Using Social Architecture to Analyzing Online Social Network Use in Emergency Management

Completed Research Paper

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Abstract

Emergency Management Agencies (EMA) are increasingly adopting online social network (OSN) such as Twitter and Facebook for interacting with partner institutions and citizens for sourcing and distributing of vital crisis information. However, EMA need to study and analyze how well they are using and, how they should be using the OSN. This paper adopts a holistic social architecture driven approach and demonstrates how to systematically study and analyze OSN adoption in the Australian EMA case study. The results of this study indicate that OSNs do not replace traditional systems and should be considered a part of the whole crisis information management environment. Further, it indicates that a holistic social architecture driven approach seems useful for studying and analyzing the OSN-enabled EMA crisis information management environment, which is critical for the identification of opportunities for improvement.

Keywords

Enterprise architecture, emergency, information management, online social network, social architecture.

Introduction

During recent times, public administrations have adopted different social media tools to promote transparency, participation, and collaboration (Mergel 2012). Social media characteristics, such as, end-user participation as co-creation of content and evaluation, collaboration-oriented problem solving through networking activities and content sharing, encourage government agencies to apply social media to achieve the Open Government objectives (Chun and Reyes 2012). After some years of experimentation, testing, and assessment, the diffusion of social media in government is now intended to innovate how public bureaucracies operate internally and how they interact with the public outside government's organizational boundaries. (Criado et al 2013). Against this backdrop, there is a growing interest among emergency management agencies (EMA) in adopting OSNs (online social networks). A large amount of information can be sourced and distributed by EMA before, during and after large-scale disaster events using the OSNs (Erskine et al 2013, Starbid and Palen 2011). For example, Twitter OSN was used to source and distribute information about Tsunami warnings and flooding (Chatfield and Brajawidagda 2012). There is an increasing awareness of OSN use to support the EMA information management needs during a crisis (Erskine et al 2013). However, EMA are often unsure how to best use OSN. If they are already using OSN, they need to study and analyze how well they are using and, how should they be using.

An EMA can be viewed as a multi-dimensional information-intensive social system in which information about a crisis is shared and managed by different entities (Palen et al. 2009; Palen and Sutton 2011). The OSN-enabled EMA social system may not be appropriately studied and analyzed by using the linear and traditional system architecture approach (Magoulas et al. 2012). It demands the relevant social system architecture lens. However, the challenge is that the existing traditional mainstream architecture frameworks such as TOGAF (Harrison 2011) and Zachman (1989) lack the support for social architecture. Social architecture is an emerging concept. The Gill Framework (Gill 2013a, b) provides the necessary support for the social architecture. This framework defines the social architecture as the "fundamental concepts or properties of a social system in its environment embodied in its elements, relationships, and in the principles of its design and evolution" (Gill 2013b). Social architecture lens seems appropriate to study and analyze the OSN-enabled EMA social system "activities, practices, and behaviours among communities of people who gather online to share information, knowledge, and opinions using conversational media" (Safko and Brake 2010). The study and analysis of the EMA social system is critical for the identification of opportunities of improvement in the context of effective use of OSN during crisis. Therefore, this paper uses the novel social architecture from The Gill Framework as an analytical lens to study and analyze the OSN-enabled Australian Capital Territory (ACT) EMA crisis information management environment. This draws our attention to the following key research question, in the context of Australian EMA and crisis information management, which is addressed in this paper:

How to best analyze OSN use for effective sourcing and distribution of disaster information using social architecture lens?

The structure of this paper is as follows. Firstly, it presents the research context and social architecture lens. Secondly, it discusses the ACT EMA research case. Thirdly, it presents the application of the social architecture by using it as an analytical lens for studying and analyzing the OSN use by the ACT EMA. Finally, it concludes with a discussion about research contribution, limitations and future research directions.

Research Context and Social Architecture

This section provides the research context and the need for a social architecture analytical lens. Firstly, it discusses the use of the OSN in disaster scenarios. Secondly, it describes the social system concept. Thirdly, it defines the emergency management as a social system and discusses the need for a social architecture lens for studying and analysing the emergency management as a social system in the context of OSN use. Finally, it describes the components of the social architecture.

OSN in Disaster Management

The use of the cloud-based OSN allows EMA, citizens and other relevant parties to gather and disseminate their views and disaster information on the web (Gill and Bunker 2011; Gill and Bunker 2012). Horita et al (2013) carried out a systematic literature review on the use of OSN in disaster management and reported that OSN is mostly used for information sharing during the response phase of the disaster, while fewer studies were found that discuss the use of OSN in mitigation and preparedness phases, and no study of the OSN use was found dealing with the recovery phase. OSN was used for all types of crisis scenarios mostly for fire (26%) and floods (26%). The prevailing channels for information sharing were found to be OSN (i.e. Twitter, Facebook and YouTube) and mobile devices. A number of case studies on the use of OSN for disaster management have been reported (e.g. 2009 Oklahoma grassfires, the 2008 hurricane season, 2007 Virginia Tech shootings; 2010-2011 Queensland floods). The review of the OSN case studies highlighted mainly three themes: (1) Situational analysis and awareness, (2) Information dissemination about the crisis at hand and 3) digital engagement. These themes are summarized in Table 1 that provides the research context for the study reported in this paper.

Source	Situational analysis and awareness	Information dissemination	Digital engagement
Sutton and Palen (2011) study about the 2007	There was an 'information dearth' which required people in non-metropolitan areas to seek information	The authorities were not using social media at this time. Thus local non-metropolitan newspapers	some media outlets were using the 'back channels' as credible sources of information as well as the

Source	Situational analysis and awareness	Information dissemination	Digital engagement
California wildfires	online through discussion groups, personal blogs, twitter and Flickr, messaging and emails.	and the general public provided information through 'back channel' (e.g. off duty firefighters used blogs for support for loss).	'back channels' using the media outlets for information as well for people who were viewing these sites and were not close to televisions or radio.
Hughes (2009) study on the Oklahoma Grassfires and the Red River floods in America in 2009	In the Oklahoma grassfires, it is reported that 40% of the sampled data included geo-tagging information, while in the Red River floods, 18% of the sampled data included geo-tagging.	The' high yield' twitters were aware of their high public role, and carefully constructed their tweets to report as much information as possible in the relevant space and often included geo-tagged information.	More digital engagement (e.g. volunteer coordination, needs) could be seen in the red river case rather than the Oklahoma grassfire case due to the fact the people were able to prepare and get ready for the emergency rather than flee the situation and tweet later about the emergency.
Vieweg et al. (2008) study about social media use in the aftermath of the 2007 Virginia tech shootings	Use of both social media and traditional media web sources became focal points for converging information as a form of situational awareness. Members of the public were using social media as a way to problem solve and understand the situation at hand (e.g. Facebook pages such as *I am ok at VT and Prayers for VT*).	The focus on this paper was about how information was distributed, in an accurate and timely manner, with users often referring on to other sites and Facebook pages regarding who was harmed or dead.	An example of digital engagement was that Facebook users acted as information gatherer and broker through using Facebook messaging, search facility for information and posting it to the Facebook group he was involved in.
Cheong and Cheong (2011) and QPS Media Report (2011) on Twitter and Facebook use during the 2010-2011 Queensland floods	During 2010-2011 floods Australian Emergency Service Agencies proved to the public that they could release information in a timely manner to the public to ensure that the public knew about situations during an emergency. The Queensland Police Media Unit ensured this by creating an online community before the floods in the December-January period. Their number of followers increased dramatically during these emergencies.	Cheong and Cheong noted the heavy use of social media use by Queensland government agencies, politicians and emergency media volunteers, which allowed for information to be disseminated quickly and efficiently to members or the public and TV and radio media. However Cheong and Cheong noted that when there were floods later in January and early February in NSW and Victoria, there was next to nothing from these government agencies.	Cheong and Cheong were able to capture many tweets over this period, which mapped out the interactions between key media figures and organizations, which were into the hundreds by the end of the period. QPS media also reported it was the first time that the hash tag #Mythbusters was used in Australia to ensure minimal misinformation and rumors spreading throughout Australian media sources and the community.
Hughes and Palen (2012) study on Public	The US department of Homeland security has a small paragraph in their public information officers	Hughes and Palen describe that some PIO's have found social media to be more effective and better than	Hughes and Palen found that PIO's had mixed feelings towards digital engagement between the

Source	Situational analysis and awareness	Information dissemination	Digital engagement
Information Officer (PIO)	handbook in regards to using social media, encouraging public information officers to use social media to help with situational awareness and crisis information management, however the PIO's Hughes and Palen interviewed found this confusing in regards to their role in their jurisdiction.	traditional media, as the PIO's can directly communicate to the direct public and therefore ensuring that the emergency authorities are not misquoted and that it makes emergency services not so reliant on media sources to get the information out to the public.	public and emergency services, some of the negative comments from PIO's included trying to manage the information that was being issued by the public that could be incorrect. While some of the positive comments included PIO's monitoring social media and reporting to ground crews during an emergency witness reports and photos, giving more power to emergency crews who might have needed the public's information for any reason.

Table 1. OSN use in Disaster Management

Social System

A social system is a relational and collaborative system, which is represented by dynamic interactions among individuals and collectives (Kroeber and Parsons 1958).The key difference between the traditional static system and social system is the "dynamic" nature of the social system structure and behaviours. Like any other system, it has input, output, people, process, constraints, and feedback components. Depending upon a situation, social system may emerge as a group of people or community, which then may expand or contract over a period of time in pursuit of achieving desired mutual goals. A social system refers to a group or organisation or society or community of practice that has the capability and capacity to create, use and share knowledge (Wenger 1998). Here, we can apply this notion of social system to dynamic emergency information management environment and define emergency management as a social system.

Emergency Management as a Social System

An emergency management is a kind of relational social system (Foster 2013) that involves internal and external interactions and collaborations between different stakeholders. Emergency management as a social system can be supported by social technologies such as OSN (e.g. Twitter, YouTube, Facebook and LinkedIn). Traditional system architecture can describe and analyze traditional system components and their interactions. In order to study and analyze the emergency management social system, which is the objective of this paper, we need a social system architecture lens. The emergency management social system coupled with the OSN can be studied, analysed, and improved by using a social architecture lens of The Gill Framework (Gill 2013a, b). The Gill Framework (Figure 1) provides the necessary social architecture construct that is used here as an analytical lens to study the OSN adoption by the ACT EMA (OSN use during the 2011 Mitchell factory fire and current use). The next section discusses the components of the social architecture lens.

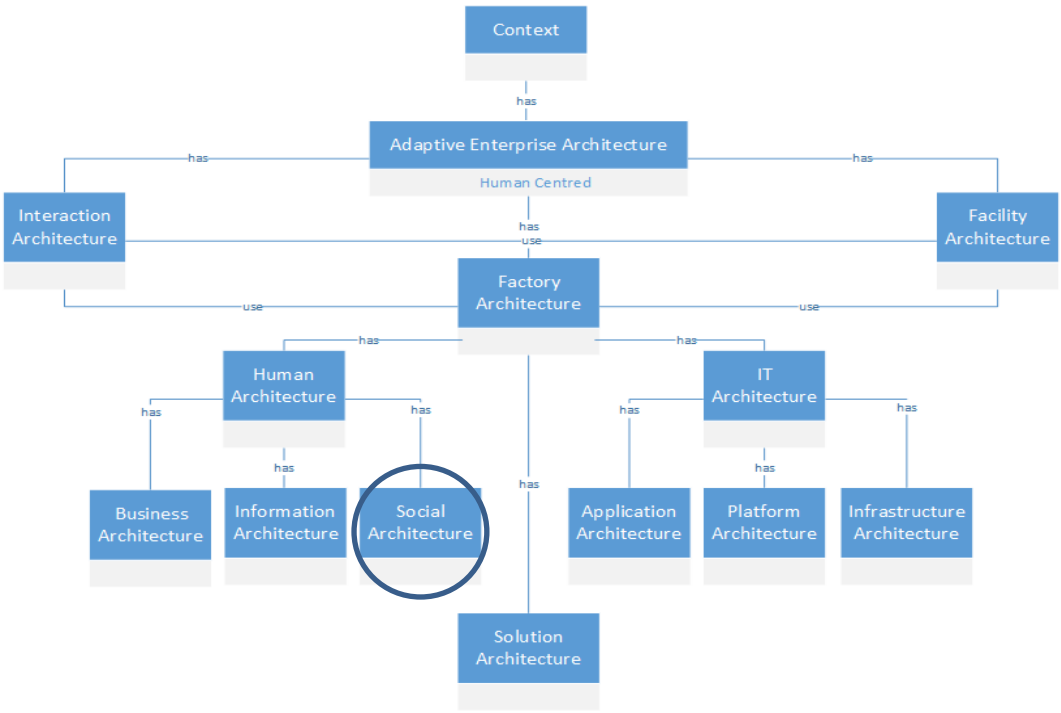

Figure 1. The Gill Framework – Domain Architectures (Gill 2013b)

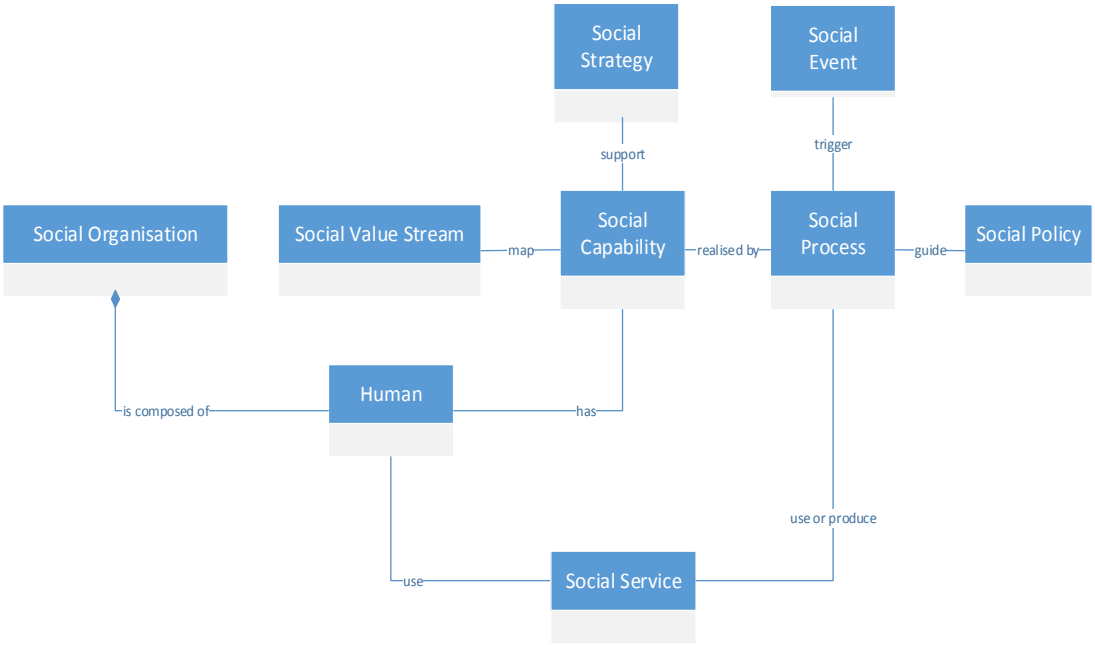

Figure 2. The Gill Framework – Social Architecture Conceptual Model (Gill 2013b)

Social Architecture

The Gill Framework (2013b) defines the social architecture as the "fundamental concepts or properties of a social system in its environment embodied in its elements, relationships, and in the principles of its design and evolution". Social architecture, in the context of EMA, is all about "social communities" who play an important role during crisis response. Social architecture has nine key elements: social strategy,

social policy, social principles, social organization or community, social value stream, social capability, social process, social service, and social event. Additional elements can be added if required. These elements have been described in Figure 2 and Table 2. Social architecture conceptual model describes the relationship between the social architecture elements. The social organization is composed of human or people that has social capability. Human use social services and has social capability that supports the social strategy. Social capability is realized by the social processes. Social processes are triggered by social events and are guided by the social policy. Social processes use or produce the human and technology oriented social services. The social architecture elements (see Table 2) provide the social technology independent description of the social architecture within overall context of enterprise architecture. An emergency management event specific social architecture can be studied and analyzed by using these elements.

Ref.	Element	Description
1	Social strategy	Social strategy describes the goals and objectives that need to be realized by the adoption of social practices and social media technologies.
2	Social policy	Social policy guides social practices and the use of social media technologies.
3	Social principles	Social principles describe the fundamental beliefs and values that impact the design of a social architecture and consequently the adoption of social media technologies.
4	Social organisation or community of Human	Social organisation describes the internal and external social structure or community of people beyond the boundary of one business unit or organisation.
5	Social value stream	Social value stream describes social organisation capabilities (end-to-end social interactions) that create value.
6	Social capability	Social capability, as a part of a formal business capability, describes what the social enterprise does?
7	Social process	Social process describes the activities within a single social capability and across multiple social capabilities.
8	Social service	Social service describes a group of recurring social activities.
9	Social event	Social event describes the events that trigger social processes.

Table 2. Social Architecture Elements

Research Case: ACT EMA

This paper presents our pilot case study, which enabled us to perform an exploratory interpretive investigation into the use of OSN in ACT EMA. In general, case studies are the preferred strategy when the focus is to study and analyze a contemporary phenomenon within some real-life context (Yin 1994). Further, Horita et al (2013) also reported that existing research on disaster management was mostly carried out using the case study research methodology. Hence, a case study approach along with the social architecture lens was applied to study and analyse the OSN-enabled ACT EMA. The ACT EMA is one of the largest Australian based EMA in Australian Capital Territory (ACT). The ACT EMA provides state-wide emergency coordination, community education, and response to major incidents in ACT.

Mitchel factory fire in 2011

In the early hours of September 16th 2011, a factory fire broke out in the industrial suburb of Mitchell in North Canberra (being the Mitchell factory fire 2011, in Canberra, Australian Capital Territory). The ACT EMA has social media Twitter (OSN) accounts, which they used for the first time to broadcast information

to the concerned residents of North Canberra during Mitchell factory fire. It is interesting to note that ACT EMA never used their OSN accounts before the day of the fire because their social media was under development and was due to be released on the day of the fire outbreak, which proved to be an unfortunate timing. It is also worth mentioning that there was a lot of criticism on the ACT EMA in their not announcing that they had a Twitter account earlier. For example, on a Canberra forum called "The RiotAct" there was a posting saying that there was no announcement of such a Twitter account, however others had said such an event like the Mitchell fire had forcibly put the knowledge of such a Twitter account in their minds, similar to what happened with the Queensland flood example where their theory of organic growth through word of mouth made their Twitter account become popular during such emergency events. From the Mitchell factory fire, the ACT government, general public and media have learnt that Twitter and social media accounts are another way to disseminate information. It should be noted that it does not replace something already used like a website or press release. The ACT EMA redeveloped their website, which was linked to their corresponding social media accounts using a tool called dlivr.it. Canberrans learned many lessons in the aftermath of this emergency.

Current status of OSN use in ACT EMA (Post Mitchel factory fire)

The Twitter account has only been intended to be used for disseminating crisis information. It is not intended to be used for interacting with members of the community. This could be due to the small size of the media team and other limiting factors. As mentioned earlier, It is was also not intended to replace the existing traditional information radiators such as websites and press with the OSN such as Twitter. Therefore, the tool like dlivr.it is deemed necessary for having the ability to link OSN and traditional sources such as the EMA website and the press to give timely information to the ACT community from multiple sources. The integrated OSN and traditional information delivery environment is now in full use. The ACT EMA intends to expand and improve their OSN use and need to understand and analyze their current state to set the vision and requirements for the future state. In order to do so, this paper used the social architecture lens to study and analyse the current OSN use in ACT EMA.

Data collection

This study collected both primary and secondary data during 2011-2013. Firstly, primary data about the use of OSN during the Mitchell factory fire was collected from the ACT EMA in 2011 and a number of critical issues and measures around the Twitter use were unfolded. Further the ACT EMA provided the supplementary information on Twitter usage, follower data, the sudden surge in Twitter use and organisational policy documentation around social media usage. They also provided a set of popular and significant tweets for the fire. To gain more information about the crisis of focus, further information was collected from newspaper articles, news bulletins and relevant blogs. Details of the Mitchell factory fire were documented in Eustace and Alam (2012). Secondly, secondary data was collected between 2012 and 2013 from the ACT EMA public sources (ACT EMA website[1] and Gov 2.0 report 2013) in order to fully understand the ACT EMA OSN adoption journey since 2011 Mitchel fire incident. The collected primary and secondary data as a whole is analyzed in this paper by using the social architecture lens from The Gill Framework.

Analysis and Results

The nine elements of The Gill Framework – social architecture domain (see Table 2) were used for analyzing the adoption of OSN in ACT EMA. This section presents the analysis results in Table 3.

Ref.	Element	Criteria Question	Analysis Results and Evidence
1	Social strategy	Does the ACT EMA social strategy has clear goals related to the use of	Yes. The following goals have been identified within the context of ACT EMA social strategy.

[1] ACT Emergency Service Agency website. http://esa.act.gov.au/

Ref.	Element	Criteria Question	Analysis Results and Evidence
		social media technologies?	• Enable real time emergency information dissemination to the ACT community via frequent alerts and updates • Enhance general awareness • Provide a way to promote recruitment programs • Enhance communication between volunteers and EMA workforce • Increase awareness about the EMA role and daily activities
2	Social policy	Does the ACT EMA have a clear social policy to guide the use of social media?	Yes. The EMA has guidelines that guide the use of social media in order to support the social strategy (published on ACT EMA website).
3	Social principles	Does the ACT EMA have clear social principles to guide the use of social media?	Yes. The ACT EMA social media guidelines are augmented with the following principles: Trust Transparency Timelessness Accuracy Accessibility To be the single source of truth
4	Social organisation or community	Who is involved and uses or requires the support of social media?	The following people or actors have been identified within the context of ACT EMA social organisation. EMA media liaison officer Citizens Volunteers ACT Ambulance Service ACT Fire Brigade ACT Rural Fire Brigade ACT State Emergency Service
5	Social value stream	Does the ACT EMA have clear end-to-end social interactions that support the goals identified in the social strategy?	Yes. ACT EMA social value stream includes information sourcing (from public or community), processing, distribution (to community, other EMA) and management for realising their social strategic goals.
6	Social capability	What are the social capabilities in the social value stream?	The following four key social capabilities have been identified within the context of ACT EMA social value stream. Disaster information crowdsourcing Crowdsourced information processing Disaster information dissemination Disaster information Management
7	Social process	Does the ACT EMA have clear processes that realise the social capabilities?	Yes. Social capability is focused on what does the ACT EMA do? The social capabilities are realised by the social processes and underlying activities.
8	Social service	Does the ACT EMA processes have recurring activities?	Yes. The ACT EMA recurring activities can be grouped into following main services. Information sourcing service Information processing service

Ref.	Element	Criteria Question	Analysis Results and Evidence
			Information sharing service Information updating service
9	Social event	What is the social event?	Social processes or activities are triggered by social emergency events. The Mitchell factory fire event triggered the social interaction processes of disaster information sourcing, processing, distribution and management

Table 3. ACT EMA Case Analysis and Results

The social strategy lens points out the social strategy within the 2011 Mitchell factory fire disaster case. Social strategy is an important element and uncovered the five key social strategic goals (see Table 3) of the ACT EMA in the context of emergency situation. The social policy and principles lens points out the social policy and principles that guide the disaster information sourcing, processing, distribution and management using OSN (see Table 3). The ACT EMA has guidelines that guide the use of social media (OSN) in order to support the social strategy. The social organisation lens describes the social structure or community of people beyond the boundary of the ACT EMA (see Table 3). There were number of parties who were involved during the fire such as ACT EMA staff, citizens, volunteers, ACT ambulance services etc. These communities of people were tweeting about the fire event.

The social value stream describes the key social interactions among the different parties involved during the crisis management such as ACT EMA, volunteers, community and other EMA agencies (see Table 3). The social capability distils the four key social capabilities embedded in the ACT EMA social value stream (see Table 3). These social capabilities are realised by the social processes or activities. Further, the social services represent the recurring social services, which are, in the case of ACT EMA and 2011 Mitchell factory fire, the disaster information related services. The social event refers to the Mitchell factory fire event that triggered the social interactions and processes.

This analysis indicates that ACT EMA has a well-established OSN-enabled environment. This analysis highlights the potential and successful use of OSN in EMA and provides baseline information to further enhance the use of OSN in ACT EMA and other similar agencies. For instance, ACT EMA is currently using OSN to support only four social capabilities during crisis response (see Table 3). They may consider using it for other capabilities such as for interacting with community during crisis planning and recovery phases. The use of The Gill Framework social architecture lens is not limited to study and analyze the existing use of the OSN in EMA. It can be used as a guide to design the future state of the social system of any public or private organization pursuing to adopt OSN. For instance, social strategy element of the social architecture lens suggests developing the social strategy before jumping on the bandwagon of OSN. Further, the social strategy can be used as guide to assess and adopt OSNs that meet organizations' strategic objectives. Similarly, other elements of the social architecture lens can be used to design the overall social system environment of any organization that can be supported through the adoption of specific OSNs. In summary, the social architecture lens provides a systematic lens to study and analyse the OSN-enabled ACT EMA social system from nine different perspectives.

Research Contribution and Limitations

A number of case studies regarding the use of OSN during crisis have been reported in the past. Most of the existing research studies are focused around the use and benefits of the OSN (Vieweg et al. 2008; Sutton et al. 2011; Hughes and Palen 2012). EMA are still learning about the complications of the use of OSN. This paper takes a socio-technical viewpoint and discusses the OSN-enabled crisis information management environment in the context of an Australian EMA. This paper used the social architecture of The Gill Framework as an analytical lens to study and analyse the OSN-enabled ACT EMA. The Gill Framework (2013a, b) has its foundation on well-known system of systems (Maier 1998), agility (Qumer and Henderson-Sellers 2007; Qumer and Henderson-Sellers 2008), service science (Spohrer and Kwan 2009), and enterprise architecture theories and frameworks (e.g. Zachman (1987), Federal Enterprise Architecture Framework (CIO Council 2001), The Open Group Architecture Framework (Harrison, 2011)). It provides the novel social architecture lens that has not been discussed before both in OSN and architecture literature.

The use of The Gill Framework social architecture, for studying the OSN-enabled ACT EMA, provided us a number of new insights. For instance, it seems useful to understand that OSN is only one aspect and there are other related aspects such as social strategy, social policy, social principles, and social community etc. that need to be taken into consideration when pursuing to adopt or improve OSN in any organization. In this paper, it seems helpful for systematically establishing the current state of the EMA in terms of their current social strategy, capabilities, policy and processes etc. and identifying missing elements, if any. The establishment of the current state is critical for developing or updating the target or future state of OSN-enabled EMA crisis information management environment. It can be observed from the analysis results that the social architecture lens is very important and lays out the foundation of how one might systematically approach when studying and analysing the OSN use in the context of EMA. One of the research contributions of this paper is the demonstration of how to systematically study and analyse the OSN-enabled EMA using a social architecture lens, which have not been discussed before in the context of OSN-enabled crisis information management environment.

This study has some limitations. Firstly, the use of a social architecture lens in a single case study could be considered a limitation when generalizing the analysis results. However, the case study organisation selected for this paper is a well-known Australian ACT EMA with advanced capabilities and OSN-enabled information management environment. The ACT EMA has been using OSN for a number of years (2011-current). The use of the social architecture lens by no means claims that it presents an exhaustive social system elements' list. However, the use of social architecture lens in the advanced ACT EMA environment indicates that it provides broader coverage of social system elements. Secondly, the research is conducted from the perspective of the particular agency – ACT EMA, it does not take into account the perspectives of the citizens other than that provided by the agency or seen in tweet samples. Finally, the use of The Gill Framework social architecture lens is not limited to OSN-enabled Australian EMA. It can be used in the context of other public services.

Conclusion

This paper uses The Gill Framework social architecture lens to study and analyze the OSN-enabled EMA crisis information management environment from nine different perspectives: social strategy, social policy, social principles, social organization or community, social value stream, social capability, social process, social service, and social event. This systematic analysis aims to reduce EMA uncertainties and increase their understanding that the adoption of OSN is not only concerned with the tools or technology. It requires a holistic social system archietcue driven approach to analyzing and improving the OSN enabled environment. The use of the holistic social architecture driven approach will ensure that the important elements of the desired OSN enabled EMA information management environment are not missed. It is also worth to note that the OSN is another way to disseminate information and it does not replace the official communication channels such as websites, electronic and print media. Based on the analysis presented in this paper, it can be suggested that the OSNs should be considered a part of the whole solution for crisis information management. In our future research, we intend to further investigate and study other cases through the social architecture lens and present it to community for feedback.

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