Disaster Knowledge Transfer in Networks: Enablers and Barriers

Nadeera Ahangama
University of Colombo
nadeera.a@gmail.com

Raj Prasanna
Massey University
R.Prasanna@massey.ac.nz

ABSTRACT

Most countries are now establishing multi-stakeholder, multi-institutional networks and partnerships to respond to flood disasters. The paucity of research directed towards knowledge transfer in networks keeps some important research questions unanswered. These include (1) how the knowledge of a certain disaster management stakeholder (or a group) is transferred to other stakeholders during the disaster response, and (2) what are the barriers and enablers of knowledge transfer in multi-stakeholder environments. This article analyses knowledge transfer practices employed by a selected local government agency and a community group in Sri Lanka and reflects on the practices with the help of Hedlund's Knowledge Management Model (1994). The grounded theory analysis was used in this study to present the enablers and barriers of knowledge transfer in this context and the findings have a great potential to be used in future research towards developing knowledge management models specific to disaster response.

Keywords

Disaster, Knowledge Transfer, networks, Knowledge Management models

INTRODUCTION

Flooding has sustained a continuous rise in the global context accounting for 47% of weather-related disasters during 1995 and 2015 (CRED & UNISDR, 2015) and has become increasingly frequent in Asian countries. Hence, building flood resilient communities in South Asian contexts have been considered as an important research agenda since United Nations has adopted the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR). Adopting these international policies encouraged countries to reshape their DRR paradigms by establishing multi-stakeholder, multi-institutional networks and partnerships to respond to disasters and build community resilience (UNISDR, 2015). However, publications still raise unresolved, alarming issues related to information and knowledge management in multi-stakeholder establishments (Abeling, 2015; Spiekermann et al., 2015; Toinpre et al, 2018). Von Lubitz and the group (2008) argued that conventional knowledge management systems turn out to be inefficient during critical events as the knowledge transformations in current systems are unable to satisfy the actual knowledge needs of an ongoing disaster. As they further articulated, the newly created and stored knowledge often happened to go missing during knowledge transformations and become inaccessible when such knowledge is actually needed during disaster response. Information and Knowledge Management for Disaster Risk Reduction (IKM4DRR) Framework (UNISDR, 2013) recognizes following knowledge management issues disconcerting the Disaster Risk Reduction(DRR) efforts of communities and agencies especially in resource-deprived environments: knowledge has scattered among various agencies, knowledge has not gathered systematically, limited analysis to understand the knowledge, disaster knowledge has not systematically used for policy and decision-making, absence of agreed-upon standards and shared definitions, less integration between regional, national and community knowledge systems, fewer resources to translate information to useful formats etc.

The complex path and place dependent nature of disaster-related knowledge presents challenges to understand transformation cycles unique to disasters, and interaction between tacit and explicit knowledge during disasters. Similar research in the past, elaborate on the key success factors and barriers of disaster knowledge transfer

(Dorasamy et al, 2013; Eriksson, 2009; King, 2005; Marincioni, 2007; Murphy & Jennex, 2006). However, knowledge transfer and knowledge integration in resource-deprived environments have not yet been fully addressed in literature and keep some important research questions unanswered in south Asian countries. These include (1) how the knowledge of a certain disaster management stakeholder (or a group) is transferred to other stakeholders during the disaster response, and (2) what are the barriers and enablers of knowledge transfer in multi-stakeholder environments.

The aims of the paper are twofold: first, to provide insight into how these different types of stakeholders involved in knowledge transfer and what kinds of knowledge transformations are required for the flood response; second, to understand how practices of these stakeholders develop barriers or enablers for knowledge transfer during flood response. The scope of this research is limited to two case studies in a single geographical area (Ratnapura division of Sri Lanka) and the analysis is conducted only on riverine floods. To achieve aforementioned objectives, Hedlund's Knowledge Management Model (the knowledge management in N-form corporations) (Hedlund, 1994) is applied. The Hedlund's Knowledge Management Model (HKMM) is chosen for this evaluation, as it is best suited to describe the case study of interest. This well-accepted model discusses knowledge transfer practices between different stakeholder levels that are organized in hierarchic, which is mostly led by tacit knowledge sharing. As this model entails the combination of knowledge rather than its division, it helps to understand the current disaster management practices embedded with the multi-stakeholder, multi-institutional networks and partnerships to respond to disasters (UNISDR, 2015). This research concerns two levels of knowledge transfer, First; knowledge transfer between individuals within a group, second; knowledge transfer between individuals and other groups (or organizational units). This article inquires the tacit and explicit knowledge dissemination of between individuals and different stakeholder groups and uses HKMM to recognize how useful knowledge could be acquired during disaster response. The remainder of the article is organized as follows: first, the article introduces theoretical background of knowledge transfer and the knowledge management models; second, the study background and the study context; third, the methodological approach section discusses the research design and the data collection methods; fourth, the data analysis section explains processes used to analyse the data and lists the emerged codes; fifth, the findings and discussions section presents the results of the study along with the elaborations; finally, the article concludes with a summary of the findings, including future research avenues and recommendations.

THEORETICAL BACKGROUND

"We can know more than we can tell," wrote Michael Polanyi (1966, p.4) one of the most cited authors in the knowledge philosophy. Nonaka (1994) defined knowledge as a personal belief, which emphasizes the importance of justification. Nonoka aligned the definition of knowledge with knowledge creation, which is "created and organized by the flow of information, anchored on the commitment and beliefs of its holder" (p.15). There are various definitions for knowledge transfer in the body of literature. Rogers (1995) defined knowledge transfer as an attempt by an entity to duplicate a specific type of knowledge from another entity. Szulanski (1996) defined knowledge transfer to be either the identical or partial replication of knowledge from one place to another involving both a provider and a receiver. Another definition presented by Kumar and Ganesh (2009) indicated that knowledge transfer is a "process of exchange of explicit or tacit knowledge between two agents, during which one agent receives and uses the knowledge provided by another" (p.163). All definitions commonly agreed to the notion of two agents in the transfer process in which knowledge owner transfers and another agent receives. After reviewing definitions of knowledge transfer in literature, this research defines knowledge transfer as the process in which knowledge providing agent communicates explicit and tacit knowledge to the recipient agent so that the recipient absorbs knowledge partially or fully and apply learned knowledge in a suitable context.

Polanyi (1966) recognized that knowledge transfers occur mainly between the two dimensions of explicit knowledge and tacit knowledge. Explicit knowledge is transmittable in formal, systematic language (ibid) and exists at the epistemological dimension where explication is possible using written or coded formats (Nonaka, 1994). Tacit knowledge has a "personal quality, which makes it hard to formalize and communicate" (Nonaka, 1994, p.16) and it is intensely entrenched in "action, commitment, and involvement in a specific context". Tacit knowledge exists at the ontological dimension (Nonaka, 1994) and it is a comprehensive cognizance of the human mind and body (Polanyi, 1966). Tacit knowledge is 'knowing how' which is linked to experience (Connell et at., 2003). The body of literature recognizes five knowledge management models on knowledge transfer among different organization levels: The Knowledge Category Model developed (Boisot, 1987), The SECI model (Nonaka & Takeuchi, 1995), Hedlund and Nonaka's Knowledge Management Model (Hedlund & Nonaka, 1993), Boisot's I-Space Model - Influential social learning model (Boisot, 1995), and Hedlund's Knowledge Management Model - The N-Form Organization (Hedlund, 1994).

The Knowledge Category Model developed by Boisot in 1987 reflected that knowledge is as either codified or

uncodified and as diffused or undiffused, within an organization (Boisot, 1987). The theory of organizational knowledge creation indicated that new knowledge is created through continuous cycles of Socializations (tacit to tacit), Externalizations (tacit to explicit), Combinations (explicit to explicit), and Internalizations (explicit to tacit) in the face of interaction between tacit and explicit means (Nonaka & Takeuchi 1995). The theory of organizational knowledge creation is based on the concept that individuals initially create knowledge and then created knowledge is embedded in organizational knowledge through continuous cycles of SECI. Nonaka and Takeuchi (1995) suggested two dimensions of organizational knowledge creation: epistemological and ontological dimensions. Epistemological dimension involves with two types of knowledge: tacit and explicit knowledge. The ontological dimension starts from the individual and ranges to team, group, organization and so forth. "A spiral emerges when the interaction between tacit and explicit knowledge is elevated dynamically from a lower ontological level to higher levels" (Nonaka & Takeuchi 1995). The basis of the spiral is developed through four modes (socialization, externalization, combination, and internalization) of knowledge conversion in which how the knowledge is converted from a knowledge type to another. Boisot proposed the Influential social learning model in 1995. Boisot (1995) brought forward the notion of I-space (information space), where knowledge emerges in a three-dimensional cyclical flow as a product of learning. Boisot's I-Space Model follows the same lines as Nonaka and Takeuchi (1995) but added a new dimension “Abstraction” which explains that knowledge can become generalized to different situations. The new dimension which ranges between abstraction and concreteness enabled to study knowledge transfer extensively (Haggie & Kingston, 2003).

Though Nonaka and Takeuchi's SECI model is one of the most cited category models exist in knowledge literature, several authors argued that knowledge transfer could be much complicated and complex than what is suggested in Nonaka’s model in modern-day non-Japanese organizations (Haslinda & Sarinah, 2009; McAdam & McCreedy, 1999). Hence Hedlund and Nonaka collaborated to enhance the SECI model to describe four levels carriers or agents of knowledge in organizations. Hedlund and Nonaka’s Knowledge Management Model suggests that knowledge should be categorized into four carrier levels including individual, group, organizational and inter-organizational domain. Hedlund and Nonaka’s Knowledge Management Model set up four main categories of knowledge transfer: Articulation and internalization; Extension and appropriation; Assimilation and dissemination; and Expansion. Articulation makes tacit knowledge articulated to explicit knowledge at all four organization levels of the model. Articulation is an essential facilitator of knowledge transfer, expansion and creates the atmosphere and potential for knowledge to be improved while transfer. Articulation is very important for the growth of an organization because “without such articulation, it is difficult to involve new employees and to divide up and specialize work” (Hedlund, 1994, p.76). Internalization refers to transforming articulated knowledge to tacit knowledge i.e. experiencing articulated knowledge unintentionally such that articulated knowledge embeds to organizational practices. This interaction, termed as reflection, is held to be a primary source of knowledge creation (Hedlund, 1994). “Extension is transfer of knowledge (possibly resulting in its transformation) from lower to higher agency levels in the model, in articulated or tacit form” (Hedlund, 1994, p.77). During knowledge extension, the internalized knowledge is observed, imitated, emulated, or spread. Extension is considered as successful establishment of anticipated corporate culture. Appropriation can be understood as the transfer of knowledge from higher organizational levels to lower levels through suitable channels, which is the opposite of extension. "Dialogue is the interaction of extension and appropriation" (Hedlund 1994). Dialogue embraces conversation at any agency level in terms of articulation or tacit knowledge. After knowledge extension and appropriation done at a satisfactory level, assimilation and dissemination processes will start. Assimilation refers to obtaining knowledge from outside the organization and dissemination refers to passing organizational knowledge to the external environment. Their interaction is termed dialogue whose, "…quantity and quality are hypothesized to be important determinants of the type and effectiveness of knowledge management" in an organization" (Hedlund, 1994). The last stage describes expansion where knowledge practices change through knowledge itself to establish new products or processes. Expansion requires frequent interactions in terms of change in substantial increments or continual improvement based on organizational knowledge culture. As McAdam and McCreedy (1999) describe, this model assumes four different agents or carriers of knowledge in the process of knowledge creation, which segregated and identified. Hedlund and Nonaka described the ontological axis of an organization in four levels namely individual, team, the organization, and the inter-organizational domain. Hedlund and Nonaka’s Knowledge Management Model (1993) views an organization as an M-form (multi-divisional) structure. The M-form structure is based on the logic of hierarchical organization where the organization is divided into permanent structures that are managed and knowledge is transferred in the vertical top-bottom hierarchy (Hedlund, 1994).

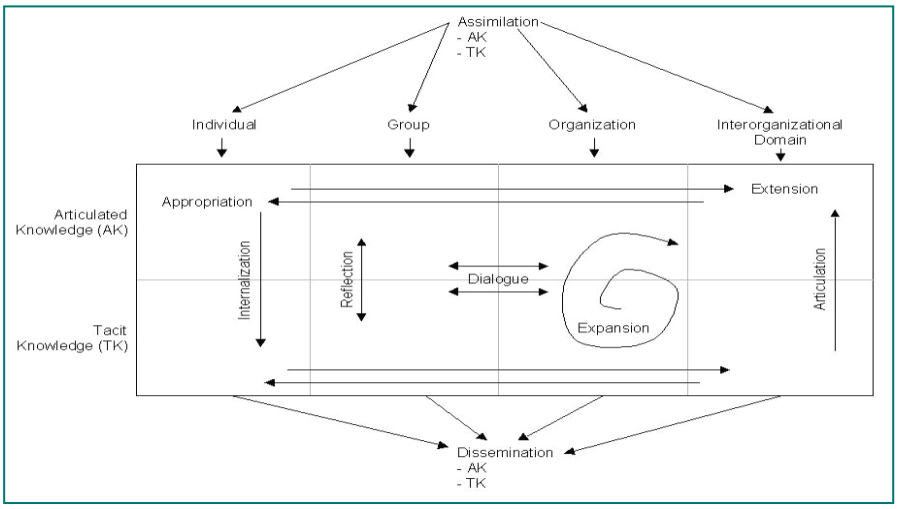

Figure 1. A model of knowledge categories and transformation processes: Types of transfer and transformation
Source: (Hedlund & Nonaka, 1993)

The N-Form Corporations model of Hedlund (1994) closely follow the knowledge categories and transformation processes of Hedlund and Nonaka (1993), but in contrast, suggested that effective knowledge management is required to depart from the logic of hierarchical organization and the M-form structure. Alternatively, Hedlund (1994) proposed the N-form structure (networked form) as more appropriate for effective knowledge management. It entails "combination of knowledge rather than its division, which is the basic principle in the M-form" (p.73). Hedlund (1994) suggest that N-form stands for "New" and "Novelty". The N-form corporation is defined by seven themes (Hedlund, 1994): (1) combining knowledge rather than dividing, (2) temporary groups of people and units rather than permanent structures, (3) the importance of personnel at 'lower' levels in inter-functional, inter-divisional, and international dialogue to handle coordination, (4) lateral communication and dialogue rather than vertical, (5) top management as catalyst of knowledge investment rather than monitor and resource allocator, (6) focusing the corporation for combining knowledge elements rather than diversifying to create semi-independent parts, and (7) Heterarchy as the basic structure rather than hierarchy. Even though the N-Form Corporations model of Hedlund (1994) is developed in the context of large business organizations, it shows the potential to apply in highly complex disaster situations to understand how different types of stakeholders involved in knowledge transfer and what kinds of knowledge transformations are required for the flood response in multi-stakeholder networks. Hence, this article utilizes Hedlund's N-form Corporations model to evaluate the practices of stakeholders in the considered context to recognize barriers and enablers for knowledge transfer during flood response. The next sections of this article discuss the background of the case study and methodological approach.

STUDY BACKGROUND

The Indian Ocean Tsunami which struck Sri Lanka in 2004, killing over 50,000 people, led the Parliament of Sri Lanka to enact a Disaster Management Act (No.13) (SLDMA) in 2005. A DMC was established to implement the functions outlined in SLDMA to ensure the protection of community and environment from further disasters. The DMC lead the strategic planning process for prevention, mitigation, response, and recovery. To unify Disaster Risk Management (DRM) efforts, the DMC charted a comprehensive National DRM Framework (NDRMF) to detect and coordinate multi-stakeholder efforts across the regions of Sri Lanka. The NDRMF is a holistic strategy that is based on Hyogo Framework for Action 2005-2015 and Sendai Framework for Disaster Risk Reduction 2015 – 2030 which covers central government, local government and civil communities (DMC-SL, 2015).

Sri Lanka divides local government into two parallel structures, the provincial councils, and the civil service. There are 9 elected provincial councils across Sri Lanka, which are led by Chief Ministers. The civil service structure is divided into 25 districts; each has an appointed district secretary. Each district has several divisions, with each division also having a divisional secretary. The civil service structure manages the village level with Grama Niladari (Village Officers) and Samurdhi Niladari (Development Officers), who report to the divisional secretary. DRM action plans for each district are based on the NDRMF and aim to strengthen disaster resilience in the civil service structure. These district level DRM action plans recommend that there are disaster stakeholder networks in each district, known as District Disaster Management Coordinating Units (DDMCU).

DDMCUs operate as inter-institutional networks to link district secretariats, divisional secretariats, Grama Niladari, Samurdhi Niladari, DMC, armed forces, and other facilitation institutes (DMC-SL, 2005). The DDMCU has the exclusive responsibility of enacting the DMC's DRM strategies. While DDMCU manages local disasters in local government jurisdictions, community resilience is promoted through village level networks that attend community-based DRM. DMC initiate the development of civil networks, known as Community Based Disaster Management Committees (CBDMC) in villages, which are led by Grama Niladari officers. CBDMCs are comprised of volunteers, village leaders, and community members. These civil networks are expected to lead disaster preparation, response, and relief, while DMC and DDMCU provide guidelines, training and necessary facilities for the establishment and maintenance of CBDMCs.

STUDY LOCATION AND FLOOD EVENTS

This study focused on DDMCU in the Ratnapura district and CBDMC in the Marapana village situated in Palmadulla division. As depicted in Figure 2, the Ratnapura district is located to the southwest and south of the Central Highlands of Sri Lanka. General rainfall records indicate an average annual rainfall of 3,800 mm. The lowlands of Ratnapura include two main river basins, Kalu and Walawe. 'Kalu' (the black river) is the second largest river basin in Sri Lanka, spanning 2766 km2 of the western slope of the central hills (Ampitiyawatta & Guo, 2009), and flows through Ratnapura and Kalutara districts. Both Kalu and Walawe river basins are known to be extremely vulnerable to frequent flooding, and the people of the Palmadulla, Alapatha and Kiriella divisions of the Ratnapura district experience floods every year. The Palmadulla division has recorded significantly intense flooding for many years as geologically it is situated in an ancient floodplain which is comprised of gem-bearing river gravels. Excessive gem mining has worsened the flood situation in this area.

The Ratnapura district has the highest number of flooding incidents in the past decade, with 80 floods occurring between 1999 and 2011 (DMC-SL, 2012). These floods occur during the southwest monsoon (May to June) and the inter-monsoonal season (September to October.) Floods significantly affected Ratnapura in 1913, 1940, 1941, 1989, 2003 and 2016. The 2003 May flood caused 122 deaths, affected 34,473 families and caused damage estimated at 1,140 million Sri Lankan Rupees (Rajapakse, 2007). The 2016 May flood affected 14,031 individuals and damaged 287 homes (Relief Web, 2016). The flood situation is particularly devastating in this area because approximately half of the population live on a floodplain, and despite recurrent floods, residents are reluctant to leave their traditional dwellings.

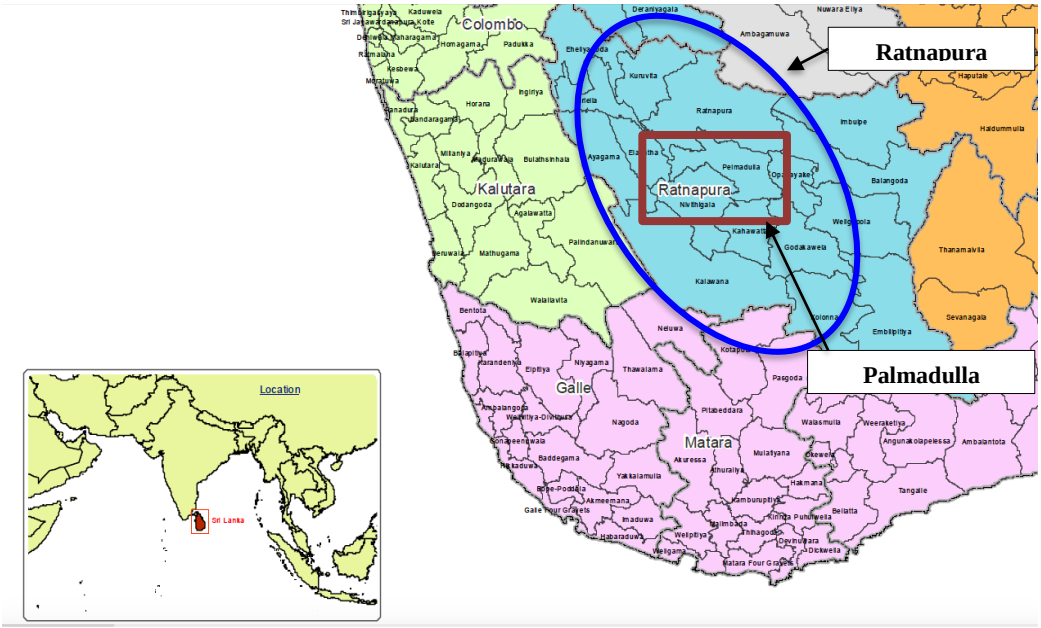

Figure 2. The study location
Adopted from: (Statistics.gov.lk, 2013)

METHODOLOGICAL APPROACH AND DATA COLLECTION METHODS

This study employs the process of Building Theory From Case Study Research proposed by Eisenhardt (1989) as the overarching methodology to study the two exploratory case study units. However, considering the theoretical and methodological complementary of employing Grounded Theory Methods (GTM) to analyze data of interpretive case studies (Andrade, 2009; Urquhart, 1999, 2013), Glaserian strand of GTM (Glaser & Strauss, 1967) was specifically used to drive the analysis. Glaserian strand of GTM is a three-stage process (open, selective and theoretical coding). This research employes only the first two stages of coding to arrive at conclusions and the theoretical coding will be not be discussed in this paper, as this paper is not intended to build theory. While the case study approach of Eisenhardt (1989), helped to provide a systematic procedure to capture a deep understanding of the participants' experiences, vigorous analytical procedures developed in GTM (Glaser & Strauss, 1967) facilitated cross-case analyses of the study themes to recognize enablers and barriers of knowledge transfer.

Initially, as the first step towards the research process, constructs were sparsely recognized to shape the research design referring to extant literature. However, the aim was not to arrive at priori hypotheses or conceptual frameworks. Unlike a pure GTM study, cases were selected earlier in this research in a more planned approach before entering the field to control the extraneous variation and to define the limits for generalizing the findings. The Critical Case Sampling, a strategy for selecting purposeful samples that looks for particularly important cases (Patton, 1990) was used to select the two cases and the participants. The Ratnapura DDMCU and CBDMC of Marapana village of Palmadulla were chosen purposively considering the criticality of the impacts from the recent flood incidents. Participant observation was employed as the primary data collection method. The data collection team was comprised of the lead researcher and two research assistants. This three-member data collection team observed the two disaster drill exercises, having secured the principle agreement from the DMC, and DDMCU of Ratnapura. The ethical considerations were handled under the guidance, and supervision of the relevant official ethics policy and procedures. It was made clear that if participants found videotaping uncomfortable at any stage of the data gathering, the process would be terminated. Before the data collection, the objectives and procedures of the study and confidentiality arrangements were explained to the organizers and the participants of the disaster drill exercises. The names of the participants were kept anonymous to maintain the ethical requirements. The same research team was participated in both exercises as observers to maintain the consistency of data collection and analysis of two case studies. All observers were instructed not to disturb the function of the exercise and behavior of the participants. Further, they were requested to avoid probing questions. Steps were taken to reduce observer bias by ensuring unobtrusive observation by the observers throughout the Case 1 and Case 2. Participants' conversations, non-verbal communications, and other actions were video recorded using two hand-held digital cameras, and they collectively yielded 325 minutes of video footage. The observations focused to obtain a clear understanding of what users actually do, what are their tasks, what is the nature of their tasks, what is the sequence they follow, what obstacles they face, and how participants react in an emergency situation? Hence, videos captured naturally occurring interactions between stakeholders when they plan response tasks during the simulation and recordings were used to reconstruct the details of how stakeholders interpret their own and the others' behaviors according to (Mondada, 2006). Dialogs captured in these recordings were transcribed verbatim and translated from Sinhala (national language of Sri Lanka) to English by the lead researcher to maintain the integrity of data. Similarly, non-verbal interactions, human expression were documented to understand the social activity. While translating expressions and concepts into English, checking and clarifying points with the participants managed linguistic and cultural knowledge specific shortcomings.

A tabletop simulation exercise that was conducted in January 2016, at the district secretariat office of the city of Ratnapura was used to gather data for the Case 1. Eighty-five district level DDMCU members designated for flood response and relief activities in Ratnapura district participated. The DDMCU of Ratnapura district was established in early 2000 and serves as the primary government representative for DRM. The tabletop exercise used an extended flood scenario and hypothesized pre-assigned incident command system duties over three hours. Participants arranged themselves into four steering committees: operations, planning, logistics and finance/admin. Participants were aged between 35 and 55 years, and most were Sri Lankan Sinhalese. All participants held executive positions in the civil service structure. All participants had secondary or tertiary education. Sixty-four percent were men.

The Case 2 was based on a village flood map development exercise executed by the CBDMC of Marapana village of Palmadulla, situated in a high flood zone. The map development exercise was conducted in July 2016 in the Marapana village temple with 32 community leaders appointed by the DDMCU of Ratnapura. The case participants were aged between 35 and 70 years and were all Sinhala Buddhists. About 60% of the participants

were literate and attained junior school education. Eighty percent were women.

DATA ANALYSIS

Understanding the importance of constant stimulation of conceptual ideas in grounded theory analysis process, the lead author of the paper independently examined the entire video footage to understand verbal and non-verbal observations. NVivo for Mac (version 11.4.1) data management tool was used on a Mac OSX platform to assist the coding process by developing a hierarchy of nodes, color codes, and theoretical memos. Nvivo offered the flexibility with modifying nodes and textural snippets to improve conceptualization.

The textural transcripts obtained were repeatedly read with a focus on participants' meanings. The lead author, who participated in the observations conducted the entire data analysis. The constant comparison method of Glaserian GTM (Glaser & Strauss, 1967) was used as the analysis tool for the entire coding process. The lead author enhanced the trustworthiness, analytical rigor, trustworthiness, and credibility of the findings, by engaging a longer time with the coding process, and time-to-time meetings with other researchers to improve reflexivity.

The coding process commenced with the line-by-line coding, and the process developed seventy open codes. Once the analysis reaches a level where no further open codes formed, the open coding stage was ceased, and the selective coding stage commenced. During selective coding, open codes were compared incident-to-incident, and then incidents-to-categories, to recognize categories that naturally emerge from data. A deep inquiry into these open codes raised two interesting issues. First, the participants identified several social links, which facilitate knowledge transfer among them. Hence, two selective codes *Brokerage* and *Closure* emerged. Second, participants frequently discussed the processes and procedures stakeholders use to transfer knowledge to their teams. Hence, a selective code *Knowledge Dynamics* emerged. *Brokerage* collectively refers to open codes that talks about interactions between stakeholders that belong to different groups, whereas *Closure* refers to interactions among stakeholders that belong to a single group. Different procedures and methods that various stakeholders followed to facilitate knowledge transfer during a flood situation collectively referred to the *Knowledge Dynamics* selective code. In this study, the *Brokerage* category is defined as an opportunity available for a certain individual or a group of individuals to access and transfer knowledge with stakeholders belong to other functional hierarchies. *Closure* is defined as an opportunity available for a group of individuals to access and transfer knowledge among acquaintances belong to a certain functional group through strong bonding relationships. *Knowledge Dynamics* is defined as the current and prospective Practices associated with accessing, absorbing and transferring knowledge to achieve disaster management objectives. Table 1 shows the selective codes emerged and the corresponding list of open codes used to arrive at each selective code. The emerged selective codes (i.e. themes) are printed in italics in future references to maintain the integrity of the discussion and analysis. The next section presents the findings of the case study and section is organized according to the three selective codes emerged from the data.

Table 1. Selective Codes and a corresponding list of open codes

Emerged Selective Codes	Open Codes
Brokerage	Follow hierarchy, Top-Down Knowledge flows, Bottom-Up Knowledge flow, Knowledge links with other stakeholders, Middle-Top-Down Knowledge Transfer, Bridging knowledge links, Limited knowledge transfer from top to community, Structural holes, Direct involvement of other stakeholder groups, Type of knowledge passes across, Top-Down knowledge halts, Validated knowledge, Improved predictions, Compensations
Closure	Bonding knowledge links, Experience-based decision making, Familiarity, Instinctive sharing habit, Nature of seeking opinion from others, Personal connections, Confidence, Knowledge repetitions.
Knowledge Dynamics	Delegation of tasks, Dependence on other stakeholders, Gaps in the knowledge flow, Experience-based Decision Making, Familiarity in existing stakeholder network, Hints of articulation, Lack of articulation, Limited knowledge transfer from top to community, Knowledge Transfer Processes, Speed of knowledge transfer, Transition Points, Role delegation, Type of Knowledge that is being transferred, Legal gaps, Criteria changes over time, Deviation of Procedure based on flood intensity, Resilient practices, Seeking for verified knowledge, Impressions of difficulty

FINDINGS AND DISCUSSION

The case study of interest in this study makes a close association with the Hedlund's knowledge management model (HKMM). As anticipated, the concepts of the Hedlund's knowledge management model could be easily compared and contrasted with the practices followed in the case study as both discuss knowledge transfer in network structures. The case study has produced three main finding streams in terms of the three selective codes emerged: (1) *Brokerage*, (2) *Closure* and, (3) *Knowledge Dynamics*. In this section, practices followed by stakeholders of the case study will be critically evaluated to recognize barriers and enablers of knowledge transfer for flood response.

Brokerage is the first category emerged during the data analysis. Data from this category provides evidence for the existence of a hierarchical functional structure, which manifested in disaster management operations for the Ratnapura district. DMC was found at the national level authority for disaster management, and it stands at the top of the hierarchy of authoritative control. The DDMCU operated by the District Secretariat stands at the second level of the hierarchy, followed by Divisional Secretariats. The community stands at the bottom of the pyramid and regarded as the main beneficiary of this system. It was seen that the function of disaster management occurs through passing knowledge in two dimensions: Top-Down and Bottom – Up. Open codes and extracts from transcripts confirmed that these stakeholders follow these hierarchical patterns during knowledge brokerage. These patterns tended to appear as a property of *Brokerage* category, which explains the knowledge transfer function of stakeholders. These findings emerged from the *Brokerage* category can be easily compared with the two concepts Appropriation and Extension of the Hedlund's knowledge management model.

Appropriation (Hedlund & Nonaka, 1993) is the process of transferring knowledge from higher agency levels to lower agency levels. The case study shows this practice by transferring knowledge in the Top – Down functional hierarchy, as when the DDMCU provides warning and evacuation alerts to the divisional secretariats, and then the divisional secretariats pass that knowledge to the relevant village officers and then the message is transferred to the susceptible community. A quote from the assistant director of the planning division of DDMCU clarified that *"messages from Divisional Secretariat to community members, usually passed through dedicated development officers in the divisional secretariat. As we are attached to the District Secretariat, we don't have direct communication with the community. But Divisional Secretary can contact Grama Niladari officers, Grama Niladari passes messages to the community"*. Data indicated that this Functional knowledge that is the knowledge essential for the formal operation of disaster management activities is passed down the line in the exact descending order of functional hierarchy. In other words, Level 1 passes knowledge to Level 2, and then Level 2 passes knowledge to Level 3 given that Level 1 (DMC) is at the top of the hierarchy and level 3 (community) is the lowest. As same as indicated in HKMM, this knowledge transfer pattern follows brokering knowledge in the articulated forms (ex. flood warnings and evacuation alerts through official memos, fax, email, and SMS) as well as tacit forms (ex. meetings, telephone communication, and verbal conversations). The HKMM describes that during appropriation, functional knowledge is transferred in the articulated route and the tacit knowledge transfer indoctrinates them to the DRM practice. The case study indicates that the flood response activities are significantly based on the accuracy and timeliness of functional knowledge arrived in the articulated route and the efficiency of transferring them to disaster responders in tacit modes. The direct knowledge transfer from Level 1 to Level 3 is not seen in the case study. One of the interesting findings of this case study is that stakeholders strictly follow this hierarchy during knowledge transfer from higher authority levels to the lower levels and it is been used to regulate the disaster management functions.

The case study also portrays Bottom-Up knowledge flows from the community to higher authority levels, which is recognized as Extension in the HKMM. Extension is the transfer of knowledge from lower to higher agency levels in the model, in explicit or tacit form. The case study shows similar extension practices in the Bottom-Up functional hierarchy. In other words, Level 3 passes functional knowledge to Level 2, then Level 2 passes functional knowledge to Level 1 given that Level 3 is at the bottom of the hierarchy. One such knowledge transfer route is seen when community passes information about the number of families and people enrolled in a relief camp, and the required facilities and special concerns to higher authority levels. Just as indicated in HKMM, the case study shows that Bottom-Up knowledge transfer requires the transfer of authorized functional knowledge in explicit modes (ex. memos, and fax) to higher authorities for the successful implementation of response activities. Apart from that, the Bottom-Up knowledge transfer is usually entailed in the complex, practical skills employed during the flood response practices by lower authority levels and such knowledge mostly resides in tacit forms. This case study verifies the need for practical dialogue between appropriation and extension for functional disaster knowledge transfer for effective flood response. This case study supports the HKMM's concepts of Appropriation and Extension for the success of knowledge transfer and indicates that the effectiveness of knowledge transfer greatly depends on the extent of Appropriation and Extension in the context. The established structural stakeholder network and the developed functional hierarchies (Top-Down and

Bottom-Up) can be recognized as an important enabling factor for disaster knowledge transfer in this context. The case study provides evidence that; current flood response mechanisms are utilizing functional knowledge transfers between these stakeholder levels in practice. However, the case study also demonstrates that the poorly connected stakeholder levels of this case study have developed significant barrier for the effectiveness of the functional knowledge transfer. One such loophole is found between community and DDMCU staff. As the community's knowledge is mostly in the tacit forms, and the two groups are functionally apart, the current extension mechanisms have shown their inability to transfer community's local and indigenous knowledge to higher authority levels. Similarly, the articulated functional knowledge of higher authorities does not sufficiently reach the lower level agencies or community due to the distance of the stakeholder levels. Hence, this case study recognizes the importance of developing engagement between different stakeholder levels to achieve efficient knowledge transfer.

Even though the HKMM model recognizes knowledge types generally as tacit and articulated knowledge, this case study recognizes that knowledge could be also classified according to the intention of the knowledge transfer. For instance, this case study showcase that the Bottom-Up knowledge flows from the community to higher authority levels can be classified according to their intention: functional knowledge and voluntary knowledge. Functional knowledge is the solicited knowledge essential for the formal operation of disaster management activities flows in descending order of functional hierarchy. In contrast to the solicited knowledge transfer, the voluntary knowledge that is possessed by community members follows a flexible flow of tacit knowledge, which allows the knowledge transfer to deviate from the functional hierarchy. In this study, the voluntary knowledge is defined as unsolicited facts, information, and skills that community members possess and share with other stakeholders. Although the functional knowledge is involved in an interplay between tacit and explicit knowledge, the case study demonstrates that the voluntary knowledge does not involve in such inter-play and remains mostly in tacit forms. HKMM identifies that knowledge is reflected in a context through the process of reflection, which is the interplay of tacit and articulated knowledge is termed reflection. In HKMM, Articulation refers to "tacit knowledge being made explicit, articulated" and Internalization occurs when "articulated knowledge becomes tacit"(Hedlund, 1994, p.76). As Nonaka and Takeuchi (1995) articulated, the genuine knowledge creation occurs through the interplay of tacit knowledge and explicit knowledge. As the voluntary knowledge does not involve articulation, that knowledge will be easily forgotten and lost during the knowledge transfer. Hence, the absence of methods to articulate the community's local and indigenous knowledge (voluntary knowledge) is recognized as one of the prominent barriers in the considered context.

The *Closure* category can be mapped to Articulation and Internalization concepts of HKMM, which is confined into a specific stakeholder group where individuals in the group are functionally homogenous. As Hedlund (1994) described, the interactions of reflection within a specific functional group, allows transformations between tacit and explicit knowledge, which promote knowledge expansion within the group. Findings of the case study appreciate the existence of strong bonding relationships between the close acquaintances within functional groups. Data suggests that these bonding relationships will be stronger if stakeholders are known to each other by sharing some functional experiences before and that support knowledge Internalization (i.e. articulated knowledge becomes tacit), during a disaster situation. It was also seen that stakeholders could develop more confidence when they have previous experience working together. Another important observation is that same knowledge seemed to circulate around the group in the iteration (in HKMM, it is recognized as reflection). Some respondents believed that being exposed to the same knowledge multiple times, sanctions deeper understanding of the situation. However, the findings of this case study also acknowledged that sharing the same knowledge or holding on to the same facts would not stand beneficial unless there is a way to update the knowledge of group members. Hence, it shall be suggested that a functional group will be able to receive certain benefits from closure, only if at least one of its stakeholders has the access to external knowledge sources (i.e. *Brokerage*). The findings of the study and the HKMM are consistent with each other as, both consider that small groups with high bonding relationships often result in innovation and development, as this is the level at which much of knowledge transfer and learning take place. However, this case study additionally suggests that the efficiency of disaster knowledge transfer also required the presence of few brokering agents in these groups who have access to novel knowledge. Findings of this case study recognize that having very strong bonding relationships among the small stakeholder functional groups (i.e. *Closure*) has served as a strong enabler of disaster knowledge transfer. The case study also identifies that DDMCU and the communities (CBDMC) have only a few brokering connections, and the two groups maintain a distant relationship with each other. Hence, this case study indicates a barrier to develop a sufficient dialogue between higher agency levels and community. When natural personals bonds exist among close acquaintances, the case study showed that tacit knowledge transfer occurs intrinsically through personal relationships without the help of special transfer mechanisms or systems. This stands as an important enabler of disaster knowledge transfer resulted from bonding since unwritten or unspoken knowledge that is integral to stakeholders would be transferred to close associates

through experience, intuition, or opinion sharing. Another opportunity opened for stakeholders who have bonding relationships is the intrinsic provision that enables the knowledge to be verified by other close acquaintances. Observations indicate that stakeholder's nature of seeking opinion from peers and providing instantaneous feedback promotes the knowledge transfer function. It was also found that stakeholders also allowed themselves to gain the opportunity to be available for novel knowledge from other stakeholders who have the benefit of special brokering relationships with external stakeholders. Sometimes even when a stakeholder does not have external connections, if any other member has access to external knowledge, it seems that knowledge will get the opportunity to be passed on through bonding relationships.

Knowledge Assimilation and Dissemination, referring to knowledge imports from and exports to the environment in HKMM is analogue to the *Knowledge Dynamics* category. The *Knowledge Dynamics* depicts the practices of stakeholders during flood situations to import and export knowledge to other stakeholders and stakeholder groups. The case study provides such shreds of evidence of stakeholders improvising the existing knowledge to operationalize their disaster management functions and share the function-related knowledge with others (i.e. Dissemination). Findings also indicated that the respondents' *Knowledge Dynamics* included practices of accumulating knowledge from others and use such knowledge to operationalize individuals' (or team's) practices (i.e. Assimilation). Observations of this case study indicated that stakeholders demonstrated a high dependency on other stakeholders (or groups) for the completion of the tasks they are assigned to. Some stakeholders refrained to initiate the tasks that they are assigned to until they receive an outcome or knowledge from another stakeholder. For example, during the tabletop exercise, two members of a certain committee argued, *"According to the plan, we should receive information about the number of camps, their locations, number of victims from the S&R team. They have not sent information yet. How can we carry out our without this information? We have to wait until we receive information. If they delay, our work also gets delayed"*. This high dependency demonstrated some serious shortcomings towards knowledge transfer, including delays in their operations, reduced the efficiency of response and recovery procedures. It was found that some knowledge was repeatedly inserted into their networks; while some other important information was fully disregarded from their knowledge flows. The N-Form Corporations model of Hedlund (i.e. HKMM) criticized that effective knowledge management is required to depart from the logic of hierarchical organization and the M-form structure. Alternatively, Hedlund (1994) proposed the N-form structure (networked form) as more appropriate for effective knowledge management, which demands "combination of knowledge rather than its division" (p.73). As Hedlund (1994) suggested, to establish an effective knowledge transfer the considered context is required to reduce division of knowledge transfer responsibilities and should aim at combining pieces of knowledge. Hedlund (1994) further argued that dividing the complexity into units as independent of each other does not produce much novelty. Hence, dividing stakeholders into separate knowledge units has resulted in a significant barrier towards effective disaster knowledge in this case study.

CONCLUSIONS AND RECOMMENDATIONS

This article aimed at two main objectives: first, to provide insight into how different types of stakeholders involved in disaster knowledge transfer and what kinds of knowledge transformations are required for the flood response; second, to understand how practices of these stakeholders develop barriers or enablers for knowledge transfer during flood response. To achieve these objectives, Hedlund's Knowledge Management Model (abbreviated as HKMM) (Hedlund, 1994) is applied in the considered case study context. It was found that the current practices of disaster stakeholders of the considered context involve in knowledge management practices of Articulation and internalization; Extension and appropriation; Assimilation and dissemination; and Expansion. This case study reflected on the current knowledge transfer practices and recognizes the enablers and barriers to disaster knowledge transfer.

The case study mainly recognized three enablers of disaster knowledge transfer. First, having an established stakeholder network with developed functional hierarchy has enabled the structural basis for the knowledge transfer. Second, having strong bonding relationships among the functional groups has served as a strong enabler of the disaster knowledge transfer. Third, the stakeholders' practices of relying on personal connections fuel the knowledge transfer capability as tacit knowledge is intrinsically transferred through the close associations of experience, intuition, or opinion sharing. The case study recognized three significant barriers for the disaster knowledge transfer. First, it was found that community and DDMCU stakeholder levels are poorly connected and very limited dialogue is demonstrated between the two groups. This distance has developed a significant barrier to allow tacit knowledge extensions between the two groups. Hence, current extension mechanisms have shown their inability to transfer the community's local and indigenous knowledge to higher authority levels. Similarly, the articulated functional knowledge of higher authorities does not sufficiently reach the lower level agencies or community due to the distance between the stakeholder levels. Second, the absence of methods to articulate local operational practices, and indigenous knowledge is recognized. Third,

stakeholders demonstrated a high dependency on other groups for the completion of DRM tasks. This high dependency demonstrated some serious shortcomings towards knowledge transfer, including delays in their operations, reduced the efficiency of response and recovery procedures.

As the Case 1 & 2 have different stakeholders groups, the finding showed differences in their knowledge transfer practices and the use of knowledge and networks during floods. Respondents in Case 1 engaged in functional knowledge transfer in functional hierarchies, but respondents in Case 2 showed voluntary knowledge transfer within the groups they are embedded in. Case 2 showed less *Brokerage* but more *Closure*. Case 1 showed more *Brokerage* but less *Closure.* Case 1 showed a better fit the HKMM, but the findings indicated that efficient *Knowledge Dynamics* require a balance between *Brokerage* and *Closure.*

The findings of this article contribute to disaster knowledge management literature by providing insights into the practical knowledge transferring practices in networked environments. Some of the findings (say barrier 1 and 3, enabler 1 & 3) partly or fully verify the existing literature. Similar to the barrier 1 in the current study, Carlile, and Rebentisch (2003) and King (2005) suggested that the interactions between multiple stakeholders generate complex forms of specialized knowledge that is constantly changing, hence integrating such knowledge remains a challenge. Marincioni's (2007) findings suggested that disseminating disaster knowledge is impacted by the professional cultures of stakeholders. Marincioni's (2007) findings are verified in this paper as this paper identified that high dependent culture of stakeholders (barrier 3) lead into shortcomings of knowledge transfer. The work of Murphy and Jennex (2006) argued that distributed teams that can utilize knowledge efficiently, and this study develops a similar finding indicating that the established distributed stakeholder network enabled the knowledge transfer (enabler 1). Findings of Eriksson (2009) verified that stakeholders discover most of the response patterns from the own earlier experiences. Though it is not the same, Eriksson's finding can be partly validated by this study because enabler 3 of this study proves that knowledge transfer capability improves through experience sharing. Apart from above validations, this paper makes unique contribution to the literature by recognizing that having strong bonding relationships among the functional groups has served as a strong enabler of the disaster knowledge transfer, and the absence of methods to articulate local operational practices, and indigenous knowledge has is turned as one of the main barriers in disaster knowledge transfer. This paper also serves as a validation of the use of HKMM model in the disaster management context.

This research is scoped to a single country, considering only flooding disasters and just focused on two cases. Hence, further research could be suggested in different contexts, for other kinds of disasters, and with other stakeholder levels such as central government to validate these findings. The data analysis in this paper is limited to participant observations during simulation exercises. Hence, future research is suggested to incorporate other data collection methods in triangulation. Another limitation of this research is, it incorporates only the first two stages of GTM. Hence, further research is suggested to continue theory building arrive at a parsimonious theory. This paper proposes the importance of establishing government efforts to develop stakeholder associations between DDMCU and community. Hence, the findings suggest important policy implications for Sri Lanka's DRM authorities, signaling the urgent need to shift the institutional framework to enhance the engagement between public and district level DDMCUs through developing further brokering knowledge connections.

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