therefore, we organized the Right Information, Right People and Right Time

major challenge categories around the “Value” conceptual theme. In order to obtain and deliver “Value”, EA need resources and information technology (IT). This led us to group the identified Financial and Human Resource major challenge categories under the “Resources” theme; and Infrastructure, Integration, Interoperability, Privacy, Security, Scalability and Resilience major challenge categories under the “IT” theme. The “Management” theme has emerged during this analysis to provide the overarching management support to other emerged themes (e.g. IT Management). The major challenge categories Policy, Process and Authority have been grouped under “Management” theme. The identification of challenge categories, major categories and themes also need to consider the other two important aspects of assessing the identified challenges. These two aspects are (1) Likelihood and Impact of the challenge, which have been identified, based on the review of new communication technologies’ issues (Heath 1997). In the context of our research, Likelihood is the possibility of challenge that can effect EA and impact is how strongly the challenge can affect EA. EA can assess each challenge listed under major challenge categories and give score from 1 to 10 (e.g. from low to high) for the two dimensions of likelihood and impact.

DISCUSSION, CONTRIBUTION AND LIMITATIONS

This analysis of the 2010 Haiti earthquake, 2011 Queensland flood and the resultant challenge assessment index (Figure 2) has reinforced the notion, through Actor Network Theory concepts, that EA (e.g. actors) really do like to collaborate via cloud-based (e.g. black box) social media platform (e.g. network) for self organizing (e.g. prescription) and exchanging information (e.g. intermediary). The challenges identified in this paper presented a number of research opportunities. This paper provides a research focus through the tables of key challenge categories, major categories (Tables 2-5), and conceptual theme (Figure 3). This paper presented a novel construct of the challenge assessment index, within the context of our large CACA framework (Figure 1), based on both the theory (e.g. literature) and practice (e.g. disaster cases). This construct and the framework need to be considered with a view of its limitations since the body of literature and practices are both dynamic in nature and it should be considered as an ongoing work to be revised and extended by future studies. Despite its limitations, this paper present previously unavailable social media and crowd sourcing related challenge assessment index. The identified challenges, if not all, could be considered a research theme. For example, consider the following challenges by category: Changing Demographics, Information Source Trust, Lack of Information Interoperability, Crowd Sourced Information Comingling, Information Overload and Social Media “self-victims”. For instance, one may be interested to research and propose theories or constructs for checking the information source trustworthiness. Others may be interested in researching in information overload and its financial aspects. This paper, purposely, did not discuss the social media hype and benefits in great detail; rather it took the critical view in order to identify challenges and future research directions. Therefore the scope of this paper is limited to only crowd sourcing challenges.

CONCLUSION

This paper aims to reduce EA uncertainties so the identified challenges can be highlighted and addressed. Based on the analysis of theory and practice, this paper presented a challenge assessment index construct of our CACA framework for cloud-based social media use for crowd sourcing by EA. Our analysis has provided a deeper insight into these challenges, which must be carefully addressed for the effective (and less-risky) use of cloud-based social media by EA. Our work in the development of CACA framework is, by necessity, taking us into the areas of Design Science research in Information Systems, which enable us to design constructs, analyse the use and impact of such constructs to improve and understand the behavioral aspects of IS.

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