Disaster Learning Aid: A Chatbot Centric Approach for Improved Organizational Disaster Resilience

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ABSTRACT

The increasingly frequent occurrence of organizational crises exemplifies the need to strengthen organizational resilience. An example of business organizations is small and medium enterprises (SMEs) which contribute largely to the economic growth. But often, their limited resources (manpower, time, financial capital), organizational structure, focus on operational routines and less priority towards disaster resilience make them more vulnerable to crisis than bigger companies. The proposed solution addresses this dilemma by establishing a collaborative medium within the organization to improve disaster resilience by raising awareness and self-learning in employees without overburdening their constrained routines and resources. Our work in progress demonstrates a conceptual model of a learning aid (collaboration channel and a chatbot) that supports the pedagogical methodologies and employs them for enhancing learnability and awareness and elaborates the usability of interactive learning instilling disaster resilience in employees and hence in an organization.

Keywords

Chatbot, CALS, SMEs, Organizations, Disaster Resilience.

INTRODUCTION

Since the beginning of human existence, knowledge has been a paramount asset and a cardinal vigor behind humans' success. According to the definition provided by Oxford dictionary, knowledge is the collection of facts, information and skills acquired through experience or education. Humans acquire knowledge by learning and remembering, also characterized as an educational process. They transform the acquired knowledge into skills and experience through training and exercise (e. g. OECD, 2006). With the industrial revolution, advancements in technology, new IT infrastructures and the world being transformed into a "global village" (McLuhan and Powers, 1992), education and training have become an even more predominant qualification criteria to excel in business. And this relates to most businesses, e. g. from farming to a big enterprise, and from a retail store to a multi-million-dollar business venture. In this era of knowledge, business organizations are exposed to numerous threats and risks, which can snowball into organizational and existential disasters, if not catered with pertinent measures. Crisis and disasters that affect companies can be of various forms and sources such as manpower shortage, blackouts, cyber-attacks, industrial espionage, accidents, larger economic crises or also natural disasters (Mitroff and Alpasan, 2003, Egner, Schorch and Voss, 2015).

Most organizations fail to prepare for extreme events due to a lack of awareness, but also because of the probability of occurrence of those events (Zsidisin et al., 2005). The lack of adequate preparation exposes organizations to environmental threats that may jeopardize organizational sustainability and individual welfare (Barnett and Pratt, 2000). Preparedness can be invoked in an organization by ensuring organizational learning. Intra-organizational learning equips members with knowledge and skills that are required for positive change. And by fostering a learning culture, the crisis in the organization can shift to a long-term process of stabilizing the organization (Wang, 2008).

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The use of technology for aiding education and training is widely researched in the communities like ISCRAM, computer supported collaborative learning (CSCL), computer supported cooperative work (CSCW), human computer interaction (HCI) and assistive technologies. Computer aided learning software (CALS) have proven to improve the teaching and learning process by providing interactive access to learning material (Abid, Zehra and Iftikhar, 2011). A review of skills acquired during exercises routines indicates that in an agile context like crisis, there is no time for learning while doing, implicating that many of the skills need to be acquired beforehand (Granholm, 2017). The use of a technological tools like virtual training systems (Field, Rankin, Lemmers and Morin, 2012) or simulations (Max, Kluckner and Jentzsch, 2014) are also effective to learn for crisis and to develop skills beforehand. These virtual training systems enable the instructors to configure events around particular training objectives and competencies and helps them to tailor each exercise to the needs of the trainees (Field et al., 2012). This conference paper combines education with training to offer the complete pair, i.e. knowledge and skills to employees in business organizations. We introduce the development of a collaboration channel in business organizations with an assistive learning option for employees using a chatbot. This paper also illustrates the utility of this channel in SMEs as an example for such business organizations, based on the peculiarity of SMEs with respect to other business organizations.

Disaster Learning Aid (DLA) is a work in progress for the development and implementation of an interactive learning medium between the management and employees. The management can start the collaborative process by creating the education and training material in the form of manuals for employees. The employees can learn from these manuals using a chatbot as learning assistant. The interaction with the disaster preparedness information is realized with the question-answering feature of the chatbot and the collaboration channel completes with the management getting feedback from the employees. The research paper initiates the discussion by briefly traversing through the conceptual considerations of the exploration like why SMEs are of interest, where the chatbot could support disaster education and training, how learning about disasters can improve disaster resilience in organizations etc. It is followed by the design implications indicating the conceptual and the detailed architecture of the proposed solution. We close the paper with a short discussion and outline of future work.

CONCEPTUAL CONSIDERATIONS

Peculiarity of SMEs in Crisis Management

Business organizations can be classified as meso, micro, small, medium, and big enterprises. SMEs are peculiar in nature due to simpler organizational structures, limited financial assets and funds, centralized decision making and the high reliability on the expertise of employees to get the job done (Thong and Yap, 1995). A small and medium enterprise is defined as an organization with less than 250 employees and less than a (or equal to) 50 million turnover (European Commission, 2017), while the United States considers SMEs to include firms with fewer than 500 employees (SBA Advocacy, 2018). SMEs own a substantial share in world economy. SMEs constitute 99 percent of all European organizations (European Commission, 2015) and 99.9 percent of all the businesses in United States and 47.5 percent of all the private sector (SBA Advocacy, 2018). These global players or "hidden champions" (Simon, 1996), are very successful, not just on a national level, but also on a global scale and are important due to their extensive economic and innovative performance (European Commission, 2015; Ludwig et al., 2018; Rieckmann et al., 2018). Despite their burgeoning importance, SMEs administer vast distinctions from large organizations, particularly in relation to their peculiar features and limited capabilities (Thong and Yap, 1995). For instance, organizational structures in SMEs are simpler when compared to large organization (Smith, 2007; Thong and Yap, 1995). SMEs are considered disadvantageous when it comes to certain capabilities vis-à-vis large organizations. However, they are oftentimes able to capitalize on their core strengths, expertise, innovation and supply-chain embeddedness to gain a competitive position in the market (May, 2017).

The SME sector is renowned for suffering the most in times of a crisis and are the least prepared of all the organizations (Ingirige et al., 2008). The inspection of the SME sector in UK highlighted that with the ever increasing threat of natural and man-made disasters, SMEs do not hold the resources and technical systems often equated with disaster resilience and there may be a need to become more strategic and proactive in their approach in managing the threat and actuality of extreme events (Sullivan-Taylor and Branicki, 2011). And often, SMEs are not prepared for extreme events such as big fires, longer blackouts or cyber-attacks. Reasons for that are manifold: former rarity of such events, lack of experience with dealing with the growing digitalization of business processes etc., but also due to a lack of an active business continuity plan (Falkner and Hiebl, 2015; Botha and Von Solms 2004; Reuter, 2015; Sullivan-Taylor and Branicki, 2011). The main challenges for crisis management in SMEs are the scarce financial and human resources, management lack of willingness to allocate resources and the hurdles associated with the complexity of carrying out the rescue, relief and rehabilitation activities (Thiel and Thiel, 2010; Thong and Yap, 1995).

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Furthermore, the lack of awareness at management levels (Oomes, 2004), inadequacy of organizational knowledge transfer about extreme events (Blackman et al., 2011) and scarcity of employee awareness and training for different risks (Kaur and Mustafa, 2013) serve as a juror in-crisis and lead to business discontinuity or shut-down in the case of a prolonged crisis. Identification of serious risks, assigning staff to disaster teams, knowing where to get help and training employees are some of the effective steps in coping with disasters (Morton, 2002). The availability and the use of education and training, and the coverage of community-based preparedness are some key factors that can aid in disaster risks reduction (Pelling et al., 2004). DLA aims to provide an effective and usable solution, especially for such business organizations like SMEs which cannot afford extensive education and training routines. Education and training acquired using DLA as a collaborative medium in SMEs will trigger better cooperation, awareness and will encourage self-learning in employees about safety and organizational disaster resilience, which will impact in coordinated efforts to cope with and prepare for unforeseen events.

Learning for Disaster: Employee Awareness and Training

Learning in the context of extreme events needs canny differentiation and elaboration, which cannot and should not come up with simplifications or generalizations (Egner and Schorch, 2015). There will be an ongoing need for innovation and learning to cope with the changing manifestation of disaster risk at the local level (Pelling et al., 2004). Prior research also validates that many employees feel immune to high-consequence, low-probability events, and this feeling is reinforced with each day that passes during which a disaster does not occur (Wood, 2015). So, how can we create a communication channel between management and employees that motivates employees to prepare for the unexpected (Wood, 2015; Kunreuther, 2006)?

In our contribution, we argue for a change of perspective: From a risk-centered perspective that focuses on disturbances and failures in a crisis to a perspective on how preparedness and awareness of crisis can be created through learning, appropriation and training. It is important for socio-technical research to find out whether employees in SMEs have a special situational awareness of crisis situations or if they can be specifically trained. Firstly, it is a question what knowledge about crises should be available to the employees. For instance, first aid, which machines must be switched off in the event of a power failure, or how production can be resumed after a crisis. This knowledge certainly varies from organization to organization, also the business sector plays a significant role. In our contribution, we focus on the acquisition of crisis-specific information and skills by employees in business organizations in general. Moreover, the greater aim is to increase the collaboration across the organizational hierarchy by investment in knowledge and human development, which can prove to be effective in crisis and for organizational resilience.

Disasters do no follow preordained scripts, even in situations where there is extensive disaster experience, those seeking to respond invariably confront unforeseen situations (Tierney, 2014). Currently, SMEs use workshops or trainings to invoke disaster awareness in employees. These exercises are a definite strain on expenses and the limitations of SMEs do not allow them to do more than mere legal obligations in terms of elaborate organizational disaster resilience. The solution realized in this research manuscript illustrates that an interactive communication channel with a chatbot (personal learning assistant) can facilitate self-learning in employees and can support disaster resilience practices in SMEs.

Learning is a complex process that needs and involves communication and interaction, cooperation, feedback, evaluation, participation, reflection, coaching (Kyndt et al., 2009; Collin, 2002; Education Development Center, 1998; Ellström, 2001; Eraut, 1994; Sterck, 2004; Skule, 2004, Egner et al. 2015). The proposed chatbot solution intends to trigger awareness in employees, emphasizing on what to do in a crisis and how employees could deal with risks. The interactive learning assistant will stimulate crisis learning by empowering employees and supporting exploration of knowledge which is crucial in crisis situations.

Personal Learning Assistant

Teaching and learning go hand in hand, one individual's teachings become the other individual's learning. People who need to learn face usually the problem of finding either the appropriate material or the right expert (Pipek and Wulf, 2003). A solution for assisted learning is question-answering systems. Question-answering system are heavily researched in fields like HCI and CSCW. 'Answer Garden' originated in early 90's as a concept in these fields of information science to allows organizations to develop databases of commonly asked questions that grow "organically" as new questions arise and are answered by an expert of knowledge in the loop (Ackerman and Malone, 1990). The concept of 'Answer Garden' grew into expertise recommendation system which locate necessary expertise within an organization to solve a difficult problem (McDonald and Ackerman, 2000), and knowledge sharing systems which make the relevant information retrievable and provide mediating access to people with knowledge (Pipek and Wulf, 2003; Ackerman, Dachtera, Pipek and Wulf, 2013). The practices of knowledge and expertise sharing are also employed in crisis context, from the point of view of the obstacles in

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inter-organizational crisis management, to generate design implications for improvised information and communication technology (Ley et al., 2014).

The ever-increasing advancements in the fields of machine learning and artificial intelligence (AI) have given a new meaning to question-answering systems. At the present time, question-answering systems are not just data base systems with expertise and knowledge sharing capabilities, but they allow user to hold an interactive conversation in natural language. These question-answering systems also referred as chatbots can also be designed to be utilized as personal learning assistants. The use of telegram bot as learning assistant for self-education and remembering concepts resulted that 72 percent students think using a chatbot could help them engage more with the subject to learn (Pereira, 2016). The applicability of a knowledge transfer medium can create a sense of cooperation in SMEs. It will instigate the human development routine in SMEs and will lead to effective relief and rehabilitation operations in case of unforeseen situations. The empirical analysis on United States organizations data illustrated that employees follow step by step procedure, if trained for crisis preparedness, also briefing for crisis was least effective as compared to the computer or media-based crisis training activities (Cloudman et al., 2006).

Sammut and Banerji explicated the human behavior for learning into machine learning concepts and explained that asking questions triggers learning and remembering concepts (Sammut and Banerji, 1986). The work in progress illustrated in this research not only sheds the lights on the need of a training and awareness based collaboration channel in SMEs for employees, but also puts forth the idea of employing a personal learning assistant in the form of a close-domain chatbot or a question/answering system (QA), as a profound and efficacious solution to trigger learning. Chatbots, also known as digital assistants or conversational interfaces, are natural language processing algorithms empowered with intelligence to simulate a human-like conversation. Based on the input of the user, they try to generate responses for engaging users in a dialogue for providing information, executing tasks, or offering services (Dale, 2016; Følstad and Brandtzaeg, 2017; Khan and Das, 2018). A chatbot based question-answering system is not just an interactive user interface but it is equipped with a robust AI-based process to support a meaningful conversation (Piccolo et al., 2018), hence it can help employees learn from the interactions on a subject of crisis.

DESIGN IMPLICATIONS

The system requirements grounded from the literature lay the foundation of the conceptual and detailed architecture of the disaster learning aid (DLA). In order to realize the concept of an interactive learning assistant and for creating a communication channel between the hierarchies in an organization the non-functional requirements like responsiveness, security and usability are also considered. These traits in a chatbot solution develop trust and lead to an improved user experience. The collaboration and communication cycle in DLA start off with the fact that most companies own standard disaster manuals and crisis handling guides to react in case of an emergency. This material is mostly textual and sometimes have pictures to aid understanding of the reader. This disaster preparedness material is often guided by the national, regional or legal policies for businesses often imposed equally for all businesses. Most of these guidelines are adapted to the needs of the respective company, for instance with integrated contact information about emergency managers, local emergency response organizations etc. But they are analog and thereby not that flexible when changes occur or with the unviability of the responsible persons. They are typically adapted and distributed manually; a digital version and aid offers more advantages in this respect.

DLA allows business organizations specially the businesses like SMEs with limited resources to make the disaster preparedness material available for their employees in digital format. Employees can learn from this material by asking questions within a selected manual. DLA also enables a feedback loop from employees to management, which can effectively improve and customize the disaster preparedness material according to the organizations need through iterative cycles. This passive interaction channel promotes collaboration, cooperation and the team building within an organization and hence having positive impacts on disaster resilience.

Conceptual Architecture

The realization of the foregoing conceptual rigor requires establishing a passive communication and knowledge sharing channel between the management and employees. This is conceived by utilizing the distinct features of model-view-controller architectural pattern. The architecture is illustrated at the highest level of abstraction in Figure 1. The application provides well-defined views for the management as well as for the employees. The controller component extends two controllers i.e. the manager-controller which manipulates the data and annotations provided by manager-view to be modeled as crisis corpus and crisis vocabulary into the data store and, the employee-controller which gets the requested crisis learning material (manuals) and sends data to the employee-view for representation. The employee also interacts with the conversational service deployed as a QA

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system. Employee asks questions from the selected and annotated manual, which are sent to the QA system and the extracted answer is modelled back to the employee's view.
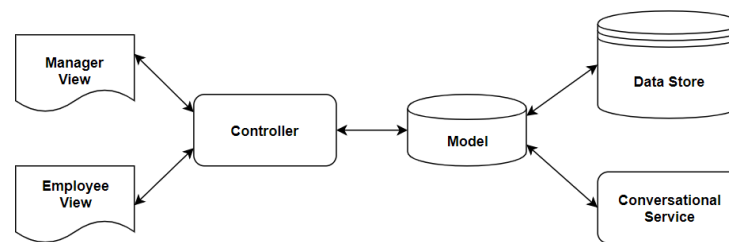

Figure 1. Highest abstraction of the conceptual architecture of DLA

Intricate Design Features with Questing Answering

QA systems have been in research focus for almost over four decades and have resulted in plenty of query and information retrieval techniques involving machine learning, natural language processing and search methodologies etc. Ravichandran et al. (2002) used a simplistic technique to find answer by deploying surface text patterns with question keywords. Corrada-Emmanuel et al. (2003) compared language model approaches to rank the quality of extracted answers from a passage and found that the performance improves by adding additional features into the baseline query likelihood or document likelihood approaches. Prager et al. (2008) presented the bag-of-words retrieval approach for QA where the corpus is annotated with a semantic parser giving named entities, which are indexed along with the keywords from the question /query yielding an answer on keyword search. The approach presented by Bilotto et al. (2007) requires that the corpus has been pre-processed with a semantic parser and a named entity tagger, resulting in text annotations indexed along the named entities and the keywords. It analyzes the question using the semantic parser, mapping the resulting structure into one or more posited answer-bearing structures, which are expressed as sets of constraints on semantic annotations and keywords, and translate directly into structured queries. Chen et al. (2017) used Wikipedia as the unique knowledge source with machine comprehension to identify the answer spans from the retrieved articles using recurrent neural network (RNN), reinstating the belief that the answer to any factoid question is a text span in a Wikipedia article. Toxtli et al. (2018) designed a Taskbot by implementing a model for detecting intents from users' utterances using the Microsoft Language Understanding Intelligent Service (LUIS) and trained the model with a keyword-based vocabulary representing human's intent. Crouse et al. (2018) employed the analogical retrieval and connection subgraph techniques to adapt a domain-general natural language understanding system to answer questions in a new domain. Wu et al. (2018) used word attentions with word context in RNN for text understanding and summarization, which can be key step for validating the information extracted as an answer. We intend to create a hybrid approach by combining the key components of the aforementioned techniques, in order to achieve validated question answering.

Proposed Design Features

Like most of the approaches mentioned above, which focus on producing a specialized conversational agent for a particular domain, we also propose on training an RNN with the crisis corpus, created by the management to train their employees. The crisis documents in the corpus are either uploaded or created manually using a template-based structure which also allows the managers to annotate the documents for crisis vocabulary. Annotating the documents elevate them for rapid information retrieval through search. Managers also list the example questions for every specific crisis document which are to be used to train the RNN. Employee has two modes for learning from the material produced by the management, either by skimming through the manual on a certain topic or by selecting a manual and asking questions to learn. When using the learning mode, employee has an opportunity to tag and annotate the article; therefore, creating remindful pointers for his memory. This action also contributes to the crisis vocabulary and helps elevate the crisis corpus.

If the employee wants to ask and learn, s/he will submit a question which will be treated in two ways by the system. On one hand the trained RNN will be tested by the question which will retrieve answer spans as answer predictions from the text manual. On the other hand, the question will be treated with natural language techniques for named entity recognition and relation extraction. The extracted keywords will formulate a search query, which will be processed by keyword search to retrieve answer passages. The two answers form RNN and keyword search respectively will be compared for contextual validation, and the highly ranked answer will be returned to the employee. This passive interaction cycle takes it full course as employee can identify ambiguities in the learning material and send feedback, to be resolved by management. Management can address the ambiguities in the

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learning material by updating and improving them for enhanced learning. This interactive cycle can also be seen as measure for learning and acquired disaster resilience can be indirectly gauged using this and other metrics. The illustration of the whole process can be seen in Figure 2.
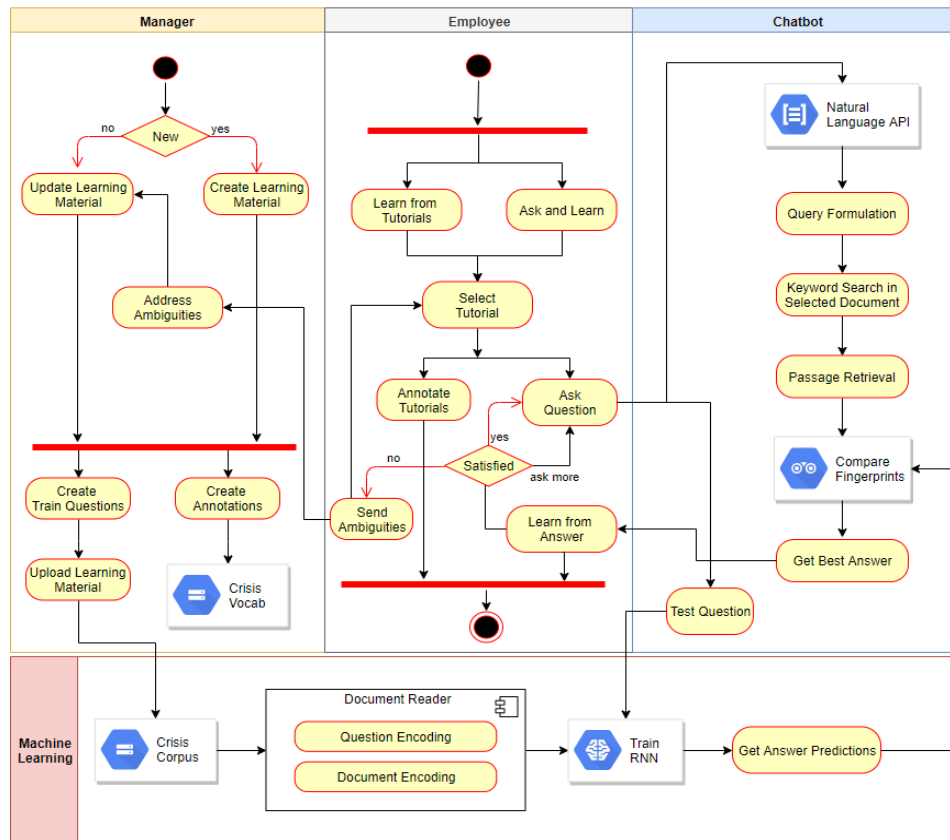

Figure 2. Detailed design and activity diagram with key processes of the proposed design architecture

PROTOTYPICAL IMPLEMENTATION

The working prototype of the proposed solution is realized with AngularJS for employee and manager views of the prototype, Java spring boot framework is used to implement the model and the controller classes, and Rivescript implement the chatbot service. The database is realized with MongoDB. The controller classes handle the respective request from the employee and the manager. The model classes receive the requests from the controllers for the manipulation of database or chatbot service. The model classes will update the respective views after the execution of request from the controllers. The work in progress is implemented till a proof of concept of the proposed approach. This includes interactive views for manager and employee with back end functionality including data base as crisis corpus with create, read, update and delete (CRUD) operations. The rivescript chatbot service is also implemented till a proof of concept level which includes more static question-answering by keyword search within a selected manual with static encoding. The future implementation of the chatbot service includes elevation of crisis corpus and creation of crisis vocab with the annotated keywords, implementation of named entity recognition and relation extraction for the enrichment of crisis corpus, creation of document and sentence level encoding for search and training the RNN with a larger cross validation ratio of crisis corpus.

Figure 3 demonstrates the manager's view, where s/he can create the manual (or upload existing material), annotate the manual, specify keywords, update the manual (edit, delete, improve etc.) and add other relevant learning material. Manager can see the list of created or uploaded manuals from which s/he can click and expand to work on. Figure 3 shows the selected manual with CRUD features.
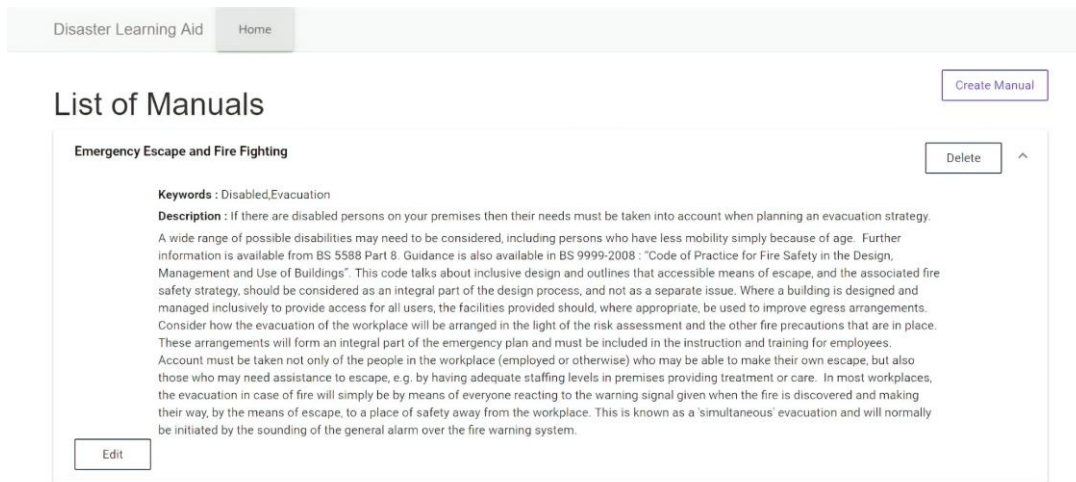
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Figure 3. Manager's view for creating and updating crisis manuals

Figure 4 represents the simplistic view for employees. An employee can select a topic to learn from a list of topics offered by the management as disaster preparedness manuals. S/he can use this platform to just read it, create remindful pointers for recall by annotating the document, or S/he can interact with the chatbot to learn by asking question and having an interactive discussion within the document with a personal learning assistant.
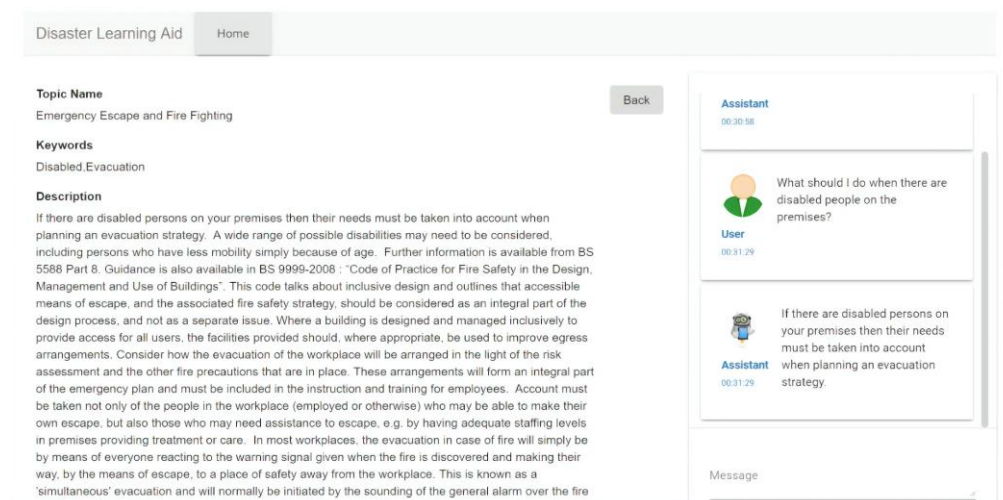

Figure 4. Employee's view for reading and learning with chatbot

DISCUSSION

In our contribution, we highlight two concerns of business organizations that directly and indirectly hinder disaster preparedness and capacity development for an effective crisis management. Firstly, business organizations heavily rely on top-down managerial hierarchy, where strategies are implemented and conveyed to employees without a procedural feedback mechanism. These strategies also include the strategies to cope with crisis. But dealing with a crisis requires collaboration, cooperation, and coordinated articulation of work. These essentials are hardly achievable in strict top-down mechanism and leaves little to no room for the involvement of employees at lowest hierarchical level. In contradistinction to the tools and technologies developed for the disaster training and education, DLA instigates a collaborative channel within an organization. This collaborative channel invokes employee involvement and the feedback mechanism highlights areas which need to be customized to adapt for employees' specifications.. Secondly, when it comes to preparing the employees for effective crisis response, training and education material is created in business organizations. This training and education material is provided to the employees with introductory workshops or training sessions. SMEs are among those business organizations which cannot afford extensive training routines and learning sessions. So, DLA develops a self-

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learning mechanism for employees by making the learning material accessible to employees and a QA based chatbot system supports the employees' learning in an interactive manner. When combined together in the form of a technological aid, these two traits can lead to better disaster preparedness. Furthermore, the feedback mechanism in the form of a collaboration channel instills confidence and security in employees. These merits replicate better communication and coordination not just for crisis, but also in daily routines.

CONCLUSION AND FUTURE WORK

Our paper represents a work in progress to articulate a passive communication channel between management and employees, in order to assist and expedite the employee training and awareness process from crisis management perspectives. The near future objectives of our work include realizing the complete conceptual methodology with trained RNN on enhanced corpus and Keyword-search optimization. We will explore the contextual validation to a step further by utilizing the techniques like TF-IDF matching and other text similarity algorithms like Jaccard similarity and cosine similarity etc. Furthermore, we plan to test it with regional SMEs in order to analyze the practical impacts of such a communication channel and learning assistant. So far, this research revolves around the close-domain QA. It will have to be tested in a more open-domain question answering context and also to analyze the effect of personal assistants for raising awareness in the fields of medical and education.

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