Volunteer Reputation Evaluation for Emergency Response Operations

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Abstract— **Natural and man-made disasters are constantly occurring leading to human casualties, infrastructure destruction and financial losses. Volunteers and volunteer organizations play a significant role in each and every phase of disaster management. Therefore, selecting and retaining skilled, motivated and able volunteers becomes important. Existing ICT based solutions focus on resource allocation, team work and other disaster management activities, however none of these systems has addressed the issue of volunteers and their reputation. Reputation of a volunteer based on his personal traits and experience can be used for his selection for an emergency operation. It can also be used as a performance measurement tool during a particular operation. The current work proposes a reputation management system consisting of a Reputation Meta-model and a reputation system architecture for reputation management and measurement.**

Keywords— *Disaster; Emergency Management; Volunteer Management; reputation; reputation management*

I. INTRODUCTION

The vulnerability of planet earth to natural disasters proves a great challenge to relief organizations and the responsible authorities. These relief organizations need effective disaster management techniques to mitigate the effects of the disaster. Volunteers play a vital role in different stages of disaster management. In mitigation and preparedness which are the initial phases of disaster management they provide awareness to the communities and information collection helping in effective disaster planning. In the later phases which are response, relief and recovery volunteers contribute by disseminating aid, supplies and funds to the communities in need of help.

For effective management the interested stakeholders are always coming up with new and innovative solutions to manage the disaster situation easily. Information & Communication Technology (ICT) based solution like OASIS emergency management and Sahana have been developed for better collaboration and coordination, resource sharing and volunteer management [1, 2]. The use of these open source systems by different countries round the globe has proven the successfulness of these systems. However, due to very complex and dynamic nature of disaster and emergency situation, constant development and improvement in methodologies, tools and technology is required.

Volunteers play a significant role, in taking part in relief operations and being a part of volunteer organizations the issue of credibility and trustworthiness is still there. There still lies the need for a system that should measure the performance of a volunteer who is working with an organization to establish trust in volunteering activities and community. Reputation of an individual is an important indicator in order to build trust. Sabeen *et al* has used reputation as an indicator, for efficient selection of teams in disaster management [3]. Moreover, in online communities (like eBay, Facebook), the interaction between people and their relationships is also dependent on reputation. This serves as our motivation to study and explore various factors affecting reputation of a volunteer so that the decision on his involvement in future operations by an origination can be taken effectively. Moreover, the reputation management approach can be used to measure the performance of individual volunteer during and after a particular disaster management activity.

In this work, we propose a reputation management system, which is based on a framework which consists of important factors (like competence, feedback and experience) which directly impact the reputation of a volunteer. This work could be easily applicable in volunteer management systems or

performance evaluation systems being used by various organisations in order to build trust.

Rest of this paper is divided into three main sections. The section II presents the existing work in the domain of reputation management and disaster management. In section III the proposed framework is explained and section IV concludes the work presented and set future directions.

II. BACKGROUND

Disasters are unpredictable and unforeseeable which can bring upon chaos in the affected area. Indian Ocean Tsunami of 2004, Pakistan's 2005 earthquake, and China's 2008 earthquake are some of the examples of recent disasters. The death toll of about 166,197 people in these major recent disaster has been reported other than the injuries, financial and infrastructure losses [2, 3]. Dealing with such kind of disasters requires humanitarian relief as well as financial support depending upon the scale of the disaster.

To handle a crisis situation different disaster management phases have been defined which are mitigation, preparedness, response and recovery. Volunteers play a significant role in each and every phase of disaster management. Different ICT tools have been developed to facilitate efficient disaster management. SAHANA and OASIS are examples of such tools. SAHANA is free and open source software (FOSS) for disaster management. A flexible component based approach makes it easily adaptable for various organizations' needs [6]. It consists of different modules and API's such as organization registry, missing person's registry, request management system, inventory management system, synchronization module, messaging module and volunteer coordination module [4]. Different relief organizations such International Federation of Red Cross (IFRC), Taiwan Project at Academia Sinica and City of New York's office of emergency management have successfully been benefiting from SAHANA. It has been used in disaster situations in Pakistan, Venezsuela, China, SriLanka, Japan, Haiti and Bangladesh in different disaster response activities [5, 6]. OASIS; a European funded project was developed to create situational awareness through effective decision making, ease of communication and resource sharing in a crisis situation [2]. For such purposes three modules have been developed in OASIS which are an IT Framework, Operational tools and Tactical Situation Objects (TSO) [8][9].

As disaster management is a tedious and a multi faceted task, it requires collaboration of multiple organizations and the formation of teams for efficient decision making. Members of these teams can be selected based on their reputation managed by a reputation management system [3]. Hasan defines reputation system as a system that computes or calculates the reputation of an entity based on the feedback of other fellow entities [10].The proposed approach consists of a reputation meta-model, reputation indicator matrix, services and information exchange mechanism and a computational algorithm to calculate the reputation of a partner before formation for a disaster management team [3].

Reputation is an important factor in order to build trust. In disaster management, trust and reputation plays an important role because positive reputation of an entity can build strong coordination and collaboration of volunteers with organizations. This is the reason for our consideration of online/Web reputation management systems.

Web based reputation systems have become an integral part of various online and social communities. Wang *et al* in [11] have analyzed the existing online reputation systems and categorized them in to three levels which are centralized vs. distributed, personal vs. resource and global vs. personalized. Audun *et al* in [12] have given an overview of the existing reputation systems and discussed reputation computation engines which provide the basis of reputation calculation of an entity in the online community.

In a disaster situation trust is a very important factor which should be taken into consideration. Well reputed volunteers can be a valuable asset for various NGOs, relief organizations and government agencies. However, identification of relevant criteria that define reputation of a volunteer, calculation method of a reputation score, and an information management system to collect, calculate and store the relevant information for disaster situations is not available. Our proposed volunteer reputation system tries to fill this gap, details of which are further discussed in the next section.

III. REPUTATION FRAMEWORK

This work focuses on the reputation management of volunteers that participate in different phases of disaster management. It would cater to volunteers who work with relief organizations regularly which are considered *affiliated volunteers* as well as the *unaffiliated volunteers* which are not able to offer their time regularly. Many relief organizations work with volunteers which include: The United Nations International Strategy for Disaster Reduction (UNIDSR) , Federal Emergency Management Agency (FEMA) of the US, Asian Disaster Reduction Center (ADRC),National Emergency Management Agency (NEMA) of the US, United Nation Volunteers (UNV) , Florida Association for Volunteers Florida Voluntary organization Active in Disaster (FLVOAD),All Hands Volunteers, National Volunteer Organizations Active in Disaster(NVOAD), Program for Enhancement of Emergency Response (PEERS), National Incident Management System (NIMS) and the International Federation of Red Cross(IFRC). The official reports and guidelines of these organizations have been considered for identifying various factors that affect reputation of a volunteer.

Through the identification of factors of the framework the reputation of the volunteer can be calculated, managed and maintained. The proposed reputation framework is divided into four main components 1)Reputation meta-model , 2)Causal loop diagram (CLD) and System Dynamics reputation model 3) Computational Algorithm and 4) Service Oriented Architecture of the reputation system. The reputation meta-model consists of important reputation indicators that can be helpful in measuring the reputation of a volunteer. The causal loop diagram of the framework helps us understand the causal relationship between various factors and see a holistic system level picture of reputation. The Computational algorithms elaborate the process of reputation score calculation. Fourth component which is the service oriented architecture defines web services for the information gathering with respect to the volunteers and the computation of the reputation score.

However, this paper will focus on the first 3 aspects of the reputation framework. 4th aspect a SOA based ICT solution and a System Dynamics model is under development.

A. Reputation Meta Model

The reputation meta-model is divided into five categories which help build the reputation score of the volunteer. The categories of the reputation meta-model are feedback, skills, motivation, volunteer experience and competence. Each of these categories consists of sub-categories and sub factors. Fig. 1 presents the Reputation meta-model for volunteers. The description of each category and factor is given below.

Feedback describes various stakeholders' perception about a particular volunteer based on their interaction and performance of the volunteer. Important sources of feedback are donors, affected population, communities and media. Such feedback is also important in better judgment as mentioned in

volunteer task assignment they closely work with affected communities, disaster management agencies, and other volunteer organizations, so the assessment report of these agencies (DMA Reports) can be very useful in such an assessment.

Skills have been considered as another important reputation factor. A skilled volunteer will have better performance and would build better reputation. This particular category consists of factors such as problem solving skills, communication skills, time management skills, problem solving skills and leadership skills. Our motivation to include these factors comes from American 4H youth program that has proposed a set of "core competencies" for volunteers [17] .

The third category proposed in our meta-model is *motivation*. Volunteering is an act where a person contributes his time and energy for charitable purposes so the motivation behind volunteering plays a vital role in measuring the
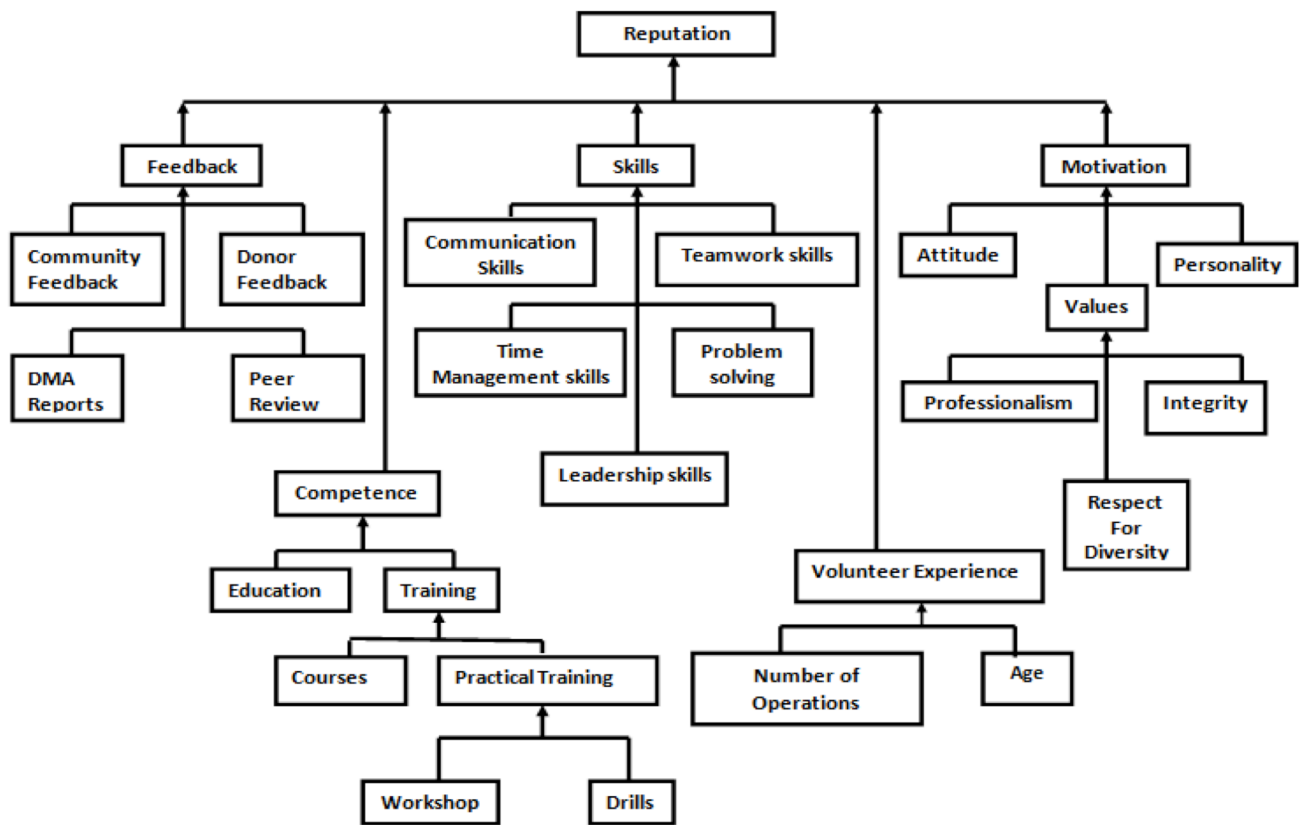

Fig. 1. Meta-Model for Reputation Management

[13], [14],[15]. This category consists of factors such as community feedback, peer reviews, donor feedback and DMA reports. *Community feedback* is collected from the people that are affected by the disaster and have a direct interaction with the volunteer. *Donor feedback* is the feedback collected from the donor organizations covering operational, managerial and personal traits of the volunteer. *Peer reviews* play a vital role as discussed in [16], as through peer ratings, evaluations we can have a better picture of the volunteer's performance in the work place and their attitude towards their peers. During

performance of the volunteer which in turn builds his reputation. The motivation of the volunteer can be judged various factors including attitude; it describes a person's viewpoint or perspective towards a situation or the environment. A volunteer's attitude is vital in determining his motivation as highlighted in [18]. The personality of an individual depicts the attributes to characterize an individual. It has been mentioned in [18] that it is very important in determining the motivation behind volunteering. A volunteer working with an organization is said to have a good reputation

if he has a set of good *values*, with the help of which he would be able to make good decisions and would be able to distinguish between right and wrong choices. Values should be a key part of the United Nation's personnel involved in various humanitarian activities. UN's core set of competencies also point out that values of an individual are dependent on the attributes such as professionalism, respect for diversity and integrity [16].

Fourth important category in the proposed reputation meta-model is *competence*. The competence of an individual can be determined by other underlying factors such as education and training. A well-educated volunteer can make better and informed judgments and in the situation of turmoil and stress can also help his team and affected people in a better way. Training is very important for a volunteer to be competent as mentioned in [19], [20]. UNISR, NEMA, FEMA, IFCR, NIMS and PEERS offer courses and workshops to enhance competence of volunteers and people involved in various disaster activities. Exercises and drills are important training activities to enhance the handout and practical skills of volunteers. Training also improves the problem solving and managerial capabilities of volunteers.

Fifth category in our framework deals with the volunteer's *experience*. Volunteer experience in the field or with the organizations is considered very important in determining the reputation of the volunteer. As reputation is built on past experiences of peers, performance and continues improvement on skills and competencies, it is important to link the new reputation score with the previous one. Therefore, if a volunteer has participated in more operations he will be more experienced. Similarly age can also be an important factor. However, it is debatable whether a younger volunteer will be more preferable due to their juvinility, youthfulness or a mature volunteer can contribute more due to experience and already built reputation.

B. Causal Loop Diagram:
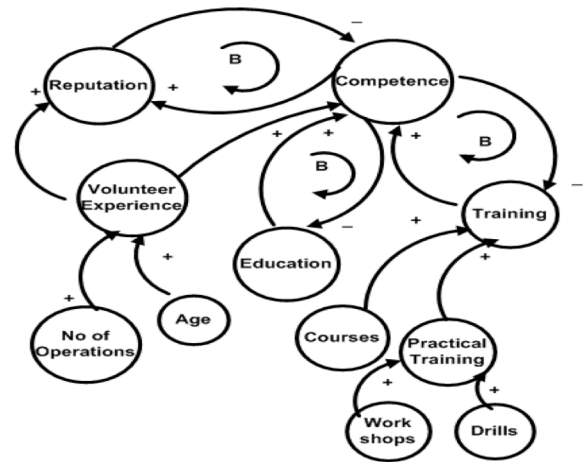Causal loop diagram explains the cause and effect relationship

Fig. 3. Causal Loop Diagram of reputation and volunteer competence

between the factors that have been mentioned in the framework and reputation. Although, various factors have been identified in our framework, it is important to see a holistic view of the system and identify how various factors come into play and effect each other. It is also interesting to unearth any causal loop relationships that exist between various factors. Further details are discussed below.

1) Relationship between Reputation and Feedback
Fig. 2 shows that feedback and reputation have a re-enforcing loop, which means that the reputation of a volunteer would increase with positive feedback from various stakeholders. Moreover, existing or previous reputation also influences the feedback provided by other people specially peers. Therefore, a reinforcing loop can be seen from the diagram.
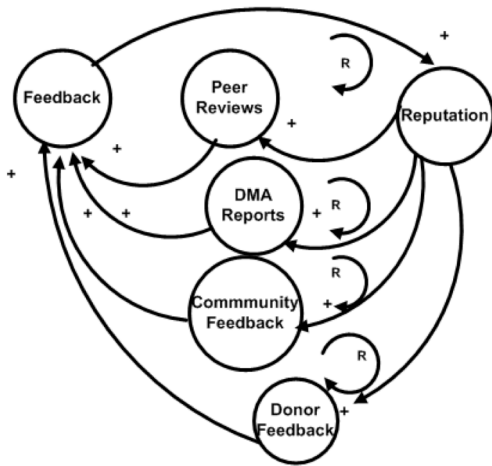

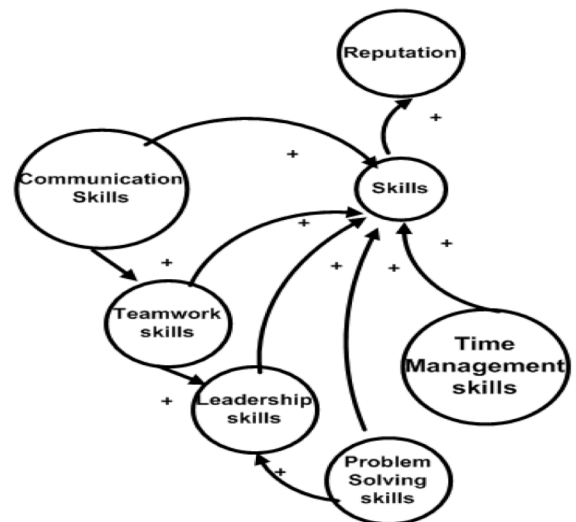Fig. 2. Causal Loop Diagram of reputation and feedback

Fig. 4. Causal Loop Diagram of reputation and skills

2) Relationship between Reputation and Competence

Fig. 3 illustrates relationship between various factors affecting competence and its impact on reputation. There is a balancing loop between the competence and the reputation, which means that as the competence of a volunteer increases his reputation increases. When a volunteer has good reputation then he would need less effort to improve his competence. Therefore, with increased competence efforts for further improvement of education and getting training also reduces.
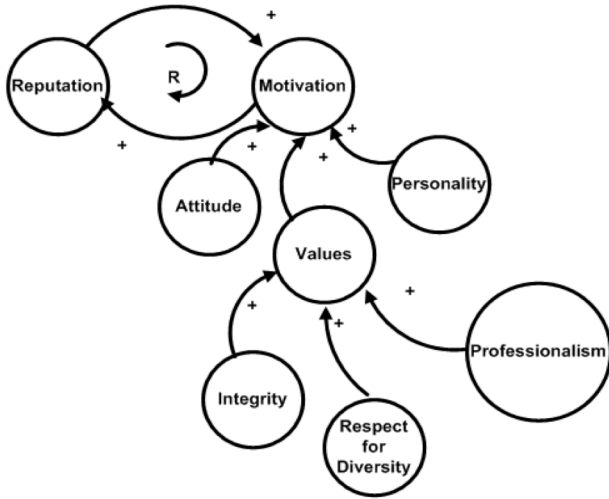

Fig.5. Causal Loop Diagram of reputation and motivation

3) Relationship between Reputation and Skills

Fig. 4 illustrates the relationship between the volunteer skills and his reputation. If volunteer has good skills then he would build a good reputation. Skills comprise of communication, teamw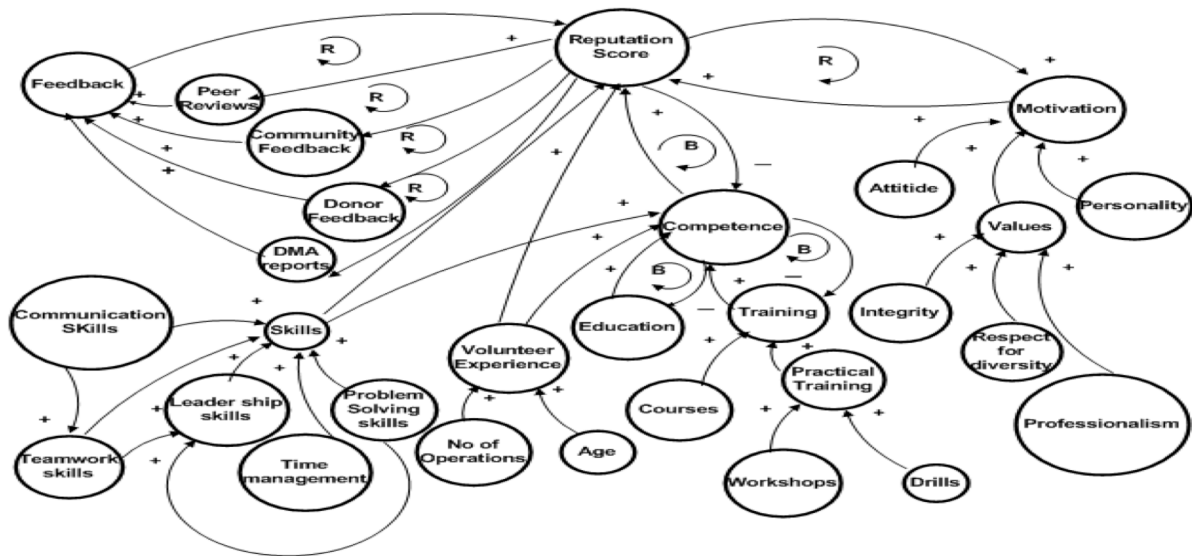ork, leadership, problem solving and time management skills. If a volunteer has good communication skills then they would help increase his teamwork skills, increase in teamwork skills and problem solving skills would in turn increase his leadership skills.

4) Relationship between Reputation and Motivation

Fig. 5 illustrates that motivation and reputation form a re-enforcing loop means that if the reputation of the volunteer increase then it would in turn also increase his motivation to excel. The motivation of the volunteer is also dependent on factors like attitude, values and personality.

Fig. 6 illustrates the combined causal loop diagram of the above mentioned factors.

C. Computational Algorithm

Different mathematical techniques have been devised for decision support systems. These techniques have been used by various existing online reputation management systems. Some of these techniques are based on the Sum and Mean Model, Bayesian network model, Belief models and Fuzzy models [12]. Our algorithm to calculate the reputation score is based on Sum and Mean Model. Steps involved in this algorithm are as follows:

1. Get the weight assigned w_n to each major category n.

2. Get the degree of satisfaction or the evaluation score of each factor f belonging to category n.

3. Get the mean score μ_n for each category n.

4. Then calculate the weighted score for each category n using the following formula:

$$P(f_n) = w_n\,\mu_n \qquad (1)$$

Where w_n is weight (relative importance) assigned to each major category and μ_n is mean value of the assigned score to all factors in this category.

5. After calculating the reputation value of each category

Fig. 6. Overall System CLD

separately, to aggregate the reputation value add up the values using the formula given below:

$$Reputation\ Score = \sum f_n \qquad (2)$$

6. Normalize the reputation score value using z normal distribution.

D. Application Scenario

This section shown the application of reputation calculation algorithm. This scenario shows how a particular volunteer *v1* can be given a particular score based on its performance in a particular operation. The individual scores assigned for factors like feedback, skills and motivation at a scale of 10 are given in table I.

TABLE I.   SCORE RANGES FOR DEGREE OF SATISFACTION

Range	Assigned Score		
	Feedback	Skills	Motivation
Excellent	5	5	5
Very Good	4	4	4
Average	3	3	3
Below Average	2	2	2
Unsatisfactory	1	1	1

Table II shows the score range for level of competence shown by a particular volunteer. A volunteer can be assigned the score based on this table. However, it is important to mention here that, these ranges can be adjusted based on an organization's preferences.

TABLE II.   SCORE RANGES FOR COMPETENCE & EXPERIENCE

Competence	
Workshops/drills/courses	
Range	Score
No Participation	0
Moderate Participation	3
Active Participation	5
Education	
Range	Score
Illiterate	0
Primary education	2
Secondary Education	3
College/University Education	5
Volunteer Experience	
Age	
Range	Score
Age <19	2
Age <25	3
35<Age<45	4
Age>50	5

Table III shows the user assigned weights (w_n) for each major category *n*. Assume that this is the first time this volunteer is participating in the operation, the organization will be focusing more on the competence and motivation of the volunteer rather than the previous feedback or relevant skills. The score earned for each factor affecting a particular category are also shown in the table. μ_n presents the mean score for each category. For example the mean score of feedback is 4.25 as shown in table III. Finally f_n presents the weighted score for each category. Here it can be seen as 8.5 for the feedback. The overall reputation score is the sum value of weighted scores f_n

for each category. This reputation score is treated as an accumulator where every time reputation is calculated it will be added to the previous value. In case of negative reputation, this calculated value will be subtracted from the previous reputation score.

IV. CONCLUSION

Role of volunteers cannot be ignored during a disaster situation. Volunteers play an important rule during preparedness, rescue, relief and rehabilitation process. However, trust between the organizations and their volunteers can be enhanced if the reputation can be measured and managed effectively. A conceptual model to understand reputation as an important trust parameter is proposed in this paper. Moreover, an insight into how various factors can affect each other and reputation has been gained using CLDs. Our research is underway to understand a holistic view of reputation by using System Dynamics models. Moreover, it is also important to identify and develop ways and means through which information can be gathered and stored that helps in measuring reputation of volunteers.

TABLE III.   REPUTATION SCORE FOR A PARTICULAR VOLUNTEER

Weights (w_n)		Sub-factor	Score	μ_n	f_n
Feedback	2	Community feedback	3	4.25	8.5
		Peer Review	4		
		DMA Report	5		
		Donor Feedback	5		
Skills	3	Communication Skills	4	3.4	10.2
		Teamwork skills	3		
		Time Management skills	4		
		Problem Solving skills	4		
		Leadership skills	2		
Volunteer Experience	10	Number Of Operations=0	0	1.5	15
		Age (Age<25C)	3		
Competence	10	Education(Primary)	2	2.5	25
		Courses	0		
		Workshops (2)	3		
		Drills (5)	5		
Motivation	8	Attitude	7	6.6	52.8
		Professionalism	8		
		Integrity	4		
		Respect for Diversity	7		
		Personality	7		
			Reputation Score		111.5

Our future work focuses on a deeper understanding of various factors on reputation and its impact back on these factors using System Dynamics modelling. Moreover, we will also develop a Service Oriented Architecture (SOA) for Volunteer Reputation Management so that effective volunteers can be engaged by the concerned agencies and organizations. This will also be used as a formal and systematic way of

performance measurement of volunteers involved in various activities.

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