MODELLING AND ANALYSIS OF INFORMATION TECHNOLOGY ISSUES IN HUMANITARIAN SUPPLY CHAIN MANAGEMENT

Ph. D. Thesis

by

GAURAV KABRA

DEPARTMENT OF MANAGEMENT STUDIES
INDIAN INSTITUTE OF TECHNOLOGY ROORKEE
ROORKEE – 247667 (INDIA)
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A THESIS

Submitted in partial fulfilment of the requirements for the award of the degree of

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ROORKEE

CANDIDATE'S DECLARATION

I hereby certify that the work which is being presented in the thesis entitled "**MODELLING AND ANALYSIS OF INFORMATION TECHNOLOGY ISSUES IN HUMANITARIAN SUPPLY CHAIN MANAGEMENT"** in partial fulfilment of the requirements for the award of the Degree of Doctor of Philosophy and submitted in the Department of Management Studies of the Indian Institute of Technology Roorkee, Roorkee, is an authentic record of my own work carried out during a period from January, 2013 to April, 2016 under the supervision of *Dr. A. Ramesh*, Assistant Professor, Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee.

The matter presented in this thesis has not been submitted by me for the award of any other degree of this or any other Institute.

(GAURAV KABRA)

This is to certify that the above statement made by the candidate is correct to the best of my knowledge.

(A. Ramesh)
Supervisor

Date:

Abstract

The steadily growing number of disasters and its severe impact throughout the world are calling for a more efficient and effective handling of disaster relief operations. The need for a systematic disaster response process is an increasing concern for both the practitioners on the ground and the academicians involved in this field of study. Hence, humanitarian supply chain management (HSCM) that become visible immediately after the occurrence of disaster, is a prevalent and widely studied research topic.

The recent disasters such as disaster that occurred in Uttarakhand (a Northern state in India) reveal that the existing preparedness is less than satisfactory and particularly, in emerging economics like India, such preparedness require high priority. In particular, India is prone to natural disasters and is one of the most disasters prone country in the world due to its unique geo-climatic condition. Consequently, the research presented in this thesis addresses what is argued to be the under-representation on the management of the relief supply chain. The low use of information technology (IT) in the HSCM was among the issues criticized by most of the keynote speakers during several international conferences such as "**International Conference on Humanitarian Logistics (ICHL, 2013)**" held at Indian Institute of Management Raipur, India during December 2-3, 2013.

The utilization of IT have proved to be one of the success driver in commercial supply chain management (CSCM); and the adoption of IT in HSCM has been promoted as a "silver bullet" in many areas of disaster relief supply chain. Despite the fact that India is the well-known IT hub, the utilization of IT inherent within CSCM have not been observed in the HSCM and is still a major concern. Therefore, this research is aimed at examining the supply chain management (SCM) practices; particularly in the Indian context with reference to utilization of IT by stakeholders involved in the disaster relief operations. Subsequently, the research presented here answers the following question that why should and how could the stakeholders effectively improve the utilization of IT in the area of HSCM?

Through a combination of qualitative and quantitative research, the research draws on the results of research contributions on the utilization of IT in the relief operations, as well as on insights arising from the case study on the disaster that occurred in the Uttarakhand (a Northern state in India) on June 14, 2013. A study was carried out to review the available literature on HSCM which helped in encapsulating various research outcomes in a structures manner, and issues related to conceptual frameworks, empirical studies, field and case studies, etc. were bought out. This research bridges some of the gaps in the contemporary research.

The research analyze various factors related to the utilization of IT in humanitarian supply chain (HSC) within Indian context. Firstly, 25 factors that hamper the utilization of IT were identified through comprehensive literature review and were empirically verified through middle level managers involved in past relief operations that occurred in India. Thereafter, the factors were

prioritized using fuzzy Analytic hierarchy process (AHP). Secondly, 19 solutions to overcome the factors affecting the maximum utilization of IT were proposed and empirically verified through the experts of HSCM. Further, these solutions are prioritized using fuzzy Technique for order performance by similarity to ideal solution (TOPSIS); that considers the ambiguity, uncertainty and impreciseness rather than a crisp value. The result indicate that the stakeholders of HSC should plan strategically to utilize the advantages of IT in the coming years. There is strong need to pay special attention to providing adequate training and support to the organizations for adopting the IT in HSC. The plan should be aligned with their goals as they have limited resources in terms of capital, time and human resources.

Furthermore, the research presented here, empirically investigate the relationship between various factors affecting the utilization of IT in HSCM using structural equation modeling (SEM). An integrated technology adoption model based on technological and organizational (TO) framework, interorganizational relationships (IOR), and unified theory of acceptance and use of technology (UTAUT) model is proposed and empirically validated. For the purpose, a questionnaire instrument and hypotheses are developed and tested to gain insight on various factors affecting the utilization of IT in HSCM. The result indicates that managerial obstacles, technology readiness, financial resources of an organization and mutual trust and information sharing among organizations significantly affect the successful implementation and utilization of IT in HSC.

The findings of the research shed some new light on the IT utilization issues in humanitarian as well as for commercial supply chain, provides a more effective, efficient, robust and a systematic way to overcome barriers so that the decision makers can realize the benefits of IT in relief operations. The findings will be of great benefit to the practitioners, academicians and policy makers in the area of humanitarian relief supply chain, as it will help the decision makers to better understand the benefits and impediments associated with the adoption and utilization of IT by helping to provide a set of critical success and failure factors. Smaller organizations in particular can benefit from the services that become accessible through a more cooperative approach by the utilization of IT in HSCM. Moreover, the research concludes with some of the issues which, if addressed will improve the utilization of IT and thereby benefit overall efficiency and effectiveness to the general betterment of future relief provision. Finally, an attempt is made to identify scope for future research work.

In summary, the research presented in this thesis is both timely and pertinent as it investigates themes and issues that have significant implications for the practitioners, academicians and researchers in order to improve the performance of HSCM

Keywords: Analytic Hierarchy Process; Fuzzy logic; Humanitarian Supply Chain Management; India; Information Technology; Performance Management; Technique for order performance by similarity to ideal solution.

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Gaurav Kabra

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List of Abbreviations

AHP	Analytic Hierarchy Process
AMOS	Analysis of Moment of Structures
ANP	Analytic Network Process
ANOVA	Analysis of Variance
AVE	Average Variance Extracted
CFA	Confirmatory Factor Analysis
CI	Consistency Index
CLM	Council of logistics Management
CR	Composite Reliability
CRED	Centre for Research on the Epidemiology of Disasters
CSC	Commercial Supply Chain
CSCM	Commercial Supply Chain Management
CSCMP	Council of Supply Chain Management Professionals
DM	Disaster Mitigation
DP	Disaster Preparedness
DRc	Disaster Recovery
DRs	Disaster Response
EMI	Emergency Management Institute
FA	Factor Analysis
FAHP	Fuzzy Analytic Hierarchy Process
FTOPSIS	Fuzzy Technique for Order of Preference by Similarity to Ideal Solution
GOF	Goodness of Fit
GOI	Government of India
HROs	Humanitarian Relief Organizations
HSC	Humanitarian Supply Chain
HSCM	Humanitarian Supply Chain Management
ICT	Information Communication and Technology
ISM	Interpretive Structural Modeling
IT	Information Technology
MCDM	Multi Criteria Decision Making
MHA	Ministry of Home Affairs
PA	Path Analysis
PCM	Pairwise Comparison Matrix
PLS	Partial Least Squares
RQ	Research Question
RG	Research Gaps
ROs	Relief Organizations

R & D	Research and Development
SAP-LAP	Situation Actor Process-Learning Action Performance
SC	Supply Chain
SCM	Supply Chain Management
SCOR	Supply Chain Operation Reference
SEM	Structural Equation Modeling
SPSS	Statistical Package for Social Science
TFN	Triangular Fuzzy Number
TOPSIS	Technique for Order of Preference by Similarity to Ideal Solution
UN	United Nation
WHO	World Health Organization

Chapter 1

Introduction

Preview

This chapter serves as an introduction to the thesis, detailing with a general overview about the frequency and rise in the occurrence of disasters in the world and setting out the need for this study. In addition, the chapter also formulates the research question and hence delimiting the scope of the research, followed by the objective of the study. A short introduction to the methodology adopted is included as well as a summary of the research findings and overall contribution to knowledge. Furthermore, the significance of the study is followed by a short explanation of the overall structure of the thesis.

1.1 Background

"As in previous years, there has been an increase in demand for humanitarian assistance while the operating environment for delivering such assistance becomes more complex. Humanitarian responders are more numerous and diverse..It will be essential over the coming years for the international system to find ways to take full advantage of the opportunities offered by this new environment and to respond more effectively to its challenges and demands."

(United Nation (UN), 2013, p.2)

The world has witnessed several disasters over the last decades, which not only affect the host country where they occur but also affect many other countries. The classic examples are the Indian Ocean earthquake (2004), the Hurricane Katrina (2005), the Pakistan earthquake (2005), the cyclone in Nargis (2008), the Haiti earthquake (2010), the Thoku earthquake and resulting Tsunami (2011), the New Zealand earthquake (2011), the Uttarakhand flash floods (2013)in India, the Nepal earthquake (2015)and the Chennai floods. The National Climatic Data Centre pointed that the "Extreme events are occurring with greater frequency and in many cases with greater intensity" (Gillis, 2010). According to Thomas and Kopczak (2007) the disasters are expected "to increase by a further multiple of five over the next 50 years."

The devastation caused as a result of the disaster, either artificial or natural, may occur at any time around the world with enormous consequences (Kovacs & Spens, 2007; Tomasini & Van Wassenhove, 2009; Yamada et al., 2006). The impact of disaster is most importantly seen on human lives and basic livelihoods, but a huge loss to the economy is always associated with such tragedies (Figure 1.1). Hence, the need for a systematic disaster response process is an increasing concern for both the practitioners on the ground and the academicians involved in this field of study.

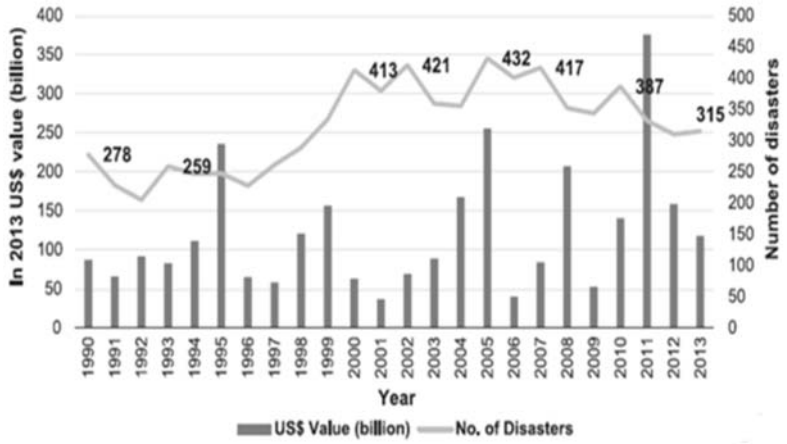

Figure 1.1: Economic Losses due to Disasters (Source: Yadav & Barve, 2015)

1.2 Disaster Management in India

Disaster management is the responsibility of the local administration, under the direction of the State Government, supported by the Government of India (see Figure 1.2). India is divided to various states and each state is divided into many districts. The administrative head of each district is Collector and District Magistrate (same person performs both the duties). Although India is having separate judicial system but certain judicial powers are also given to the administrators, like Collectors. The Ministry of Home Affairs is the nodal Ministry for coordinating relief, response and the overall management after a natural disaster (MHA, 2011).

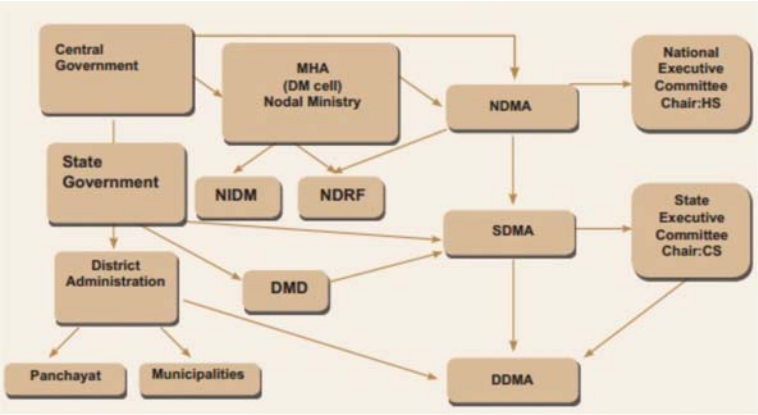

Figure 1.2: Disaster Management in India (Source: MHA, 2011)

For the purpose of this research, a disaster is defined as "a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources" (UNISDR, 2009, p.9). After the occurrence of disaster, the emergency plans of the local actors mobilizes without any delay. Actors in HSC refers to various stakeholders who are directly or indirectly involved in the relief operations such as the government of the host country, governments of other countries, private donors, aid agencies, humanitarian relief organizations (HROs), logistic providers, the military, media and the local people (Kovacs & Spens, 2007).

National Disaster Management Authority (NDMA) is the apex body for disaster management, headed by the prime minister of India. It approves the national disaster management plans of the Central Ministries/Departments. It oversees the provision and application of funds for mitigation and preparedness measures. The general superintendence, direction and control of the National Disaster Response Force (NDRF) is vested in and exercised by the NDMA. The National Institute of Disaster Management (NIDM) works within the framework of broad policies and guidelines laid down by the NDMA. At the State level, the State Disaster Management Authority (SDMA), headed by the Chief Minister, lays down policies and plans for DM in the State in accordance with the guidelines laid down by the NDMA.

The District Disaster Management Authority (DDMA) is headed by the District Collector, Deputy Commissioner or District Magistrate as the case may be, with the elected representative of the local authority as the Co-Chairperson. It is the planning, coordinating and implementing body for DM at the District level and take all necessary measures for the purposes of DM in accordance with the guidelines laid down by the NDMA and SDMA. It is responsible for preparing district DM plan. The National Institute of Disaster Management (NIDM) in partnership with other research institutions has capacity development as one of its major responsibilities, along with training, research, documentation and development of a National level information base. It organises training of trainers, DM officials and other stakeholders.

NDMA ensure mainstreaming of disaster risk reduction in the developmental agenda of all existing and new developmental program and projects which shall incorporate disaster resilient specifications in design and construction. The relief activity does not include only proving the aid materials but also includes relocating, restoring and reconstructing the life of the disaster victims. Despite of the fact that relocation and restoration activities begins at the end, they are considered as one of the most important activities after saving the life of the people. The restoration activity includes building new shelters for those who have lost their homes, providing required financial and moral support for starting the new life (John & Ramesh, 2012).

1.2.1 Disaster Management to Humanitarian Supply Chain Management

The number of stake holders in the disaster management has increased in the last few years. This includes the local and the global humanitarian organisations, governments, military, individuals and companies to name a few. Management of humanitarian relief activities also becomes more complex due to the increase in the number of stakeholders. As such, a single organization is unable to respond to the multiple needs and wants of the disaster victims. All stakeholders works in a coordinated manner as these actors have different resources and supply chain arrangements in terms of cost, time and quality Baker and Refsgaard (2007); Balcik, Beamon, Krejci, Muramatsu, and Ramirez (2010); Therrien (1995).

After the occurrence of disaster, these organizations have to work in a coordinated way to mitigate the impact of disaster on society. When working together, these groups form a supply chain (SC).

Hall et al. (2010) cited the definition of SC proposed by Christopher (1992) saying that "SC is the network of organizations that are involved, through upstream and downstream linkages, in the different processes and activities that produce value in the form of products and services delivered to the ultimate consumer." Regarding normal supply chain (SC) and HSC, both are considered as a network of members that supports flow of goods, information and funds from the source to final customers; however, the only difference is that the customer in the case of HSC includes the disaster affected peoples as well as the donors who provided support to improve the performance of HSC.

1.3 Humanitarian Supply Chain Management (HSCM)

Humanitarian supply chain management (HSCM) mobilizes immediately after the occurrence of a disaster, with the aim of saving lives, alleviating suffering and reducing the impact on the stability of the society (Costa, Campos, & Bandeira, 2012; Oloruntoba & Gray, 2006). For the purpose of this research, a disaster is defined as "a serious disruption of the functioning of a community or a society causing widespread human, material, economic or environmental losses which exceed the ability of the affected community or society to cope using its own resources" (United Nations International Strategy for Risk Reduction, 2009, p.13). Thomas and Mizushima (2005) defined HSCM as "The process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials, as well as related information, from the point of origin to the point of consumption for the purpose of alleviating the suffering of vulnerable people."

The humanitarian supply chain (HSC), unlike the commercial supply chain (CSC), does not have the typical supply chain stages like those of suppliers, manufacturers, distributors, retailers and customers. Instead, the HSC consists of donors, non-government organizations (NGOs), local bodies and the aid recipients. If we define commercial supply chain as a network that supports the flow of goods, information and finances from the source to the final customers, humanitarian supply chain can be defined quite similarly to this as a network for managing the flow of goods, information and finances from donors to affected persons. Figure 1.2 illustrates a typical HSC showing supports from the donors through NGOs to customers.

Figure 1.3: A Typical Humanitarian Supply Chain (Source: Oloruntoba & Gray, 2006)

1.3.1 HSCM in Contemporary Research

The humanitarian supply chain has received significant attention from both the academicians involved in the field of study and the practitioners on the ground. The trend will shift towards the capacity building of the state and central government along with the local communities of the disaster prone areas. The governments of many countries are focusing on community-based preparedness planning and programming in pilot communities. The banks and the non-government organizations (NGOs) will be empower in order to enhance the process of capacity building of the local communities (Kovacs & Spens, 2009, 2007; Kunz & Reiner, 2012; Oloruntoba & Gray, 2009). Disaster management capacity building and hazard mitigation strategies are more and more being incorporated in country development strategies. There is evidence that the voluntary community has been involved in the aftermath of the disaster that occurred in the Uttarakhand (a Northern state in India).

The occurrence of disasters worldwide has been steadily increased. Over the last decade, China, the United States, the Philippines, India and Indonesia are ranked amongst the top 5 natural disaster prone countries in the world. According to World Banks report entitled "Natural Disaster Hotspots: A Global Risk Analysis" highlighted that the one-fourth population of over more than 160 countries in the world are residing in the highly natural disaster prone regions. Disasters not only disturb the normal functioning of the society, but it leaves a long lasting impact on the people who are directly or indirectly affected (Alexander, 1997; Wisner, 2004). It is not possible to predict natural disasters but a quick and intelligent response of appropriate actions can reduce the impact of a disaster on people and society (CSE, 1996; Kovacs & Spens, 2007). The need for the quick and well planned response to the disaster was identified as one of the major area which requires attention from both the practitioners and academicians (Pateman, Hughes, & Cahoon, 2013; Pathirage, Seneviratne, Amaratunga, & Haigh, 2012).

The adoption of IT in HSCM has been promoted as a "silver bullet"in many areas of supply chain management (SCM) and is contended to be a mechanism to prevent organisations within the supply chain optimising solely their own results rather than integrating their goals and activities with others to benefit overall end user value (Cooper, Lambert, & Pagh, 1997; Porter, 1998; Varaprasad, Sridharan, & Anandakuttan B, 2013; Varaprasad, Sridharan, & Unnithan, 2014). However, the utilization of IT inherent within CSC have not been observed in the HSC and is still a major concern (T. C. Chan, Killeen, Griswold, & Lenert, 2004; Jefferson, 2006a; Overstreet, Hall, Hanna, & Kelly Rainer, 2011; Stephenson & Anderson, 1997; Telleen & Martin, 2002; Tomasini & Van Wassenhove, 2009). Whilst acknowledging the attention that the field of HSCM has gained as a research area, and the fact that researchers have begun to lay the foundations for a core body of knowledge, numerous researchers (Beamon, 2004; Kovacs & Spens, 2009, 2011a; Murray, 2005; Overstreet et al., 2011; Thomas & Kopczak, 2005; Tomasini & Van Wassenhove, 2009) suggested that the field is relatively new and is still in its infancy. Moreover, criticism is also levelled at the predominance of quantitative methodologies in current research and there are urgent and immediate need for more qualitative and quantitative research within HSCM.

1.3.2 Use of Information Technology (IT) in HSCM

Several researchers have used interchangeably the terms i.e. Information Technology (IT) and Information and Communication Technology (ICT); however, the World Bank (2004) defines ICT as the networks consisting of software, and hardware for the data collection, storage, processing, and transmission. Singh (2009) further defined ICTs as "a diverse set of technological tools and resources used to communicate and to create, disseminate, store and manage information." Beynon-Davis (2009) defines IT "as any technology used to support information gathering, processing, distribution, and use and is composed of hardware, software, data, and communication technology." This research adopts Maiers, Reynolds, and Haselkorn (2005) definition of IT which state that IT does not refer to any specific type of information technology, but includes people, process, practices and organizational environments. This can range from something as simple as an email to an expert system for HSCM.

In recent years, the utilization of IT in commercial supply chain management (CSCM) has been increased significantly (M. N. Faisal & Banwet, 2008; Mathew & Sahu, 2007). The revolutions in the use of IT have profound implications for economic and social development and have pervaded every aspect of human life (A. K. Singh & Sahu, 2008). Therefore, IT is regarded as a vital tool for the efficient administration of any organisation and in the delivery of services to its clients. In the case of a commercial supply chain (CSC), many organisations tend to rely heavily on IT solutions in order to develop and grow their businesses (Asgarkhani, 2005), low use of IT may increases the inventory costs, lengthens delivery time and compromises customer service (Simatupang, Wright, & Sridharan, 2002). Yet the timely delivery of goods and services is crucial to victims for whom it is a matter of life or death in the case of HSCM. "Time is money" may be the mantra in the commercial supply chain but "time is life" is paramount in the case of HSCM.

Disasters are unavoidable. However, the impact of a disaster can be reduced by the effective use of IT (Cate, 1994; Gustavsson, 2003; Patterson, 2005; Pettit & Beresford, 2009; Roh, Pettit, & Beresford, 2008; Tomasini & Van Wassenhove, 2009). The use of IT is also found to be very helpful in coordinating relief activities during different phases of a disaster. For example, it assists the communication process, provides enhanced access to past experiences (T. C. Chan et al., 2004; Jefferson, 2006a; Overstreet et al., 2011; Stephenson & Anderson, 1997; Telleen & Martin, 2002; Tomasini & Van Wassenhove, 2009) and generates timely warning signals in the probable disaster area. This can allow evacuation of the people from that area, thus reducing the effect of these disasters on the local population.

The utilization of IT within the supply chain makes it possible to react more quickly and more effectively with the available information to hand and to access relevant supports from a greater number of sources (Beaumaster, Dickey, & Thomson, 1999; Pettit & Beresford, 2009; Roh et al., 2008). For example, specific decision support systems, communications and information systems could be used for key tasks such as transportation, logistics and procurement of relief materials (Pettit & Beresford, 2009).

1.4 Need for Research in HSCM in India

India is worlds second most natural disaster prone country with frequent earthquakes, floods, cyclones, drought, tsunami, landslide, and avalanches. The chances of disasters are increasing everywhere, but disaster types vary by country and de- pend on geography technology and many other factors. Casualties in developed countries are often less when compared to developing countries. Their vulnerability is lower because of their ability to acquire and employ greater resources. The frequency and occurrence of disaster, along with its economic impact is on rise in India. (see Figure 1.4). India is extremely vulnerable to disasters due to the unique geo-climatic conditions within the country. India belongs to the category of most disaster prone countries in the world (Ministry of Home Affairs (MHA, 2011)). India is the seventh largest country in the world and covers an area of 3,287,590 km^2 extending from the snow-covered Himalayan heights to the tropical rain forests of the south.

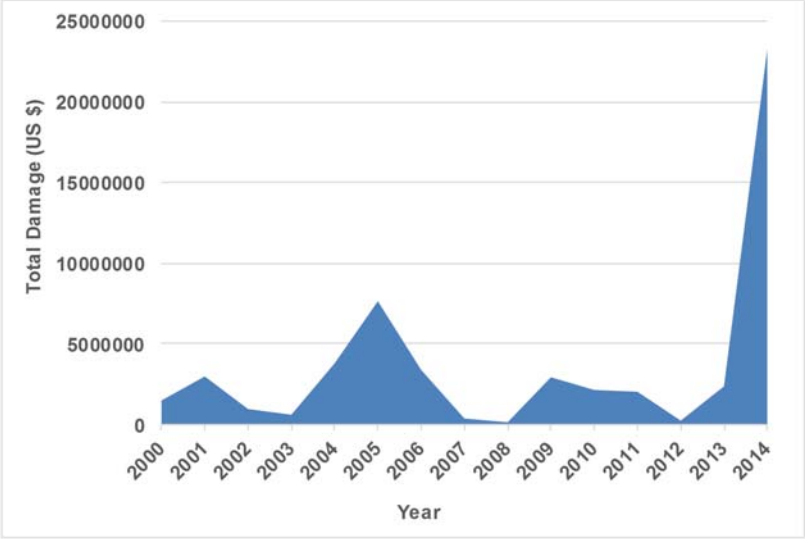

Figure 1.4: Impact of Disasters in India (Source: EMDAT, 2015)

According to the Ministry of Home Affairs (2011), when considering the entire Indian land mass, around 60% of the landmass is susceptible to earthquakes of different intensities; over 40 million hectares is susceptible to floods; about 8% of the total area is susceptible to cyclones and 68% of the area is susceptible to drought. Floods, earthquakes, cyclones and hailstorms are responsible for the most frequently occurring disasters in India. India was rated as one of the "high risk" countries in absolute terms along with six other countries (Mexico, the Philippines, Turkey, Indonesia, Italy and Canada). The direct financial loss due to natural disasters alone accounts for 2% of Indias gross domestic product (GDP) and up to 12% of central government revenues.

In the past, India has witnessed various devastating natural disasters, such as super cyclones in Orissa in the year 1999, an earthquake in the Gujarat in the year 2001 and the Tsunami in coastal states in 2004. In June 2013 a cloud burst in Uttarakhand caused heavy floods in the area of Uttarakhand, Haryana, Delhi, Uttar Pradesh, Himachal Pradesh and some of the regions of Tibet and Nepal. Table 1.1 illustrates the losses due to disasters during the period of 2000-2015.

Table 1.1: Losses due to different Disasters in India (Source: EMDAT, 2015)

Year	Total deaths (in No.)	Total Affected (in No.)	Total Damage ('000 $)
2000	3,457	10,04,29,097	1495500
2001	21,485	2,70,20,326	2984924
2002	3,882	34,20,29,618	9,61,910
2003	3,024	81,01,172	6,13,000
2004	18,410	3,38,61,550	37,98,800
2005	6,280	2,86,68,727	76,50,000
2006	1,997	73,87,865	33,90,000
2007	2,717	3,81,63,386	3,76,151
2008	2,517	1,46,99,400	1,45,000
2009	2,416	1,10,99,040	29,34,000
2010	2,259	48,03,183	21,49,000
2011	1,495	1,28,29,805	20,34,625
2012	1,026	42,81,193	2,44,000
2013	7,656	1,67,09,159	23,75,471
2014	1,383	56,54,739	2,32,63,000
2015 (June)	2881	1,54,197	2,61,000

The importance of the HSCM area could also be demonstrated that the Indian Institute of Management Raipur, India is annually organizing the conference entitled "**International Conference on Humanitarian Logistics**". The low use of information technology (IT) in the HSCM was among the issues criticized most during this conference. The recent United Nations global assessment report on disaster risk, highlighted that the average annual economic loss due to disasters in India is estimated to be 9.8 billion US$. This includes more than 7 billion US$ loss on account of floods. These report suggest that this is a high time to make adequate investment in disaster risk reduction (DRR) strategies such as strengthening the use of IT otherwise it will hinder the development of country.

1.5 An Overview of IT utilization in HSCM in India

The countries over the world have been developing mechanisms to mitigate disasters but some of the recent disasters such as disaster that occurred in Uttarakhand reveal that the existing preparedness is less than satisfactory and particularly, in emerging economics like India, such preparedness require high priority. Though complete prevention of natural disasters is beyond human capabilities, the adverse impact of any disaster on human lives and their livelihoods can be minimized by taking adequate early warning, preparedness and mitigation measures. The key to cope up with impact of disasters is the implementation of preventive measures such as the utilization of IT.

With advancement in IT in the form of Internet, geographic information system (GIS), Remote Sensing, satellite-based communication links; it can help a great deal in planning and implementation of disaster risk reduction measures. These technologies have been playing a major role in designing early warning systems, catalyzing the process of preparedness, response and mitigation. IT tools are also being widely used to build knowledge warehouses using internet and data warehousing techniques. These knowledge warehouses can facilitate planning and policy decisions for preparedness, response, recovery and mitigation at all levels. Similarly, GIS-based systems improve the quality of analysis of hazard vulnerability and capacity assessments, guide development planning and assist planners in the selection of mitigation measures. Communication systems have also become indispensable for providing emergency communication and timely relief and response measures.

Information technology systems usually used in relief operations includes shared/ relational databases, Geographic information systems, Inventory control systems and decision control systems (Maitland, Pogrebnyakov, & Van Gorp, 2006). Communication technologies generally used in relief operations are fixed or wireless satellite internet connection, satellite phones and radio. There are number of IT tools and applications developed to help the disaster managers function efficiently. These include India Disaster Resource Network (IDRN), inventory management softwares, etc. GIS-based information tools allow disaster managers to quickly assess the impact of the disaster/emergency on geographic platform and plan adequate resource mobilization in most efficient way.

However, the experts involved in the management of disaster that occurred in Uttarakhand (a Northern state in India) on June 14, 2013 suggested that "the potential of such advance technologies was not been harnessed adequately in early warning, preparedness and response systems, along with adequate emphasis on building human capacities to use these tools and technologies, in disaster management phase by smaller organizations involved in HSCM" The experts have strongly recommended the need for more utilization of IT by organizations involved in HSCM to take full advantage of the available IT tools and applications. Ramachandran (2013) also reported that "the recently occurred disaster in Uttarakhand begs the question: are we missing out on opportunities to deploy new technology-driven ways of collecting and processing information to help people in that State, as they struggle to come to terms with the massive destruction and loss of life caused by the floods?".

Despite the fact that India is well known IT hub, even India is the world's largest sourcing destination for the information technology (IT) industry, accounting for approximately 52 per cent of the US$ 124-130 billion market, there is low utilization by the organizations involved in HSCM. In particular, the commercial organizations are using technology in almost every stage of their supply chain but the use of technologies in HSC is low. The recently occurred Uttarakhand disaster also served as a wake-up call for disaster management systems in India.

It is high-time that real-time technologies like these are institutionalized into official disaster management systems of the country. India has already shifted its focus towards DRR initiatives

by making a provision of over Rs 55,000 crore (about 9 billion US $) towards disaster management fund for states as part of the 14th finance commission grants. The successful launch of INSAT-3D (launched by ISRO) to enhance Indias capability in the field of weather forecasting and disaster warning system after Kalpana-1 and INSAT-1A, the two existing geostationary satellite rendering weather data service for last decade. INSAT-3D will place India in a better position to improve the weather forecast and also will help mitigating the loss of life and property caused by floods and natural calamities. Nowadays the use of IT by the organizations involved in relief activities is increased, but the adoption of use of advanced or sophisticated technologies is slower in India as compared to other countries.

1.6 Motivation of the Research

" the most deadly killer in any humanitarian emergency is not dehydration, measles, malnutrition or the weather, it is bad management"

John Telford (1994) as cited by Altay (2008)

Dash, Mishra, and Mishra (2013) reported that the "Disaster response supply chain management is an emerging field and there is great potential for research in emergency logistics and disaster response initiatives." S. Kumar and Havey (2013) also highlighted the need for more research on disaster relief supply chain management in light of frustrations with the delays in receiving aid following the Haiti earthquake in 2010. Various researchers have highlighted that whilst the humanitarian relief process is an important domain for SCM it has received little academic attention.

In recent years there has been an increase in the number and severity of disasters in India. The recent disaster that occurred in the Uttarakhand (a Northern state in India) during June 14-17, 2013 demonstrated that there is low level of development amongst the actors involved in the relief operations in the state, since many of them still operate using traditional approaches rather than adopting modern technologies. The experts during the interview also state that "Although the use of IT in relief activities has increased, the utilization of advanced or sophisticated technologies in HSCM in India is very slow, compared to the commercial supply chain". Thus it is indeed essential to improve the preparedness of the disaster through the adoption of IT in the supply chain of the organizations involved in HSCM.

1.7 Research Gap Analysis

In the light of above discussion, the use of IT in HSCM has been considered as the silver bullet in the area of HSCM but the area has not received enough attention from research point of view. Therefore, the following the research gaps are identified through literature review as given below

Gap 1: Further research is needed on investigating the issues affecting the maximum utilization of IT in HSCM in Indian context.

Many countries of the world have witnessed disasters over the last decade. The rise in the occurrence of such disasters has hampered the development of these countries. Under the pressure to proactively deal with the situations arising due to disasters, practitioners and academicians are making continuous demands to enhance the utilization of IT in humanitarian supply chain management (HSCM) in order to continue or enhance the pace of economic growth and development of countries, as well as to reduce the impact of disaster on society.

It is often argued that the proliferation of the utilization of IT in HSCM has become a necessity to enhance the success rate of relief operations as it offers a platform to enhance information sharing, coordination, and collaboration among the actors involved in the relief operations. The low use of IT in the HSCM is among the issues criticized most during various International conferences such as "**International Conference on Humanitarian Logistics (ICHL, 2013)**" organized by Indian Institute of Management Raipur, India; "**6th annual Conference on Health and Humanitarian Logistics**" organized by the Gordon Institute of Business Science (GIBS) and co-organized by the Georgia Tech Center for Health & Humanitarian Systems (HHS), the INSEAD Humanitarian Research Group, the MIT Humanitarian Response Lab and Northeastern University. Fritz Institute has hosted the first Humanitarian Logistics Conference (HLC) in Geneva, Switzerland and keep on organizing annually. Despite the importance of IT in HSCM there are few studies on exploring the factors affecting the proliferation of IT in HSCM. This clearly highlight the need for more research in this area.

The steadily growing number of disasters and its severe impact throughout the world are calling for a more efficient and effective handling of disaster relief operations. In particular, India is prone to natural disasters and is one of the most disasters prone country in the world due to its unique geo-climatic condition. In India, floods, earthquakes, cyclones, droughts, and landslides are common (Ministry of Home Affairs, 2011). The utilization of Information Technology (IT) have proved to be one of the success driver in commercial supply chain management and India is the well-known IT hub, despite that there are few studies in the area of Humanitarian Supply Chain Management (HSCM), particularly in the Indian context.

The researchers have emphasized that the adoption of advanced IT systems in HSCM has been quite slow in India in comparison to other developed countries. Therefore, it is vital to focus more on exploring various strategic issues related to IT enablement of HSCM in the Indian context. It is important to recognize various constraints such as limited resources in terms of capital, time, human resources and policy initiatives, so prioritizing the factors affecting the proliferation of IT, on the basis of their severity is essential for stepwise implementation of solutions. The perspective for prioritization of barriers is to focus more on the critical barriers to have the best possible outcomes as the resources are limited in terms of capital, time, human resources, etc.

Gap 2: Further research is needed on investigating and prioritizing the solutions to overcome the barriers to the proliferation of IT in HSCM in Indian context.

The utilization of IT is an emerging priority of organizations in commercial supply chain management (CSCM). For example, IT capabilities are required in knowledge management, change management, inventory management etc. in the CSC. Similarly, the use of IT in HSC reduces the immediate impact of disaster on society before enhancing the pace of economic recovery and development of a country in the longer term (Antonio & Cathy, 2012; Hu & Kapucu, 2014). Although, the utilization of IT has been promoted as a Silver Bullet in many areas of commercial SCM and is contended to be a mechanism to prevent organizations within the supply chain optimizing solely their own results rather than integrating their goals and activities with others to benefit overall end user value (Cooper et al., 1997; Porter, 1998). However, the utilization of IT inherent within commercial supply chains have not been observed in the HSC and is still a major concern (T. C. Chan et al., 2004; Jefferson, 2006a; Overstreet et al., 2011; Stephenson & Anderson, 1997; Telleen & Martin, 2002; Tomasini & Van Wassenhove, 2009).

In spite of benefits, the utilization of IT is found to be the most important problem among the stakeholders, from both the government and the private sector in HSC (McLachlin & Larson, 2011; Sandwell, 2011; Whiting & Ayala-Ostrm, 2009). Therefore barriers to the proliferation of IT in HSC are to be handled on priority to improve the performance of HSC. It is not possible to improve all the barriers at the same time. In view of this limitation, it is necessary to prioritize solutions on the basis of severity of barriers, to overcome barriers and improve them in a step wise manner. Thus, it is vital to explore and prioritize the solutions to overcome IT barriers in HSCM.

Gap 3: Existing literature lacks a framework that analyze various factors related to enhancing the use of IT in HSCM

The rise in the occurrence of natural disasters such as floods, earthquakes, is of growing concern for developing countries such as India. The devastation caused as a result of a disaster, either artificial or natural, may occur at any time with enormous consequences. The impact of disaster is most evidently seen on human lives and basic livelihoods but a huge loss to the economy of a country is always associated with such tragedies. Practitioners and academicians are continuously brainstorming existing contemporary knowledge to reduce the impact of disaster and supported that IT have become an integral part of society (Cate, 1994; Mitrea, Werner, & Greif, 2010; Patterson, 2005; Pettit & Beresford, 2005; Polikanov & Abramova, 2003; Roh et al., 2008; Tomasini & Van Wassenhove, 2009; Troy, Carson, Vanderbeek, & Hutton, 2008; Whybark, 2007).

Despite the promising benefits of IT in HSCM, a number of factors, such as low priority by management, resistive nature of volunteers and support from government, affect the utilization of technology that can really help. Existing literature has not considered various factors affecting the utilization of IT from various perspectives, such as Technolgical and Organizational (e.g., technology readiness, financial resources, user perceptions) and inter-organizational relationships (e.g.,mutual trust, information sharing) and IT integration among the organizations. Past research has attempted to provide an understanding of factors affecting the utilization of IT through conceptual studies (Patterson, 2005). Empirical research into the context of humanitar-

ian relief supply chain which explores the relationship between these individual factors is often limited. Hence it is vitally important to understand the linkages among these factors, so that they can be handled efficiently to realize the maximum benefits of IT in HSCM.

Therefore, this study examine the characteristics of users, such as middle level managers who were involved in past disaster relief operations. These factors, which not only affect the whole system, also affect each other. Hence it is vitally important to understand the mutual relationship among these factors, in order to improve the performance of HSC. Therefore, to assist the organizations involved in HSCM, this gap has been addressed by developing and empirically validating the conceptual model that examines the factors affecting the proliferation of IT.

Gap 4: More research is required within the field to analyze the issues affecting the performance of HSCM particularly with respect to developing countries such as India.
The chances of disasters are increasing everywhere, but disaster types vary by country and depend on geography technology and many other factors. Casualties in developed countries are often less when compared to developing countries. Their vulnerability is lower because of their ability to acquire and employ greater resources. There are several challenges to overcome in order to support the effective and efficient delivery of relief materials to the disaster affected peoples during complex emergencies. These challenges are not only technology related, but are often related to core organizational issues of mission, culture, environment, and communication (Maiers et al., 2005). Existing literature lacks a framework that analyze various learning issues related to enhancing the use of IT in HSCM. Therefore, it is vital to analyse the disaster as a case for the purpose of identifying the status of utilization of IT and the ways to further enhance the performance of HSC by suggesting some ways to improve the utilization of IT.

1.8 Research Questions

The development of a research question (RQ) is a process of looking at an issue that might be a problem and formulating a question about it. Grace-Martin and Sweet (2008) states that the research question emphasizes a lack or absence of understanding about an issue. It refers to the gap that the researcher intends to address. Within this context, the overall objective of this research is to fill the identified gaps in the literature, and to evaluate how these issues might be addressed in the future to enhance the utilization of IT within the HSCM. Therefore, the RQs for the present research are as follows:

RQ1: How can the factors affecting the adoption and effective utilisation of IT in developing countries HSCM be resolved?
Sub Research Questions:

1. What are the inhibitors to IT proliferation in HSCM in India?
2. What is the current level of IT utilisation in HSCM in India?

3. What are the drivers to improve the utilization of IT in HSCM in India?
4. How do the factors affecting the utilization of IT in HSCM are interrelated?
5. How does the use of IT affect/impact on the organisational performance in HSCM in India?
6. How can the adoption and effective utilization of IT be improved in HSCM in India?

1.9 Objectives of the Research

The aim of this study is to fill the identified gaps in knowledge surrounding as well as on discussions with a range of practitioners and academicians in the area of humanitarian relief operations regarding the significance of various topic alternatives. As a result, a set of research questions is formulated to highlight and shape this focus and guide the selection of an appropriate research approach and structure for this thesis.

There is a substantial amount of literature available on the importance and use of IT in effective and efficient management of past disasters, but there are few studies which discuss the strategic issues related to enhancing the use of IT in HSCM, particularly in the Indian context. Hence, there is a strong need to analyze and highlight the importance of IT in HSCM from a broader perspective. This requires critical analysis of present supply-chain situations, various supply-chain actors and different supply-chain activities. Within this context, the aim of this study is to fill the identified gaps in knowledge surrounding. Therefore, the objectives of the study are as follows

1. To identify and prioritize the barriers to the proliferation of IT in HSCM.
2. To identify and prioritize the solutions to overcome the barriers to the proliferation of IT in HSCM.
3. To examine the relationship among the factors affecting the utilization of IT in HSCM.
4. To analyze various strategic issues affecting the utilization of IT in HSCM, with special emphasis on disaster that occurred in the Uttarakhand (a Northern state) in India.

1.10 Scope of the Research

The scope of the research presented in this thesis focuses on the organizations involved in HSCM, particularly within the Indian context. These organizations are often termed as humanitarian relief organizations (HROs). To reduce risk associated due to uncertainty about the occurrence of disaster, these organizations should continually identify, measure and assess their operating environments for further improvement (Kovacs & Spens, 2007). For the purpose of this research, actors in HSCM refers to various organizations who are directly or indirectly involved in the relief operations. After the occurrence of disaster, these organizations have to work in a coordinated

way to mitigate the impact of disaster on society. When working together, these groups form a supply chain (SC). These organizations play a vital role in HSC performance as many of them are the first responder to the chaotic situation created by the disaster. Many of these organizations serve the roles of suppliers, distributors.

This research aims to examine the supply chain management (SCM) practices; with reference to the disaster relief operations in India. This research investigates what synergies and potential types of benefits the use of IT in HSCM could produce, and what impediments to their realization exist. The utilization of IT in HSCM could prove to be useful in all phases of the disaster namely, pre, during and post phase of a disaster. However, the studies focusing on issues related to the education, training, adoption of IT and plan to reduce the impact of disaster were classified in the preparedness phase. Hence, this research mainly focuses on the disaster preparedness phase to enhance the efficiency of the system. This research focuses on actors involved in humanitarian supply chain since they play a vital role in the relief operations and significantly contribute in reducing the impact of disaster on society.

1.11 Research Design

This section presents an overview of the research methodology applied in this research. Identifying and analyzing key decision variables affecting the maximum utilization of IT in HSCM is a challenge in trying to improve overall performance. Therefore, this study utilize mixed method research approach which combines both a qualitative as well as quantitative analysis to achieve the objectives that are given in the preceding section. The importance of mixed method research are discusses in the subsequent section

1.11.1 Mixed Method Research

Mixed method research (MMR) is a growing area of methodological choice for many academics and researchers from across a variety of discipline areas. An oftused quotation by Creswell and Clark (2007, p.5) provides a comprehensive definition of mixed methods as follows: “Mixed methods research is a research design with philosophical assumptions as well as methods of inquiry. As a methodology, it involves philosophical assumptions that guide the direction of the collection and analysis of data and the mixture of qualitative and quantitative data in a single study or series of studies. Its central premise is that the use of quantitative and qualitative approaches in combination provides a better understanding of research problems than either approach alone.” Mixed methods research is dened as “the type of research in which a researcher, or a team of researchers, integrates qualitative and quantitative research approaches within a single study or a set of closely related studies” (Creswell & Clark, 2007; Johnson, Onwuegbuzie, & Turner, 2007). It is also defined as the research approach or methodology focusing on research questions that call for real-life contextual understandings, multi-level perspectives, and cultural influences.

Mixed method research allows the researchers to use all methods required to address the problem on hand. Mixed method research employs both qualitative research methods quantitative research methods. There are several reasons for using mixed methods for the research presented in this thesis. Kamali (2014) also strongly demonstrate the importance of the utilization of mixed research methods for analysing IT issues. These include developing a more complete understanding of a problem; to develop a complementary picture; to explore, validate, or triangulate results; to provide illustrations of context for trends; or to examine processes/experiences along with outcomes (Clark, 2010).

Mixed method research is more suitable if there are more number of stakeholders in the supply chain. As already discussed in the section 2 that lack of utilization of IT in HSCM is a major stumbling block due to involvement of large number of stakeholders such as Government, NGOs, Media, Private Organizations, Military, etc. Therefore, the research presented in the thesis adopted mixed method research. The present research view problems from multiple perspectives to enhance and enrich the meaning of a singular perspective. This research seeks to contextualize information, to take a macro picture of a situation. For example, disaster that occurred in Uttarakhand (a Northern state in India) and add in information about individuals (e.g., working at different levels in the relief operations of the disaster). The mixed method research are found to be more suitable to increase the generalizability of the research presented in this thesis.

Qualitative tool such as Focus group discussion, brain storming session, interview method, and SAP-LAP analysis has been used for data collection. Nonetheless, a survey has been used to provide an exploratory snapshot of the actors in HSCM in context. Quantitative statistical tools to be used in the research include correlation analysis, regression analysis, factor analysis, structural equation modeling, fuzzy Analytic hierarchy process (AHP), and for objectives mentioned earlier for the research. The questionnaire survey is structured to elicit response on various strategic issues related to HSCM in India. The research also employs a case study based research method which is appropriate for investigating a contemporary research phenomenon. Case study offers in-depth and relatively unstructured approach to develop theories and frameworks. Case studies provide a good platform for understanding various interrelated issues.

The methodology adopted for this study also includes the empirical investigation of some of the factors, which was based on the following statements as cited by Kovacs and Spens (2011b):

"Whilst there is indeed little empirical research in HSCM, and researchers tend to shy away from implementation luckily, more and more academics have started to address this problem".

(Ron McLachlin, University of Manitoba)

"Most of what's been done seems to me to be case study type work and conceptual reviews but not a lot of empirical/analytical. Time is a big gap and there doesn't seem to be a strong dialogue between the sector and academia about things that could make a real difference".

(Martijn Blansjaar, Oxfam)

1.12 Research Design

The research overview along with the objectives and the methods adopted to achieve the particular objective is given in the Figure 1.5.

1.12.1 Phase 1: Exploratory Research Design

This phase puts the research problem into perspective by reviewing the related literature and through the discussion with the experts. Initially, the contact and willingness of the participants was sought to confirm the issues developed during literature review process. After performing the literature review, several gaps are identified as discussed in section 1.7. Accordingly, the research objectives are listed in section 1.9.

1.12.2 Phase 2: Prioritization of Factors

This phase aims to prioritize the solutions to overcome IT barriers in HSCM. An integrated Fuzzy logic, analytic hierarchy process (AHP) and Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) has been utilized for the purpose of prioritization. This phase has explored and prioritize 25 barriers identified through extensive literature review as listed in section 2.14.2 (chapter 2). In addition, 19 solutions as listed in 2.12.2 (chapter 2) are proposed and prioritized to overcome the barriers by stepwise implementation of solutions. The input from the middle level managers and top management of the organizations involved in HSCM has been duly considered while finalizing the barriers and solutions to overcome these barriers respectively.

1.12.3 Phase 3: Conceptual Model Development and Validation

In this phase, a conceptual model which consider the factors affecting the utilization of IT in HSCM within Indian context has been developed on the basis of extensive literature review and input from the experts. In addition, the same model has been validated through the inputs from the managers involved in the past disaster relief operations. Structural Equation Modeling has been used to validate the model.

1.12.4 Phase 4: Case Study on Uttarakhand Disaster

In this phase, the related findings and interpretations were confirmed with participants through a checking and feedback process. This phase present a first-hand description of disaster, that occurred in the Uttarakhand, India and its prompt management. This phase analyse various strategic issues affecting the IT enablement of HSCM with special emphasis on disaster that occurred in

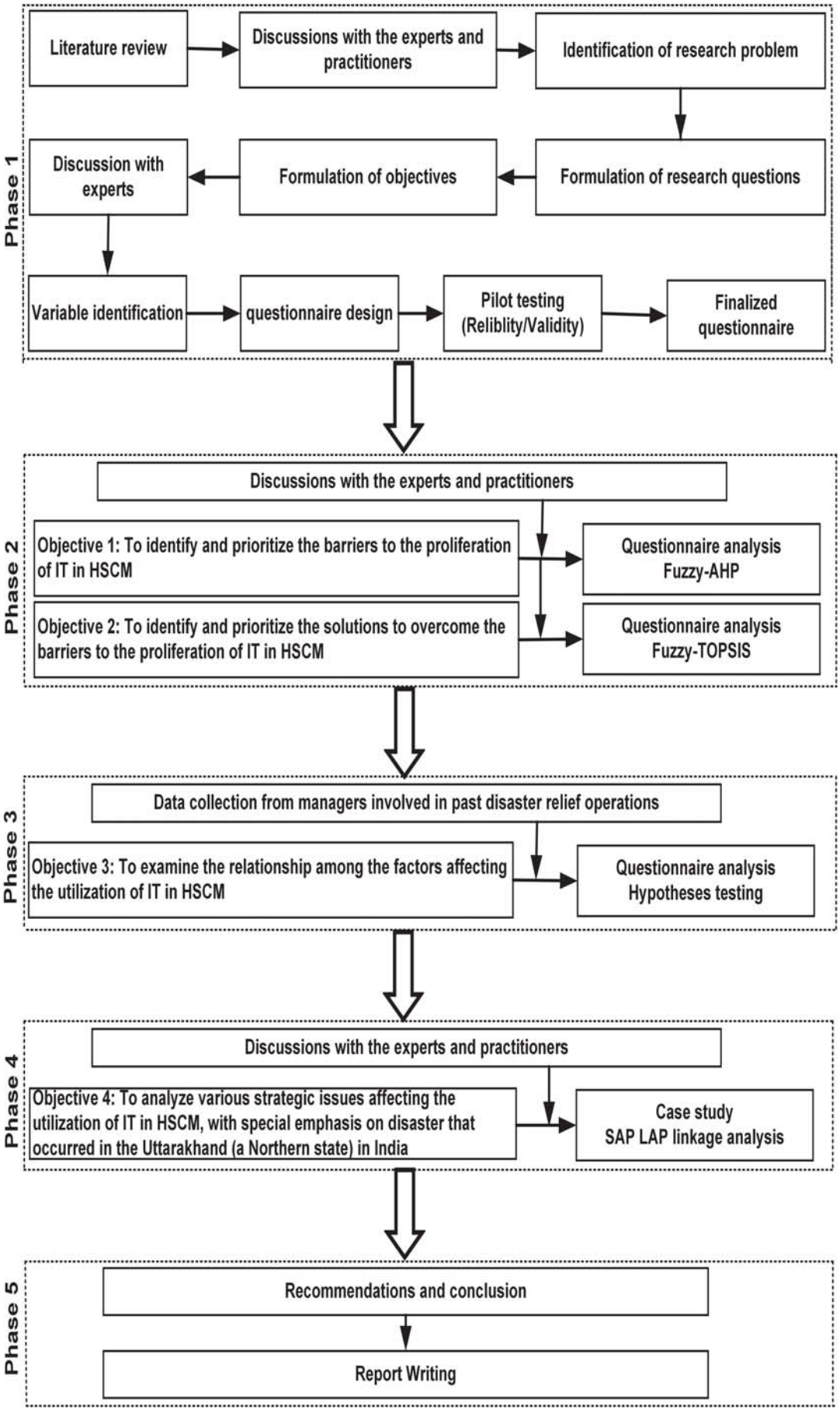

Figure 1.5: Research Design

the Uttarakhand (a Northern state in India) on June 14, 2013. A survey questionnaires was used to gather the response of the participants along with the focus group discussion and interview with the experts. Semi-structured interviews were conducted from the following persons, who are actively involved in the relief activities in the past disaster occurred in India involving Government Officers, logistics officers, IT experts, Military Officers, Humanitarian relief organizations (HROs) Management, Academic experts and others actors involved in the relief operation. SAP LAP analysis followed by SAP LAP linkages analysis has been used for analyzing various strategic issues to IT enablement of HSCM in India.

1.12.5 Phase 5: Report Writing

In this phase, the suggestions for improvement were made and finally, the findings of this research work was presented in this phase. This phase discusses an overview of the research, implications of this research for the academicians, managers and policy makers have been proposed with some limitations and scope for further research in this area.

1.13 Significance of the Research

The utilization of IT by the commercial organizations has been increased tremendously all over the world. In recent times, actors in developed countries are adopting and effectively utilizing IT in HSCM for developmental purposes, unlike India where the use of IT in HSCM is still very low, despite the fact that India is a well-known IT hub. Currently, the area of IT utilization in HSCM particularly in the Indian context is still under-researched. Thus, this study is of rising relevance, generating a grounded understanding to help stakeholders in HSCM toward various IT interventions in India.

The research presented in this thesis aims to make a theoretical contributions to the general body of knowledge to existing humanitarian supply chain practice, practical and methodological contributions. This research has narrowed the gaps of previous research in terms of investigating the factors affecting the utilization of IT in HSCM. It has advanced the mainstream literature concerning the HSCM. In addition, this study reveals what factors restrict the effective utilization of IT within humanitarian relief environments and suggesting how these issues might be addressed in the future. In terms of the theoretical contribution, this study explores various strategic issues affecting the proliferation of the utilization of IT in HSCM. Moreover, the findings of the study throw some new light on the IT issues in HSCM and provide a more effective, efficient, robust and systematic way to overcome coordination barriers and further contribute towards India's socio-economic advancement. Finally, the study also suggest some possible solutions to eliminate or reduce the intensity of barriers affecting the proliferation of IT in HSCM.

Furthermore, the study makes a methodological contribution by employing different quantitative techniques such as Fuzzy AHP, Fuzzy TOPSIS and hypothesis testing, in addressing issues relat-

ing to proliferation of IT adoption in Indian HSCM; highlight the importance of IT in HSCM and to further examines the present status of the use of IT in HSCM in India, especially sophisticated IT applications. This study highlights that the increase in the occurrence of disaster has been accompanied by massive global relief operations involving a range of actors requiring substantial support from the donor community. This study developed and validated the conceptual model that examines the factors affecting the utilization of IT in HSCM. An integrated technology adoption model based on a technological and organizational (TO) framework, inter-organizational relationships (IOR) and a unified theory of acceptance and use of technology (UTAUT) model is proposed and empirically validated. This study makes an important contribution to existing literature by examining the perceptions of managers toward the utilization of IT in the context of HSCM.

The results reveal that there is a strong need to establish mutual trust among the organization in HSCM. The institutions engaged in enhancing the efficiency of actors in relief operations need to interact more frequently and improve the intra and inter coordination systems for the welfare of the society involved. Furthermore, it is necessary to initiate joint action between governments and private organizations to improve the coordination of the major players. The government or the central authority responsible for the management of disaster related activities should show their willingness to lead as any policy and regulatory initiatives alone are not sufficient to effectively address the issues. The critical problems such as finance, information sharing, use of technology and attitude of the organizations need to be addressed on a priority basis.

The findings of this study will be of great benefit to the stakeholders in the humanitarian sector, as it will help the decision makers to better understand the benefits associated with the adoption and utilisation of IT by helping to provide a set of critical success and failure factors. Findings of the research will also assist to better position stakeholders, researchers and practitioners in their attempts to implement and manage IT initiatives within HSCM in India. The findings suggest that there needs to be more drive by management to take initiatives forward toward the utilization of IT.

In summary, the research presented in this thesis is both timely and pertinent as it investigates themes and issues that have significant implications for the policy makers; practitioners; academicians; and researchers in order to enhance the performance of the HSC.

1.14 Structure of the Thesis

The structure of thesis is as follows:

Chapter 1

This chapter explores the embededdness of scope of the present research, research contexts and significance. This chapter will highlight why the area under investigation in this thesis is of high and rising relevance, particularly within the Indian context and contributes to the effective and efficient management of the relief operations in particular. Further in this chapter, the research

concept is explained by describing focus, central questions, approach and methodology.

Chapter 2

This chapter presents the review of literature and the thematic evaluation of the research area. This chapter summarizes the various studies in the area of HSCM. The chapter initially develops the concept of the HSCM and its evolution form disaster management. Further in the chapter, selected papers from the literature has been analysed, related to the philosophy of the concerned area under investigation in HSCM. The identified gaps are also listed in this chapter.

Chapter 3

This chapter adopts a comprehensive and rigorous procedure to explores the barriers to enhance the utilization of IT in the HSCM. The chapter is divided into three phases. Initially, barriers to the proliferation of IT were identified through an extensive literature review, allied to discussion with experts. These were then grouped into five categories, i.e. strategic barriers (SB); organizational barriers (OB); financial barriers (FB); human barriers (HB); and technological barriers (TB). Secondly, a survey questionnaire was designed, tested and refined to incorporate the views of the managers involved in the past relief operations of the disaster that occurred in India in order to empirically verify the barriers. Finally, barriers were prioritized on the basis of their severity using fuzzy analytic hierarchy process (F-AHP).

Chapter 4

This chapter sets out to explore and prioritize the solutions to overcome barriers to the proliferation of IT in HSCM in Indian context. The research design is divided into three phases; Initially, the solutions are collected through an extensive literature review. Secondly, solutions were verified with the middle level managers involved in past relief operations of the disaster. Finally, based on the weight of barriers estimated by fuzzy analytic hierarchy process in chapter 3, solutions to overcome the barriers to the proliferation of IT are prioritized using fuzzy technique for order performance by similarity to ideal solution (F-TOPSIS) which considers the uncertainty of the data and impreciseness rather than crisp value.

Chapter 5

This chapter develop and empirically validate the conceptual model that examines the factors affecting the utilization of IT from various perspectives, such as those from the, Organizational (e.g., Technical, financial resources, user perceptions), and Inter-organizational (e.g. mutual trust, information sharing). Therefore, this study examine the characteristics of users, such as middle managers who were involved in past relief operations. This study is based on the premise of that the utilization of IT SCM goes through a series of stages starting from IT adoption in an organization inter and intra SC processes, then the mutual trust and information sharing among other organizations will bring all other members of SC on same platform through IT integration. A series of hypotheses were proposed and empirically investigated in this chapter. This chapter discusses the result and present managerial implications on the basis of the hypotheses results.

Chapter 6

This chapter highlight the importance of IT in the HSCM and explain the present status of use of IT in the HSCM in India with special emphasis on heart wrenching and deadliest disaster, that occurred in the Uttarakhand (a Northern state in India) on June 14, 2013. The study will develop a SAP LAP linkages framework in order to analyse various learning issues related to enhancing the use of IT in HSCM. The developed framework considers the inter-relationship amongst all elements of different components of the SAP LAP framework by developing assessment, self-interaction and cross interaction matrices.

Chapter 7

This chapter present the contributions, conclusions and implications of this research. This chapter discusses an overview of the research, implications of this research for the academicians, managers and policy makers have been proposed with some limitations and scope for further research in this area.

1.15 Summary

This chapter has laid the foundations for the thesis by introducing the background of the study as well as the extent of the research problem. A short introduction to the methodology adopted was included together with a summary of the research findings and overall contribution to knowledge. Moreover, the significance of the research was discussed which highlighted the proposed contributions of the study. Finally, a short explanation of the overall structure of the thesis was set out. What emerges is a timely and pertinent investigation into a burgeoning field of academic interest. The literature in the area of humanitarian sector indicates that there is growing demand for the utilization of IT in HSCM. It is clear that HSCM both as a practice and a research topic is very prevalent area and that the research presented here has a valid contribution to make to the developing body of knowledge in the field. The next chapter deals with the literature review in the area under consideration for the research presented in this thesis.

Chapter 2

Literature Review

Preview

The previous chapter laid the foundation for this research. This chapter presents the exhaustive review of published papers in the area of humanitarian supply chain management along with the research gaps. This chapter aims to deepen the knowledge about HSCM by reviewing the contemporary papers. In addition, this chapter also present the distribution of studies according to different disaster stages such as disaster mitigation, disaster preparedness, disaster recovery and disaster recovery.

2.1 Introduction

"There is little point in reinventing the wheel.....the work that you do is not done in a vacuum, but builds on the ideas of other people who have studied the field before you. This requires you describe what has been published, and to marshal the information in a relevant and critical way."

Jankowicz (2005, p.161)

The increase in occurrence of disasters throughout the world are calling for a more effective and efficient handling of disaster relief operations. Hence, humanitarian supply chain management (HSCM) which mobilizes immediately after the occurrence of disaster, is become a prevalent and widely studied research topic. The number of scientific articles dedicated to the study of the Humanitarian Supply Chain (HSC), either general or focused on a specific issue, was remarkably low five years ago. This has changed recently with the publication of a substantial number of papers related to disaster management. This is evident by the enormous publications in various scientific journals in recent years. There are various studies discussing various issues which requires immediate attention, based on different type of disaster, and region where they occur. Hence, a comprehensive literature review of recent and state-of-the-art publications is vital to draw a framework of the past, and to shed light on future directions. In this context, the purpose of this study is to deepen the knowledge about HSCM by reviewing the contemporary papers in the area of supply chain with reference to disaster relief operations (humanitarian supply chain management). A total of 330 papers published between 1982 and 2015 are selected and reviewed to construct a useful foundation of past research. This chapter a detailed report on the literature reviewed on HSCM.

The part of this chapter has been under review as "Kabra, G., & Ramesh,A. Humanitarian supply chain management: A literature review, framework and future research agenda, *International Journal of Disaster Risk Reduction* (Elsevier)."

2.2 Logistics versus Supply Chain Management (SCM)

There has been significant debate surrounding what distinguishes logistics and SCM. It appears that SCM is "Logistics taken across inter-organizational boundaries" (Cooper et al., 1997, p.1) but what is also clear is that for SCM to succeed managers must appreciate how their organizational processes are linked in with those of their suppliers, distributors and customers (Bozarth & Handfield, 2015; Chopra & Meindl, 2007). Larson and Halldorsson (2004) offer 4 conceptual perspectives as shown in Figure 2.1.

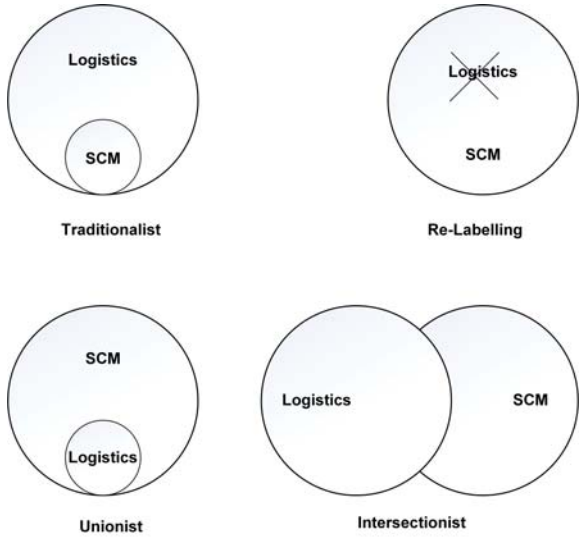

Figure 2.1: Perspectives on Logistics versus Supply Chain Management(Source: Ramsden (2014))

The traditionalist view places SCM within logistics, and suggests that SCM is just one small part of the logistics function. The re-labeling perspective contends that SCM is simply a renaming of what was once understood to be logistics and is now known as SCM. The unionist perspective regards logistics as a fundamental part of SCM in that SCM completely subsumes the logistics function. Finally, the intersectionist perspective is described by Larson and Halldorsson (2004, p.21) as "The intersection concept suggests SCM is not the union of logistics, marketing, operations management, purchasing and other functional areas. Rather, it includes strategic, integrative elements from all of these disciplines."

The Council of Supply Chain Management Professionals (CSCMP) acknowledge that SCM as a profession has continued to change and evolve to fit the needs of the growing global supply chain. They also note that the fact that the supply chain is expected to cover a broad range of disciplines, means that it can be difficult to clearly define what a supply chain actually is. Indeed the CSCMP argue that at times SCM can be confused with the term logistics management; accordingly, they propose the following definition: "Logistics management is that part of supply chain management that plans, implements, and controls the efficient, effective forward and reverses flow and storage of goods, services and related information between the point of origin and the point of consumption in order to meet customers requirements."(CSCMP, 2014).

2.3 Commercial SCM versus Humanitarian SCM

Humanitarian supply chain management (HSCM) is now an important focus of both the practitioners on the ground and the academicians involved in this field of study due to the rise in occurrence of disasters in recent years. HSCM mobilizes immediately after the occurrence of a disaster with the aim of mobilizing the necessary goods, organizing finance and administering immediate services to the disaster affected peoples. HSCM can also be considered as the supply chain which focuses on "disasters" rather than a commercial or profit-motivated supply chain. The objective of a humanitarian supply chain (HSC) is to manage large-scale risks as well as to minimize the impact of disaster. On the other hand, a commercial supply chain (CSC) may have less socially minded motives for intervention, as a disaster anywhere on the globe can disrupt supplies or destroy markets leading to disruption of commercial activities (Wallace & Webber, 2010). The objectives of humanitarian supply chain (HSC) and CSC are different in their motives and the realms at which they operates are given in Table 2.1.

Table 2.1: Difference between CSCM and HSCM (Adapted from: Sheu (2007a))

S.No.	**Topic**	**CSCM**	**HSCM**
1	Main objective	Maximize profit	Save lives and help beneficiaries
2	Demand pattern	Fairly stable and can be predicted with forecasting techniques	Irregular with respect to quantity, time and place. Demand is estimated within the first hours of response
3	Supply pattern	Mostly predictable	Cash is donated for procurement. Unsolicited donations and in-kind donations need sorting, prioritizing to decrease bottlenecks
4	Flow type	Commercial products	Resources like evacuation vehicles,people, shelter, food, hygiene kits, etc.
5	Lead time	Mostly predetermined	Approximately zero lead time, demand is needed immediately
6	Delivery network Structure	Established techniques to find the number and locations of warehouses, distribution canters	Ad hoc distribution facilities or demand nodes, dynamic network structure

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Table 2.1: Difference between CSCM and HSCM (Adapted from: Sheu (2007a))

S.No.	Topic	CSCM	HSCM
7	Inventory control	Safety stocks for certain service levels can be found easily when demand and supply pattern is given	Unpredictable demand pattern makes inventory control challenging. Prepositioned inventories are usually Insufficient
8	Technology and information systems	Highly developed technology is used with commercial software packages	Less technology is used, few software packages that can record and track logistics data. Data network is non-existent
9	Performance measurement method	Based on standard supply chain metrics	Time to respond the disaster, fill rate, percentage of demand supplied fully, meeting donor expectation
10	Equipments and Vehicles	Ordinary trucks, vehicles and forklifts	Robust equipment are needed to be mounted and demounted easily
11	Human resources	Commercial SCM is now a respected career path	High employee-turnover, based on voluntary staff, harsh physical and psychological environment
12	Stakeholders	Shareholders, customers and suppliers	Donors, governments, military, NGOs, United Nations, etc.

In order to consider the specific context of the humanitarian supply chain, given that these generic definitions are set against the business sector it is appropriate at this point to consider a comparison of the humanitarian supply chain with that for the business sector. Whilst commercial supply chain (CSC) has already been clearly defined by numerous authors (Chopra & Meindl, 2007; Harrison, Van Hoek, & Skipworth, 2005; Mangan, Lalwani, & Butcher, 2008; Slack, Chambers, & Johnston, 2010), the definitions of humanitarian SCM are less prevalent.

2.4 An Overview of Definitions of Humanitarian SCM

HSCM involves the effective and efficient management of different elements in the system i.e. available information, goods and materials, human resources, available infrastructure etc. to reduce the impact of a disaster on the disaster affected people (John & Ramesh, 2012). The HSC and CSC, both are considered as a network of members that supports flow of goods, information and funds from the source to final customers; however, the only difference is that the customer in the case of HSC include the disaster affected peoples as well as the donors who donated to improve the performance of HSC. There is no single definition of the HSCM which explains the complete meaning, issues and tasks of the relief supply chain. However, various authors have defined HSCM under different contexts (Sheu, 2007a) as given in Table 2.2.

Table 2.2: Definitions of HSCM

S. No.	Definition	Author	Context
1	The systematic use of policy instruments to deliver humanitarian assistance in a cohesive and effective manner. Such instruments include strategic planning;gathering data and managing information; mobilizing resources and assuring accountability; orchestrating a functional division of labour in the field; negotiating and with host political authorities; and providing leadership maintaining a serviceable framework	Minear (2002)	Coordination
2	The process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials as well as related information, from the point of origin to the point of consumption for the purpose of meeting the end beneficiarys requirements	Thomas and Mizushima (2005)	Humanitarian logistics
3	To design the transportation of first aid material, food, equipment, and rescue personnel from supply points to a large number of destination nodes geographically scattered over the disaster region and the evacuation and transfer of people affected by the disaster to health care centres safely and very rapidly	Kovacs and Spens (2007)	disaster relief
4	A process of planning, managing and controlling the efficient flows of relief, information, and services from the points of origin to the points of destination to meet the urgent needs of the affected people under emergency conditions	Sheu (2007b)	Emergency logistics
5	The range of activities designed to maintain control over disaster and emergency situations and to provide a framework for helping at-risk persons to avoid or recover from the impact of the disaster. Disaster management deals with situations before, during and after a disaster	Schulz (2009)	Disaster relief

to be cont'd on next page

Table 2.2: Definitions of HSCM

S. No.	Definition	Author	Context
6	Supply chain management (SCM) in humanitarian organizations currently evolves towards increased effectiveness and efficiency in terms of responsiveness and improved resource allocation as e.g. the military sector gained from the corporate world in the latest past	Widera, Dietrich, Hellingrath, and Becker (2013)	Resource planning

The occurrence of disaster is on the rise throughout the world owing to increased rates of urbanization, deforestation and natural debasement because of a worldwide temperature alteration. Intensifying climate variables such as higher temperatures, extreme precipitation and more fierce wind and water storms all have an impact. Disasters, either natural or man-made, affect hundreds of thousands of people every year with immense monetary harm also done. Such calamities are on a relentless upturn. Hence, HSCM that activates immediately after the occurrence of disaster is very much in the spotlight both as a practical and a research topic. This is evident by the enormous growth in publications in this area in the past few years. Therefore, given the increasing number of works published in the HSCM field, there is a need for an updated and detailed review of contemporary research as well as more in-depth assessment for further literature classification.

In this chapter, the papers were reviewed to observe trends, identify the research gaps and to propose future research directions. Existing literature lacks review studies in the area of HSCM. There is a need for a systematic and theme wise classified analysis of recent papers to identify future avenues of research. This paper tries to address this gap. Therefore, the purpose of this study is to conduct a structured and analytical review of previously published studies in the area of HSCM to identify important trends and to explore future research opportunities.A total of 330 papers published between 1982 and 2015 are selected and reviewed.

There is lack of comprehensive review study in HSCM examining the recent and state-of-the-art publications was found in the current literature. Some review studies cover either the definition of HSCM only, while some are partial reviews with specific aims, for example, Altay and Green III (2006) reviewed only operations research (OR) and management science (MS) journals pertaining to OR/MS research in the HSCM area; Kovacs and Spens (2007) discussed the conceptual framework that distinguishes the actors and various phases of the logistical process of disaster relief; Natarajarathinam, Capar, and Narayanan (2009) looked at CSC during a crisis; Abidi, de Leeuw, and Klumpp (2014) examined performance measurement indicators with reference to HSCM.

Among all review/partial review papers, Kunz and Reiner (2012) and Leiras, Jr, Peres, Bertazzo, and Yoshizaki (2014) considered 174 and 228 papers respectively. Notably, none of these studies has covered the theme based classification of published papers in HSCM and most of the authors

have covered papers until 2012 only. The theme based classification provides a valuable resource for both the practitioners on the ground and academicians involved in the field of study. This classification helps to clarify key topics in HSCM. The review study presented in this paper is an attempt to address this critical research gap. In addition, aiming at a specific end goal to shed light on the future direction in HSCM studies, it is important to reconstruct a new review study in light of the recent publications in the area.

2.5 Methodology for Analyzing Previous Studies

Irani, Gunasekaran, and Dwivedi (2010) pointed out various research methods used to examine previous studies in a particular area. These include literature review, historical analysis, bibliometric analysis, meta-analysis and structured analysis. Previous review studies are based on qualitative and quantitative approaches. For example, Gunasekaran and Ngai (2011) described the future of OM research using a qualitative approach. Machuca, del Mar Gonzalez-Zamora, and Aguilar-Escobar (2007) reported on topic and methodological trends and future research directions in the area of service operations using a quantitative approach. The literature review presented in the current paper incorporates the views of both Brewerton and Millward (2001) and Seuring and Mller (2008) by reporting the state of HSCM research through content analysis, involving a blend of quantitative and qualitative methods as presented in Figure 2.2.

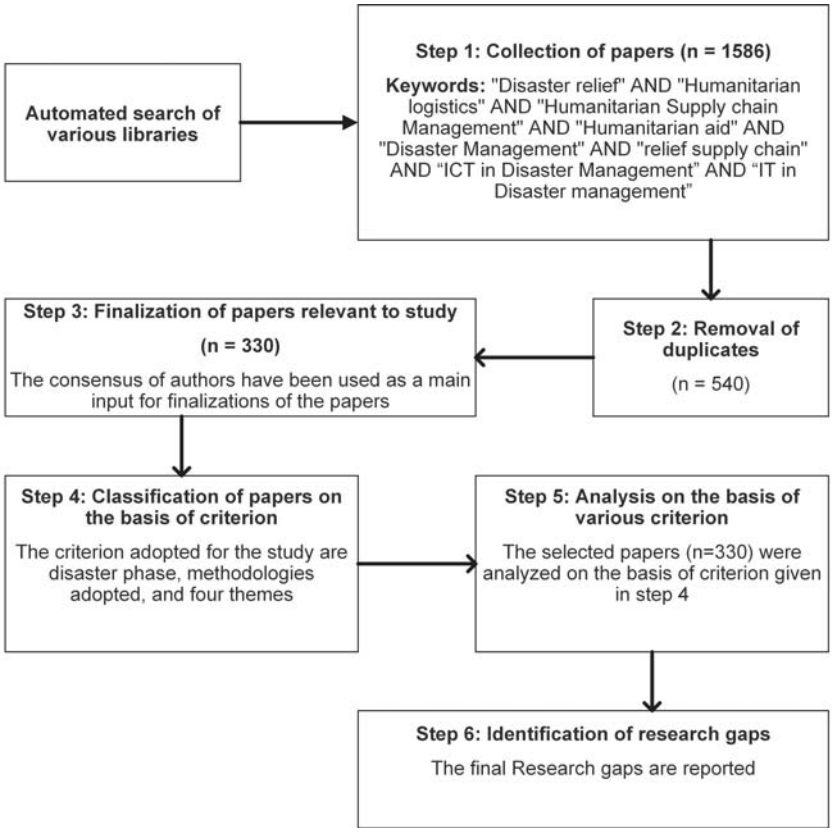

Figure 2.2: Research Process

In order to support steps 3-5 (Figure 2.2) in a more structured way, the four stage process of Mayring (2003), namely material collection, descriptive analysis, category selection and material evaluation were utilized to attain the aforementioned objective of this study.

2.6 Material Collection

The papers for further investigation relevant to the present study were collected in this stage (Mayring, 2003). The principal criteria used in the selection was would this paper be relevant in the area of HSCM? This approach ensures and confirms the inclusion of all key papers in this study. Papers were sourced from various publishers. This includes Elsevier, Emerald, Taylor and Francis, IEEE, Springer, Wiley, Inderscience. In addition, papers were also extracted from various library services such as Google scholar, Scopus, Ebsco. The related papers in the fields of HSCM are selected and reviewed. The related papers in the field of HSCM were then selected and reviewed.

The number of papers collected was 1015. Thereafter, multiple copies of the same paper were removed. The process was repeated for the year 2015 to incorporate the most recent publications in the area under consideration. This procedure reduced the numbers of papers from n=1015 to n=330 relevant for investigation. This is in agreement with Ngai, Moon, Riggins, and Candace (2008) who have examined 85 publications in the area of radio-frequency identification (RFID) between the years 1995 to 2005.

2.7 Descriptive Analysis

This stage provides an important background for subsequent analysis, covering areas such as number of publications per year and general trends of the publications of papers (Mayring, 2003).

2.8 Category Selection

The method used to classify the literature based on the research framework is presented in Figure 2.3. The classification criterion is divided into five blocks with one block showing the intersection of all five criteria. Some of these criteria have already been used in previous literature reviews. However, more criteria from more recent papers are proposed to provide a wholly comprehensive review of the analyzed papers. The categories presented in Figure 2.3 are general paper information such as year wise classification, disaster lifecycle stage, theme based, research method and geographical classification.

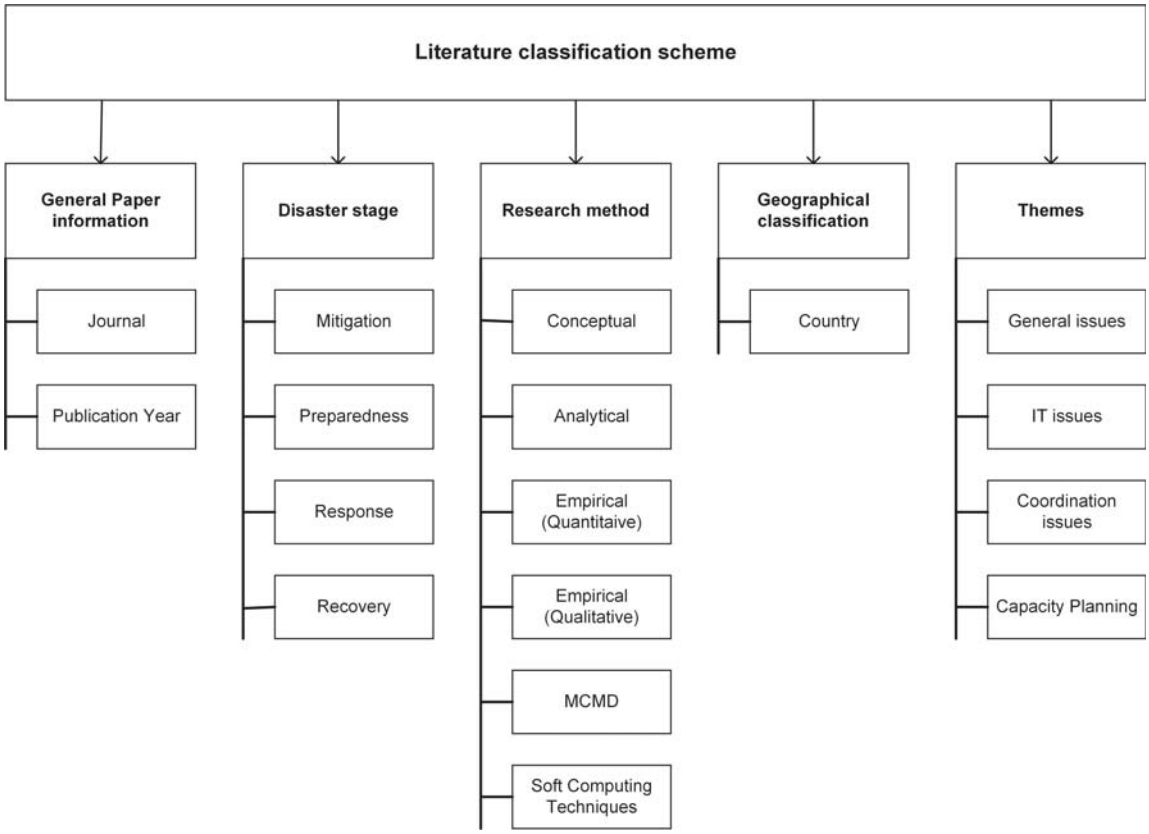

Figure 2.3: Literature Classification Scheme

2.9 Material Evaluation

This study adopts the material evaluation method utilized by Mayring (2003) i.e. the single papers in a single category. Figure 2.4 illustrates the process of evaluation of the papers for this study. Initially, the paper was reviewed and finalized on the basis of themes adopted for this study (refer Figure 2.4). For the purpose of the classification of the studies, the cross-checking method was adopted to ensure the reliability and validity of the study. The input from the authors of this study has been used for classification purposes. Firstly, the authors have classified the papers separately on the basis of criteria. Secondly, the results were compared and the papers were classified on the basis of the consensus of the authors. Thereafter, the papers on which no clear categorization emerged in the second phase were again reviewed by the authors for consensus.

This procedure followed Machuca et al. (2007), whereby in cases where it was not possible to clearly determine the true focus of the article, a consensus amongst the authors determined whether it should be accepted or rejected. Finally, the suggestions of the professors (who have more than 25 years of experience) have been used to address any ambiguity among the authors. This gave an added quality of academic judgment so that finally, all of the 330 papers were classified.

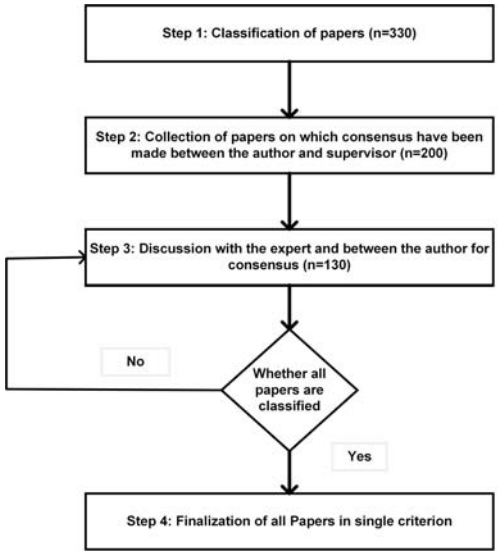

Figure 2.4: Research Procedure for Classification of Papers

2.10 Results

The result of this study provides valuable insights for those practitioners on the ground as well as academicians involved in this field of study. This is discussed in the subsequent sections.

2.10.1 Disaster Stage Based Classification

The following are the four stages identified in disaster management i.e. mitigation, preparedness, response and recovery (Altay & Green III, 2006). The distribution of papers according to disaster stage is presented in Figure 2.5. This study followed the criteria adopted by both Altay and Green III (2006) and Leiras et al. (2014). The activities to prevent the occurrence of disaster or to reduce the impact of disaster on society are considered in the disaster mitigation stage. Hence, the articles on risk measurements and risk analysis were classified in the mitigation stage. The studies focusing on issues related to education, training and planning to reduce the impact of disaster were classified in the preparedness phase. Disaster mitigation and the preparedness stage are the stages in place before the occurrence of disaster. In contrast to this, the disaster response and recovery stages are stages undertaken after the occurrence of disaster.

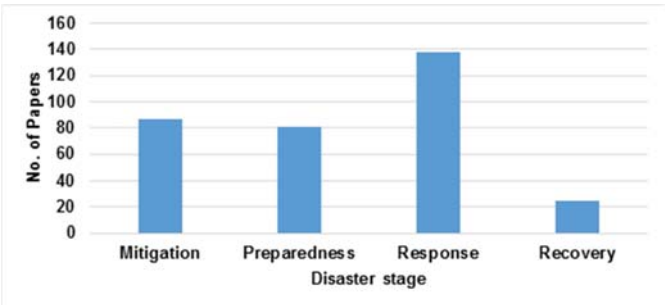

Figure 2.5: Disaster Stage based Classification of Papers

The response stage comprises the emergency procedures employed in the immediate aftermath in order to provide assistance to the affected peoples. The recovery stage comprises of post disaster economic recovery planning for the community. This aims to return conditions back to normal by focusing on long term recovery, reconstruction and rehabilitation measures. The results indicate an emphasis on the response stage followed by preparedness, response and mitigation stage. The results clearly highlight the need for more research in the recovery stage.

2.10.2 Descriptive Result of the Studies

The studies in the area of HSCM are classified on the basis of journal title and publication year. This is in agreement with Leiras et al. (2014) and Natarajarathinam et al. (2009). The annual distribution of papers per year according to the disaster stage is shown in Figure 2.6 .

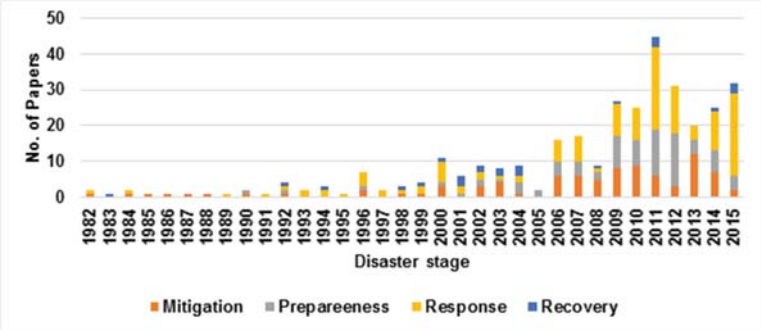

Figure 2.6: Annual Distribution of Papers and Disaster Phase

It is evident from Figure 7 that the number of articles is clearly increasing in the whole area of HSCM. However, there was a sharp increase during the period of 2011. Thereafter, the area has received significant attention from many researchers throughout the world. In total, 330 studies were considered for this study with a significant number of these publications occurring after the year 2000.

The results also indicate an emphasis on the response phase from the year 2006 onwards. In addition, it is also evident from Figure 7 that there was a dearth of studies in the area of HSCM prior to 2000, indicating that it was an under-explored field. There has been a sharp increase in the number of publications on the subject in the past few years, especially after 2010, when journals published special issues. Several new journals have started up since 2010 in the area of disaster and HSC management. Publishing groups involved include Elsevier, Emerald and Wiley. These include the Journal of Humanitarian and Supply Chain Management, International Journal of disaster risk reduction and the Journal of Crisis Management.

2.10.3 Research Method

The classification of research method employed in this study was adopted from the previous literature reviews (Altay & Green III, 2006; Dobrzykowski, Saboori Deilami, Hong, & Kim, 2014;

Leiras et al., 2014; Natarajarathinam et al., 2009; Perego, Perotti, & Mangiaracina, 2011). The research methods identified are literature review, conceptual, case study, empirical (quantitative), empirical (qualitative), analytical, multi criterion decision making (MCDM) problems and soft computing techniques.

The conceptual studies are comprised of frameworks, conceptual models or an approach to disaster management. For example, Herzog (2007) developed a model for natural disaster administration. Literature review studies include critical discussion and the summary of previous studies. For example, Ortuño et al. (2013) discussed the use of information systems in humanitarian logistics. The research methods such as mathematical modeling and simulation were classified in the analytical category. The main objectives were to minimize the response time, examine logistics, cost etc. and also ensure that the supply/vehicle availability, security and accessibility were in place. For example, Ertem, Buyurgan, and Rossetti (2010) proposed a multiple-buyer procurement auctions framework to help the humanitarian organizations to supply the relief material to disaster sites more efficiently.

The empirical studies are classified into two categories i.e. qualitative and quantitative. The qualitative studies illustrate collection of data in the form of text, images drawn from observations, meetings, narrative confirmation and examining the utilization of qualitative data analysis methods such as case study etc. For example, knowledge management issues were analyzed and the need for more utilization of IT was highlighted in order to store knowledge for future use (Thanurjan & Indunil P. Seneviratne, 2009). In addition, case study methods and other methods like the Delphi technique, action research or field experiments are also classified as qualitative studies. For example, the perceptions of stakeholders such as disaster victims, managers and volunteers involved in the relief operations were measured to help address the challenges faced in HSCM. On the other hand, the quantitative studies show collections of data in the form of numbers and further analyze data using statistical methods such as analysis of variance (ANOVA), regression etc.

The studies which have utilized analytic hierarchy process (AHP), analytic network process (ANP) and techniques for order of preference by similarity to ideal solution (TOPSIS) are classified as MCDM techniques. For example, MCDM techniques are utilized to prioritize the barriers to coordination in HSCM. Some research papers have utilized neural networks, genetic algorithm, ant colony optimization, fuzzy classification and other optimization techniques such as particle swarm optimization in order to find the optimum solutions. These papers were classified in the soft computing techniques. For example, Rath and Gutjahr (2014) utilized "math-heuristic" technique, mathematical programming within a heuristic framework to solve warehouse location-routing problems after the occurrence of disaster. The distribution of papers by the disaster stage and the research method are shown in Figure 8.

The results suggest that the conceptual studies are predominant over analytical studies followed by empirical(qualitative) and soft computing techniques. The literature review (LR), empirical (quantitative) and MCDM techniques are among the least used research methods in previous

studies. Research using empirical (qualitative), analytical and conceptual methods is mainly used for those studies involving the disaster response phase. The conceptual studies are used in all four disaster phases. The soft computing research techniques are mainly used in the disaster response and recovery phases. The empirical (quantitative) method and MCDM research method were used mainly in the area of the disaster response phase. The LR research method mainly focused on the preparedness phase. It is also evident from Figure 2.7 that the disaster response and recovery phase are more dominant over other phases in terms of the publications in the whole area of HSCM.

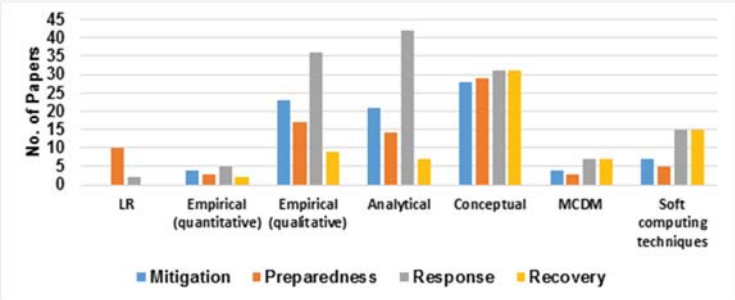

Figure 2.7: Research Method and Disaster Stages

2.10.4 Publication by Country

Table 2.3 illustrates the publication distribution by country for the studies published in the area of HSCM. In this paper, only those countries which have produced at least seven publications in the area of HSCM were considered. This paper has made the classification for each respective country on the basis of the area under study; if the context is not specified then the corresponding authors country has been taken as the basis for classification. It is evident from Table 4 that the USA is the main contributor in terms of studies in the area of HSCM. The table indicates that the USA and Europe have the highest number of papers in total i.e. 129 and 99 respectively.

Table 2.3: Country based Publications

Country	Papers
USA	159
UK	137
Netherlands	18
Turkey	17
France	14
Germany	14
Austria	13
Finland	12
Japan	12
Norway	10
Spain	10

to be cont'd on next page

Table 2.3: Country based Publications

Country	Papers
Canada	9
India	8

2.11 Theme Based Analysis

The review process comprises of the classification of the papers under study on the basis of structural aspects such as topics or themes (Mayring, 2003). This dimension addresses the research questions under study, namely: (1) What are the principal topics or themes in the extant humanitarian supply chain management (HSCM)? The themes used for the purpose of classification of papers under study in order to inform the above research question are given in Table 5. The themes adopted for this study have been accepted from the classification used by previous researchers (Dobrzykowski et al., 2014; Machuca et al., 2007).

The distribution of papers by the topics under consideration is presented in Figure 2.8. It is clearly evident from Figure 2.8 that more studies have focused on the general issues around HSCM and the capacity planning issues in HSCM. Despite the promising benefits of the utilization of IT as highlighted by various researchers (Balcik et al., 2010; Beamon, 2004; Long & Wood, 1995; Tomasini & Van Wassenhove, 2004), the results indicate that there is a strong need for research in the area of utilization of IT in HSCM. To understand the importance given to themes in previous studies, the subsequent section discusses the theme "Information Technology issues in HSCM" (issue under investigation) with respect to the four stages of disaster management. This will help in understanding the emphasis given to the theme in addressing specific stages of disaster management.

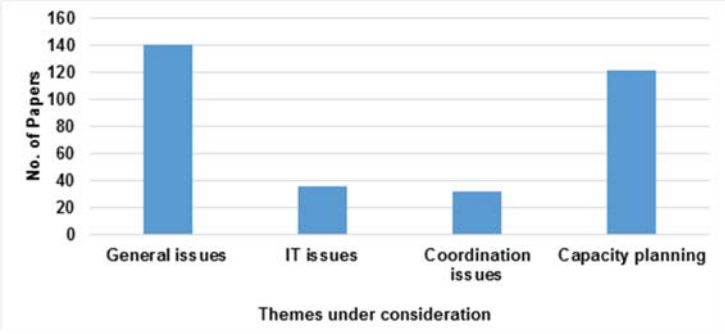

Figure 2.8: Theme based Classification of Papers

This theme examines studies related to the key issues or factors affecting the HSCM. Figure 2.9 illustrates that the conceptual studies were predominant under this theme.

It is also evident from Figure 2.10 that the studies under this theme focus primarily on the disaster mitigation stage followed by preparedness, response and recovery stage.

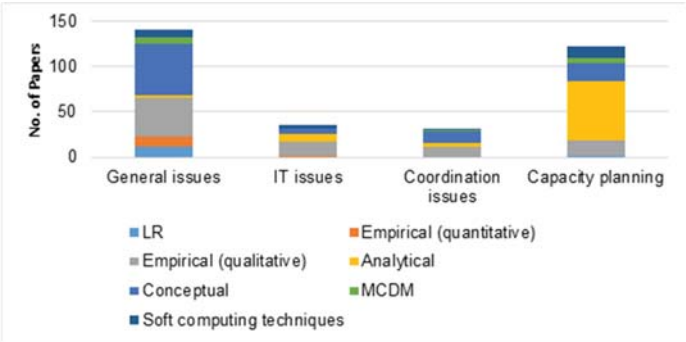

Figure 2.9: Theme and Research Methods

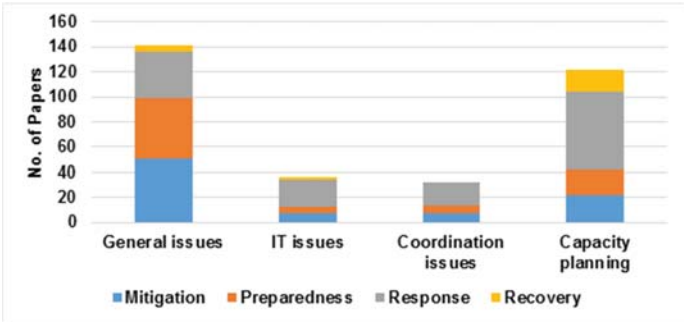

Figure 2.10: Theme and Disaster Stage

Figure 2.10 clearly demonstrates that there is a lack of studies focusing on recovery stage with regard to this theme. The above Figures clearly demonstrate the need for more research in the area of IT utilization in HSCM. The use of IT allow local communities to be made more aware about the probable cause of the disaster in a disaster prone area. Therefore, the research presented in this thesis highlights various issues to IT utilization in HSCM.

2.12 Motivation to adopt IT in HSCM

Disasters, be it natural or man-made have caused tremendous human sufferings, property damage and environment damage each year. The utilization of technology supports all the phases of disaster management but IT usage in HSC has not gained enough attention from the research point of view. On the other hand, IT have brought about unprecedented convenience and possibilities in the HSC. The international community, national authorities and the private organizations have realize the importance of IT in mitigating the impact of disasters. Indeed, over the recent years, the international community has recognized the role and importance of the information Technology (IT) in the HSCM area. For example, Hu and Kapucu (2014) emphasized that the use of IT in HSC enhances the coordination among actors e.g. IT offers more transparency and accountability towards donors as well as other actors. This will increase trust among the actors which then further enhances the information sharing among actors and finally, maximizes the coordination among actors, which is the major bottleneck in the coordination problem Kovacs and Spens (2007); H. W. Lee and Zbinden (2003); Sandwell (2011). However, still this area has not

gained enough attention from the research point of view. Therefore, this research is an attempt to fill this critical research gap.

The theme (IT issues in HSCM) represents only a very few (38) studies as compared to other themes such as general issues and capacity planning in this review. Figure 2.9 illustrates that the empirical (qualitative) research methods were predominant under this theme and research papers focuses more on the disaster response stage (Figure 2.10). It is evident from Figure 2.12 that there is a lack of studies focusing on the recovery stage. Several IT systems utilized in the past relief operations are given in Table 2.4.

Table 2.4: Disaster Management System

Disaster management systems	Disaster
Sahana Disaster Management Systems	Tsunami (2004)
Sarvodaya.org	Tsunami (2004)
IMASH	Hurricane Disasters (2001)
Case Management Systems in Singapore	SARS (2003)
DesInventar Systems	Latin America, Orissa, South Africa

2.12.1 Various IT Solutions for Disaster Management

IT solutions can range from something as simple as an email to an expert system for HSCM, For example:

1. **GIS (Geographical Information Systems):** A Geographic Information System or GIS is a computer system that allows you to map, model, query, and analyze large quantities of data within a single database according to their location. GIS gives you the power to create maps.

2. **EWS (Early Warning Systems):** An early warning system, or specifically a functional early warning system can be implemented as a chain of information communication systems and comprises sensors, event detection, decision support, and message broker subsystems, in a given order, working in conjunction, forecasting and signaling disturbances adversely affecting the stability of the physical world; and giving sufficient time for the response system to prepare resources and response actions to minimize the impact on the stability of the physical world.

3. **GPS (Global Positioning Systems):** The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites.

4. **Remote sensing:** Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object and thus in contrast to on site

observation. In modern usage, the term generally refers to the use of aerial sensor technologies to detect and classify objects on Earth (both on the surface, and in the atmosphere and oceans) by means of propagated signals (e.g. electromagnetic radiation).

5. **Electronic mail:** E-mail (electronic mail) is the exchange of computer-stored messages by telecommunication. (Some publications spell it email; we prefer the currently more established spelling of e-mail.) E-mail messages are usually encoded in ASCII text. However, you can also send non-text files, such as graphic images and sound files, as attachments sent in binary streams.

6. **Electronic data exchange:** Electronic data interchange (EDI) is an electronic communication method that provides standards for exchanging data via any electronic means.

2.12.2 Drivers for IT Enablement of HSCM

The use of IT is considered vital for emergency management (Jennex, 2005, 2007, 2015; Sriramesh, Wattegama, & Abo, 2007; Turoff, Chumer, de Walle, & Yao, 2004). IT supports all the four phases of disaster such as mitigation, preparedness, response and recovery. For example, Hobeika, Kim, and Beckwith (1994) developed a transportation evacuation DSS (TEDSS) to assist the managers for evacuation plans around nuclear power stations. Manivannan and Guthrie (1994) developed a fatal incident decision model (FINDM) to assist the forensic scientists involved in the skeletal ID process after the occurrence of a mass casualty.

Various researchers have previously noted that the use of IT can enhance the efficiency of relief operations Cate (1994); Gustavsson (2003); Kehoe and Boughton (2001); Patterson (2005); Pettit and Beresford (2009); Tomasini and Van Wassenhove (2009). IT makes it much easier to integrate various activities such as transportation, logistics and procurement. It also provides useful and immediate information for the effective and efficient management of relief activities Beaumaster (2002); Pettit and Beresford (2009); Roh et al. (2008). The utilization of IT within the supply chain makes it possible to react more quickly and more effectively with the available information to hand and to access relevant supports from a greater number of sources.

The researchers have emphasized that the adoption of advanced IT systems in HSCM has been quite slow in comparison to CSC. In spite of benefits, the utilization of IT is found to be the most important problem among the stakeholders, from both the government and the private sector in HSCM McLachlin and Larson (2011); Sandwell (2011); Thomas (2003); Whiting and Ayala-Ostrm (2009). Therefore, the Table 2.5 given below explains the enablers for the IT enablement of HSCM in Indian context.

Table 2.5: Enablers for IT enablement in HSCM

S.No.	Enablers	Definition	References
S1	Commitment from top management	Top management commitment means the intention to advocate and support the process at every stage.	Christopher and Peck (2004); Dronavajjala, Nichenametla, and Sahu (2009); McEntire (2002); S. K. Schneider (1995); Thevenaz and Resodihardjo (2010); Tierney (1985)
S2	Strategic tie-up among the commercial and humanitarian organization	Strategic tie-ups refer to the joint work of two or more organizations for the betterment of relief activities not only during a disaster but also before a disaster.	Maiers et al. (2005); McEntire (2002); Schulz and Blecken (2010)
S3	Effective policy for IT adoption	IT policy refers to guidelines that promote the interaction among HSC actors to remove the obstacles in the process of IT implementation.	Jefferson (2006a); Maiers et al. (2005); Schulz and Blecken (2010)
S4	Employee motivation	Employee motivation is the level of energy, commitment, and creativity that a company's workers bring to their jobs.	McEntire (2002); Moshtari and Gonçalves (2012)
S5	Build trustworthy environment among the actors in HSCM	A trustworthy environment refers to an environment that supports information sharing, which is essential for motivating the actors toward a higher level of coordination.	Maiers et al. (2005); McEntire (2002); Moshtari and Gonçalves (2012); Sheffi and Rice (2005)
S6	Retention of skilled and experienced workers	There is strong need to develop policy for retention of skilled and experienced workers. Retaining skilled and experienced workers helps ensure customer service, satisfied coworkers and staff.	Balcik et al. (2010); Maiers et al. (2005)
S7	Donor support	The utilization of ICT in HSCM needs a large amount of funds, effort, time. Hence it requires huge support and commitment from donors. Donors commit funds on a regular basis, which provide the support for effective working of organizations.	Balcik et al. (2010); Jefferson (2006a); Kovacs and Spens (2009); Maiers et al. (2005)

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Table 2.5: Enablers for IT enablement in HSCM

S.No.	Enablers	Definition	References
S8	Access to financing and capitalization	The utilization of ICT in HSCM needs a large amount of funds. Access to finance refers to the ability of an organization to obtain necessary financial support and services such as funds, deposit, payment, insurance, and other risk management services.	Agostinho (2013); Balcik et al. (2010); Gustavsson (2003); Kovacs and Spens (2009); Maiers et al. (2005)
S9	Establish a transparent work flow or open door policy	A transparent work flow encourages information sharing among actors at all levels of supply chain and ensures agility, adaptability, and alignment in the chain. The financial supply chain needs to be accountable and transparent so donors can see how the money that donate is utilized	Agostinho (2013); Sheffi and Rice (2005); Thomas and Kopczak (2005)
S10	Long term focused planning	Long-term planning is essential for establishing the responsibilities of actors so that system wide improvements can be made.	Agostinho (2013); Kovacs and Spens (2007); Maiers et al. (2005); Moshtari and Gonçalves (2012); Natarajarathinam et al. (2009); Pettit and Beresford (2005); Schulz and Blecken (2010)
S11	Government support	The government can make necessary changes in the policies to introduce more subsidy programmes such as indirect tax benefits, monetary benefits etc. to support the process of more utilization of ICT by those organizations involved in HSCM.	Gustavsson (2003); Kovacs and Spens (2009); Maiers et al. (2005); Sandwell (2011)
S12	Industry funding	The industry should support this process by providing sufficient funds for R&D work at the university/ institution level.	Agostinho (2013); Gustavsson (2003); Kovacs and Spens (2009); Maiers et al. (2005)

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Table 2.5: Enablers for IT enablement in HSCM

S.No.	Enablers	Definition	References
S13	Feedback mechanism to facilitate learning from prior experiences	A feedback mechanism refers to learning from the mistakes of earlier relief operations so they will not be repeated.	Agostinho (2013); Balcik et al. (2010); Thomas and Kopczak (2005)
S14	Coaching/training to the employees	Training is critical for capacity building so trained personnel can respond more effectively and efficiently to different kinds of disasters.	Kovacs and Spens (2009); Maiers et al. (2005); Overstreet et al. (2011); Sandwell (2011)
S15	Onsite disaster management process expert	There is need for an disaster management expert with diverse experience in emergency management. This will improve the effectiveness of the relief operations.	Boin (2005); Maiers et al. (2005); McConnell (2003); Moshtari and Gonçalves (2012)
S16	Supply chain expert	Supply chain expert should have all the knowledge about the process and management of SC	Gustavsson (2003); Maiers et al. (2005); Overstreet et al. (2011)
S17	Information technology expert	Information Technology expert knows and understand all the barriers and enablers for adoption of IT	Gustavsson (2003); Maiers et al. (2005)
S18	Enhance awareness about the benefits of IT in HSCM	IT systems can be used to store, retrieve, and share information for processing across organizational boundaries.	Agostinho (2013); Balcik et al. (2010); DeJohn (2005); Maiers et al. (2005); McEntire (2002); Schulz and Blecken (2010)
S19	Coordination among the actors during all phases of disaster management	Improving cultural cohesion facilitates the development of employees at every level regarding what the supply chain needs from them as an individual or as a part of team and supports information sharing.	Balcik et al. (2010); Kleindorfer and Saad (2005); Schulz and Blecken (2010)

2.13 Distribution of Papers on IT Issues in HSCM

IT supports all the four phases of disaster such as mitigation, preparedness, response and recovery. The distribution of studies according to different disaster stages are given below:

2.13.1 Disaster Mitigation

This section discusses the role of IT in estimating the probable impact of disaster before its occurrence utilizing analytical and empirical (qualitative) research methods. For example, the use of IT assists the communication process, provides enhanced access to past experiences and generates timely warning signals in the probable disaster area. This can allow evacuation of the people from that area, thus reducing the effect of these disasters on the local population. The probable impact of a natural disaster can be estimated before the occurrence with the help of computer simulation, while the impact of a disaster can be examined with the help of computer graphics (Patterson, 2005). Therefore, following research gap (RG) is proposed under this stage:

RG 1: Lack of studies which focuses on LR, Empirical (quantitative), MCDM research methods, empirical (qualitative), analytical, MCDM problems and soft computing techniques research methods.

2.13.2 Disaster Preparedness

This section discusses the issues affecting the utilization of IT in HSCM using empirical (qualitative) studies. For example, Maiers et al. (2005) have reported various IT issues in HSCM such as low use of IT, poor IT infrastructure, a need for more effective planning etc. Appropriate use of IT within the supply chain makes it possible to react more quickly to the available information, to process more information more frequently, more accurately and from more sources from all over the globe by using sophisticated analysis, modelling and decision support capabilities (Kehoe & Boughton, 2001). These challenges, which not only affect the whole system, also affect each other. Relationships among these barriers have not been identified in current literature. Therefore, following research gaps (RG) are proposed under this stage:

RG 1: Lack of studies which focuses on LR, Empirical (quantitative), and MCDM research methods.
RG 2: Lack of studies investigating the barriers to the proliferation of IT in the context of HSCM.

2.13.3 Disaster Response

This section discusses the use of IT after the occurrence of disaster using analytical and empirical (qualitative) studies. For example, IT makes it much easier to integrate various activities such as transportation, logistics and procurement. It also provides useful and immediate information for the effective and efficient management of relief activities (Pettit & Beresford, 2009; Roh et al., 2008). The utilization of IT within the supply chain makes it possible to react more quickly

and more effectively with the available information to hand and to access relevant supports from a greater number of sources. For example, Hobeika et al. (1994) developed a transportation evacuation DSS (TEDSS) to assist the managers for evacuation plans around nuclear power stations.

Manivannan and Guthrie (1994) developed a fatal incident decision model (FINDM) to assist the forensic scientists involved in the skeletal ID process after the occurrence of mass casualties. Community Disaster Information System (CDIS) was developed using information technology for enhancing community-based disaster preparedness (Troy et al., 2008). Such systems can assist in disaster management to reduce the suffering of the resulting victims. There has been significant growth in the use of GISs and GPSs systems. All of these systems are found to be very useful in effective management of scarce resources (Board on Natural Disasters, National Research Council, Washington (1999)). There seems to be a need for more studies in the area of soft computing or simulation based exercises as they can be used to imitate the real situation to assess what may happen if some relief operations do not reach a specific location in a given time. It may predict the impact of disaster in advance and can help to plan or dedicate the required resources accordingly. Therefore, following research gap (RG) are proposed under this stage:

RG 1: Lack of studies focuses on LR, Empirical, conceptual and MCDM research methods.

2.13.4 Disaster Recovery

This section discusses the use of IT after the occurrence of a disaster management phase utilizing analytical and empirical (qualitative) research methods. For example, advanced technologies have the capability to improve acute medical care for mass casualty victims from the disaster site to the hospital by highlighting the importance of an effective integrated information and telecommunications network system. Therefore, following research gap are proposed under this stage:

RG 1: Lack of studies which focuses on LR, Empirical (quantitative), conceptual, MCDM and soft computing research methods.

2.14 Barriers to the Proliferation of IT

Despite the promising benefits of IT in relief operations, a number of challenges have hampered the full utilization of technology that can really help. These challenges, which not only affect the whole system, also affect each other. Therefore, obstacles to coordination are classified into two categories, i.e. internal and external barriers. To explain further in-depth the foremost factors that affects the coordination are analyzed in the subsequent section:

2.14.1 Internal Barriers

Many researchers have demonstrated the barriers to the proliferation of IT in HSC such as poor IT infrastructure, Lack of IT experts. The low level of supply chain understanding often complicates the IT adoption issues in the organizations. The attitudes the reluctance towards IT may prevent the organizations from being involved in the adoption of IT applications. Odedra-Straub (1993) supports the poor IT infrastructure issue in developing countries and highlights that due to poor IT infrastructure, people are not able to gather information and collaborate with each other to solve their problems.

The utilization of IT in HSCM needs a large amount of funds, effort, time, support and commitment from top management, starting from the first phase. However, top management regard investment in IT systems as an overhead cost (Maiers et al., 2005), so the utilization of IT in HSCM is not a priority for organizations. The investment in IT systems is generally considered as an overhead cost rather than as a fundamental activity in the organizations involved in the relief operations (Maiers et al., 2005). Hence, investment in IT is not on their priority list. Kapucu and Garayev (2012) also supported the view that the utilization of IT called for more investment in IT infrastructure. The organizations involved in the relief operations do not have the proper infrastructure needed for IT systems.

Finally, the organizations have limited awareness about the IT solutions (Maiers et al., 2005). Besides, there is great difficulty in selecting and quantifying the "intangible" benefits that the utilization of IT offers to improve coordination. The costs associated with the adoption of IT solutions is regarded as one of the major obstacle in the implementation of IT applications.

2.14.2 External Barriers

The key issues noted by the practitioners and the researchers is the donor's behavior. Murray (2005) highlighted that the behavior of donors reflects that their money is expected to be used to help after the occurrence of an event (Whiting & Ayala-Ostrm, 2009). This means that prevention measures are often neglected, particularly in developing countries (Kovacs & Spens, 2007; Maiers et al., 2005). Thomas (2003) also supported the view that the behavior of donors is among the major stumbling blocks which resists the actors from developing processes and systems to improve the performance of HSC.

A huge amount of funds is required for the successful implementation of ICT in HSCM, but the behavior of donors does not encourage investment in improved systems (Thomas, 2003; Whiting & Ayala-Ostrm, 2009). The restricted and short-term nature of donor funding complicates strategic investment to enhance IT infrastructure (Maiers et al., 2005). Donors hesitate to provide funding for enhancing the basic facilities needed for the full utilization of IT due to the absence of transparency and accountability mechanisms in HSC (Agostinho, 2013; Thomas & Kopczak, 2005). The list of barriers is given in Table 2.6.

Table 2.6: Barriers to the Proliferation of IT in HSCM

S.No.	Barrier	Definition	References
1	Lack of top management commitment	Resistance of top management to change existing investments, information systems and habits make the adoption/implementation of IT system challenging.	Lester and Krejci (2007); Moshtari and Gonçalves (2012); Oloruntoba and Gray (2006)
2	Lack of strategic planning	There is absence of proper planning to support the process of adoption/implementation of IT	Balcik et al. (2010); McEntire (2002); Oloruntoba and Gray (2006)
3	Lack of supply chain understanding	Resistance of top management toward the adoption of IT due to lack of supply chain understanding	Agostinho (2013); Balcik et al. (2010)
4	Lack of clear policies to support the adoption of IT	Regulatory authorities are not able extend proper support to the process of the adoption of IT.	Boin, Kelle, and Whybark (2010); Kovacs and Spens (2011b); Maiers et al. (2005); McConnell (2003); Moshtari and Gonçalves (2012); Tzeng, Cheng, and Huang (2007); Whiting and Ayala-Ostrm (2009)
5	Lack of awareness about IT	The organization involved in HSC area are generally unaware of the benefits of IT in relief operations.	Balcik et al. (2010); Beaumaster et al. (1999); McEntire (1999); Thompson (2012)
6	Lack of mutual trust among the actors	Lack of mutual trust among the actors is a psychological barrier.	Byman, Lesser, Pirnie, Benard, and Waxman (2000); Fugate, Sahin, and Mentzer (2006); Maspero and Ittmann (2008); Moshtari and Gonçalves (2012); Sandwell (2011); Tapia, Maldonado, Tchouakeu, and Maitland (2012)
7	Non availability of IT experts	Inability to find an IT expert required to initiate and manage the process of IT enablement.	Beaumaster et al. (1999); Maiers et al. (2005); Schulz and Blecken (2010)

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Table 2.6: Barriers to the Proliferation of IT in HSCM

S.No.	Barrier	Definition	References
8	Non availability of supply chain experts	Lack of enough experts who have the understanding of supply chain. Basically, the fundamental obstacle to adopt IT in business process is lack of supply chain of expert.	Gustavsson (2003); Maiers et al. (2005)
9	Lack of interaction with industry players	There is absence of regular meetings with the industry players which make the process of adoption of IT a challenge	Byman et al. (2000); Fugate et al. (2006); Maspero and Ittmann (2008); Moshtari and Gonçalves (2012); Sandwell (2011); Tapia et al. (2012)
10	Lack of policy for retention of skilled and experienced employee	Regulatory authorities are not able extend proper support to the skilled and experienced employees. There is absence of policy in HSC area for retention of skilled and experienced employee.	Agostinho (2013); Oloruntoba and Gray (2006); Thomas and Kopczak (2005)
11	Lack of funds for investment in IT	Lack of enough funds for the investment in IT. Basically, this the fundamental obstacle in improving the performance of HSC.	Balcik et al. (2010); Gustavsson (2003); H. W. Lee and Zbinden (2003); Long and Wood (1995); Maiers et al. (2005)
12	Lack of donor support towards adoption of IT	A huge amount of funds is required for the successful implementation of ICT in HSCM, but the behavior of donors does not encourage investment in improved systems	Balcik et al. (2010); Moshtari and Gonçalves (2012); Murray (2005); Thomas (2003)
13	Lack of industry support toward adoption of IT	Industries are generally unaware of the implementation of IT in HSC area.	Balcik et al. (2010); Moshtari and Gonçalves (2012); Murray (2005); Thomas (2003)

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Table 2.6: Barriers to the Proliferation of IT in HSCM

S.No.	Barrier	Definition	References
14	Lack of in-kind financial support	Finance plays major role in the adoption of IT in HSC. The HSC lacks in-kind financial support.	Boin et al. (2010); Maiers et al. (2005); Moshtari and Gonçalves (2012); Whiting and Ayala-Ostrm (2009)
15	Lack of transparency in financial supply chain	Non-availability of appropriate technology/process within the supply chain for transparency in the utilization of funds available.	Agostinho (2013); Kovacs and Spens (2009); Oloruntoba and Gray (2006); Thomas and Kopczak (2005)
16	Lack of motivation to adopt IT	The organizations are not encouraged to adopt IT in their internal supply chain	Agostinho (2013); Oloruntoba and Gray (2006); Sandwell (2011); Thomas and Kopczak (2005)
17	Lack of education and training to the employees	Employees of the organizations involved in HSC area need training to adopt IT in their business process.	Agostinho (2013); Beaumaster et al. (1999); Kovacs and Spens (2011b); Maiers et al. (2005); Thevenaz and Resodihardjo (2010)
18	Inadequate information sharing among employees	Restriction in information flow across the organization involved in HSC area makes the adoption of IT a big challenge	Balcik et al. (2010); McEntire (2002); Van Wassenhove (2006)
19	Lack of willingness to adopt and use IT	Actors are unwilling to adopt and use IT in business process due to fear of losing job.	Balcik et al. (2010); Beaumaster et al. (1999); McEntire (2002)
20	Lack of IT skills in employee	The organizations involved in HSCM lack the essential IT skills such as knowledge about computers, Emails, etc.	Balcik et al. (2010); Oloruntoba (2010); Tomasini and Van Wassenhove (2009)

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Table 2.6: Barriers to the Proliferation of IT in HSCM

S.No.	Barrier	Definition	References
21	Lack of technical assistance to the employee	Continuous improvement by means of training is vital for the implementation of IT. Lack of technical assistance to the employees often complicates the process of IT implementation.	Byman et al. (2000); Fugate et al. (2006); Moshtari and Gonçalves (2012); Sandwell (2011); Tapia et al. (2012)
22	Disparity in IT facility among actors involved	The utilization of IT SCM goes through a series of stages starting from IT adoption in an organization inter and intra SC processes, then the mutual trust and information sharing among other organizations will bring all other members of SC on same platform through IT integration.	Agostinho (2013); Hu and Kapucu (2014); Maiers et al. (2005)
23	Lack of proper IT infrastructure	The organizations involved in HSC are lacks proper IT infrastructure essential for the adoption of IT.	Agostinho (2013); Maiers et al. (2005); Ponomarov and Holcomb (2009); Sandwell (2011); Schulz and Blecken (2010)
24	Lack of IT supporting facilities such as power	The organizations lacks IT supporting facilities such as power.	Maiers et al. (2005); Ponomarov and Holcomb (2009); Sandwell (2011)
25	Lack of R&D research	R & D research in the area of IT implementation in HSC is an area required immediate attention.	Gustavsson (2003); Maiers et al. (2005); Ponomarov and Holcomb (2009); Sandwell (2011)

2.15 Discussion

The study presented in this paper follows the premise of Brewerton and Millward (2001) in that the quantitative analysis allied with the qualitative analysis of some important papers is a prerequisite for a good review study. The findings of this study are expected to provide valuable insights for practitioners on the ground as well as the researchers involved in the field of study.

Thus, the current study makes a number of important contributions by examining published studies in the area of HSCM; (1) using quantitative methods to identify themes of current investigation, (2) quantify methodological trends, (3) describe qualitatively the directions for future research. All of these are important contributions that may be of interest to the vast and growing audience in HSCM studies. Practitioners will be especially interested in the previous section which provides a comprehensive description of the research themes and to a lesser extent, the discussion of future research.

This section discusses overall results presented in the previous sections by following an integrated and holistic approach. This chapter indicates that after the occurrence of the tsunami in the Indian Ocean in 2004, the frequency of studies in HSCM has received significant attention with an increase again in 2012. It has remained at peak levels since then. This trend indicate that leading journals such as "Production and Operations Management", "International Journal of Logistics & distribution management", "Disasters", "Disaster Prevention and Management" are attempting to address the need for more research in HSCM area, along with new journal "Journal of Humanitarian Supply Chain Management", "International Journal of disaster risk reduction" and "Risk, Hazards & Crisis in Public Policy".

The results confirm the findings of Kunz and Reiner (2012) that the contemporary papers in the area of HSCM focus primarily on disaster relief, with the continuing humanitarian aid almost overlooked. The reason for this is that continuing aid is often merged with long term planning to improve the efficiency of relief operations. Generally, most of the studies focus either on natural or on both natural and man-made disasters. Few papers deal specifically with man-made disasters. The problem of reaching the regions impacted by man-made disasters is certainly a significant reason for less research being conducted in this area.

The findings indicate an emphasis on the response stage followed by mitigation, preparedness and recovery stage. This study validates the findings of earlier review studies (Altay & Green III, 2006; Kovacs & Spens, 2007; Natarajarathinam et al., 2009; Overstreet et al., 2011) showing that there is a need for more research in the disaster recovery stage. Although the recovery stage creates less urgency, it should in any case not be overlooked, since the activities during this stage strongly influence the performance of the entire disaster recovery process, particularly when it comes to sustainability and long-term effectiveness (Beamon & Balcik, 2008; Besiou, Stapleton, & Van Wassenhove, 2011; Kovacs & Spens, 2011b). Therefore, this clearly highlights the need for more research in the disaster recovery stage, including sustainability issues in HSCM (Kovacs & Spens, 2011b). The findings also inform methodological trends in current HSCM literature.

The conceptual studies are predominant over analytical studies followed by empirical (qualitative) and soft computing techniques. Therefore, this clearly highlights the need for research methods such as MCDM, empirical (quantitative) and LR to be used more to extend knowledge in the HSCM area.

The geographic distribution of the papers reveals an interesting scenario. Continents such as America and Europe have the highest number of papers in total among the countries involved in the field of research i.e. 129 and 99 respectively. Among the most frequently investigated regions were USA and Finland, Norway, Netherlands and Turkey in Europe. Other predominant regions are Pacific Island countries (e.g. Australia and New Zealand) and Southeast Asia (e.g. Japan, Malaysia and Singapore). There are few studies in the context of Asian countries (mainly comprising India, Pakistan, Bangladesh, Nepal and Bhutan). There are more studies in American and European regions due to their technological advancement and their greater capacity to forecast the occurrence and impact of disaster. This highlight the need for more research in the field of humanitarian supply chain management in the context of Asian countries: Humanitarian SCM is starting to receive attention as a field of research and scholars have begun to lay the foundations for a core body of knowledge; however the field still needs significantly more academic research and associated publications.

The subsequent findings offer significant insights to the state-of the HSCM research. Finally, a rich and perhaps most substantial, contribution of this study is the qualitative description of contemporary studies in four prominent themes. The results indicate that earlier studies focuses more on the theme, Introduction to key issues to HSCM followed by capacity planning issues, technology related issues and coordination issues to HSCM.

The results indicate that the studies under the theme Introduction to key issues to HSCM focus more on the disaster mitigation and preparedness stage. The conceptual studies are more common in this theme followed by empirical (qualitative), empirical (quantitative) and MCDM techniques. The results indicate that those studies in the theme issues to technology utilization focus more on the disaster response stage. The empirical (qualitative) studies are more common in this theme followed by analytical and conceptual. Studies based on empirical (quantitative) and MCDM techniques are not available in this theme. The results presented here suggest that the studies in the theme issues to coordination focus more on the disaster response stage. Conceptual studies are more common in this theme followed by empirical (qualitative) and analytical techniques. The results indicate that the studies in the theme capacity planning also focus more on the disaster response stage. Analytical studies are more common in this theme followed by conceptual and soft computing techniques.

As discussed in section 2.1, the other operational variables considered important to enhance the performance of HSCM are agility, flexibility, technology utilization, incidence of improvisation, top management support, volunteer empowerment and communication between the actors involved in relief operations. H. L. Lee and Whang (2000) suggested that information sharing is a basic enabler for coordination and effective sharing would further improve the flexibility in

the HSC. In order to improve the coordination and flexibility in the HSC, timely and accurate transfer of information is a prerequisite. This will occur only if there is a trust between the organizations. Flexibility has been considered as an important characteristic of the HSC due to the unpredictability in the occurrence of the disasters. In order to quickly react to any situation created by a disaster, supply chain networks are built instantly by the actors involved in the relief operations.

In contrast to commercial supply chains (CSC), there are two types of customers in HSC i.e. one who is affected by the disaster; the second is the person who has donated finance for the welfare of the first. Thus, the, customer to be satisfied in the HSC is in effect the donor. Hence, agility in the context of HSC must address the unstable nature of funding (Bennett, Bertrand, Harkin, Samarasinghe, & Wickramatillake, 2006). The seamless flow of information is critical during the disaster response phase, highlighting the need to use a common integrated platform by organizations involved in HSCM. Implementation of effective IT solutions may be considered as one of the probable solutions, although this can only happen if humanitarian actors are willing to share information. A successful operation requires strategic planning and investment of capital, mutual trust for long-term relationships and con?dentiality of information. HSC performance will be measured in terms of delivery time, quality of the delivered materials, reduction in the loss of lives, reducing stock-out of necessary medicines, equipment and other necessary items, the best use of donated items, constructing temporary shelters allied with ensuring the security of victims. HSC performance is dependent on the quality of information shared among partnering firms.

Technology utilization offers various benefits such as support agility, flexibility and incidence of improvisation; these would further improve the performance of HSC. It is evident that the role of top management is crucial in providing support to the process of appropriate technology utilization within organizations. For example, top management can provide all the essential resources such as time, money and expertise to promote the use of technology. In addition, relevant training for volunteers would also enhance the technology utilization and incidence of improvisation during relief operations.

It is desirable that IT provides strong links among stake holders, as can be seen in section 4.2. Hence IT alignment, technology capability and technology awareness would help in exploiting the benefits of IT and IT utilization. It may also help in controlling many situations if learning from past data is implemented; this can help in reacting more quickly to a similar problem. The HSC will then become agile and proactive. Unlike CSC, HSC may need to measure the supply chain performance using measures like agile or flexible SCs. The choice of effective technology and implementation of this technology in the proper manner should come from knowledgeable leadership. HSC cannot afford disaster over disaster by the wrong selection of technology or by implementation in the wrong way. However, the way in which relief activities are carried out in any emergency are strongly dependent on the scale, type and region of the disaster where it occurs.

2.15.1 Critical Review of Literature

While the systematization of current literature in the HSCM area makes a significant contribution to this emerging field of research. These are summarized as follows:

1. The humanitarian supply chain (HSC) network is similar with the commercial supply chain (CSC) that supports flow of goods, information and funds from the source to final customers; however, the only difference is that the customer in the case of HSC include the disaster affected peoples as well as the donors who donated to improve the performance of HSC. The complexity of the HSC network to transfer the relief materials at disaster site depend on the scale and region of the disaster where it occurs. Disasters, be it natural or man-made have caused tremendous human sufferings, property damage and environment damage each year. On the other hand, IT have brought about unprecedented convenience and possibilities in the HSC. The international community, national authorities and the private organizations have realize the importance of IT in mitigating the impact of disasters. Indeed, over the recent years, the international community has recognized the role and importance of the information technology (IT) in the HSCM area. Although India is a well known IT hub this area has not gained enough attention from the research point of view.

2. Investigating the barriers to the proliferation of IT in HSCM is an important issues that require further investigation. One of these barriers may be related to the fact that this review did not identify any policy for the IT usage among the organizations in their supply chains. These barriers are not only technology related, they are often relating to core organizational issues of mission, culture, environment, and communication. These challenges, which not only affect the whole system, also affect each other. It is important to recognize various constraints such as limited resources in terms of capital, time, human resources and policy initiatives, so prioritizing the barriers on the basis of their severity is essential for stepwise implementation of solutions. The perspective for prioritization of barriers is to focus more on the critical barriers to have the best possible outcomes as the resources are limited in terms of capital, time, human resources, etc. Therefore, need arises to explore and prioritize the barriers affecting the utilization of IT in HSCM in order to improve the performance of HSCM.

3. There are barriers to the utilization of IT but their counter enabler also exist to improve the present situation. For example, poor IT infrastructure could be improve by the interference of the government. The government can introduce various tax incentives, organize conferences, workshops to enhance awareness about the importance of IT in HSC. Therefore, it is essential to explore and prioritize the solutions to improve the utilization of IT in HSC, based on the severity of barriers, so decision makers can focus on overcoming these barriers and realize the benefits of the utilization of IT in HSCM. Since, it is not possible to improve all factors at the same time it is necessary to prioritize solutions and implement them in a step wise manner. The importance of priority of solutions on the basis of the weight of the barriers is widely reported in the CSC literature as it enables an organiza-

tion to take more effective and efficient decisions. However, this has not received enough attention from research point view in the context of HSC.

4. The utilization of IT has been considered as the silver bullet to improve the performance of HSCM. However, there are several factors that affect the utilization of IT in an organization in the context of HSC. These include managerial obstacles, technology readiness, financial resources, government support and user perceptions (performance expectancy, social influence, effort expectancy) toward the utilization of IT. There seems to be a lack of studies focusing on the inter-relationship among these factors. Refining key variables for these factors that affects the utilization of IT in HSCM research may lead to a deeper understanding of their commonalities, differences and relationships. The lack of well-defined variables in the context of HSC is a drawback for field studies, as it may not be clear which phenomena is to be measured. The development of a coherent body of knowledge may also be compromised since comparisons between studies might become impossible.

5. Business management philosophy systematically integrates the use of IT into a wide number of management roles. No reports were found, either in formal policies or programmes, stating the need for using IT and how this should be done in the humanitarian area. This can become a bottleneck in improving the performance of HSC, as theory building would benefit from the real life experiences of some agencies in previous chaotic situations. Hence, there is a strong need to analyze and highlight the importance of IT in HSCM from a broader perspective. This requires critical analysis of present supply-chain situations, various supply-chain actors and different supply-chain activities. This highlighted the need for more case studies for different cases of disaster.

2.16 Summary

This chapter provide valuable insights for practitioners on the ground as well as academicians involved in the field of research. This chapter makes a number of important contributions by examining previously published studies in the area of HSCM (1) quantifying publications and methodological trends, (2) quantifying studies according to disaster stage, (3) providing a structured analysis of the publications under four themes and (4) qualitatively describing the gaps in the literature. This chapter investigates what synergies and potential types of benefit the utilization of IT in relief operations could produce. The barriers to achieving this are also identified. In terms of the theoretical contribution, this study explores various strategic issues affecting the proliferation of the utilization of IT in HSCM. The findings will be of great benefit to the stakeholders, practitioners and academicians in the humanitarian sector, as it will help the decision makers to better understand the issues central to HSCM. The next chapter deals with the verification and prioritization of IT barriers in HSCM.

Chapter 3

Prioritizing Information Technology Barriers in Humanitarian Supply Chain Management

Preview

In the previous chapter, review of previous studies in the area of issue under investigation which include factors affecting the utilization of IT has been presented. In this chapter, barriers to the proliferation of IT are explored and verified with the middle level managers involved in the past disaster relief operations. Furthermore, these barriers are prioritized on the basis of their severity using fuzzy analytic hierarchy process (F-AHP) which considers the uncertainty of the data and impreciseness rather than crisp value.

3.1 Introduction

Practitioners and academicians are making continuous demands to enhance the utilization of information technology (IT) in humanitarian supply chain management (HSCM) in order to continue or enhance the pace of economic growth and development of countries, as well as to reduce the impact of disaster on society. Identifying and analyzing key decision variables affecting the proliferation of IT in HSCM is a challenge in trying to improve overall performance. Therefore, to assist the organizations involved in HSCM, this chapter explored and prioritized 25 barriers that hampers the utilization of IT, using fuzzy analytic hierarchy process (F-AHP) which considers the uncertainty of the data and impreciseness rather than crisp value. This chapter is a pioneering attempt to understand the issues that affects the utilization of IT in HSCM and to classify them, on the basis of their severity in order to realize the benefits of IT in HSCM.

Previous researchers such as Asgarkhani (2005); Coursey and Norris (2008); Dawes (2008); Milakovich (2012); Norris and Moon (2005); C. Powell (2015); Reddick (2005); Swafford, Ghosh, and Murthy (2008); Yang and Melitski (2007) have examined the use of IT in the commercial context by looking at management effectiveness, service delivery and civic engagement. Yet the use of IT in the humanitarian area is often limited, with relatively little research conducted on the role of IT in emergency management (Rao, 2007; Vogt, Hertweck, & Hales, 2011). Despite the promising benefits of IT in HSCM, a number of challenges, such as low priority by management and the resistive nature of volunteers, have hampered the full utilization of technology that can really help. These challenges, which not only affect the whole system, also affect each other.

The part of this chapter has been under review as "Kabra, G., & Ramesh,A. Prioritization of barriers to the proliferation of information technology in humanitarian supply chain management, *Computers in Human Behavior*, (Elsevier)."

This study adopts a comprehensive and rigorous procedure to analyze the barriers to the proliferation of IT in HSCM. The study is divided into three phases. First, factors affecting the proliferation of IT are collected through an extensive literature review allied with the discussion with the experts (decision makers). This study explored 25 factors affecting the proliferation of IT in HSCM and these factors were grouped into five categories, namely, strategic factors, organizational factors, technological factors, financial factors and human factors. Second, the input of experts has been utilized to form pair wise comparison matrices for the factors and sub factors. Finally, factors affecting the proliferation of IT were prioritized on the basis of their severity using fuzzy analytic hierarchy process (F-AHP) which considers the ambiguity and impreciseness of the data.

In literature (section 2.14, page-44), the barriers to utilization of IT in HSCM have been identified but they are based on the past studies and expert opinions gathered from few experts. In this study, barriers were empirically verified with the middle level managers who were involved in the relief operations of the past disaster and the weights were gathered from a number of respondents. Therefore, this study is designed to suggest the ways to strengthen the utilization of IT by identifying and prioritizing the factors affecting the proliferation of IT in HSCM. As it is almost impossible to instantly remove all the factors affecting the proliferation of IT. It is important to recognize various constraints such as limited resources in terms of capital, time, human resources and policy initiatives, so prioritizing the factors affecting the proliferation of IT, on the basis of their severity is essential for stepwise implementation of solutions. The perspective for prioritization of barriers is to focus more on the critical barriers to have the best possible outcomes as the resources are limited in terms of capital, time, human resources, etc.

3.2 Literature Review

The occurrence of disasters and its severe impact are on rise throughout the world. In particular, natural disasters are often unavoidable, but their impact on the society and the country concerned could be greatly minimized by proper proactive planning and preparedness. The chances for the occurrence of disasters is increasing everywhere, but the types of disasters is different for each country and depends on their geography, use of technology and many other factors. Casualties in developed countries are less as compared to developing countries. Their vulnerability is lower because of their ability to acquire and employ greater resources (EMI, 2013). The factors affecting the proliferation of IT are discussed in the subsequent section.

3.2.1 Barriers to the Proliferation of IT

There are various challenges to the development and utilization of IT in support of effective delivery of relief materials to disaster victims during complex emergencies. The management of humanitarian relief activities is complex due to a large number of stakeholders from both

the government and private sector (Balcik et al., 2010; Dolinskaya, Shi, Smilowitz, & Ross, 2011). Moreover, challenges arise due to a lack of policies and financial incentives regarding coordination (McLachlin & Larson, 2011; Tomasini & Van Wassenhove, 2009). Thomas and Kopczak (2005) reported that some of the problems while delivering aid include the shortage of expert logisticians, limited collaboration and coordination, manual supply chain processes, and inadequate assessments and planning. Many researchers have confirmed the shortage of experienced logisticians since it is not considered a professional discipline Balcik et al. (2010); Gustavsson (2003); Maiers et al. (2005); Whiting and Ayala-Ostrm (2009).

The utilization of IT is low in HSC as compared to commercial supply chain (CSC) and the key problem emphasized by practitioners to enhance the technical capabilities of the humanitarian sector is the behavior of donors(Gustavsson, 2003; Thomas, 2003). Murray (2005) and Whiting and Ayala-Ostrm (2009) also emphasized that the behavior of donors reflect that their money should be used to help disaster victims after the occurrence of an event, which means avoidance techniques are often ignored, particularly by developing countries (Kovacs & Spens, 2007).

Developing countries are far behind as compared to developed countries in terms of education, funding, and equipment to reduce their vulnerability. The vulnerability of developing countries to various disasters is higher, due to their impoverished living conditions and weak warning systems. Weakness is seen in building rules and their implementation in developing nations. Tsunami in 2005 has washed the villages on the coast of India, Thailand and Sri Lanka because of their risky location and primitive construction (EMI, 2013).

There are various challenges in support of effective and efficient delivery of relief materials to the disaster affected peoples during complex emergencies. These challenges are not only technology related, they are often relating to core organizational issues of mission, culture, environment, and communication (Maiers et al., 2005). Many researchers have demonstrated the barriers to the proliferation of IT in HSC includes poor IT infrastructure (Datta, Byrd, Okoli, & Mbarika, 2005), Lack of IT experts. The low level of supply chain understanding often complicates the IT adoption issues in the organizations. The attitudes the reluctance towards ICT may prevent the organizations from being involved in the adoption of IT applications. IT infrastructure is well established in developed countries as compared to developing countries (Mbarika, A, Byrd, & Anthony, 2005). Odedra-Straub (1993) also supports the poor IT infrastructure issue in developing countries and highlighted that due to poor IT infrastructure peoples are not able to gather information and coordinate with each other to solve their problems.

The utilization of IT in HSCM needs a large amount of funds, effort, time, support and commitment from top management, starting from the first phase. However, top management regard investment in IT systems as an overhead cost (Maiers et al., 2005), so the utilization of IT in HSCM is not a priority for organizations. The investment in IT systems is generally considered as an overhead cost rather than as a fundamental activity in the organizations involved in the relief operations (Maiers et al., 2005). Hence, investment in IT is not on their priority list. Kapucu and Garayev (2012) also supported the view that the utilization of IT called for more investment

in IT infrastructure. The organizations involved in the relief operations do not have the proper infrastructure needed for IT systems.

Finally, the organizations have limited awareness about the IT solutions (Maiers et al., 2005). Besides, there is great difficulty in selecting and quantifying the intangible benefits that the utilization of IT offers to improve coordination. The costs associated with the adoption of IT solutions is regarded as one of the major obstacle in the implementation of IT applications. The key issues noted by the practitioners and the researchers is the donors behavior. Murray (2005) highlighted that the behavior of donors reflects that their money is expected to be used to help after the occurrence of an event (Whiting & Ayala-Ostrm, 2009). This means that prevention measures are often neglected, particularly in developing countries (Kovacs & Spens, 2007; Maiers et al., 2005). Thomas (2003) also supported the view that the behavior of donors is among the major stumbling blocks which resists the actors from developing processes and systems to improve the performance of HSC.

A huge amount of funds is required for the successful implementation of IT in HSCM, but the behavior of donors does not encourage investment in improved systems (Thomas, 2003; Whiting & Ayala-Ostrm, 2009). The restricted and short-term nature of donor funding complicates strategic investment to enhance IT infrastructure (Maiers et al., 2005). Donors hesitate to provide funding for enhancing the basic facilities needed for the full utilization of IT due to the absence of transparency and accountability mechanisms in HSC (Agostinho, 2013; Thomas & Kopczak, 2005). The challenges in providing effective and efficient delivery of relief materials to people affected by disaster during complex emergencies are related to core organizational issues of mission, culture, environment and communication (Maiers et al., 2005).The barriers to the proliferation of IT in HSC are listed in Table 3.1.

Table 3.1: Barriers to the Proliferation of IT

Main Criteria	Code	Sub Criteria
Strategic Barriers	SB1	Lack of top management commitment
	SB2	Lack of strategic planning
	SB3	Lack of supply chain understanding
	SB4	Lack of clear policies to support the adoption of IT
	SB5	Lack of awareness about IT
Organizational Barriers	OB1	Lack of mutual trust among the actors
	OB2	Non availability of IT experts
	OB3	Non availability of supply chain experts
	OB4	Lack of interaction with industry players
	OB5	Lack of policy for retention of skilled and experienced employee
Finance Barriers	FB1	Lack of funds for investment in IT
	FB2	Lack of donor support towards adoption of IT
	FB3	Lack of industry support toward adoption of IT

to be cont'd on next page

Table 3.1: Barriers to the Proliferation of IT

Main Criteria	Code	Sub Criteria
	FB4	Lack of in-kind financial support
	FB5	Lack of transparency in financial supply chain
Human Barriers	HB1	Lack of motivation to adopt IT
	HB2	Lack of education and training to the employees
	HB3	Inadequate information sharing among employees
	HB4	Lack of willingness to adopt and use IT
	HB5	Lack of IT skills in employee
Technological Barriers	TB1	Lack of technical assistance to the employee
	TB2	Disparity in IT facility among actors involved
	TB3	Lack of proper IT infrastructure
	TB4	Lack of IT supporting facilities such as power
	TB5	Lack of R&D research

3.3 Need for Fuzzy-AHP

Analytic hierarchy process (AHP) is a quantitative technique for multi criteria decision making (MCDM) developed by Satty in 1980. AHP uses the discrete scale (1-9) for pairwise comparison M. N. Faisal, Khan, and Farooqi (2011); Mohanty and Deshmukh (1993); Varma, Wadhwa, and Deshmukh (2008). However, in many practical situations, AHP alone is not able to express the human preference as decision maker find it extremely difficult to express the strength of his preferences and to provide exact pairwise comparison judgments. Therefore, the use of the theory of decision making in a fuzzy environment developed by Bellman and Zadeh (1970) in combination with AHP is required to deal with the impreciseness and vagueness of the discrete scale (1-9) (M. Kumar, Vrat, & Shankar, 2004; T.-R. Lee, Phuong Nha Le, Genovese, & Koh, 2011; T.-R. Lee, Tuan, & Liu, 2008; A. K. Singh & Sahu, 2004).

Fuzzy AHP method is a systematic approach to solve MCDM problems by using the concepts of fuzzy set theory and hierarchical structure analysis. The prioritization of the factors affecting the proliferation of IT is a multi-criteria decision making (MCDM) problems. MCDM problems originate due to the absence of a unique optimal solution. In this instance, the decision makers have to select the best alternative from a set of available alternatives. The decision makers preferences are used to differentiate between the set of available alternatives Muralidharan, Anantharaman, and Deshmukh (2002).

There are various techniques available to solve MCDM problems such as analytic hierarchy process (AHP), analytic network process(ANP), etc (M. Faisal, Banwet, & Shankar, 2007). These methods utilize discrete scale (1-9) for the pairwise comparison of alternatives. Although the discrete scale is easy to use, the MCDM problem is highly ambiguous M. N. Faisal and Khan

(2008). Hence, a decision maker may find it extremely difficult to express the strength of his preferences using the discrete scale (1-9). Thus, these methods are ineffective in handling the ambiguous problems of real world. Many researchers such as Zadeh (1965) and Zimmermann (1991) demonstrated that these methods, are more effective in handling MCDM problems when applied in combination with fuzzy set theory since fuzzy set theory consider the imprecise judgments of decision makers. For the purpose of this study, fuzzy AHP has been utilized to solve MCDM problem as it can effectively handle both qualitative and quantitative data.

3.3.1 Application of Fuzzy AHP

The main advantage of the Fuzzy- AHP (F-AHP) over other MCDM methods is its flexibility, inherent ability to handle uncertain and imprecise judgment of experts. F-AHP is the only MCDM that measure the consistency in the decision makers judgments along with the uncertainty of data (Duran & Aguilo, 2008; Triantaphyllou & Lin, 1996). Recently, F-AHP has been used by various researchers for multi-criteria decision problems as given in Table 3.2.

Table 3.2: Application of Fuzzy AHP

S. No.	Author	Context
1	Y. Wang, Jung, Yeo, and Chou (2014)	Selection of a cruise port for call location
2	Patil and Kant (2014)	Prioritizing the solutions for knowledge management
3	Taylan, Bafail, Abdulaal, and Kabli (2014)	Selection and risk assessment of construction projects
4	Jiang, Li, and Zhu (2014)	Security evaluation of building disaster protection

3.4 Methodology

The present study adopts a 3 phase methodology. Initially, factors affecting the proliferation of IT are collected through an extensive literature review allied with the discussion with the experts (decision makers). Second, barriers were empirically verified through questionnaire analysis from the middle level managers involved in the relief operations of past disasters occurred in India. Finally, F-AHP has been utilized to prioritize the barriers using the experts opinions since all the barriers cannot be handled at the same time. Several important definitions of fuzzy logic as cited by T.-R. Lee and Li (2006) are given below:

Definition 1: A fuzzy set $\tilde{A}$ is subset of a universe of discourse X, which is a set of ordered pairs and is characterized by a membership function $\tilde{\mu}_A(x)$ representing a mapping $\tilde{\mu}_A : x \rightarrow [0, 1]$. The function value of $\tilde{\mu}_A(x)$ for the fuzzy set $\tilde{A}$ is called the membership value of x in $\tilde{A}$, which

represents the degree of truth that x is an element of the fuzzy set Ã. It is assumed that $\tilde{\mu}_A$: $x\epsilon[0,1]$, where $\tilde{\mu}_A(x) = 1$ reveals that x completely belongs to Ã, while $\tilde{\mu}_A(x) = 0$ indicates that x does not belong to the fuzzy set Ã.

$$\tilde{A} = x, \tilde{\mu}_A(x)), x\epsilon[X] \tag{3.1}$$

where $\tilde{\mu}_A(x)$ is the membership function and X = $\{x\}$ represents a collection of elements x.

Definition 2: A fuzzy number Ã, if it belongs to a triangular fuzzy number like Figure 5.1, it should satisfy the following properties:

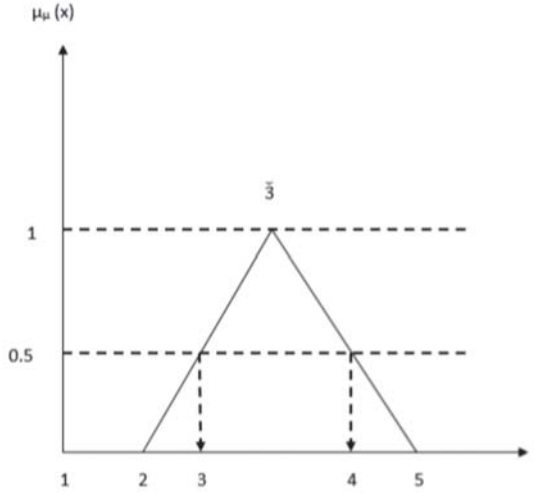

Figure 3.1: Alpha cut Operation on a Triangular Fuzzy Number

- $\tilde{\mu}_A(x) = 0, \ \forall \ x \ \epsilon \ (-\infty, 1)$;
- $\tilde{\mu}_A(x)$ is strictly increasing on [1, m];
- $\tilde{\mu}_A(x) = 1$, for x = m;
- $\tilde{\mu}_A(x)$ is strictly decreasing on [m, u];
- $\tilde{\mu}_A(x) = 0, \ \forall \ x \ \epsilon \ (u, \infty)$;

Definition 3: Let Ã be a triangular fuzzy number (l,m,u) and its membership function can be defined as

$$\tilde{\mu}_A(x) = \begin{cases} \frac{x-l}{m-l} & l \leq x \leq m \\ \frac{u-x}{u-m} & m \leq x \leq u \\ 0 & otherwise \end{cases} \tag{3.2}$$

Definition 4: The α cut of the fuzzy set Ã of the universe of discourse X is defined as

$$A_\alpha = \{x\epsilon X, \ \tilde{\mu}_A(x) \ \leq \ \alpha\} \ where \ \alpha \ \epsilon \ [0,1] \tag{3.3}$$

Definition 5: Suppose $a = (a_1, a_2, a_3)$ and $b = (b_1, b_2, b_3)$ are two TFNs, the distance between them is calculated as

$$d_v(\tilde{a},\ \tilde{b}) = \sqrt{\frac{1}{3}[\ (a_1\ -\ b_1)^2 + (a_2\ -\ b_2)^2 + \ (a_3\ -\ b_3)^2\ ]} \tag{3.4}$$

Definition 6: If $\tilde{A}_1 = (l_1, m_1, u_1)$ and $\tilde{A}_2 = (l_2, m_2, u_2)$ are representing two triangular fuzzy numbers then algebric operations can be expressed as follows:

$$\tilde{A}_1(+)\tilde{A}_2 = (l_1,m_1, u_1)\ and\ \tilde{A}_2 = (l_2,m_2, u_2) = (l_1 + l_2), (m_1 + m_2)\ and\ \tilde{A}_2 = (u_{1+}u_2) \tag{3.5}$$

$$\tilde{A}_1(-)\tilde{A}_2 = (l_1,m_1, u_1)\ and\ \tilde{A}_2 = (l_2,m_2, u_2) = (l_1 - l_2), (m_1 - m_2)\ and\ \tilde{A}_2 = (u_{1-}u_2) \tag{3.6}$$

$$\tilde{A}_1(*)\tilde{A}_2 = (l_1,\ *\ m_1, u_1)\ and\ \tilde{A}_2 = (l_2,m_2, u_2) = (l_1\ *\ l_2), (m_1\ *\ m_2)\ and\ \tilde{A}_2 = (u_1\ *\ u_2) \tag{3.7}$$

$$\tilde{A}_1(/)\tilde{A}_2 = (l_1,m_1, u_1)\ and\ \tilde{A}_2 = (l_2,m_2, u_2) = (l_1/l_2), (m_1/m_2)\ and\ \tilde{A}_2 = (u_1/u_2) \tag{3.8}$$

$$\leq A * \tilde{A}_1 = (\alpha * l_1\ , \alpha * m_1\ , \alpha * u_1\ ) \tag{3.9}$$

$$\tilde{A} \leq 1\ ^{-1} = \leq (l_1 \leq, m_1 \leq, u_1\ )^{-1} = (\frac{1}{u_1},\ \frac{1}{m_1}, \frac{1}{l_1}) \tag{3.10}$$

3.4.1 Verification of IT barriers

In this chapter, barriers to the proliferation of IT (established within chapter 2) were empirically verified from the middle level managers involved in the relief operations of past disasters that occurred in India. For the purpose, data has been collected from the actors who were actively involved in the relief operations. The subsequent section discusses the process of data collection in detail.

3.4.1.1 Scale and Measure

The survey questionnaire includes three sections; Section 1 is related with the demographic profile of the respondents; and Sections 2 contains 25 items related to IT barriers, developed on the

basis of available literature and brainstorming sessions with experts. To ensure the reliability of the questionnaire, it was reviewed by the experts, Based on the feedback from experts and pilot test modifications were made to the questionnaire to ensure the face validity according to Ye and Wang (2013). A five point Likert scale (1-strongly disagree, 2-disagree, 3-Neither agree nor disagree, 4-agree and 5-strongly agree) was used to measure the response of respondents.

The questionnaire instrument developed in this study has a content validity since the selection of measurement items was based on an exhaustive review of the available literature and evaluations by experts. The content validity was further tested during a pilot survey as per the guidelines prescribed by Hair, Black, Babin, Anderson, and Tatham (2009). After a careful review of the respondents answers obtained during pilot survey, several questions were modified to convey their intended meaning and a few questions were deleted from the questionnaire as per the suggestions received from the experts.

3.4.1.2 Data Collection

The study was conducted using a random sample of respondents actively involved in relief activities. The survey questionnaires were personally administered to the actors involved. In total, the research questionnaire was presented to 180 respondents, consist of 25 barriers to the proliferation of IT in HSCM gathered through chapter 2. Approximately, 145 questionnaires were returned, and out of which 16 were rejected due to missing data as they were occupied in other activities. Finally, 119 completed responses (66 %) were considered for the study, which is an acceptable number according to Hair et al. (2009). Out of 119 completed responses 105 respondents are managers (middle level managers) and remaining are from top management of various organizations involved in the relief operations; whose responses were utilized; which is in agreement with Carter, Ellram, and Ready (1998) and Bowen, Cousins, Lamming, and Farukt (2001).

The managers were selected using purposive snowball sampling in order to identify the respondents who would be able to provide the necessary information in agreement with Raju and Becker (2013). Moreover, to avoid any personal bias, the mediators were selected on the basis of their experience and contribution either directly or indirectly in many relief operations. To overcome the challenges of low response rate, survey questionnaires were distributed with the help of mediators who were involved in the relief activities. The mediators were asked to explain the objectives of the research, the questionnaire, any questions about the research team and to assure them that their suggestions would be kept confidential.

3.4.1.3 Result

The result of survey analysis are presented in Table 3.3. The survey results show that all the barriers are significant in the Indian context as the mean scores of barriers range from 3.85 to 4.19 with standard deviation (SD) less than 0.90. Therefore, we can conclude that all the barriers

were applicable according to (Somsuk & Laosirihongthong, 2014). Table 3.2 presents the results of descriptive statistics for IT barriers in HSCM. The result suggests that the lack of collaborative and strategic planning and disparity in IT facility among actors involved in HSCM are the most important factors affecting the proliferation of IT in HSCM. These are followed by lack of trust among actors and a lack of clear policies for IT adoption.

Table 3.3: Descriptive Statistics of Barriers to the proliferation of IT

S.No.	Barriers	Mean	S.D
1.	Lack of top management commitment	3.96	0.83
2.	Lack of strategic planning	3.92	0.86
3.	Lack of supply chain understanding	4.11	0.85
4.	Lack of clear policies to support the adoption of IT	4.07	0.83
5.	Lack of awareness about IT	4.09	0.81
6.	Lack of mutual trust among the actors	3.88	0.79
7.	Non availability of IT experts	4.09	0.80
8.	Non availability of supply chain experts	4.19	0.80
9.	Lack of interaction with industry players	3.97	0.79
10.	Lack of policy for retention of skilled and experienced employee	4.06	0.81
11.	Lack of funds for investment in IT	3.87	0.78
12.	Lack of donor support towards adoption of IT	3.97	0.81
13.	Lack of industry support toward adoption of IT	4.05	0.84
14.	Lack of in-kind financial support	3.88	0.84
15.	Lack of transparency in financial supply chain	3.87	0.83
16.	Lack of motivation to adopt IT	3.97	0.83
17.	Lack of education and training to the employees	3.92	0.81
18.	Inadequate information sharing among employees	3.86	0.85
19.	Lack of willingness to adopt and use IT	3.85	0.83
20.	Lack of IT skills in employee	3.97	0.85
21.	Lack of technical assistance to the employee	3.94	0.82
22.	Disparity in IT facility among actors involved	3.95	0.80
23.	Lack of proper IT infrastructure	3.99	0.81
24.	Lack of IT supporting facilities such as power	3.90	0.80
25.	Lack of R&D research	3.88	0.82

3.4.2 Fuzzy-AHP

Analytic hierarchy process (AHP) is a quantitative technique for multi criteria decision making (MCDM) developed by Satty in 1980. The traditional AHP utilize discrete scale (1-9) for the pairwise comparison of alternatives. Although the discrete scale is easy to use, the MCDM

problem is highly ambiguous. Hence, a decision maker may find it extremely difficult to express the strength of his preferences using the discrete scale (1-9). Thus, these methods are ineffective in handling the ambiguous problems of real world. Hence there is a need to use fuzzy sets in decision-making (Bozbura & Beskese, 2007; D. Y. Chang, 1996; Choudhary & Shankar, 2012; Govindan, Kannan, & Shankar, 2014; Govindan, Khodaverdi, & Jafarian, 2013; Govindan & Murugesan, 2011; Kristianto, Gunasekaran, Helo, & Hao, 2014; Kwong & Bai, 2002; Y. Wang et al., 2014) pioneered by Zadeh (1965). Therefore, Fuzzy AHP methodology extends Sattys AHP by combining it with fuzzy set theory to solve MCDM. The fuzzy AHP method is explained as follows:

Step 1: Defining a scale of relative importance used in the pair wise comparison matrix
In F-AHP, the TFNs, $\tilde{1}$ to $\tilde{9}$, are used to improve the nine-point scaling scheme of AHP as given in Table 3.4. In order to account for the fuzziness of human qualitative assessments, 5 TFNs were used with the corresponding membership function as given in Figure 3.2.

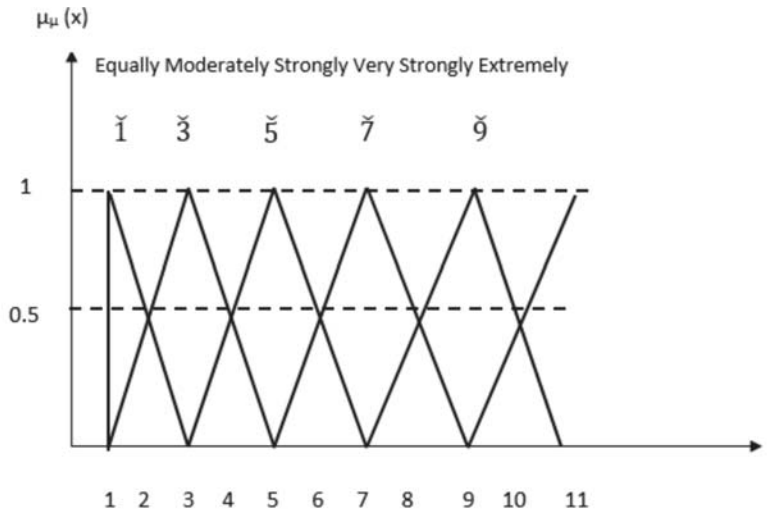

Figure 3.2: Fuzzy Membership Function for Criteria

Table 3.4: Triangular Fuzzy Conversion Scale

Intensity of importance	Fuzzy number	Linguistic variable	Membership function	Reciprocal membership function
1	$\tilde{1}$	Equally important/preferred	(1,1,1)	(1,1,1)
3	$\tilde{3}$	Weakly important/preferred	(1,3,5)	(1/5,1/3,1)
5	$\tilde{5}$	Strongly more important/preferred	(3,5,7)	(1/7,1/5,1/3)
7	$\tilde{7}$	Very strongly important/preferred	(5,7,9)	(1/9,1/7,1/5)
9	$\tilde{9}$	Extremely more important/ preferred	(7,9,11)	(1/11,1/9.1/7)

Step 2: Construct the fuzzy comparison matrix

With the help of expert opinions, pair wise comparisons for the main criteria and sub criteria were made by using TFN as shown in Table 3.4. The geometric mean of the pair wise comparisons from different experts was calculated to form fuzzy comparison matrix Ã. The brief profile of experts is given in Table 3.4.

$$\tilde{A} = \begin{bmatrix} 1 & \widetilde{\mathbf{a}}_{12} & \cdots & \widetilde{\mathbf{a}}_{\mathbf{1n}} \\ \vdots & 1 & \cdots & \widetilde{\mathbf{a}}_{\mathbf{2n}} \\ \vdots & \cdots & 1 & \vdots \\ \widetilde{\mathbf{a}}_{\mathbf{n1}} & \cdots & \cdots & 1 \end{bmatrix} \tag{3.11}$$

$\widetilde{a}_{ij}$is the relationship of component i to component j. If i equals to j then $\widetilde{a}_{ij}$= 1 otherwise $\frac{1}{\tilde{A}_{ij}}$.

Table 3.5: Brief Profile of Experts

S.No.	Area of Expertise	Years of Experience	Profession
1.	DM Expert	20	Practitioner
2.	IT Expert	15	Practitioner
3.	IT Expert	10	Practitioner
4.	DM Expert	20	Professor
5.	DM Expert	20	Professor

Step 3: Converting the fuzzy comparison matrix into a crisp comparison matrix

Adamo (1980) proposed the well known cut method, which considers the experts confidence over the suggestions they provided to rank fuzzy numbers. This method will yield an interval set of values from a fuzzy number. For example, $\alpha = 0.8$ will yield $\alpha_0.8$ = (1.5, 5) by using equation 3.12 (see Figure 3.3). The i index of optimism 0.5 (determined by the decision-maker) i.e., a linear convex combination as defined in equation 3.13 (M. Lee, Pham, & Zhang, 1999), was used to calculate the degree of satisfaction for the judgment matrix while is fixed as 0.8.The α cut fuzzy comparison matrix was converted into their crisp comparison matrix A by using the value of equation l2 in equation 13.

$$\tilde{A}_\alpha = \begin{bmatrix} [a^\alpha_{11l},\ a^\alpha_{1lu}] & \cdots & \cdots & [a^\alpha_{1nl},\ a^\alpha_{1nu}] \\ \vdots & \cdots & \cdots & \vdots \\ \vdots & \cdots & \cdots & \vdots \\ [a^\alpha_{n1l},\ a^\alpha_{nlu}] & \cdots & \cdots & [a^\alpha_{nnl},\ a^\alpha_{nnu}] \end{bmatrix} \tag{3.12}$$

$$Where\ \ \check{A}_\alpha = [a^\alpha_L,\ a^\alpha_R] = [(a_2 - -a_1)\ \alpha + a_{1,}(a_3 - -a_2)\ \alpha + a_3] \tag{3.13}$$

$$\widetilde{a}_{ij}^{\alpha} = a_{iju}^{\alpha} + (1-)a_{iju}^{\alpha} where 0 < \ = 1 \tag{3.14}$$

$$A = \begin{bmatrix} 1 & \mathbf{a_{12}} & \cdots & \mathbf{a_{1n}} \\ \vdots & 1 & \cdots & \mathbf{a_{2n}} \\ \vdots & \cdots & 1 & \vdots \\ \mathbf{a_{n1}} & \cdots & \cdots & 1 \end{bmatrix} \tag{3.15}$$

Step 4: Calculate relative frequencies
The relative frequency is calculated by the following equation

$$\begin{bmatrix} \frac{a_{11}}{S_1} & \frac{a_{12}}{S_1} & \cdots & \frac{a_{1n}}{S_1} \\ \vdots & 1 & \cdots & \cdots \\ \vdots & \cdots & \cdots & \vdots \\ \frac{a_{n1}}{S_n} & \frac{a_{nn}}{S_n} & \cdots & \frac{a_{nn}}{S_n} \end{bmatrix} = \begin{bmatrix} 1 & f_{12} & \cdots & f_{1n} \\ \vdots & \vdots & \cdots & \mathbf{a_{2n}} \\ \vdots & \vdots & \cdots & \vdots \\ f_{n1} & f_{n2} & \cdots & f_{nn} \end{bmatrix} \tag{3.16}$$

$$where\ S_k = \sum_{j=1}^{n} a_{kj} \tag{3.17}$$

Step 5: Calculate entropy value
The entropy values are calculated by using the relative frequencies and the following equation

$$H_1 = -\sum_{j=1}^{n} (f_{ij}) log_2\ (f_{1j}) \tag{3.18}$$

$$H_2 = -\sum_{j=1}^{n} (f_{2j}) log_2\ (f_{2j}) \tag{3.19}$$

$$H_3 = -\sum_{j=1}^{n} (f_{nj}) log_2\ (f_{nj}) \tag{3.20}$$

where H_i is i^th entropy value.

Step 6: Calculation of weights of the criteria The resultant aggregate weight of each criterion will be calculated by normalizing the entropy values obtained in step 5.

3.5 Prioritization of IT barriers

In this phase pair wise comparison matrix, the criteria and sub criteria were constructed from the scale given in Table 3.4. The pair wise comparison matrixes of the criteria and sub-criteria are given in Tables 3.6 to 3.11. The results were calculated (as explained in the previous section) from the pair wise comparison matrix (see 3.6 to 3.11) and are given in Table 3.12.

Table 3.6: A pair wise Comparison Matrix of the Major Criteria

Criterion	SB	OB	FB	HB	TB
SB	(1,1,1)	(1,3,5)	(5,7,9)	(5,7,9)	(7,9,11)
OB	(1/5,1/3,1)	(1,1,1)	(1,3,5)	(5,7,9)	(5,7,9)
FB	(1/9,1/7,1/5)	(1/5,1/3,1)	(1,1,1)	(1,3,5)	(3,5,7)
HB	(1/9,1/7,1/5)	(1/9,1/7,1/5)	(1/5,1/3,1)	(1,1,1)	(1,3,5)
TB	(1/11,1/9.1/7)	(1/9,1/7,1/5)	(1/7,1/5,1/3)	(1/5,1/3,1)	(1,1,1)

Table 3.7: A pair wise Comparison Matrix of the Strategic Barriers (SBs)

Criterion	SB1	SB2	SB3	SB4	SB5
SB1	(1,1,1)	(3,5,7)	(1/7,1/5,1/3)	(3,5,7)	(5,7,9)
SB2	(1/7,1/5,1/3)	(1,1,1)	(1/11,1/9.1/7)	(1,3,5)	(1,3,5)
SB3	(3,5,7)	(7,9,11)	(1,1,1)	(7,9,11)	(7,9,11)
SB4	(1/7,1/5,1/3)	(1/5,1/3,1)	(1/11,1/9.1/7)	(1,1,1)	(1,3,5)
SB5	(1/9,1/7,1/5)	(1/5,1/3,1)	(1/11,1/9.1/7)	(1/5,1/3,1)	(1,1,1)

Table 3.8: A pair wise Comparison Matrix of the Organizational Barriers (OBs)

Criterion	OB1	OB2	OB3	OB4	OB5
OB1	(1,1,1)	(1/5,1/3,1)	(1/7,1/5,1/3)	(1/5,1/3,1)	(1,1,1)
OB2	(1,3,5)	(1,1,1)	(1/7,1/5,1/3)	(1/5,1/3,1)	(1,3,5)
OB3	(3,5,7)	(3,5,7)	(1,1,1)	(3,5,7)	(1,3,5)
OB4	(1,3,5)	(1/5,1/3,1)	(1/7,1/5,1/3)	(1,1,1)	(1,3,5)
OB5	(1,1,1)	(1,3,5)	(1/5,1/3,1)	(1/5,1/3,1)	(1,1,1)

Table 3.9: A pair wise Comparison Matrix of the Financial Barriers (FBs)

Criterion	FB1	FB2	FB3	FB4	FB5
FB1	(1,1,1)	(1/7,1/5,1/3)	(1/11,1/9.1/7)	(1/5,1/3,1)	(1/7,1/5,1/3)
FB2	(3,5,7)	(1,1,1)	(1/5,1/3,1)	(1,3,5)	(1/5,1/3,1)
FB3	(7,9,11)	(1,3,5)	(1,1,1)	(1/7,1/5,1/3)	(3,5,7)
FB4	(1,3,5)	(1/5,1/3,1)	(1/7,1/5,1/3)	(1,1,1)	(1/7,1/5,1/3)
FB5	(3,5,7)	(1,3,5)	(1/7,1/5,1/3)	(3,5,7)	(1,1,1)

Table 3.10: A pair wise Comparison Matrix of the Human Barriers (HBs)

Criterion	HB1	HB2	HB3	HB4	HB5
HB1	(1,1,1)	(1/7,1/5,1/3)	(1,3,5)	(3,5,7)	(1,3,5)
HB2	(3,5,7)	(1,1,1)	(3,5,7)	(5,7,9)	(3,5,7)
HB3	(1/5,1/3,1)	(1/7,1/5,1/3)	(1,1,1)	(1,3,5)	(1/5,1/3,1)
HB4	(1/7,1/5,1/3)	(1/9,1/7,1/5)	(1/5,1/3,1)	(1,1,1)	(1/7,1/5,1/3)
HB5	(1/5,1/3,1)	(1/7,1/5,1/3)	(1,3,5)	(3,5,7)	(1,1,1)

Table 3.11: A pair wise Comparison Matrix of the Technological Barriers (TBs)

Criterion	TB1	TB2	TB3	TB4	TB5
TB1	(1,1,1)	(1/7,1/5,1/3)	(1,3,5)	(1/5,1/3,1)	(3,5,7)
TB2	(3,5,7)	(1,1,1)	(3,5,7)	(1/5,1/3,1)	(5,7,9)
TB3	(1/5,1/3,1)	(1/7,1/5,1/3)	(1,1,1)	(1/7,1/5,1/3)	(1,3,5)
TB4	(1,3,5)	(1/5,1/3,1)	(3,5,7)	(1,1,1)	(3,5,7)
TB5	(1/7,1/5,1/3)	(1/9,1/7,1/5)	(1/5,1/3,1)	(1/7,1/5,1/3)	(1,1,1)

Table 3.12: Weight of barriers to the Proliferation of IT in HSCM

Major Criterion	Major Criterion weight	Notation	Ratio Weight	Final Weight	Rank
Strategic barriers	0.2273	SB1	0.209	0.047	7
		SB2	0.186	0.042	11
		SB3	0.231	0.053	2
		SB4	0.167	0.038	14
		SB5	0.211	0.048	5
Organizational barriers	0.2230	OB1	0.111	0.025	24
		OB2	0.222	0.050	4
		OB3	0.240	0.054	1
		OB4	0.200	0.045	8
		OB5	0.227	0.051	3
Finance barriers	0.1808	FB1	0.207	0.038	16
		FB2	0.188	0.035	21
		FB3	0.226	0.041	12
		FB4	0.173	0.031	22
		FB5	0.207	0.038	15
Human barriers	0.1655	HB1	0.215	0.036	19
		HB2	0.241	0.040	13
		HB3	0.187	0.031	23
		HB4	0.216	0.036	25
		HB5	0.143	0.024	18

Table 3.12: Weight of barriers of coordination in HSC

Year.	Topic	CSCM	HSCM		
		TB1	0.180	0.037	17
		TB2	0.230	0.047	6
Technological barriers	0.2035	TB3	0.171	0.035	20
		TB4	0.210	0.043	9
		TB5	0.209	0.042	10

3.6 Discussion

The rise in the occurrence of disasters in recent years is the major hurdle in the overall development of the country. The solution to this problem is to take maximum advantage of the available technology to reduce the impact of the disaster on society, as the occurrence of disaster is uncertain. This study is a pioneering attempt to explore and prioritize barriers to utilization of IT in HSCM, particularly in the Indian context. In this study, barriers were identified through an extensive literature review and verified with the managers of the organizations involved in the relief operations of the past disasters in India. Thereafter, the barriers were validated with a team of experts and prioritized using F-AHP, keeping in mind the socio-economic context of India that resources required to overcome barriers are limited in terms of capital, time, human resources and thus require judicious application.

The survey result (see Table 3.3) indicates that non availability of supply chain experts and lack of supply chain understanding are the most important factors affecting the utilization of IT. These are followed by lack of clear policies to support the adoption of IT, non availability of IT experts and lack of awareness about IT.

Lack of industry support, Poor IT infrastructure, lack of support from donors have a high degree of influential power on adoption of IT in HSCM. A sufficient amount of funds is needed to enhance the use of IT to increase coordination by supporting information sharing. Lack of funds for investment in IT contributes to a poor infrastructure and manual supply chain processes which further leads to low use of IT in HSCM. The temporary nature of the work environment in the organizations involved in the HSCM also contributes to the low use of IT by organizations in HSCM. The temporary nature of jobs reduces the motivation and information sharing spirit of the members involved in HSC. The result also highlights the need for collaborative and strategic planning.

For the purpose of the validation of the survey findings and prioritization of the IT barriers, the experts suggestions were utilized in agreement with Leedy (1997). Based on the survey results, all twenty barriers are critical to coordination in HSCM and are applicable to the Indian context. Therefore all 25 barriers were prioritized using fuzzy AHP. This study provides a more systematic and robust method for evaluation of IT barriers in HSCM by considering them as five separate

criteria, supporting the premise of Nagesha and Balachandra (2006) that the individual criterion approach ignores the impact of other factors, as it does not project the holistic picture. This investigation and prioritization of barriers brings out two critical facts:

- Although there is a difference in the weight of barriers in different categories, none of them obtained insignificant weight. This supports the premise that the considered barriers are relevant in the Indian context.
- Strategic barriers are the most important group followed by organizational, technological, finance and human barriers.

Several issues have contributed to the ranking of strategic barriers as the highest group. The reason for this is that the investment made to enhance the technological capabilities of the actors in the HSCM requires management commitment. Yet top management lacks understanding of the supply chain Gustavsson (2003); Van Wassenhove (2006). The organizations, such as HROs, come into the picture only after the occurrence of disaster. They are not working for the improvement of systems and processes in the long term. The majority of organizations do not have the aptitude, knowledge and dynamism required to tackle coordination and technology-related problems that would enhance efficiency. In addition, they do not have enough funds available as their main source of funding is temporary. Despite this, top management can still create awareness about the importance of advanced systems that can enhance the performance of HSCM by organizing workshops and advertising through websites and blogs In the past, these kind of activities were very rare. Furthermore, there are no existing policies to advance coordination among the organizations. There needs to be more drive by management to take initiatives forward (Byman et al., 2000).

Although there is no apparent difference among the barrier groups in terms of overall weights, organizational barriers is marginally ahead of the others. The organizational barriers group can be mainly attributed to non availability of supply chain and IT experts as well as lack of mutual trust among the actors involved in HSCM. The result also supports the finding of McEntire (1999) that lack of trust between actors resists the necessary information sharing among stakeholders. This in turn acts as a multiplier effect, producing low coordination and collaboration between the commercial and humanitarian sectors. The FEMA report (2006) also emphasized the point that disaster management is a system-level problem and that there is not one system available that satisfies the requirements of all organizations. Dramatic improvements in one technological area may have relatively little impact overall, unless other interconnected technologies are able to leverage and utilize any improvements made.

As per the results in Table 3.12, “strategic barriers” was rated as the highest influential IT barrier, but the sub criteria of “organizational barriers” was rated first. This os due to following reasons. First of all, most of the actors in HSC, such as HROs, lack investment capability and hence they do not invest in appropriate IT systems or efficient technologies. Secondly, the HSC lacks transparency and accountability Agostinho (2013); Thomas and Kopczak (2005). Thirdly, the size of the organizations involved is normally small with inefficient structures Maiers et al. (2005);

McEntire (2002); Schulz and Blecken (2010). They do not have sufficient expertise to carry out several key management functions such as logistics and transportation Agostinho (2013); Gustavsson (2003). Fourthly, the training given to the employees in organizations is inappropriate. There is a general focus on HR aspects, whereas the target should be on the lack of expertise in the use of IT Agostinho (2013); Maiers et al. (2005); Thevenaz and Resodihardjo (2010).

Kovacs and Spens (2007) reported that the actors come into contact with each other only after a disaster happens, but plan separately during the preparedness phase, independently of each other. The focus is not on the "local context" during the preparedness phase. There is a need for a local focus in organizational planning and practices. The majority of organizations display an attitude of helplessness towards the IT issue and depend too much on Government and other external sources to help them in this regard. Generally, it has been found that the employees of organizations resist change and consider adopting new technology or processes to improve efficiency as a risky endeavor (Maiers et al., 2005). Davidson (2006) demonstrates that the main challenges in adopting management systems are the culture, the way performance is monitored and inefficient analysis of events.

The results of the survey findings are in line with the experts opinions. The results indicate that commitment is required from all the actors involved in HSCM to advocate and support the process of coordination in HSC. Use of improved technology systems can help all of the actors in HSC to improve upon trust, transparency and communication issues. There is a strong need to promote closer coordination between various technological communities involved in crowd sourced mapping, disaster management and space technology for the enhancement of the effectiveness of relief activities.

3.7 Summary

This study explores and prioritizes the barriers to utilization of IT among actors in HSCM in order to enhance the performance of the relief operations. In addition, this study also incorporates the views of mangers involved in relief operations. The barriers hindering the effective and efficient management of relief activities pose challenges both for managers and strategists in the field of humanitarian aid management. By using these priorities, actors in HSCM can decide which barrier they should focus on first, next and then last. This study provides a more effective, efficient and systematic method to overcome the barriers to utilization of IT in HSCM. In order to enhance the performance of relief operations, management teams should arrange their methods of working in a systematic manner to initially address the barriers that have the highest priority. The findings of this chapter would enable the policy makers or decision makers in Indian HSCM to understand different barriers with their relative importance to utilization of IT. As reported in this chapter, resources available to improve the utilization of IT in HSCM are limited in terms of time and capital. Therefore, the next chapter deals with the identification and prioritization of solutions to overcome these barriers affecting the utilization of IT in HCSM.

Chapter 4

Prioritizing Drivers to Information Technology in Humanitarian Supply Chain Management

Preview

In the previous chapter, barriers to the proliferation of IT are presented. In addition, barriers are prioritized on the basis of their severity using F-AHP. This chapter proposes, prioritize the solutions utilizing Fuzzy-TOPSIS, to overcome the barriers affecting the proliferation of IT on the basis of the weight of the barriers estimated by using fuzzy AHP.

4.1 Introduction

The increase in the occurrence of disasters worldwide is of growing concern for the social and economic development of the countries involved. The disaster, i.e. natural or man-made, affects hundreds of thousands of people every year. Disasters are unavoidable but preventive actions can be taken to reduce the impact of disaster on the country concerned. The operational effectiveness of the disaster response phase cannot be enhanced as a whole; it needs to fragment the management process into meaningful elements and factors such as utilization of IT in order to improve the performance of the humanitarian relief supply chain.

The major challenge highlighted by academicians and practitioners in disaster preparedness measures is the lack of use of IT in relief operations. The major stumbling block resisting the use of IT is behaviour of donors (Whiting & Ayala-Ostrm, 2009). The majority of the sources of funds are typically only available after the occurrence of disaster, and also must be spent in a short time window (FEMA Report, 2006). Limited funding drives the actors such as humanitarian relief organizations (HROs) to focus on immediate and direct relief rather than investing in systems and processes that will improve the efficiency of the relief operations over the long-term (Thomas, 2003). Therefore, poor IT infrastructure, traditional supply chain, disparity of IT facility among actors involved in HSCM exists in the humanitarian sector.

Many researchers have demonstrated the barriers to the proliferation of IT in HSC includes poor IT infrastructure (Datta et al., 2005), Lack of IT experts. The low level of supply chain understanding often complicates the IT adoption issues in the organizations. The attitudes the reluctance towards ICT may prevent the organizations from being involved in the adoption of IT applications. IT infrastructure is well established in developed countries as compared to developing

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countries (Mbarika et al., 2005). Odedra-Straub (1993) also supports the poor IT infrastructure issue in developing countries and highlighted that due to poor IT infrastructure peoples are not able to gather information and coordinate with each other to solve their problems.

Although, the utilization of IT has been promoted as a "silver bullet" in many areas of commercial SCM and is contended to be a mechanism to prevent organizations within the supply chain optimizing solely their own results rather than integrating their goals and activities with others to benefit overall end user value (Cooper et al., 1997; Porter, 1998). However, the utilization of IT inherent within commercial supply chains have not been observed in the HSC and is still a major concern (T. C. Chan et al., 2004; Jefferson, 2006a; Overstreet et al., 2011; Stephenson & Anderson, 1997; Telleen & Martin, 2002; Tomasini & Van Wassenhove, 2009).

Therefore, this chapter presented in this research is a pioneering attempt to address this critical research need by examining 25 barriers (identified in chapter 3) and 19 solutions to the proliferation of IT in HSCM. The weight of the barriers estimted in chapter 3 using Fuzzy analytic hierarchy process (F-AHP) has been used to prioriotze the solutions to overcome the barriers using fuzzy technique for order performance by similarity to ideal solution (F-TOPSIS) that considers uncertainty and impreciseness rather than a crisp value. This robust framework is expected to provide a more effective and a systematic decision support tool to improve the utilization of IT which would further improve the performance of HSC. As it is not possible to instantly improve the situation by removing all the barriers resisting the maximum utilization of IT. It is important to recognize various constraints such as limited resources in terms of capital, time, human resources and policy initiatives, so prioritizing the solutions to improve the factors affecting the proliferation of IT, on the basis of their severity is essential for stepwise implementation of solutions. The perspective for prioritization of solutions is to focus more on the critical enabler to have the best possible outcomes as the resources are limited in terms of capital, time, human resources, etc.

Therefore, this chapter examines 25 barriers to the proliferation of IT in HSCM identified through the discussion with the experts (see chapter 3); grouped into 5 categories i.e., strategic barriers, organizational barriers, financial barriers, human barriers barriers and technological barriers, and finally 19 solutions were proposed and prioritized to overcome the barriers so decision makers can focus on overcoming these barriers and realize the benefits of IT in HSCM. Fuzzy AHP was used to estimate the weight of barriers while fuzzy TOPSIS helped to prioritize the solutions to overcome the barriers. This framework provides a more precise, efficient, effective, robust and a systematic decision support tool for a stepwise implementation of solutions.

4.2 Literature Review

There are various challenges in support of effective and efficient delivery of relief materials to the disaster affected peoples during complex emergencies. These challenges are not only technology related, they are often relating to core organizational issues of mission, culture, environment, and

communication (Maiers et al., 2005). The utilization of IT in HSCM needs a large amount of funds, effort, time, support and commitment from top management, starting from the first phase. Kapucu and Garayev (2012) also supported the view that the utilization of IT called for more investment in IT infrastructure. The solutions to overcome the barriers to the proliferation of IT are discussed in the subsequent section.

4.2.1 Solutions to the Factors Affecting the Proliferation of IT in HSCM

Van Brabant and Place (1999) reported that "similar standards of quality, cost-effective use of resources, rational allocation of tasks, and working towards agreed priorities" promote coordination among humanitarian actors. Researchers have suggested varied and situation specific solutions to overcome the challenges to the proliferation of IT in HSCM (Table 5.2) in order to improve the efficiency of relief operations (World Health Organization, 2007). A strategic tie up between actors involved in relief activities can have a positive influence on the performance and knowledge sharing capabilities of organizations (McEntire, 2002).

The deployment of avoidance techniques and the development of relationships among actors prior to disasters is not evident, particularly in developing countries (Kovacs & Spens, 2007). This includes inefficient training to the workers, resistive behaviour to learn new skills such as interpersonal, verbal/written/communication. In an interrupted environment, the needs are urgent, events are unpredictable and resources are scarce. The use of better-trained people is vital (Thomas & Mizushima, 2005). Staff training may include activities such as the specific ability to communicate with military and government agencies, professional courses in logistics, knowledge about alternative suppliers and shipping documentation and drawing up needs assessments.

Table 4.1: Solutions to Overcome Barriers to the Proliferation of IT in HSCM

S. No	Solutions
S1	Commitment from top management
S2	Strategic tie-up among the commercial and humanitarian organization
S3	Effective policy for IT adoption
S4	Employee motivation
S5	Build trustworthy environment among the actors in HSCM
S6	Retention of skilled and experienced workers
S7	Donor supports
S8	Access to financing and capitalization
S9	Establish a transparent work flow or open door policy
S10	Long term focused planning
S11	Government support
S12	Industry funding
S13	Feedback mechanism to facilitate learning from prior experiences

to be cont'd on next page

Table 4.1: Solutions to Overcome Barriers to the Proliferation of IT in HSCM

S. No	Solutions
S14	Coaching/training to the employees
S15	Onsite disaster management process expert
S16	Supply chain expert
S17	Information technology expert
S18	Enhance awareness about the benefits of IT in HSCM
S19	Coordination among the actors during all phases of DM

Top management commitment and an effective performance management system are vital in order to overcome the problem of funds, strategic planning, awareness, trust and other issues (Agostinho, 2013; Gunasekaran, Patel, & McGaughey, 2004; Moshtari & Gonçalves, 2012; Ponomarov & Holcomb, 2009; W. Smith & Dowell, 2000; Thevenaz & Resodihardjo, 2010; Waugh & Streib, 2006). The mutual learning of commercial and humanitarian organizations is crucial to enhance the competence of SC partners (Agostinho, 2013). Joerin, Shaw, Takeuchi, and Krishnamurthy (2012) reported that community-driven participatory solutions in collaboration with other stakeholders have beneficial effect in enhancing the resilience of communities to climate-related disasters. Joerin et al. (2012) reported that community-driven participatory solutions in collaboration with other stakeholders have beneficial effect in enhancing the resilience of communities to climate-related disasters.

Regular meetings between actors are essential to evaluate the effectiveness of current relief activities (McEntire, 2002). The use of IT enhances the agility and flexibility in supply chain (Gunasekaran & Ngai, 2004). Advanced IT systems that can be used to store, retrieve, and share information across organizational boundaries (Agostinho, 2013; Balcik et al., 2010; DeJohn, 2005; Gunasekaran, Ngai, & McGaughey, 2006; Maiers et al., 2005; Mandal & Gunasekaran, 2003; McEntire, 2002; Schulz & Blecken, 2010) are of utmost need (Kala, 2014; H. W. Lee & Zbinden, 2003). Establishing a transparent workflow policy in an organization supports the flow of information at different levels within the HSC and ensures flexibility, agility and alignment in a command chain (Sheffi & Rice, 2005). Strengthening cultural cohesion and cooperation among the actors will help bridge the cultural gap between different actors (Agostinho, 2013; Balcik et al., 2010; Sheffi & Rice, 2005).

The financial supply chain needs to be accountable and transparent so donors can see how the money that donate is utilized (Agostinho, 2013; Balcik et al., 2010; Thomas & Mizushima, 2005). It is essential to view the process of disaster management holistically instead of a short-term view (Agostinho, 2013; Kovacs & Spens, 2007; Maiers et al., 2005; Natarajarathinam et al., 2009; Pettit & Beresford, 2009; Schulz & Blecken, 2010) and a feedback mechanism is required to incorporate the lessons learned from prior disasters (Balcik et al., 2010; Ponomarov & Holcomb, 2009).

4.3 Need for Fuzzy TOPSIS

The prioritization of the solutions to the factors affecting the utilization of IT is a multi-criteria decision making (MCDM) problems. MCDM problems originate due to the absence of a unique optimal solution. In this instance, the decision makers have to select the best alternative from a set of available alternatives. Although MCDM methods such as AHP in combination with fuzzy logic alone can also fulfil the objective of the study, the fuzzy TOPSIS has several advantage over fuzzy AHP. For the purpose of this chapter, fuzzy TOPSIS has been utilized to solve MCDM problem as it is one of the widely used MCDM method, and it has the ability to deal with data related to uncertainty.

TOPSIS analysis has been used since (1) TOPSIS uses closeness index value that accounts for the best and worst alternative choices simultaneously for the ranking of solution. All the alternatives are compared with positive ideal solution (PIS) and negative ideal solution (NIS), rather than directly among themselves as in case of AHP (Joshi, Banwet, & Shankar, 2011). The basic philosophy of TOPSIS is that the selected solution should have shortest distance, in a geometrical sense, from the ideal solution (that maximizes the benefit criteria and minimizes the cost criteria) and longest distance from the worst solution. Due to this limitation of AHP, several researchers have used TOPSIS as compared to AHP in ranking of the solutions as given in Table 4.2. (2) According to Shi, Peng, Liu, and Zhong (2008) AHP is suitable for either hierarchical decomposition or 7+-2 attributes, whereas, there is no limitation over number of attributes in TOPSIS. In order to obtain the final priority of solutions, fuzzy AHP involves n*m*(m-1)/2 comparisons. Fuzzy AHP is preferred if the number of solutions are less, so that the number of pairwise comparison would be less. Therefore, to avoid an unreasonably large number of pairwise comparisons, the fuzzy TOPSIS is employed to achieve the final ranking results.

Table 4.2: Application of Fuzzy TOPSIS

S. No.	Author	Context
1	Büyüközkan, Feyzioğlu, and Nebol (2008)	Selection of the strategic alliance partner
2	Shaw, Shankar, Yadav, and Thakur (2013)	Global supplier selection
3	Choudhary and Shankar (2012)	Evaluation and selection of thermal power plant location
4	Chu (2002)	Selection of plant location
5	Dağdeviren, Yavuz, and Kılınç (2009)	Weapon selection

4.4 Methodology

In the chapter, an integrated framework of fuzzy logic and TOPSIS was used to explore, propose, and prioritize solutions to improve the utilization of IT in HSC in the Indian context. The proposed methodology consists of three phases (Patil & Kant, 2014). Initially, solutions to overcome the barriers were explored by brainstorming sessions with experts. Second, solutions were empirically verified through questionnaire analysis from the top level management of the organizations and other experts involved in the relief operations of past disasters occurred in India. Finally, weight of barriers estimated using fuzzy AHP in Chapter 3, has been used to prioritize the solutions to overcome the barriers using fuzzy TOPSIS. Several important definitions of fuzzy logic are already discussed in Chapter 3.

4.4.1 Verification of Solutions to Overcome IT Barriers

The solutions to overcome IT barriers (established within chapter 2) were empirically veried from the top level management of the organizations and other experts involved in the relief operations of past disasters occurred in India. For the purpose, data has been collected from these experts through a well structured questionnaire. The data was collected following the same procedure as reported the Chapter 3. The Likert scale was used for the purpose of data collection from the experts. The survey questionnaires were personally administered to the 38 experts. The experts were selected using purposive snowball sampling in order to identify the respondents who would be able to provide the necessary information in agreement with Raju and Becker (2013).

4.4.1.1 Result

The result of survey analysis are presented in Table 4.3. The survey results show that all the solutions are significant in the Indian context as the mean scores of barriers range from 3.58 to 4.18 with standard deviation (SD) less than 0.7. Therefore, we can conclude that all the solutions were applicable according to (Somsuk & Laosirihongthong, 2014). Table 4.3 presents the results of descriptive statistics for IT barriers in HSCM.

Table 4.3: Descriptive Statistics of Solutions to the Proliferation of IT

S.No.	Solutions	Mean	S.D
1.	Commitment from top management	3.84	0.855
2.	Strategic tie-up among the commercial and humanitarian organization	3.92	0.749
3.	Effective policy for IT adoption	4.16	0.855
4.	Employee motivation	3.68	0.809
5.	Build trustworthy environment among the actors in HSCM	3.76	0.883
6.	Retention of skilled and experienced workers	3.58	0.793

to be cont'd on next page

Table 4.3: Descriptive Statistics of Solutions to the Proliferation of IT

S.No.	Solutions	Mean	S.D
7.	Donor supports	3.71	0.835
8.	Access to financing and capitalization	3.82	0.834
9.	Establish a transparent work flow or open door policy	4.13	0.935
10.	Long term focused planning	3.79	0.843
11.	Government support	3.97	0.854
12.	Industry funding	3.92	0.818
13.	Feedback mechanism to facilitate learning from prior experiences	4.13	0.777
14.	Coaching/training to the employees	3.84	0.789
15.	Onsite disaster management process expert	3.95	0.868
16.	Supply chain expert	4.11	0.863
17.	Information technology expert	4.18	0.865
18.	Enhance awareness about the benefits of IT in HSCM	4.24	0.751
19.	Coordination among the actors during all phases of DM	3.97	0.885

4.4.2 Fuzzy-TOPSIS

In 1981, Hwang and Yoon proposed TOPSIS, which is one of the MCDM methods. It is based on the concept that a selected attribute should have the least and largest distance from the positive ideal solution (PIS) and the negative ideal solution (NIS), respectively (Shi et al., 2008). In the classical TOPSIS method, individual preferences are represented with crisp values. However, in order to consider the impreciseness and uncertainty of real life cases, linguistic variables can be used instead of crisp value (Büyüközkan et al., 2008; Chen & Tsao, 2008; Choudhary & Shankar, 2012; Chu, 2002; Dağdeviren et al., 2009; Shaw et al., 2013). The fuzzy TOPSIS method is explained as follows:

Step 1: Choose the linguistic rating values for the alternative with respect to criteria on the basis of scale given in Table 4.4.

Table 4.4: Linguistic Variables for Solutions Ratings

Linguistic variables	Corresponding TFN
Very poor (VP)	(1,1,3)
Poor (P)	(1,3,5)
Medium (M)	(3,5,7)
Good (G)	(5,7,9)
Very Good (VG)	(7,9,11)

Step 2: Calculate aggregate fuzzy ratings for the alternatives

If the fuzzy ratings of all experts are described as TFN $\widetilde{R_k}$ = (a_k,b_k,c_k), k = 1,2,3...K then the aggregated fuzzy rating is given where

$$a = min_k\{a_k\},\ b = \frac{1}{k}\ \sum_{k=1}^{k} b_k,\ c = max_k\{C_k\} \tag{4.1}$$

Step 3: Construct the fuzzy decision matrix

The fuzzy decision matrix for the alternatives is constructed as follows:

$$\begin{array}{c} A_1 \\ A_2 \\ \vdots \\ A_n \end{array} \begin{bmatrix} \widetilde{\mathbf{x}}_{\mathbf{11}} & \widetilde{\mathbf{x}}_{\mathbf{12}} & \cdots & \widetilde{\mathbf{x}}_{\mathbf{1n}} \\ \widetilde{\mathbf{x}}_{\mathbf{21}} & \widetilde{\mathbf{x}}_{\mathbf{22}} & \cdots & \cdots \\ \vdots & \cdots & \cdots & \vdots \\ \widetilde{\mathbf{x}}_{\mathbf{m1}} & \widetilde{\mathbf{x}}_{\mathbf{m2}} & \cdots & \widetilde{\mathbf{x}}_{\mathbf{m}n} \end{bmatrix} \tag{4.2}$$

where i= 1, 2, 3,..... m; j=1,2,.....n

Step 4: Normalized fuzzy decision matrix

The normalized fuzzy decision matrix is given by:

$$\widetilde{R} = [r_{ij}]_{mxn},\ where\ i = 1, 2, ...m;\ j = 1, 2, ..., n, \tag{4.3}$$

$$\tilde{r}_{ij} = (\frac{\tilde{a}_{ij}}{C_j^*}, \frac{\tilde{b}_{ij}}{C_j^*}, \frac{\tilde{c}_{ij}}{C_j^*})\ and\ c_j^* = max_i\{c_{ij}\}(benefit\ criteria) \tag{4.4}$$

$$\tilde{r}_{ij} = \left(\frac{a_j^-}{C_{ij}}, \frac{a_j^-}{b_{ij}}, \frac{a_j^-}{a_{ij}}\right)\ and\ a_j^- = min_i\{a_{ij}\}(cost\ criteria) \tag{4.5}$$

Step 5: Construct the weighted normalized matrix

The weighted normalized matrix for criteria is computed by multiplying the weights (wj) of evaluation criteria with the normalized fuzzy decision matrix.

$$\tilde{V} = [\tilde{v}_{ij}]_{mxn}\ i = 1, 2, ...m;\ j = 1, 2, ..., n,\ where\ \tilde{v}_{ij} = r_{ij} * W_j \tag{4.6}$$

Step 6: Determine the fuzzy (PIS) and fuzzy (NIS)

The FPIS and FNIS of the alternatives is computed as follows:

$$A^* = (\ \widetilde{v}_1^{\alpha},\ \widetilde{v}_2^{\alpha}, ... \ \widetilde{v}_n^{\alpha})\ where\ \widetilde{v}_j^*\ = (\ \widetilde{c}_j^*,\ \widetilde{c}_j^*,\ \widetilde{c}_j^*)\ and\ c_1^* = \ max_i\{\tilde{c}_{ij}\} \tag{4.7}$$

$$A^- = (\widetilde{v}_1^-,\ \widetilde{v}_2^-, \ldots\ldots\ \widetilde{v}_n^-)\ where\ \widetilde{v}_j^- = (\widetilde{a}_j^-, \widetilde{a}_j^-,\ \widetilde{a}_j^-)\ \ and\ a_1^- =\ max_i\{\tilde{a}_{ij}\} \tag{4.8}$$

$$\forall i = 1, 2, \ldots, m;;\ \ j = 1, 2, \ldots n$$

Step 7: Calculate the distance of each alternative from FPIS and FNIS

$$d_i^+ = \sum_{j=1}^{n} dv\ (v_{ij}^{\sim}, v_j^*),\ i = 1, 2, \ldots..m \tag{4.9}$$

$$d_i^- = \sum_{j=1}^{n} dv\ (v_{ij}^{\sim}, v_j^*),\ i = 1, 2, \ldots..m \tag{4.10}$$

Step 8: Calculate the closeness coefficient (CCi) of each alternative The closeness coefficient of each alternative is calculated as:

$$CC_i = \frac{d_i^-}{d_i^- + d_i^+} \tag{4.11}$$

Step 9: Based on the CC_i value, strategies are prioritized in descending order.

4.5 Application of Proposed Framework

The integrated fuzzy AHP - TOPSIS framework is used to prioritize solutions to overcome barriers to the proliferation of IT in HSC. The application of integrated framework consist of three phases provided in the methodology section is given as follows:

4.5.1 Problem Description

The importance being proactive and prepared for disasters was a crucial lesson learned from the past disaster that occurred with huge impact on the society. For example, a study conducted in the aftermath of the 2005 U.S. response to Hurricane Katrina found that the utilization of IT is critical by the organizations involved in HSCM. For example, IT has the potential to estimate and communicate the probable impact of natural disasters before its occurrence (Patterson, 2005). There are abundant examples that efficiency of the HSC could be improve by maximizing the utilization of IT in HSC as explained in the Section 1. Therefore barriers to the proliferation of IT in HSC are to be handled on priority to improve the performance of HSC. It is not possible to improve all the barriers at the same time. In view of this limitation, it is necessary to prioritize solutions to overcome barriers and implement them in a step wise manner. The three phase adopted for the study are discussed in the subsequent section.

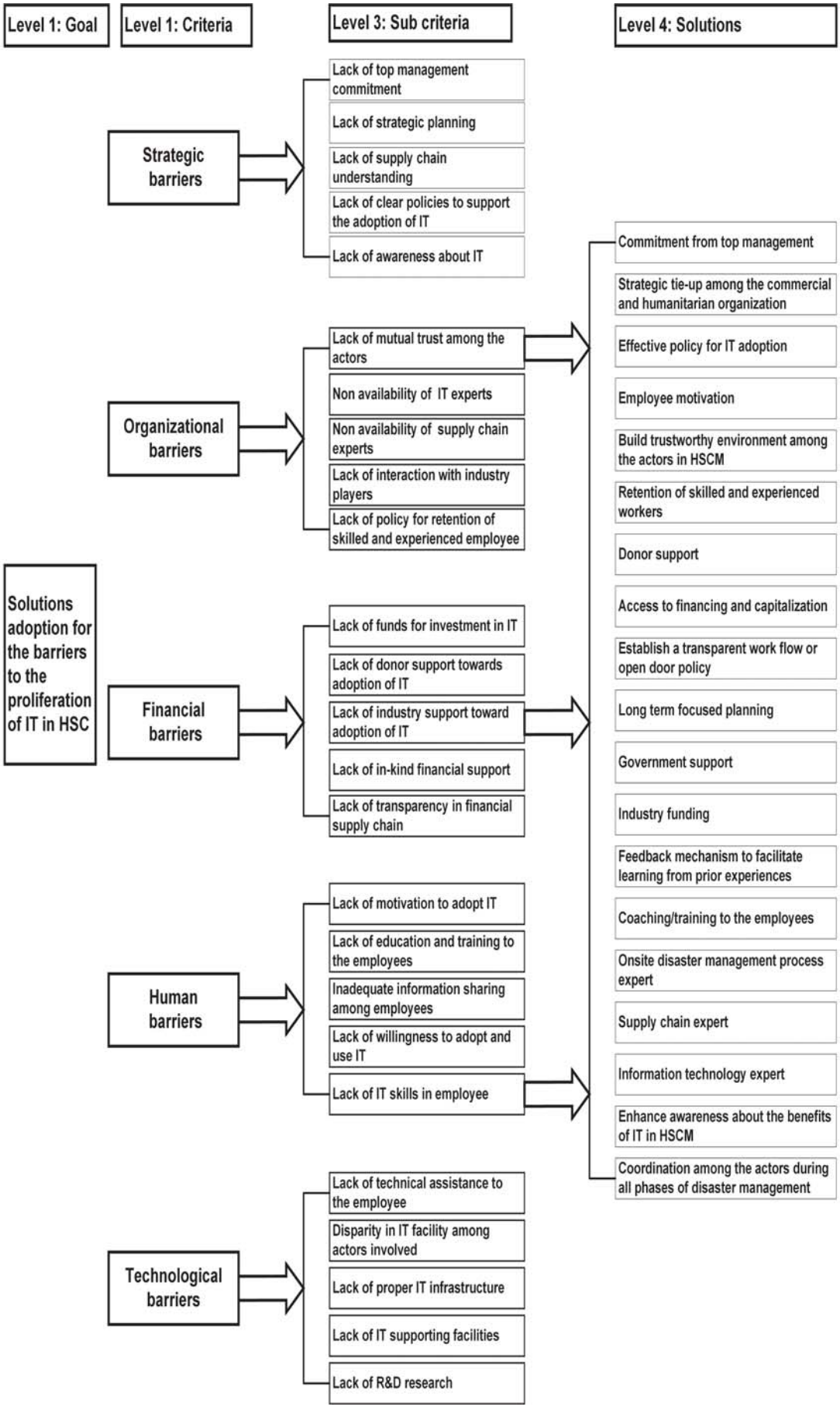

Figure 4.1: Decision Hierarchy

4.5.2 Problem Analysis

Phase 1: Identification of solutions to overcome barriers to the proliferation of IT in HSC
In this phase, solutions to overcome barriers to the proliferation of IT in HSC have been identified through the extensive literature review and expert discussion. This phase identified 19 solutions through a literature review and intensive discussion with experts (comprising of SC and IT expert) who were actively involved in the past disaster relief activities. The decision hierarchy consist of four levels; the overall goal of the decision process determined as "Solutions adoption for barriers to the proliferation of IT in HSC" is at the first level. The second level consists of major criteria, the third level is the sub criteria and the fourth level consists of solutions to overcome these barriers (see Figure 4.1).

Phase 2: Verification of solutions to overcome barriers to the proliferation of IT in HSC
The 19 solutions to overcome barriers to the proliferation of IT in HSC identified through literature review were empirically verified through the top management and the experts of HSCM. The Likert scale was used for the purpose of data collection from the experts. The survey questionnaires were personally administered to the 38 experts. The experts were selected using purposive snowball sampling in order to identify the respondents who would be able to provide the necessary information in agreement with Raju and Becker (2013).

Phase 3: Evaluation of the solutions to overcome the barriers to the proliferation of IT in HSC by fuzzy TOPSIS
The weight of the barrier estimated using F-AHP is given in Chapter 3. The fuzzy evaluation matrix was formed by using linguistic variables from an expert panel (see Table 4.4). It was constructed by comparing the solutions under each of the barriers separately (see Table 4.5). Then linguistic terms were converted into corresponding TFN and a fuzzy evaluation matrix was constructed (see Table 4.6).

Aggregate fuzzy weights of the alternatives were calculated using equation (4.1) and presented in Table 4.7. In this study all the criteria are the barriers, and as per goal minimization, these barriers are termed as cost criteria and normalization performed by equation (4.5) (see Table 4.8). In the next step, the weighted evaluation matrix was constructed using equation (4.6) as shown in Table 4.9. The fuzzy positive-ideal solution (FPIS, A*) and fuzzy negative-ideal solution (FNIS, A-) are given below for all these barriers as they are cost criteria.

$$v^{*} = (0, 0, 0)$$

$$v^{-} = (1, 1, 1)$$

The final results are summarized in the Table 4.10. Based on the CCi value calculated using equation (4.7 to 4.11) , solutions are ranked in descending order.

Table 4.5: Linguistic Scale Evaluation Matrix for the Solutions (Expert 1)

S. No.	SB1	SB2	SB3	SB4	SB5	OB1	OB2	OB3	OB4	OB5	FB1	FB2	FB3	FB4	FB5	HB1	HB2	HB3	HB4	HB5	TB1	TB2	TB3	TB4	TB5
S1	VG	VG	VG	VG	G	G	G	G	G	G	G	G	G	G	VG	VG	G	G	VG	G	G	G	G	G	G
S2	G	VG	VG	G	G	G	G	VG	G	M	G	G	G	G	VG	VG	G	G	G	G	G	G	VG	G	VG
S3	VG	VG	VG	VG	G	VG	M	P	M	G	G	VG	G	M	G	G	G	VG	G	G	VG	G	VG	G	VG
S4	M	G	M	G	P	P	P	G	P	G	P	VP	VG	G	G	P	VP	VG	G	G	G	G	VP	VP	VP
S5	G	VG	M	G	M	VG	P	M	G	G	VG	M	M	M	G	G	VG	G	G	G	VG	G	VG	G	VG
S6	P	G	G	G	G	G	G	G	P	P	P	P	P	P	G	G	G	G	G	G	VP	VP	P	P	P
S7	G	G	G	G	G	G	G	G	VG	VG	G	VG	VG	G	G	G	G	G	M	G	G	G	VG	VG	M
S8	G	G	G	G	G	G	G	G	VG	VG	G	VG	VG	G	G	G	G	G	M	G	G	G	VG	VG	M
S9	G	G	G	G	VG	G	P	VG	G	VG	VG	VG	G	M	VG	VG	VG	G	VG	VG	VG	VG	VG	VG	VG
S10	G	G	VG	G	G	G	P	G	VG	G	G	VG	G	VG	VG	VG	G	VG	VG	VG	VG	G	G	G	G
S11	VG	VG	G	G	G	G	G	G	VG	VG	G	VG	VG	G	G	G	G	G	M	G	G	G	VG	VG	M
S12	G	G	G	G	G	G	G	VG	VG	VG	G	VG	VG	G	VG	G	V	G	M	G	G	G	VG	VG	M
S13	VG	VG	VG	VG	G	G	G	G	G	VG	G	G	G	VG	G	VG	G	VG	VG	VG	VG	VG	VG	VG	VG
S14	P	VG	M	G	VG	P	G	VG	VG	VG	VG	P	P	P	M	VG	G	VG	VG	G	VG	G	G	G	G
S15	VG	VG	VG	VG	G	VG	M	P	M	G	G	VG	G	M	G	G	G	VG	G	G	VG	G	VG	G	VG
S16	G	G	G	VG	G	VG	G	G	G	G	M	G	G	G	G	G	VG	G	G	G	G	G	VG	G	VG
S17	VG	VG	VG	VG	G	VG	G	P	M	G	G	VG	G	M	G	G	G	VG	G	G	VG	G	VG	G	VG
S18	VG	G	G	VG	P	G	G	G	G	M	G	G	VG	G	G	G	G	G	G	G	G	G	VG	G	VG
S19	G	G	G	VG	G	VG	VG	G	G	G	M	G	G	G	G	G	VG	G	G	G	G	G	VG	G	VG

Table 4.6: Fuzzy Evaluation Matrix for Solutions (Expert 1)

S. NO	SB1	SB2	——	——	FB4	FB5	——	——	TB1	TB2
S1	(7,9,11)	(7,9,11)	——	——	(5,7,9)	(7,9,11)	——	——	(5,7,9)	(5,7,9)
S2	(5,7,9)	(7,9,11)	——	——	(5,7,9)	(7,9,11)	——	——	(5,7,9)	(5,7,9)
S3	(7,9,11)	(7,9,11)	——	——	(3,5,7)	(5,7,9)	——	——	(7,9,11)	(5,7,9)
S4	(3,5,7)	(5,7,9)	——	——	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)
S5	(5,7,9)	(7,9,11)	——	——	(3,5,7)	(5,7,9)	——	——	(7,9,11)	(5,7,9)
S6	(1,3,5)	(5,7,9)	——	——	(1,3,5)	(5,7,9)	——	——	(1,1,3)	(1,1,3)
S7	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)
S8	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)
S9	(5,7,9)	(5,7,9)	——	——	(3,5,7)	(7,9,11)	——	——	(7,9,11)	(7,9,11)
S10	(5,7,9)	(5,7,9)	——	——	(7,9,11)	(7,9,11)	——	——	(7,9,11)	(5,7,9)
S11	(7,9,11)	(7,9,11)	——	——	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)
S12	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(7,9,11)	——	——	(5,7,9)	(5,7,9)
S13	(7,9,11)	(7,9,11)	——	——	(7,9,11)	(5,7,9)	——	——	(7,9,11)	(7,9,11)
S14	(1,1,3)	(7,9,11)	——	——	(1,3,5)	(3,5,7)	——	——	(7,9,11)	(5,7,9)
S15	(7,9,11)	(7,9,11)	——	——	(3,5,7)	(5,7,9)	——	——	(7,9,11)	(5,7,9)
S16	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)
S17	(7,9,11)	(7,9,11)	——	——	(3,5,7)	(5,7,9)	——	——	(7,9,11)	(5,7,9)
S18	(7,9,11)	(5,7,9)	——	——	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)
S19	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)	——	——	(5,7,9)	(5,7,9)

Table 4.7: Aggregate Fuzzy Decision Matrix for Solutions

S. No	SB1	SB2	——	——	TB1	TB2
S1	(1,6.33,11)	(5,7.67,11)	——	——	(3,7,11)	(5,7,9)
S2	(5,7.67,11)	(1,5.66,11)	——	——	(5,7,9)	(5,7,9)
S3	(1,5.67,11)	(3,7.67,11)	——	——	(5,7.67,11)	(5,8.33,11)
S4	(1,5,9)	(5,7.67,11)	——	——	(5,7,9)	(5,7,9)
S5	(1,5.6,11)	(1,6.3,11)	——	——	(5,8.33,11)	(5,7.67,11)
S6	(1,5,11)	(1,5,9)	——	——	(1,5,11)	(1,5,9)
S7	(1,5,9)	(1,5.67,9)	——	——	(5,7.67,11)	(5,7,9)
S8	(1,5,9)	(3,6.33,9)	——	——	(5,7,9)	(5,7,9)
S9	(3,7,11)	(5,7.67,11)	——	——	(5,7.67,11)	(7,9,11)
S10	(3,6.33,9)	(5,7.67,11)	——	——	(1,4.33,11)	(1,5,9)
S11	(1,5.67,11)	(3,6.33,11)	——	——	(1,5.67,9)	(1,6.33,11)
S12	(1,5.67,9)	(3,5.67,9)	——	——	(3,6.34,9)	(3,6.33,9)
S13	(5,8.33,11)	(5,7.67,11)	——	——	(5,8.33,11)	(3,7.67,11)
S14	(1,5.67,11)	(1,6.33,11)	——	——	(5,8.33,11)	(3,7,11)
S15	(5,8.33,11)	(5,7.6,11)	——	——	(5,7.67,11)	(3,6.33,9)
S16	(5,7,9)	(3,5.6,9)	——	——	(5,7,9)	(5,7,9)
S17	(7,9,11)	(5,7.67,11)	——	——	(7,9,11)	(5,8.33,11)
S18	(7,9,11)	(5,8.3,11)	——	——	(5,8.33,11)	(5,8.33,11)
S19	(5,8.33,11)	(5,7,9)	——	——	(5,7,9)	(5,7,9)

Table 4.8: Normalized Fuzzy Decision Matrix for Solutions

S. No	SB1	SB2	—	—	TB1	TB2
S1	(.0909,0.1579,1)	(.0909,.1304,.2)	—	—	(.0909,.1429,.3333)	(.1111,.1429,.2)
S2	(.0909,.1304,0.2)	(.0909,.1765,1)	—	—	(.1111,.1429,.2)	(.1111,.1429,.2)
S3	(.0909,.1765,1)	(.0909,.1304,.3333)	—	—	(.0909,.1304,.2)	(.0909,.1200,.20)
S4	(.1111,0.2,1)	(.0909,.1304,.2)	—	—	(.1111,.1429,.2)	(.1111,.1429,.2)
S5	(0.0909,0.1705,1)	(.0909,.1579,1)	—	—	(.0909,.12,.2)	(.0909,.1304,.2)
S6	(.0909,2,1)	(.1111,.2,1)	—	—	(.0909,.2,1)	(.1111,.2,1)
S7	(0.1111,.2,1)	(0.1111,.1765,1)	—	—	(.0909,.1304,.2)	(.1111,.1429,.2)
S8	(.1111,0.2,1)	(.1111,.1579,.3333)	—	—	(.1111,.1429,.2)	(.1111,.1429,.2)
S9	(.0909,.1429,0.3333)	(.0909,.1304,.2)	—	—	(.0909,.1304,.2)	(.0909,.1111,.1429)
S10	(.1111,0.1579,0.3333)	(.0909,.1304,.2)	—	—	(.0909,.2308,1)	(.1111,.20,1)
S11	(.0909,.1765,1)	(.0909,.1579,.3333)	—	—	(.1111,.1765,1)	(.0909,.1579,1)
S12	(.1111,1765,1)	(0.1111,.1765,0.3333)	—	—	(.1111,.1579,.3333)	(.1111,.1579,.3333)
S13	(.0909,.12,.2)	(.0909,.1304,.2)	—	—	(.0909,.12,.2)	(.0909,.1304,.33)
S14	(.0909,1765,1)	(.0909,.1579,1)	—	—	(.0909,.12,.2)	(.0909,.1429,.33)
S15	(.0909,.12,.2)	(.0909,.1304,.2)	—	—	(.0909,.1304,.2)	(.1111,.1579,.3333)
S16	(.1111,.1429,.2)	(.1111,.1765,.3333)	—	—	(.1111,.1429,.2)	(.1111,.1429,.2)
S17	(.0909,.1111,.1429)	(.0909,.1304,.2)	—	—	(.0909,.1111,.1429)	(.0909,.12,.2)
S18	(.0909,.1111,.1429)	(.0909,0.12,.2)	—	—	(.0909,.12,.20)	(.0909,.12,.2)
S19	(.0909,.12,.2)	(.1111,.1429,.2)	—	—	(.1111,.1429,.2)	(.1111,.1429,.2)

Table 4.9: Weighted Normalized Fuzzy Decision Matrix for Solutions

S. No	SB1	SB2	——	——	TB1	TB2
S1	(.0042, .0073,.0038)	(.0038, .0055, .0084)	——	——	(.0033, .0052, .0122)	(.0052, .0067, .0094)
S2	(.0042,.0061,.0093)	(.0038, .0075, .0422)	——	——	(.0041, .0052,.0073	(.0052, .0067, .0094)
S3	(.0042,.0082,.0465)	(.0038, .0055, .0141)	——	——	(.0033, .0048, .0073)	(.0043, .0056, .0094)
S4	(.0052, .0093,.0465)	(.0038, .0055, .0084)	——	——	(.0041, .0052,.0073	(.0052, .0067, .0094)
S5	(.0042, .0082, .0465)	(.0038, .0067, .0422)	——	——	(.0033,.0044, .0073)	(.0043, .0061, .0094)
S6	(.0042, .0093, .0465)	(.0047, .0084, .0422)	——	——	(.0033, .0073, .0366)	(.0052, .0094, .0468)
S7	(.0052, .0093, .0465)	(.0047, .0075, .0422)	——	——	(.0033, .0048, .0073)	(.0052, .0067, .0094)
S8	(.0052, .0093, .0465)	(.0047, .0067, .0141)	——	——	(.0041, .0052,.0073	(.0052, .0067, .0094)
S9	(.0042, .0066, .0155)	(.0038, .0055, .0084)	——	——	(.0033, .0048, .0073)	(.0043, .0052, .0067)
S10	(.0052, .0073, .0155)	(.0038, .0055, .0084)	——	——	(.0033, .0085, .0366)	(.0052,.0094, .0468)
S11	(.0042, .0082, .0465)	(.0038, .0067, .0141)	——	——	(.0041, .0065, .0366)	(.0043, .0074,.0468)
S12	(.0042, .0082, .0465)	(.0047, .0075, .0141)	——	——	(.0041, .058, .0122)	(.0052, .0074, .0156)
S13	(.0042, .0056, .0093)	(.0038, .0055, .0084)	——	——	(.0033, .0044, .0073)	(.0043, .0061, .0156)
S14	(.0042, .0082, .0465)	(.0038, .0067, .0422)	——	——	(.0033, .0044, .0073)	(.0043, .0067, .0156)
S15	(.0042, .0056, .0093)	(.0038, .0055, .0084)	——	——	(.0033, .0048, .0073)	(.052, .0074, .0156)
S16	(.0052, .0066, .0093)	(.0047, .0075, .0141)	——	——	(.0041, .0052,.0073	(.0052, .0067, .0094)
S17	(.0042, .0052, .0066)	(.0038, .0055, .0084)	——	——	(.0033, .0041, .0052)	(.0043, .0056, .0094
S18	(.0042, .0052, .0066)	(.0038, .0051, .0084)	——	——	(.0033, .0044, .0073)	(.0043, .0056, .0094
S19	(.0042, .0056, .0093)	(.0047, .0060, .0084)	——	——	(.0041, .0052,.0073	(.0052, .0067, .0094)

Table 4.10: Closeness Coefficient and Final Ranking of the Solutions

S.No	Solutions	d+	d-	Sum	CCi	Rank
S1	Commitment from top management	0.259	24.784	25.043	0.990	10
S2	Strategic tie-up among the commercial and humanitarian organization	0.196	24.826	25.022	0.992	6
S3	Effective policy for IT adoption	0.301	24.760	25.060	0.988	14
S4	Employee motivation	0.410	24.680	25.090	0.984	18
S5	Build trustworthy environment among the actors in HSCM	0.303	24.756	25.059	0.988	16
S6	Retention of skilled and experienced workers	0.433	24.667	25.100	0.983	19
S7	Donor support	0.380	24.699	25.077	0.985	17
S8	Access to financing and capitalization	0.266	24.778	25.044	0.990	12
S9	Establish a transparent work flow or open door policy	0.188	24.832	25.021	0.992	5
S10	Long term focused planning	0.289	24.761	25.049	0.989	13
S11	Government support	0.301	24.757	25.057	0.988	15
S12	Industry funding	0.252	24.787	25.039	0.989	8
S13	Feedback mechanism to facilitate learning from prior experiences	0.179	24.839	25.018	0.993	3
S14	Coaching/training to the employees	0.254	24.791	25.046	0.991	9
S15	Onsite disaster management process expert	0.259	24.780	25.040	0.989	11
S16	Supply chain expert	0.186	24.829	25.014	0.992	4
S17	Information technology expert	0.178	24.840	25.018	0.992	2
S18	Enhance awareness about the benefits of IT in HSCM	0.171	24.844	25.015	0.993	1
S19	Coordination among the actors during all phases of disaster management	0.226	24.803	25.029	0.990	7

4.6 Discussion

It is difficult to say sure that which solution is most important in improving the utilization of IT in HSC, but prioritizing solutions by using an integrated framework of fuzzy AHP-TOPSIS made it more comprehensive and systematic. This integrated framework is intended to improve the utilization of IT in HSC, which will bring the drastic change in the effective and efficient management of relief activities. Total 25 barriers and 19 solutions are identified with the help of literature review and were further verified through middle level managers of the organizations involved in HSCM. Finally, solutions are prioritized with the help of experts' opinions.

The final result of the integrated fuzzy AHP-TOPSIS framework is shown in Table 4.10. The evaluation of the solutions in enhancing the coordination in HSC in Indian context is realized and according to the CCi value ranking of the solutions is S18-S17-S13-S16-S9-S2-S19-S12-S14-S1-S15-S8-S10-S3-S11-S5-S7-S4-S6 from most important to least. The need to enhance awareness about the benefits of IT in HSCM is the highest rank solution, while need for Information technology expert is at second and establishing a feedback mechanism to facilitate learning from prior experiences is ranked third. Hence, actors of HSC should implement these solutions on a priority basis and remaining in a stepwise manner as per ranking.

There is strong need to enable and motivate relief organizations to incorporate changes in their structures and processes. Agility is the key in the effective and efficient management of disasters because none of the organizations is capable of handling any kind of situation or problems that can arise in disaster management. It is required to view the disaster management process holistically instead of short term oriented. It is required to have a performance evaluation mechanism in place to analyse the strength and weakness of the current relief activities. Effective communication system is of paramount importance in rescue and relief operations. If field staff at an emergency site is able to communicate easily to organizations involved in relief activities, it will improve the efficiency of the relief effort for e.g. If field staff is able to communicate about the present condition of roads i.e. which roads are wiped out, then relief materials can reach the disaster site quickly.

For the purpose of improving the utilization of IT in HSCM, it is necessary for statutory agencies to develop long term relationships with commercial organizations, learn from the training of humanitarian logisticians in the commercial realm and make strategic tie-ups with organizations with corporate social responsibility programmes. Situational awareness is most important for all the actors involved in different phases of disaster management to perform relief activities in a more effective and efficient manner. Situation awareness provides reliable and relevant information to the decision makers and helping them to understand, analyses and assess advantages and disadvantages of alternative courses of action and help them to follow-up on their decisions, by providing feedback loop mechanism.

Training in disaster management holds the key in successful activation and implementation of any disaster management plan. Training is most important in capacity building, as trained personnel respond in a more effective and efficient manner to a different kind of disasters. The strategic tie-ups between the actors of the humanitarian supply chain management (HSCM) are required to streamline the activities of commercial supply chain management (CSC) and humanitarian supply chain (HSC) so they do not compete for already scarce resource.

4.6.1 Sensitivity Analysis

A sensitivity analysis was performed to observe the effect of changes in barrier weights on the evaluation process and ranking of solutions to enhance the coordination of the HSC. In the first 18

experiments, the weight of each barrier was set higher one by one and other set to low and equal values. For example, in experiment 1 the weight of barrier SB1 (WSB1) = 0.70 and the weight of the remaining 22 barriers (WSB2WCB3) are assumed to be of equal importance, therefore they are allocated equal weight = 0.15. In experiment 19, the weight of all the barriers is equal to 0.15. In experiment 20, the weight of barriers (WSB1WSB6) = 0.15 and others barriers were weight equal to 0. The change in the final ranking of solutions, when the weights of the barriers were changed is given in Figure 5.6. It can be seen from Figure 5.6 that solution rankings significantly changes the weight of the barriers. This indicates that the proposed integrated framework of the combination of Fuzzy logic, AHP and TOPSIS is robust, systematic, effective, efficient, and sensitive to barriers weights.

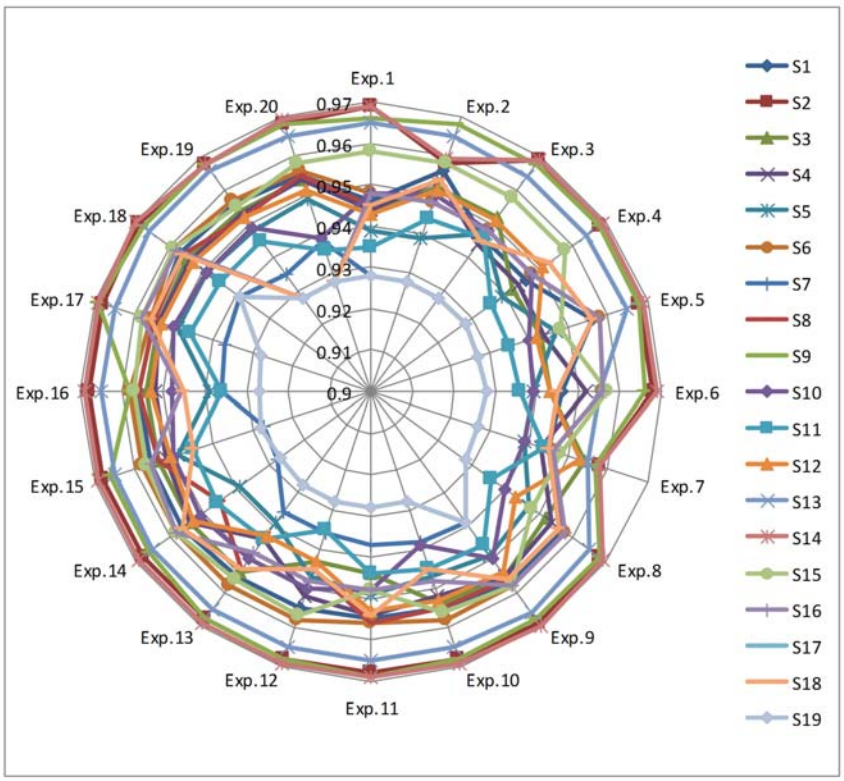

Figure 4.2: Result of Sensitivity Analysis (CCi scores)

4.7 Summary

The utilization of IT is low in HSCM is relatively low due to the presence of several barriers. Therefore, it is essential to overcome the barriers by providing solutions. It is difficult for practitioners to implement all solutions at the same time; therefore, ranking solutions is necessary for a stepwise implementation of these solutions. This study presents a more comprehensive and systematic framework for ranking solutions to enhance the utilization of IT by using a MCDM technique that combines fuzzy logic, AHP and TOPSIS. Humanists are often uncertain when it comes to assigning evaluation scores. Therefore, AHP and TOPSIS methods are performed in a

fuzzy environment. Fuzzy AHP is used to estimate the weight of barriers while fuzzy TOPSIS is used to prioritize the solutions. The empirical problem analysis demonstrates the applicability of the proposed framework.In addition, a sensitivity analysis was performed to discuss and explain the results. The literature review and discussions with experts yielded 25 barriers and 19 solutions to overcome the barriers. These solutions were prioritized through an integrated framework of fuzzy logic, AHP and TOPSIS.

The results indicate that developing a long-term relationship with commercial organizations, exchange programs and training for humanitarian logisticians in the commercial realm, and strategic tie-ups with organizations that have corporate social responsibility programs are important to improve the performance of HSC. There is also a need to develop new coordination mechanisms, optimize the usage of scarce resources to reduce the suffering of the beneficiaries.

The results showed that long-term focused planning instead of short-term focused planning is the highest ranked solution to overcome the barriers to enhance coordination in HSCM in the Indian context. According to the results shown in the empirical case, the proposed method is robust, more systematic and practical, and gives a new and reliable approach to prioritize the solutions that overcome barriers to the proliferation of IT in HSCM. Ranking solutions helps the various actors involved in relief operations make better choices that will enhance the performance of HSCM.

Chapter 5

Developing a Structural Model of Factors affecting the Humanitarian Supply Chain Management

Preview

In the previous chapters, introduction to the thesis along with the review of previous studies in the area of issue under investigation has been presented. The factors affecting the maximum utilization of IT in HSCM has been presented. In addition, solution to overcome the barriers to the proliferation of IT are prioritized on the basis of weight of the barriers. This chapter develop and empirically validate the conceptual model that examines the factors affecting the utilization of IT in HSCM. PLS a "regression-based path modelling" technique has been utilized to investigate the relationships among the factors. Finally, discussion and managerial implications on the basis of the hypotheses results are also presented.

5.1 Introduction

The organizations involved in HSCM face great challenges due to the unpredictability about the occurrence of disaster. These organizations play a significant role in HSC as many of them are the first responders to the chaotic situation created by the disaster. As already discussed in chapter 1, the utilization of IT is considered as the silver bullet for the organizations involved in HSCM. Although the concept of utilization of IT in SCM has been widely studied, the area needs significant attention in the HSC context. Existing studies in the context of CSCM on IT adoption have considered technological and organizational factors (e.g. managerial obstacles), users' traits (e.g. effort expectancy) and inter-organizational relationships (e.g. mutual trust, information sharing). Specifically, Jeyaraj et al. argued that individuals (users) perceptions within the organization play a key role in an organization's decision to implement IT in the supply chain. Jeyaraj, Rottman, and Lacity (2006) further reported the need for more research to study the users traits, such as middle level managers in the organization.

Clemons and Row (1991); T. C. Powell and Dent-Micallef (1997) argued that in order to realize the benefits of IT, IT should be combined with other factors that produce valuable complementary sustainable resources. These are mutual trust, information sharing and IT integration among the organizations involved in SCM. Earlier studies from researchers such as Crook and Kumar (1998); Iacovou, Benbasat, and Dexter (1995); Y.-M. Wang, Wang, and Yang (2010) reported that large organizations are more willing to adopt IT in their supply chain if there is availability of

The part of this chapter has been under review as "Kabra, G and Ramesh,A. Factors affecting the utilization of information technology in humanitarian supply chain: An empirical investigation, *Service Science*, (INFORMS)."

plentiful resources. In contrast, Zhu et al. (2006) argued that it is easier for smaller organizations in comparison with large organizations to adopt IT in their supply chain as they have fewer legacy systems to overcome. Nonetheless, the adoption of IT in the SC of organizations involved in HSC remains low in India.

Existing studies in the context of HSCM have attempted to provide an understanding of factors affecting the HSCM through conceptual research methods (Kovacs & Spens, 2007; Oloruntoba & Gray, 2006). However, these studies also indicated the need for more research examining the factors affecting the utilization of IT. Regarding normal SC and HSC, both are considered as a network of members that supports flow of goods, information and funds from the source to final customers; however, the only difference is that the customer in the case of HSC includes the disaster affected peoples as well as the donors who provided support to improve the performance of HSC.

Moreover, our knowledge of relationships among factors affecting information technology (IT) utilization are often limited to the context of the CSCM. As the operating environment of both the CSC and HSC significantly differ from each other. For example, ”Time is money” may be the mantra in the commercial supply chain (CSC) but ”time is life” is paramount in the case of HSCM. It is interesting and very much needed to test these same relationships (factors affecting the utilization of IT by organizations) in the context of the HSCM.

Several researchers, such as Kovacs and Spens (2011b); Kunz and Reiner (2012), also highlighted the strong need for more qualitative empirical research in the context of HSC. Hence, this study is an attempt to address this critical research need; the aim of this study is to better understand the relationships among factors affecting information technology (IT) utilization, in the context of the humanitarian supply chain. This study is based on the premise of F. T. Chan, Chong, and Zhou (2012) that the utilization of IT SCM goes through a series of phases commencing from IT adoption in an organization, to inter and intra SC processes followed by inter-organizational relationships. Networking with other organizations will bring all members of the SC onto the same platform through IT integration. This will help in improving the performance of HSC.

5.2 Factors affecting the utilization of IT in HSCM

Several researchers such as Grandon and Pearson (2004); Joo and Kim (2004); N. Singh, Krishnamurthy, Kaynak, Tatoglu, and Kula (2005); Thatcher, Foster, and Zhu (2006), explained the reasons for adopting and not adopting IT by the organizations in their SC. For example, Kaynak and Tuer (2014) found that perceived benefits of IT utilization significantly impact the adoption of IT by organizations in Turkey. Similarly, Grandon and Pearson (2004) reported that perceived usefulness, organizational readiness and perceived ease of use positively affect the adoption of IT by organizations in USA. These studies suggest that the majority of factors affecting the utilization of IT can be grouped into technological and organizational (TO) factors (F. T. Chan et al., 2012).

However, in the present era of social media, the technological and organizational factors considered alone are no longer enough to explain the factors affecting the utilization of IT. For example, compatibility among the organizations involved in SC is indeed essential for improving the performance. For that reason, Huang, Janz, and Frolick (2008) and Chong, Ooi, and Sohal (2009) suggest that inter-organizational relationships (IOR) play a significant role that affect the process of harmonizing the organizations on a common IT platform in a SC. SC members will best benefit from IT if they integrate IT with their key business processes within the SC. These arrangements will help the organization to have a flexible and agile SC that will enable it to effectively respond to the fast changing demands of the customer created due to the unpredictability about the occurrence of disaster. The IT usage in organizations can support the process of SC integration through mutual trust and sharing of key SC expertise and information. Lack of integration may be a major stumbling block that impacts on the organizations in HSCM, especially humanitarian relief organizations (HROs) who are protective in sharing their business information since they compete with each other for funding.

Besides technological issues, organizational factors and IOR, an imperative area of research is in users' perceptions on IT. Jeyaraj et al. (2006) acknowledged the need to understand the users traits since they play a pivotal role on whether organizations can successfully adapt IT in their SC. Several studies have used the Technology Acceptance Model (TAM) model proposed by Davis (1989) to analyze the users' perceptions on IT. These include Straub, Keil, and Brenner (1997)s study on internet technologies such as email, Brown, Dennis, and Venkatesh (2010)s study on short messaging service (SMS) and Gefen, Straub, and Boudreau (2000)s study on online shopping. However, the TAM model is often criticized due to its simplicity in explaining the wide range of IT adoption methods Bagozzi, Yi, and Phillips (1991). Therefore, an alternate model unified theory of acceptance and use of technology (UTAUT) was proposed by Venkatesh, Morris, Davis, and Davis (2003). UTAUT model is built on the foundation of TAM's model, examining both the user traits to make use of a technology as well as the consequent actual usage. Brown et al. (2010) and F. T. Chan et al. (2012) employed the UTAUT model to enhance understanding on technology usage in a SC.

However, the applicability of these studies in the HSC area has not gained enough attention from the research point of view. The implementation of IT is a continuing process that requires a huge amount of funds and involves continual change in the operating environment, such as converting a manual process to a computer integrated process. This requires sufficient resources in terms of time as well as capital. The ongoing work of HROs mainly depends on funding from private donors and the government. The environmental component for TOE framework is not applicable in the context of HSC since the organizations involved in HSCM do not affect the environment; efforts are made to support the environment in their work to reduce the impact of disaster on society. Therefore, this research considers only technological and organizational factors from the TOE model, IOR and UTAUT model. Based on the above discussion, each model complements each other as they cover the technological (e.g. technology readiness) factors, IOR among SC members (e.g. trust, information sharing) and user perceptions (e.g. social influence).

5.3 Conceptual Model and Hypothesis Development

During the 1990s, organizations tended to implement IT in their internal SC processes Chou, Tan, and Yen (2004). However, numerous studies suggest that since the year 2000, many organizations have shifted towards the implementation of IT in their SC (Chong, Ooi, Lin, & Raman, 2009; Chou et al., 2004). Beynon-Davis (2009) defined IT as "any technology used to support information gathering, processing, distribution and use and is composed of hardware, software, data and communication technology." The use of IT in HSC has become fundamental to enhancing performance as it offers a platform to facilitate information sharing, coordination and collaboration among the actors in HSCM (T. C. Chan et al., 2004; Jefferson, 2006b; Overstreet et al., 2011; Stephenson & Anderson, 1997; Telleen & Martin, 2002). The utilization of IT is found to be beneficial for organizations to improve the HSC performance.

The utilization of IT does not focus only on transparency in funds, it covers the flow of information and ideas among the organizations which allows them to collaboratively design, develop, build and manage products through their life cycle. The measure of IT utilization used in this study is adapted from previous studies such as those of Cassivi (2006); Yee-Loong Chong, Ooi, Lin, and Yi Tang (2009). This study examines IT use in the areas of procurement, logistics, inventory, warehouse management etc. This approach is in agreement with research by F. T. Chan et al. (2012); Chong, Ooi, Lin, and Raman (2009); Chong, Ooi, and Sohal (2009); Zhu, Kraemer, and Xu (2006).

Several researchers such as F. T. Chan et al. (2012); Zhu et al. (2006) acknowledged that the factors affecting the utilization of IT are user characteristics (effort expectancy, performance expectancy, social influence), organizational (managerial obstacles, availability of funds, technology readiness) and IT integration among the organizations involved in the supply chain. To investigate the relationships among the factors affecting the utilization of IT in organizations involved in HSCM, the conceptual model is shown in Figure 5.1. The definition of various factors considered for this study is discussed in the subsequent section.

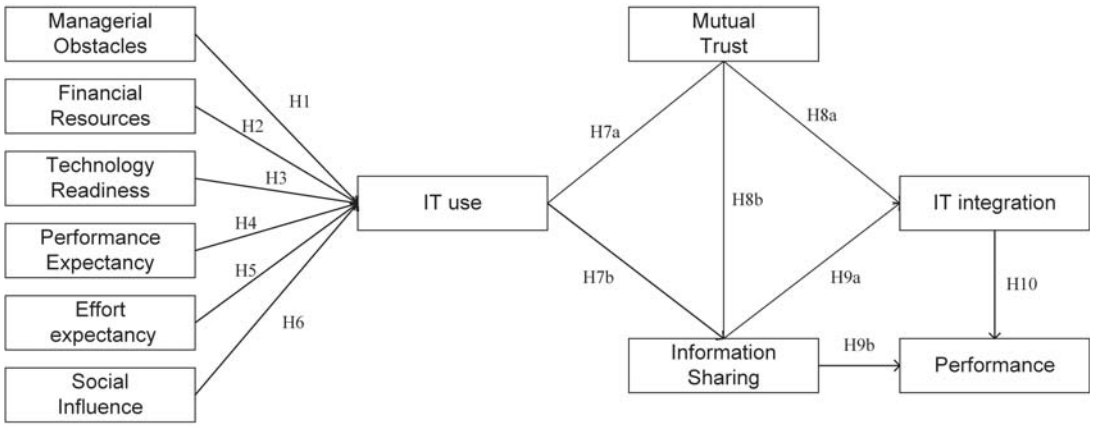

Figure 5.1: Conceptual Framework

5.3.1 Technology-Organizational model

5.3.1.1 Managerial Obstacles

Managerial obstacles (MO) refer to the problems identified at managerial level toward the utilization of IT in HSC. In order to successfully adopt IT in an organization's internal supply chain, the prerequisites are a suitable organizational structure and an organization culture that is open to change. This includes willingness to share information, hiring of knowledge workers such as SCM experts, IT experts, etc. and redesigning existing business processes F. T. Chan et al. (2012); Zhu et al. (2006). The ability of an organization to address these critical issues will improve the utilization of IT in their internal SC. Chatterjee, Grewal, and Sambamurthy (2002) also emphasized that the reason for not adopting IT by an organization in their internal SC is the failure of an organization in making the desirable organizational adaptations. This study theorizes that the reasons for an organization's failure to use IT in their internal SC are organizational changes, redesigning processes and acquiring new expertise Zhu et al. (2006). Furthermore, Grandon and Pearson (2004) reported that the managers who perceive the usage of IT as an added advantage to their organizations SC will have a positive attitude toward IT utilization within the organization. Therefore, interventions to change the perceptions of managers about the strategic value of the utilization of IT in their organizations make an impact on the utilization of IT in their internal SC. Therefore this study hypothesize that:

H1: Managerial obstacles are negatively related to the utilization of IT in an organization.

5.3.1.2 Financial Resources

Financial resources refers to financial funds available with the organization. Financial resources (FR) are one of the fundamental resources that can support the process of implementation of IT. Kim and Garrison (2010) also stressed the importance of financial resources in the implementation of IT. Bayraktar, Demirbag, Koh, Tatoglu, and Zaim (2009) also supported the view of other researchers such as Kim and Garrison (2010) and Dubey, Gunasekaran, Childe, Fosso Wamba, and Papadopoulos (2015) by demonstrating that there is a greater likelihood of the adoption of IT in larger organizations as they have more financial resources. Thus this formulate the following hypothesis:

H2: Financial resources are positively related to IT usage in an organization.

5.3.1.3 Technology Readiness

Technological readiness (TR) refers to whether the organization has the necessary technology infrastructure and IT human resources. Zhu et al. (2006) defined technology infrastructure as various technologies that enable the utilization of IT. This includes the computers, labs for computers and software supporting the utilization of IT. Chong, Ooi, Lin, and Raman (2009) reported that the organizations with proper IT infrastructure such as computers, printers, facilities for emails

and video conferencing are more willing to adopt IT in their internal as well as external supply chains with other members. Technological readiness in an organization also includes the IT expertise to implement and support the adoption of IT in their internal SC (Zhu et al., 2006). According to earlier studies, facilitating conditions, such as organizational and technical infrastructure found in (UTAUT), agree with Zhu et al. (2006)'s study on technological readiness in an organizational context. Facilitating conditions in UTAUT examines user beliefs about the presence of prerequisite organizational and technical infrastructure for IT usage in an organization (Venkatesh et al., 2003). Therefore this research hypothesize that:

H3: Technology readiness is positively related to IT usage in an organization.

5.3.2 Unified Theory of Acceptance and Use of Technology

5.3.2.1 Performance Expectancy

Performance expectancy (PE) is related to the user belief toward the utilization of IT in the supply chain of an organization. F. T. Chan et al. (2012) cited Venkatesh et al. (2003) suggesting that performance expectancy is the degree to which an individual believes that using IT will help him or her to attain gains in job performance. Performance expectancy is one of the attributes of the UTAUT model. This attribute is similar to the perceived usefulness variable of the TAM model proposed by Davis (1989). This study theorizes that performance expectancy influences the utilization of IT in the supply chain of an organization. Earlier studies have not examined the relationships between user characteristics such as employees and managers who are more likely to use IT in contrast to top management of an organization involved in HSCM. Thus, this study tries to fill this critical gap. Therefore this research hypothesize that:

H4: Performance expectancy is positively related to IT usage in an organization.

5.3.2.2 Effort Expectancy

Effort expectancy (EE) refers to "the degree of ease associated with IT usage in the supply chain" (Venkatesh et al., 2003). The EE variable was derived from past models such as TAM and TAM2 (F. T. Chan et al., 2012). EE is the combination of perceived ease of use, complexity and ease of use of IT in the supply chain (Venkatesh et al., 2003). Earlier studies from researchers such as Agarwal and Prasad (1998); F. T. Chan et al. (2012); Venkatesh et al. (2003) reported a significant impact of effort expectancy on technology adoption. This study also hypothesizes a similar impact in the context of organizations involved in HSCM. In this connection, the following hypothesis is suggested:

H5: Effort expectancy is positively related to IT usage in an organization.

5.3.2.3 Social Influence

Social influence (SI) refers to "the degree to which an individual perceives the person who is important to him/her believe that he/she should use IT" (F. T. Chan et al., 2012). Ajzen (1991); Moore and Benbasat (1991) derived a SI variable. SI was drawn upon the subjective norm, social factors and image. (F. T. Chan et al., 2012) suggest that a SI variable considers the "influence of users from the people who are important to the users, as well as the senior management of the organization." The support and influence of the top management of an organization, as well as peers, is expected to significantly influence the user's decision on continuing IT usage in the supply chain. Therefore, social influence will play a vital role in the process of IT use in the supply chain. Therefore, this research hypothesizes that:

H6: Social influence is positively related to IT usage in an organization.

5.3.3 Information Technology Use

The use of IT in HSC has become fundamental to enhancing performance as it offers a platform to facilitate information sharing, coordination and collaboration among the actors in HSCM (T. C. Chan et al., 2004; Hall, Skipper, & Hanna, 2010; Jefferson, 2006a; Overstreet et al., 2011; Stephenson & Anderson, 1997; Telleen & Martin, 2002). This can allow evacuation of the people from the affected area, thus reducing the impact of a disaster on the local population H. W. Lee and Zbinden (2003); Whybark (2007). Maiers et al. (2005) state that IT does not refer to any specific type of information technology but includes people, process, practice and organizational environments. This can range from something as simple as an email to a complex, expert system for HSCM.

Information systems allow an organization to implement strategy to take decisions quickly (Stank & Lackey, 1997). This will further improve the organizational performance through flexibility Cash and Konsynski (1985); Patterson (2005). Boyson, Corsi, and Verbraeck (2003) reported that the timely availability of information in conjunction with the accuracy of information is vital for successful operations. The appropriate use of IT is the key to efficient information transfer and communications between the organizations involved in HSCM. This helps the organizations by relocating resources in a responsive manner to keep track of the marketplace needs. The utilization of IT also provides useful and immediate information for the effective and efficient management of relief activities by reducing response time to unforeseen events and market changes Beaumaster et al. (1999); Pettit and Beresford (2005, 2009). This demonstrates the profound implications of IT for the social and economic development of a society Francis, Babajide, and K. (2014); Talero and Gaudette (1995). Therefore, the utilization of appropriate IT is recognized as a key for efficient administration in an organization as well as in customer service and the achievement of successful outcomes. As such, we propose the following hypotheses:

H7a: IT use is positively related to IT mutual trust among the organizations.

H7b: IT use is positively related to information sharing among the organizations.

5.3.4 Inter-Organizational Relationship

5.3.4.1 Mutual Trust

Trust among the organizations is a key factor that affects the utilization of IT in HSCM. A huge amount of investment is foremost for the purpose of IT implementation. This requires the commitment of financial resources as well as sharing of information with other organizations involved in SC. The cost of providing the necessary infrastructure for the implementation of IT might not be a significant portion of budget for large organizations. However, for organizations involved in HSCM it is essential to have long term funding before they decide to invest in utilization of IT in their supply chain. H. L. Lee and Whang (2000) reported that mutual trust among the organizations is a basic enabler for information sharing. Mutual trust can be considered as the binding force in setting up relations between organizations. Mutual trust is a vital relational asset that improves quality of information shared between the organizations. Mutual trust facilitates the quality of information in terms of accuracy, timeliness and openness between the organizations in the supply chain. S. Youn, Yang, Hong, and Park (2013) demonstrated that in order to achieve flexibility, timely and accurate transfer of information is a prerequisite and it will occur only if there is a trust between organizations. Thus, the following hypotheses are suggested:

H8a: Mutual Trust is positively related to information sharing among the organization.
H8b: Mutual Trust is positively related to IT integration among the organization.

5.3.4.2 Information Sharing

Information sharing (IS) is a prerequisite for IT adoption in an organization. Although organizations are aware of the importance of information sharing in HSC, organizations involved in HSCM need to overcome their mindsets that sharing information with other members of SC will significantly affect their business since they always compete with each other for funding. This view was supported by various researchers (Sandwell, 2011). For response agencies, individual responders and survivors, information is a critical resource necessary to facilitate life-saving operations. Previous researchers have also highlighted the significance of information; “In modern supply chains, the information replaces the inventory” (Simchi-Levi, Kaminsky, & Simchi-Levi, 2003). ”Access to information is critical to successful disaster risk management. You cannot manage what you cannot measure.” Thus, the relief activities are mainly guided by the information coming from the disaster site, clarity of the situation and the management of information Long and Wood (1995); Perry (2007); Simchi-Levi et al. (2003). Therefore, the following hypotheses are suggested:

H9a: Information sharing is positively related to IT integration among the organization.
H9b: Information sharing is positively related to HSC performance.

5.3.5 IT Integration

F. T. Chan et al. (2012) cited the definition of IT integration proposed by Zhu et al. (2006) as "the degree of inter-connectivity between the organization's back-end information system and databases, and those externally integrated with the supply chain partners' enterprise systems and databases." IT integration is seen as similar to compatibility of systems in Rogers (1995)'s study on diffusion of innovation. HSCM involves a large number of actors such as the government, military, media, logistics providers, aid agencies, donors, relief organizations and NGOs etc. (Kovacs & Spens, 2007). All actors should collaborate to maximize the utilization of IT, as close networking can develop more effective and efficient strategies. In particular, the successful utilization of IT can streamline the activities of the organizations involved in HSCM. Therefore for the purpose of this study, IT integration refers to integration of IT in the internal supply chain, as well as with other organizations information systems and databases. Earlier studies from researchers such as Gibbs and Kraemer (2004) and Huang et al. (2008) suggest that small organizations in terms of operating environments and size are more likely to adopt IT technologies in their internal supply chain. These organizations are more flexible and agile in decision making and can easily overcome the present legacy systems. As this study focuses on organizations involved in HSCM, this research therefore hypothesizes that:

H10: IT integration among organizations is positively related to HSC performance.

5.4 Research Design

Research design works as an outline of a study. According to R. Yin (1994) research design is "the logical sequence that connects the empirical data to the studys initial research questions and ultimately its conclusions". Three categories of research design have been suggested by N. K. Malhotra (2008) for empirical studies, namely exploratory, descriptive and causal. The objective of the present research examines all three research designs, namely exploratory, descriptive and causal research design. Firstly, the exploratory research design (Sharon, Griffin, Sprigg, & Wall, 2002) has been used in identifying the factors affecting the proliferation of IT in HSCM in the Indian context as presented in chapter 2. Based on the factors explored in chapters 2, 3 and 4, a research model has been developed for empirical verification as shown in Figure 5.1. This study also used causal research design. In a causal research design, the relationship between two or more variables is established.

For this study, survey methodology has been utilized to empirically investigate the aforementioned relationships (see Figure 5.1). The data has been collected from a group of respondents involved in past relief operations. Several researchers such as Gall, Borg, and Gall (1996); B. Schneider, Ashworth, Higgs, and Carr (1996); N. Smith and Dainty (1991), reported that survey methodology was a suitable means of assessing unobservable phenomena, such as perception of the employees of the organizations or the relationships between various processes

and their attributes. The present study has also followed the guidelines of Flynn, Sakakibara, Schroeder, Bates, and Flynn (1990) and Hair et al. (2009). Data was gathered that allowed us to test the various hypotheses proposed above.

In summary, a mixed approach has been used by combining exploratory, descriptive and causal research designs in the present study. A mixed approach provides a better, more holistic and structured solution to the research problem under consideration. The mixed approach has been suggested by Amaratunga, Baldry, and Sarshar (2001) to get better results since these three research designs are complementary to each other.

5.4.1 Data Collection Methods

Most of the previous empirical studies in the HSCM area used the interview method to collect data. Some of the researchers have interviewed the top level management from the various agencies involved in past disaster relief operations. However, the personnel actually involved in the relief operations who have closely observed the process of disaster management are the middle level managers from these agencies. In another method of data collection, researchers have used published documents for the content analysis. Most of the organizations involved in HSCM are comparatively less structured as compared to organizations in the commercial area. Therefore, it is more difficult to get this type of disclosure from some organizations involved in HSCM.

The third approach researchers have used for data collection is a questionnaire (Abdeen, Rajah, Gaur, Brashear Alejandro, & Sharma, 2015; Birasnav, 2013a, 2013b, 2014; Holt & Ghobadian, 2009; Mehta, Sharma, & Swami, 2013; Pandey, Sharma, & Mittal, 2013; Varaprasad, Chandran, Sridharan, & Unnithan, 2013). There are many advantages of using a questionnaire survey. Firstly, respondents are aware of the problem under consideration and they are able to give a suitable response. Secondly, response bias is reduced since researchers promise to keep the anonymity of the respondent. Besides, using a questionnaire survey is inexpensive, accurate, covers a wide range and enables data to be collected quickly (Creswell, 2013; Zikmund, Babin, Carr, & Griffin, 2012). In addition, previous researchers have proposed data collection through an online survey since it is better for internal consistency and predictive validity (Sethuraman, Kerin, & Cron, 2005). However, there are some disadvantages of using the questionnaire survey method, such as the unavailability of internet access among the population of interest. In the present study, data has been collected mainly from middle level management where data collection is not a problem. However, finding such organizations that were actually involved in past relief operations after the completion of the disaster response phase was not an easy task. Data has been collected by a research instrument developed by following a well-accepted scale development procedure proposed by Churchill JR (1979). The following steps were adopted for the collection of data from the respondents:

- A questionnaire was sent along with a cover letter by e-mail. The cover letter introduced the researcher, explaining the purpose and significance of the study. A verification letter signed

by the author was also attached to ensure the authenticity of the researcher (Appendix)

- The cover letter was addressed to the name and position of key people who are responsible for the management of chaotic situations created by a disaster, the supply chain manager or to the middle level manager involved in operations
- After one month, a reminder was sent to the respondents who did not return their responses
- The same process was adopted once again with the help of a second reminder letter to elicit more responses.

Finally, in some cases an appointment was made for a personal meeting in order to cover the entire population under consideration.

5.4.2 Scaling Techniques

Scaling is the process that involves "creating a continuum upon which measured objects are located" (N. K. Malhotra, 2008). There are two scaling categories: comparative scales and non-comparative scales. In the present study, a 5-point Likert scale questionnaire was used to collect the data. The Likert scale is best suited to meet the purposes of the research (Srivastava & Sharma, 2013a, 2013b; Yap & Gaur, 2015). The reasons for using the Likert scale include the ease in construction and administration of the research instrument and suitability for personal, e-mail and telephonic data collection (N. K. Malhotra, 2008).

This study was based on primary data. Primary data was collected from a questionnaire sent by e-mail or through personal meetings. Collecting data by an e-mail questionnaire has been used by many researchers in the area of supply chain studies (S.-Y. Lee, 2008). The data used for this study only belongs to those organizations who have been involved in past relief operations. The questionnaire was sent to the middle and top level managers of organizations. The questionnaire was also personally presented to the middle level managers of organizations. A covering letter (Appendix A.1) that explained the objective of the study was issued along with the questionnaire (Appendix A.5).

5.4.3 Sampling

The present study uses survey method with the data collected from the NGOs, managers, and other members of the organizations involved in the past relief operations of the disaster. To ensure the reliability of the questionnaire, it was reviewed by experts (Professors) in the area of supply chain management. Professors have experience of more than 15 years and has published several research papers and case studies in journals of international repute. After review and taking relevant comments into account, some questions were removed and restructured to bring more clarity. In addition, the questionnaire was pilot-tested with 22 respondents to ensure the face validity according to Ye and Wang (2013).

5.4.4 Measures

The items examined within the current study were adopted from the existing literature, although modified to incorporate the IT utilization in HSC. The items are listed in Appendix A.5. The dimensions considered in this study are proposed by various researchers (Agarwal & Prasad, 1998; F. T. Chan et al., 2012; Hall et al., 2010; Kovacs & Spens, 2007; Legris, Ingham, & Collerette, 2003; Moon, Yi, & Ngai, 2012; N. Singh et al., 2005; Tatham & Spens, 2011; Thatcher et al., 2006; Ye & Wang, 2013; S. H. Youn, Yang, Kim, & Hong, 2014; Zhu et al., 2006). In this study, the constructs were measured using a 5 point Likert-scale with items drawn from previously used multi-item scales.

The measures of managerial obstacles reflect the lack of availability of suitable experts such as a SCM expert or an IT expert to support the process of IT utilization in the SC (F. T. Chan et al., 2012). The measures of technology readiness reflect the availability of proper technology infrastructure and human resources e.g. IT professionals to maximize the utilization of IT in HSCM (Zhu et al., 2006). The measures of financial resources reflect those funds available to the organizations as well as the funds allotted to maximize the utilization of IT Hall et al. (2010); N. Singh et al. (2005).

The measures of IT use reflect the use of IT in various supply chain activities such as procurement, inventory management, logistics and distribution as well as coordination among the organizations involved in the relief operations (Hall et al., 2010; N. Singh et al., 2005). The measures of mutual trust reflect the confidence of an organization toward the other organizations involved in the HSCM (F. T. Chan et al., 2012; Chong, Ooi, Lin, & Raman, 2009). The measures of information sharing reflect the frequency and amount of information shared with other organizations in HSCM for their mutual benefits in order to enhance the efficiency of relief operations (F. T. Chan et al., 2012; Chong, Ooi, Lin, & Raman, 2009).

The measures of performance expectancy reflect the user belief toward the utilization of IT in the supply chain of an organization (Chong, Ooi, Lin, & Raman, 2009; Chong, Ooi, & Sohal, 2009). The measures of effort expectancy reflect the ease of use toward the utilization of IT in the supply chain of an organization. These measure the effort needed for IT usage in an organization (Chong, Ooi, Lin, & Raman, 2009; Chong, Ooi, & Sohal, 2009). The measures of IT social influence reflect the importance of IT usage in the supply chain of an organization from both peers and top management where these interventions are seen to be important to the user (Chong, Ooi, Lin, & Raman, 2009; Chong, Ooi, & Sohal, 2009).

The measures of IT integration reflect the utilization of IT in the internal as well as external supply chain of the organizations involved in HSCM Swafford (2003); Swafford et al. (2008). IT utilization considers the utilization of SCM planning software and ERP in the supply chain. The measures of performance reflect how the response after disaster is made. They gauge how quickly proper aid materials and medical facilities are made available. This examines basic relief materials such as food, water etc. They are the perceived value of the managers working within

the organizations involved in past relief operations (Dubey, Ali, Aital, & Venkatesh, 2014; Dubey & Gunasekaran, 2015).

5.4.5 Participants

In this study, data was collected through an e-mail survey and through personal discussion with the middle level managers who have been involved in past relief operations. For the purpose of enhancing the response rate, the respondents were monitored from time to time using several methods. These methods included telephone, personal contact and personal visits after telephone appointments. The response rate is well-accepted in literature (Klassen & Vachon, 2003). Initially, 12.44% (26) were received. Then after regular follow-ups, the response rate increased to 55.55% (116). Thereafter, in the final follow-ups 32.05% (51) responses were received. This was due to various follow up actions such as telephone calls and personal visits.

The sample for this study was the personnel involved in the relief operations of the disaster that occurred in India. The organizations are selected on the basis of their presence in the current relief operations on the basis of newspaper articles and news. However, we again ensure their presence in the relief operations by section 1 in the questionnaire (refer Appendix). Section 1 of the questionnaire (Demographic section), Question No. 3 and 4 questions about their organizations and their presence in the current relief operations. If their response is no to the Question 3 and 4 then their responses are excluded from the study. This was done to ensure the widest range of response and to support generalizability of our results. Along with the information about the items listed above, information was also gathered about the size of the respondents organizations. Respondents were requested to categorize the size of their organization as $<$50 employees, 51 to 100 employees, 101 to 200 employees, 201 to 300 employees, or > 300 employees.

Of the questionnaires distributed, 209 completed questionnaires were received, out of which 16 were discarded from further analysis due to missing data. Finally, 193 completed responses (60%) were considered for the study, an acceptable figure for such surveys (M. K. Malhotra & Grover, 1998). To encourage more responses and enhance the quality of replies, each potential participant was offered a copy of the survey results. After collecting all questionnaires in the sequence of receipt, the questionnaires were deleted from the system to maintain the anonymity of the respondents e-mail addresses.

5.4.5.1 Details about Respondents

This section discusses the details of the respondents for the present study. The survey questionnaires were personally administered to the respondents involved in the past relief operations of the disaster under examination. The present study uses a survey method with data collected from the middle level managers from NGOs, humanitarian relief organizations (HROs) and other members of the organizations involved in past relief operations.

Demographic Profile of Respondents

Demographic data provides information about the characteristics of the respondents and sufficient information to make a clear picture of the respondents. This is necessary to make generalizations about the respondents. The first section of the self-administered questionnaire was dedicated to the demographic data of the respondents, including certain questions related to demographic profiling and the organizations where they were working. The sample was male dominated with 89 % (172 out of 193) represented by males and only 11 % (21 out of 193) represented by females as shown in Figure 5.2.

Figure 5.2: Demographic Profile of Respondents

Individual Job Function

The managers (middle level managers) are from various organizations involved in the relief operations in agreement with Carter et al. (1998) and Bowen et al. (2001). The managers were selected using purposive snowball sampling in order to identify the respondents who would be able to provide the necessary information in agreement with Raju and Becker (2013). The positions held by the respondents who participated in the survey indicated that more than 88.6% (171) respondents held a position at middle level management. This predicts that the responses received provide the desired information needed to attain the objectives of this study. Only 7.80% (22) belong to top level management (Director, Executive Director).

Experience of Respondents

The majority of the respondents 51% (98) have experience of less than 5 years while 31% (16) had experience of 10 to 15 years. Around 14% (27) of respondents have experience of between 15 to 20 years. Only 11% (22) and 8% (15) respondents were placed in the category of 5 to 10 years of experience and more than 20 years of experience respectively. This demonstrates that respondents had a diverse field of experience as shown in Figure 5.4. Of the total respondents, 40% belong to organizations with fewer than 50 employees; 22% and 20% belong to organizations with 101-200 and 50-100 employees; 10% belong to organizations with 200-300 employees while the remaining 8% of respondents belong to those organizations with more than 300 employees.

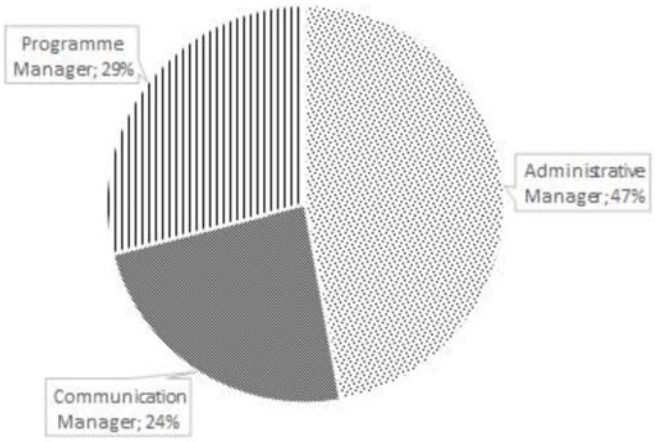

Figure 5.3: Job Position of Respondents

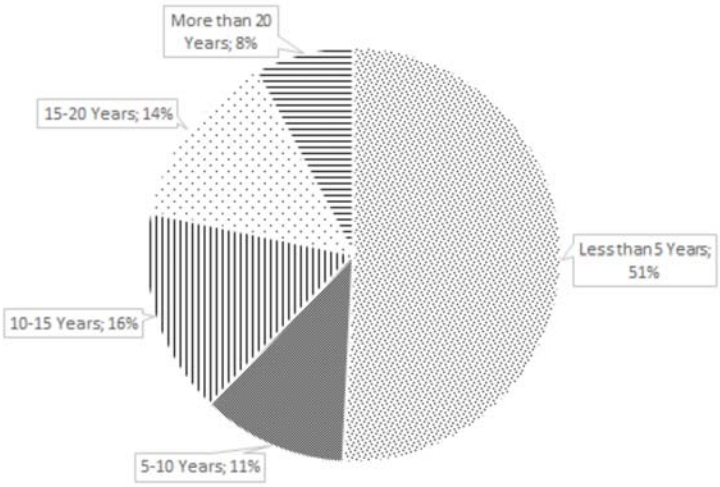

Figure 5.4: Experience of Respondents

5.4.6 Sample Size

Green, Morton, and New (1998) stated that a desirable sample size (n) should be:

$$n > 50 + 8V$$

where V is the number of independent variables for testing the multiple regression. In addition, there is a difference in the suggestions provided by many authors based on the statistical tests used in research. Nunnally, Bernstein, and Berge (1967) suggested that the number of cases should have a ratio of 1:10 to ensure factor reliability. The minimum requirement for developing a structural equation model is a sample size of 150 (Hair et al., 2009). Following the guidelines of various studies in the area of HSCM, the survey questionnaire was sent to the involved organizations (Dubey & Gunasekaran, 2015).

The acceptable sample size for a multiple regression study with acceptable statistical power level of 0.8, probability level 0.05, 10 independent variable and an effect size of 0.15 is 118. According

to W. Chin and Newsted (1999), as a rule of thumb, the sample size in PLS should be 10 times the number of items in the most complex constructs in the model (Gefen et al., 2000). In addition, Barclay, Higgins, and Thompson (1995) suggested that the sample size in case of PLS should be at least ten times the largest number of structural paths directed at a particular construct in the inner path model. For the present model under consideration, the rule of thumb indicates that the acceptable sample size is 118. However, the usable sample in this study is 193, a more than acceptable figure according to both methods.

5.4.7 Research Instrument Development

In this study, a well-accepted scale development process proposed by Churchill JR (1979) has been adopted. This process was further modified by various researchers such as Bentler and Bonett (1980); Turker (2009). The subsequent section discusses the various stages of the scale development.

5.4.8 Item Generation and Selection

For the purpose of finalizing the constructs and their items, a comprehensive review of past studies has been carried out. A total of 76 items has been found under these nine constructs. An initial screening reduced the number of items to 63. Following this, experts (professors/managers) were invited to examine the group of items. Experts deleted 7 items, reducing the number of items to 56. Next, following a similar approach as Lin and Hsieh (2011), experts were asked to rank the items into one of three categories, “not representative”, “somewhat representative” or “clearly representative”. Only items rated clearly and somewhat representative by at least 80 percent of the judges were retained.

Specific to the HSCM area, this exercise resulted in the deletion of 7 items, leaving 49 items remaining. These items were again reviewed by another group of five experts with no additional items deleted by these experts. To ensure the reliability of the questionnaire, it was reviewed by experts (professors) in the area of supply chain management. These professors have experience of more than 15 years and have published several research papers and case studies in journals of international repute. After review and taking relevant comments into account, some questions were removed and restructured to bring more clarity. In addition, the questionnaire was pilot-tested with 22 respondents to ensure the face validity proposed by Ye and Wang (2013).

5.5 Data Analysis

PLS was found to be very useful in earlier studies to analyze structural models with multiple item constructs (Lowry & Gaskin, 2014; Willaby, Costa, Burns, MacCann, & Roberts, 2015). PLS is especially suited to theory building and predictive applications (Gefen et al., 2000). PLS can map

formative, reflective or models with mixed variables. As in the conceptual model (see Figure 1), the outcome variable is reflective, and for complex models that have less theoretical information, PLS is the appropriate method of analysis (Lowry & Gaskin, 2014). Partial least squares (PLS) analysis is used to analyze the proposed hypothesis in this study.

PLS requires fewer responses in order to test a hypothesis in the model as compared to other modelling techniques. This technique puts minimum criteria on the measurement scale and sample size (W. W. Chin, Marcolin, & Newsted, 2003), unlike AMOS and LISERAL. The basic objective of the CB-SEM is to minimize the variation between sample covariance and what the theoretical model forecasts. The main problem with this approach is that it needs a large sample size Kline and Santor (1999). The minimum size of sample should be 10 times the number of items. On the other hand, SEM efficiently works in the case of reflective models (W. Chin & Newsted, 1999; Cho & Park, 2001; Mahdavi, Mohebbi, Zandakbari, Cho, & Mahdavi-Amiri, 2009). An underlying assumption for SEM analysis is "items or indicators used to measure an LV are reflective in nature" (W. W. Chin, 1998). Various reliability and validity tests were conducted to analyze and validate both the measurement and structural models.

5.5.1 Measurement Model

In this stage, various constructs used in the questionnaire were validated by applying the partial least square technique. The questionnaire, refined from an earlier stage containing 49 items, was sent to managers working in the Indian automobile industry. Respondents were asked to assess the items on a 5-point Likert scale. The respondents were contacted through an e-mail survey followed by telephone calls and personal visits to the companies. The mail contained a cover letter indicating the purpose of the study. The total number of responses was 193. The sample size was sufficient for the execution of the PLS technique as suggested in the literature (W. Chin & Newsted, 1999). The consolidated results regarding the descriptive statistics of the data collected for this chapter are presented in Table 6.1.

Table 5.1: Descriptive Statistics of the Items

Item	Mean	Std. Deviation	Item	Mean	Std. Deviation
MO1	2.881	0.925	TR1	3.943	0.655
MO2	2.751	0.924	TR2	3.829	0.675
MO3	3.041	0.900	TR3	4.098	0.600
MO4	3.016	0.971	TR4	3.886	0.683
MO5	3.057	0.969	TR5	3.684	0.770
SE1	2.715	0.993	EE1	2.368	0.987
SE2	3.269	0.941	EE2	2.207	0.822
SE3	2.606	1.031	EE3	2.249	0.878
SE4	2.694	0.997	EE4	2.233	0.843
PERF1	2.420	0.955	IS1	4.041	0.720
PERF2	2.207	0.822	IS2	4.000	0.714

to be cont'd on next page

Table 5.1: Descriptive Statistics of the Items

Item	Mean	Std. Deviation	Item	Mean	Std. Deviation
PERF3	2.249	0.878	IS3	3.990	0.722
PERF4	3.057	0.969	IS4	3.995	0.703
PERF5	2.943	0.931	IS5	4.052	0.683
PE1	3.741	0.704	MT1	2.782	0.875
PE2	3.927	0.787	MT2	2.881	0.925
PE3	3.839	0.743	MT3	2.751	0.924
PE4	3.259	0.887	MT4	3.041	0.900
FR1	3.073	0.787			
FR2	3.161	0.743			

5.5.1.1 Internal Consistency

Before proceeding with path analysis, uni-dimensionality check of each construct is deemed to be essential. The values for Cronbachs- and Dillon-Goldsteins- is checked to ensure uni-dimensionality. The values for Cronbachs alpha and Dillon-Goldsteins alpha must be greater than 0.7 (Tenenhaus, Vinzi, Chatelin, & Lauro, 2005). However, a Cronbachs alpha value of more than 0.6 is also acceptable for a construct having less than five items (Petrick & Backman, 2002). As shown in Table 6.2, the values of Cronbachs alpha and Dillon-Goldsteins alpha is greater than 0.7. Thus, uni-dimensionality is not an issue in the study. The items used in this study have a content validity since the selection of measurement items was based on an exhaustive review of the available literature and evaluation by experts.

Table 5.2: Coefficients for Internal Consistency

Variable	Cronbachs alpha	Dillon-Goldsteins alpha
Effort Expectancy	0.809	0.910
Financial Resources	0.746	0.875
IT Integration	0.927	0.951
IT Use	0.848	0.928
Information Sharing	0.938	0.962
Managerial Obstacles	0.913	0.938
Mutual Trust	0.879	0.936
Performance	0.852	0.932
Performance Expectancy	0.763	0.878
Social Influence	0.937	0.962
Technology Readiness	0.835	0.925

5.5.1.2 Non Response Bias

In survey methodology, non-response bias (NRB) is a common concern as it changes the sample frame and can lead to a non-representative sample of the population Forza (2002). Thus assuring the absence of NRB in the sample is a must for effective study. According to Armstrong and Overton (1977) and Lambert and Harrington (1990), late responses were considered to have similar opinions as non-respondents. To investigate this issue, we compared the early responses (i.e. those who responded in first discussion) with late responses (i.e. those who responded in follow-up discussion). An ANOVA F-test has been used to compare any differences with respect to the response time. The result suggests the absence of NRB as there are no significant statistical differences between the two groups.

5.5.1.3 Common Method Bias

To further enhance the reliability of the study, absence of common method bias (CMB) must be taken into account. CMB occurs when data is collected through the same questionnaire during the same period of time S. H. Youn et al. (2014), causing a systematic measurement error which affects the true relationship between constructs (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003; S. H. Youn et al., 2014). CMB was tested using two methods. Firstly, a correlation matrix method was used. This suggests that if the inter-correlation among the manifest variables is less than 0.9, then the data is classified as not having common method bias (Bagozzi et al., 1991). Secondly, a factors analysis method was used (Lowry & Gaskin, 2014). These results of correlation analysis clearly demonstrate the absence of CMB. Further, the result of this factor analysis produced 9 factors with a highest variance of 26.35%, suggesting the absence of CMB. Thus, CMB was not of major concern. The sample suggests the absence of bias meaning that we can proceed with the data.

5.5.1.4 Convergent Validity

Convergent validity refers to the extent of which measures of constructs that theoretically should be related are in fact related. It can be evaluated by using the average variance extracted measure (AVE). AVE is the average value of the squared loadings of each item on a construct. It gives an idea of how well a theoretical latent construct explains the variance of a set of items that are supposed to measure that particular construct. Put simply, AVE is used to quantify the amount of variance captured by the items of a construct versus the amount of variance caused by the measurement error. If the value of AVE is 0.5 or more than 0.5, it is acceptable to justify the convergent validity of the measurement model (Fornell & Larcker, 1981). Table 6.5 shows the AVE value of the various constructs of the measurement model. It signifies the convergent validity of the measurement model. Convergent validity (CV) is also exhibited by higher factor loading of a measurement item on its latent construct with a significant t-value. According to the significant t-values and factor loading for the item measures shown in Table 6.3, CV is established. A high

composite reliability (CR) score exceeding the suggested value of 0.7 also exhibits convergent validity.

Table 5.3: CFA and Composite Reliability

Variable	Items	Loadings	t-value	CR	AVE
Effort Expectancy	EE-1	0.722	4.088	0.861	0.61
	EE-2	0.754	4.271		
	EE-3	0.73	4.246		
	EE-4	0.904	7.045		
Financial Resources	FR-1	0.868	25.038	0.886	0.796
	FR-2	0.915	68.175		
Information Sharing	IS-1	0.857	38.442	0.953	0.802
	IS-2	0.916	58.270		
	IS-3	0.916	49.918		
	IS-4	0.935	67.295		
	IS-5	0.851	23.997		
IT Integration	ITI-1	0.892	40.235	0.948	0.82
	ITI-2	0.929	61.430		
	ITI-3	0.908	61.370		
	ITI-4	0.893	36.580		
IT USE	ITU-1	0.779	16.261	0.899	0.69
	ITU-2	0.878	27.268		
	ITU-3	0.891	47.226		
	ITU-4	0.767	18.724		
Managerial Obstacles	MO-1	0.858	33.101	0.935	0.741
	MO-2	0.84	27.996		
	MO-3	0.863	39.438		
	MO-4	0.868	24.495		
	MO-5	0.875	26.887		
Mutual Trust	MT-1	0.899	49.288	0.917	0.735
	MT-2	0.864	31.350		
	MT-3	0.851	32.389		
	MT-4	0.814	23.712		
Performance Expectancy	PE-1	0.826	34.525	0.849	0.588
	PE-2	0.784	15.568		
	PE-3	0.832	29.554		
	PE-4	0.602	8.539		
Performance	PERF-1	0.84	28.501	0.893	0.628
	PERF-2	0.854	23.220		
	PERF-3	0.837	27.864		

to be cont'd on next page

Table 5.3: CFA and Composite Reliability

Variable	Items	Loadings	t-value	CR	AVE
	PERF-4	0.714	9.697		
	PERF-5	0.702	8.667		
Social Influence	SE-1	0.891	19.256	0.948	0.82
	SE-2	0.917	22.025		
	SE-3	0.914	19.124		
	SE-4	0.9	14.731		
Technology Readiness	TR-1	0.773	20.118	0.884	0.604
	TR-2	0.792	17.183		
	TR-3	0.812	22.783		
	TR-4	0.824	28.353		
	TR-5	0.676	11.003		

5.5.1.5 Discriminant Validity

Discriminant validity indicates how much each construct is different from the other constructs. In the PLS, there is one method to indicate the discriminant validity. A construct should share more variance with its measures than it shares with the other constructs measures (Hulland, 1999). It can be estimated by comparing the square root of AVE with the correlation among the latent variables to ensure that the square root of AVE is more than the correlation among the latent variables (W. W. Chin, 1998). The above analysis shows that the criteria of the measurement model are reliable and valid. In the next section, structural model is analyzed, representing the relationships between the hypothesized constructs in the conceptual model.

5.5.2 Structural Model

In the PLS analysis, there are two criteria for evaluating the model. One is the coefficient of determination R2, the other is the significance level (W. W. Chin, 1998). Falk and Miller (1992) mentioned that the value of R2 should be greater than 0.1. The results of structural models are provided in Figure 6.4. For the present conceptual model, the values of R2 are greater than 0.1, demonstrating the model fit.

5.5.2.1 Goodness of Fit

The goodness of fit (GOF) was also assessed for the hypothesized model to appreciate its applicability for the prediction (Al-Jabri & Roztocki, 2015). In the PLS the goodness of fit of the model is used for understanding its applicability for the prediction. GoF is SQRT (average

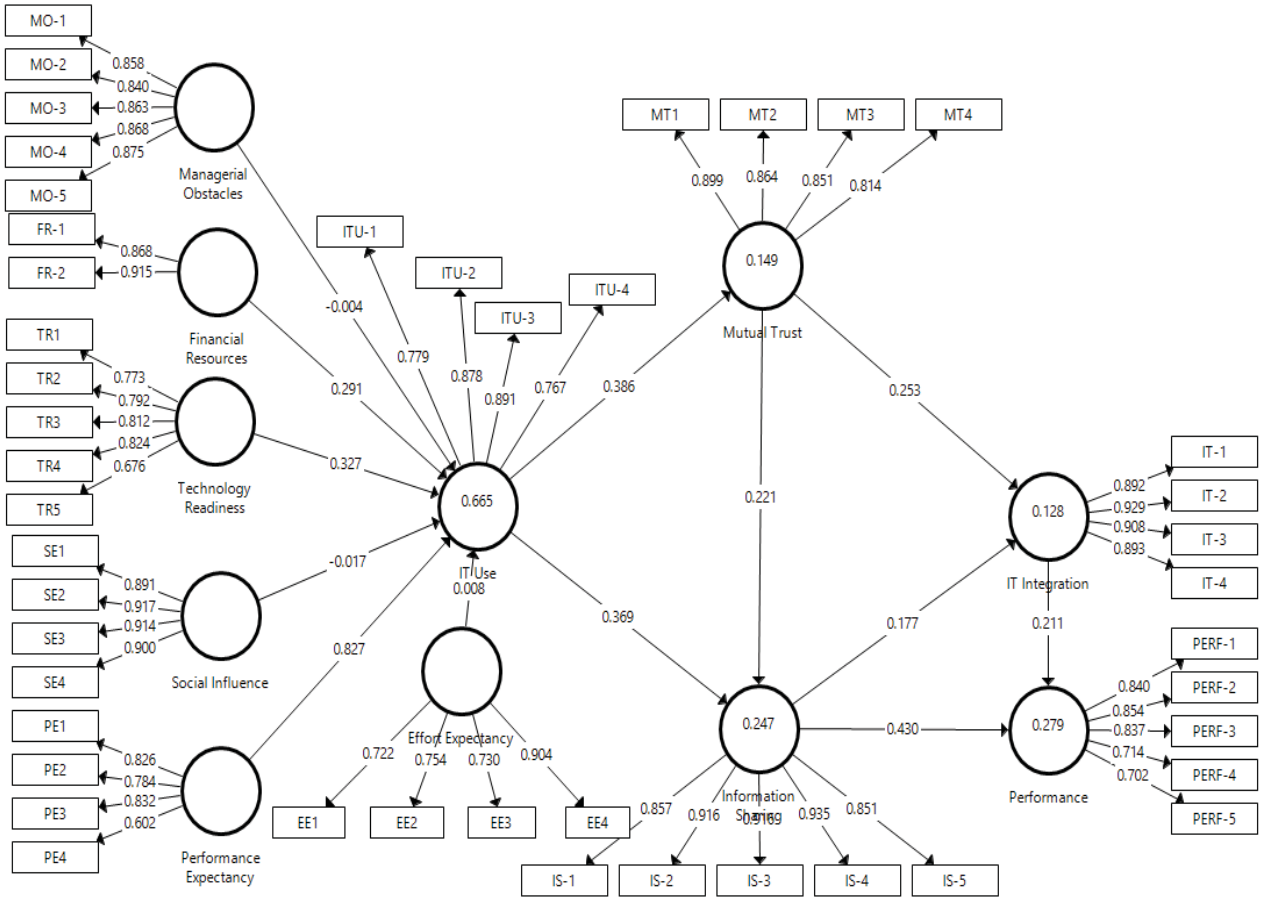

Figure 5.5: Result of Structural Model

Communality Constructs multiplied by average R-Square for endogenous constructs). For the model under consideration, the value of GOF is 0.56; this provides a substantial model fit (Wetzels, Odekerken-Schröder, & Van Oppen, 2009). The overall fit confirms the relationships among aforementioned factors in the context of HSCM.

5.6 Hypothesis Testing

PLS performs both factor analysis and path analysis during its execution. The results of confirmatory factor analysis (CFA) are shown in Table 6.3. The above presented model assessment indicates that the model is valid and results presented here are interpretable. The path coefficients and results are given in Table 6.4. Managerial obstacles is found to have a significant relationship with IT usage in an organization. Therefore H1 is not supported. Financial resources is found to have a significant effect on IT usage in an organization. Therefore H2 is supported. Technological readiness (TR) is also found to have a significant effect on IT usage (ITU) in an organization. Therefore H3 is supported. Similarly with other studies such as Y. Chang, Wilkinson, Potangaroa, and Seville (2012), performance expectancy (PE) is found to have a significant effect on IT usage in an organization. Therefore H4 is supported. Effort expectancy (EE) is found to have

a significant but negative relationship with IT usage in an organization. Therefore H5 is not supported. Similarly, social influence (SI) is found to have a significant but negative relationship with IT usage in an organization. Therefore H6 is not supported.

Table 5.4: Summary of Findings

Relationship	Path Coefficient	T Statistics	P Values	Supported?
Effort Expectancy ->IT Use	0.008	0.167	0.867	No
Financial Resources ->IT Use	0.291	3.388	0.001	Yes
IT Integration ->Performance	0.211	3.285	0.001	Yes
IT Use ->Information Sharing	0.369	5.828	0.000	Yes
IT Use ->Mutual Trust	0.386	6.704	0.000	Yes
Information Sharing ->IT Integration	0.177	2.516	0.012	Yes
Information Sharing ->Performance	0.430	6.820	0.000	Yes
Managerial Obstacles ->IT Use	-0.004	0.073	0.942	No
Mutual Trust ->IT Integration	0.253	3.351	0.001	Yes
Mutual Trust ->Information Sharing	0.221	3.095	0.002	Yes
Performance Expectancy ->IT Use	0.827	9.244	0.000	Yes
Social Influence ->IT Use	-0.017	0.361	0.718	No
Technology Readiness ->IT Use	0.327	5.384	0.000	Yes

IT use is found to have a significant effect with mutual trust among the organizations. Therefore H7a is supported. IT use is found to have a significant effect with information sharing among the organizations. Therefore H7b is supported. Mutual trust among the organizations is found to have a significant effect with information sharing and IT integration among the organizations. Therefore H8a and H8b are supported. Information sharing among the organizations is found to have a significant effect with IT integration among the organizations and HSC performance. Therefore H9a and H9b are supported. IT integration among the organizations is found to have a significant effect with HSC performance. Therefore H10 is supported. These findings are further discussed in the next section.

5.7 Discussion

India is the fastest growing economy in Asia and indeed the world, but the rise in the occurrence of natural disasters has hampered the development of the country. To continue or enhance the pace of economic growth and reduce the impact of such disasters on society, India should enhance the utilization of IT among actors involved in HSCM. This study empirically validates the relationship between the TO framework, UTAUT model, IOR framework, IT integration and HSC performance. The results indicate that managerial obstacles, technology readiness, financial resources of an organization, mutual trust and information sharing among organizations are the foremost important factors in successful implementation and utilization of IT in HSC. The findings are discussed below as per the framework.

TO framework

The results show the influence of managerial obstacles, technological readiness and financial resources on IT usage in an organizations supply chain. This indicates that the organizations involved in HSCM are more concerned with regards to the technology and organization factors. This finding is in agreement with Zhu et al. (2006) and Yeung, Shim, and Lai (2003). The result indicates that managerial obstacles (MO) significantly affect the IT usage in an organizations SC. The findings are consistent with Grandon and Pearson (2004), in that many organizations lack prerequisite financial and technical resources to adopt IT. The result indicates that the technology readiness of an organization is the most important factor affecting the utilization of IT among the TO framework. The organizations have to ensure the availability of technical skills that are essential for adopting IT in the business process. Without the necessary financial and technological resources, an organization might not succeed in the adoption of IT in the supply chain.

The organizations involved in HSCM are comparatively small compared to organizations in CSC. The implementation of IT is a long-term process that requires huge amount of funds and might involve changing the whole business environment to include a change from a manual process to a computer integrated process. This requires sufficient resources in terms of time as well as capital. Initially, organizations have to ensure the availability of resources that are essential for the successful utilization of IT in HSCM. This view was supported by various researchers (Zhu et al., 2006). This study has integrated the TO and IOR frameworks with facilitating conditions of the UTAUT model.

UTAUT model

The results indicate the positive impact of performance expectancy while effort expectancy and social influence do not have significant relationships with IT usage in an organizations supply chain in the context of HSCM. Although the results are surprising, they are well supported by previous studies. One possible reason may be the non-awareness about the benefits of IT in supply chains. In the present era of social media, managers are aware that IT usage in the SC will positively influence the HSC performance. Therefore, PE has a significant relationship with IT usage in an organization. On the other hand, the result suggests the resistive behavior of the managers towards IT utilization. This indicates that they are aware of the benefits and advantages of IT but have not put this into practice. This is due to lack of training and IT facilities within the organizations. Managers believe that the utilization of IT will improve their productivity and working efficiency. However, some managers perceptions toward IT indicate their anxiety over its use. Since they have not experienced the benefits and advantages of IT during training, it is difficult for them to adapt. This finding is in agreement with earlier studies suggesting that organizations do not strategically plan the use of IT.

The results indicate the non-significant relationship between social influence and IT usage in an organization. One possible explanation is that top management does not consider the utilization of IT as one of the main critical success factors in improving the performance of HSCM. Therefore, larger firms have to encourage the small organizations involved in HSCM to adopt the utilization of IT. This will not only benefit the large organizations but also the smaller organizations

involved in HSCM (Gunasekaran et al., 2006). Earlier studies have argued that organizations involved in HSCM do not plan the utilization of IT well, as they have technical and financial constraints. Greater financial support is required for the organizations involved in HSCM as many have very limited sources of funding. Support should be extended to provide an infrastructure at low or reduced charges and to seek further avenues of additional finance and resources. Infrastructure refers to access to workshops and other specially equipped facilities which would allow the organizations to develop an innovative and learning environment. The work of Gustavsson (2003) and Van Wassenhove (2006) is supported by verifying that the top management of actors involved in HSCM lack the necessary supply chain understanding. This emphasized the value of having experienced and expert professionals from the commercial sector as they can play an important role in nurturing the organizations to achieve success by adopting the IT in their operating environment.

The awareness level regarding the importance of advanced IT systems, efficient technologies, in HSC and associated aspects such as institutional initiatives, regular meetings, learning from previous disasters, etc., need to be raised immediately (Kovacs & Spens, 2007, 2011b). With this in mind, more educational and awareness campaigns, workshops, training programmes, seminars and conferences can help. The report published by FEMA in 2006 also emphasized the point that disaster management is a system-level problem and that there is not one system available that satisfies the requirements of all organizations. Dramatic improvements in one technological area may have relatively little overall impact unless other interconnected technologies are able to leverage and utilize any improvements made.

IOR framework

The results suggest that IT use in an organization positively influences the mutual trust and information sharing among the organizations involved in HSCM. One possible reason for this is that the managers are aware that their operating environment is highly uncertain and dynamic due to unpredictability about the occurrence of disaster. As such, there is an urgent need to adopt IT in their business SC to improve the existing business environment and coordination with other organizations involved in HSCM. This is only possible by the mutual trust and information sharing among the organizations.

Mutual trust serves as a driving force in achieving coordination through information sharing among organizations in HSCM. The results are in agreement with previous studies that suggest real coordination or sharing of information and resources can happen only in a learning and participative environment where all feel comfortable in expressing their views and opinions. Knowledge transfer from the commercial sector to humanitarian sector is essential for improving the sharing of information in HSCM. The government should organize a wide range of knowledge transfer activities including regional and sub-regional training workshop programmes, seminars, conferences, exhibitions and expert group meetings. The overall objectives should be to improve the volunteers management skills and help to transfer knowledge and skills learned from training into practice. This will enable volunteers not only to enhance their existing skills but to apply them into life-saving situations. For example, workers must know the importance of the

information which is to be transferred first to strategic headquarters at the time of disaster.

HSCM involves large number of actors such as the Government, Military, Media, logistics providers, Aid agencies, donors, relief organizations, NGOs, etc. (Kovacs & Spens, 2007). The actors should coordinate for maximizing the utilization of IT, as their collaboration can triggered the process by developing effective and efficient strategies. In particular, the successful utilization of IT requires to streamline the activities of commercial and humanitarian sector as the former has all the expertise who can manage the IT function of the organizations at different levels i.e. strategic, tactical and the operational levels. This requires strategic planning to ensure long term commitment of the private sector, since every corporate house is actively involved in social responsibility programmes and it is easier to redefine these programmes along with humanitarian activities.

Thomas and Kopczak (2005) highlighted the shortage of expert logisticians in the field as one of the challenges, which was supported by many researchers. By not acknowledging logistics as a professional discipline, this problem has been created (Whiting & Ayala-Ostrm, 2009). Furthermore, barriers to coordination arises due to the fact that there is a lack of command and control practices (McLachlin & Larson, 2011; Tomasini & Van Wassenhove, 2009). Sandwell (2011) highlighted lack of preparedness as one of the reason for low coordination. Murray (2005) describes the many reasons for a lack of preparedness by quoting Van Wassenhove (2006) that "There is a long way to go, and a lot of it has to do with politics, insufficient resources, and insufficient understanding that you need to prepare if you want to react."

The major challenge highlighted by academicians and practitioners in disaster preparedness measures is the lack of use of IT in relief operations. The major stumbling block resisting the use of IT is behaviour of donors (Whiting & Ayala-Ostrm, 2009). The majority of the sources of funds are typically only available after the occurrence of disaster, and also must be spent in a short time window (FEMA Report, 2006). Limited funding drives the actors such as humanitarian relief organizations (HROs) to focus on immediate and direct relief rather than investing in systems and processes that will improve the efficiency of the relief operations over the long-term (Thomas, 2003). Therefore, poor IT infrastructure, traditional supply chain, disparity of IT facility among actors involved in HSCM exists in the humanitarian sector.

The results suggest that if an organization involved in a supply chain wishes to integrate technology utilization, then the mutual trust and information sharing among agencies are prerequisites. This would improve the performance of HSC. Technology integration requires long term relationships among the organizations. Mutual trust and information sharing are required for long term relationships since it leads to specific behaviours among the organizations in supply chains that would boost the probability of getting some additional benefits from the current relationship of exchange (Sahay, 2003).

5.7.1 Managerial Implications

The rise in the occurrence of disasters in recent years is the major hurdle in the overall development of the country. The solution to this problem is to take maximum advantage of the available technology to reduce the impact of the disaster on society, as the occurrence of disaster is uncertain. The use of technology in HSCM has speeded up in the last years and the future appears promising. However, the speed of the process of IT enablement of HSCM can be enhanced by removing the identified barriers. The decision makers face many challenges in pinpointing and working on these barriers that impede the effects and benefits of the utilization of IT.

The practitioners on the ground and academicians within the area are continuously demanding to improve the utilization of IT in HSCM. Based on HSCM in the Indian context, this study is an attempt to advance the understanding of the factors affecting the utilization of IT in HSCM. For the purpose of achieving the objectives, a questionnaire instrument and hypotheses are developed and tested to gain insight into various factors affecting the utilization of IT in HSCM. This study integrates the TO, IOR framework and UTAUT model to examine the factors affecting the utilization of IT in HSCM. This research reports several important findings. Firstly, it is noted that variables under a TO framework have significant effect on IT usage in an organizations supply chain. Secondly, out of three variables in the UTAUT model, only performance expectancy significantly affects the IT usage in an organizations supply chain. Thirdly, IT use in an organization influences mutual trust and supports the process of IT integration which in turn significantly affects the performance of HSCM.

The results reveal that there is a strong need to establish mutual trust among the organization in HSCM. The institutions engaged in enhancing the efficiency of actors in relief operations need to interact more frequently and improve the intra and inter coordination systems for the welfare of the society involved. Furthermore, it is necessary to initiate joint action between governments and private organizations to improve the coordination of the major players. The government or the central authority responsible for the management of disaster related activities should show their willingness to lead as any policy and regulatory initiatives alone are not sufficient to effectively address the issues. The critical problems such as finance, information sharing, use of technology and attitude of the organizations need to be addressed on a priority basis. The next chapter discusses the case of the disaster that occurred in Uttarakhand (a Northern State in India) to further validate the findings of our study. The case also analyzes various strategic issues affecting the IT enablement of HSCM in the Indian context.

To enhance the capacity of organizations involved in HSC, agencies could consider the above characteristics identified in this study while developing multi-agency training and exercises. An important implication is to avoid the same kind of training for all types of disaster, given that the scale and region where it occurs may differ every time. The rate at which new, advanced technologies are being incorporated in the process of the commercial supply chain management (CSCM) is a major success driver; however, in the humanitarian relief supply chain the use and adoption of IT could prove to be useful as presented in the results. In order to generate meaningful

improvements toward the utilization of IT by these organizations, there must be commensurate efforts made to promote the usefulness and benefits of IT.

- The stakeholders of HSC should plan strategically to utilize the advantages of IT in the coming years. The plan should be aligned with their goals as they have limited resources in terms of capital, time and human resources.

- There is a strong need to make the volunteers of organizations aware that the use of IT will enhance the mutual trust among those involved in relief work and further improve the performance of future relief activities.

- Governments can also support the process by providing relief organizations with reliable infrastructure and basic facilities such as free internet, mobile technologies etc. needed to enhance the utilization of IT.

- Governmental departments also need to pay special attention to providing adequate training and support to the organizations involved in HSC. For example, special workshops, training programmes, seminars and symposiums could all be organized to promote the benefits of the use of IT. In addition, government departments should provide ample opportunities to the members of organizations to explore the utilization of IT.

- A series of milestones, general operating policies and key performance indicators (KPIs) are required to establish a system to monitor the performance of the relief operations. This will enable an organization working for the betterment of disaster affected people to learn from their previous mistakes, ensuring that any mistakes are not repeated in future. This will create an environment of mutual and case based learning for the actors in HSCM.

- The senior management teams of the organizations involved need to provide a facilitating culture where employees are encouraged to use new technologies. This can be achieved by clarifying expectations and possible impact on employee job description, workload and an encouragement to interact with the members of other organizations.

- The institutions engaged in enhancing the efficiency of actors in relief operations need to interact more frequently and improve the intra and inter coordination systems for the welfare of the society involved. Furthermore, it is necessary to initiate joint action between governments and private organizations to improve the coordination of the major players. The government or the central authority responsible for the management of disaster related activities should show their willingness to lead as any policy and regulatory initiatives alone are not sufficient to effectively address the many issues that arise. The critical problems such as finance, information sharing, use of technology and attitude of the organizations need to be addressed on a priority basis.

5.8 Summary

In this chapter, a model has been developed and validated that examines the factors affecting the utilization of IT in HSCM. These factors are managerial obstacles, availability of funds, technology readiness, government support, performance expectancy, effort expectancy, social influence, IT use, mutual trust and IT integration among the organizations. This study is based on the premise that the usage of IT in SCM goes through a series of phases commencing from IT adoption in an organization, to inter and intra SC processes, to mutual trust and finally IT integration with other organizations. All members of SC can be brought onto the same platform through IT integration.

For the purposes of this research, a psychometric scale development process has been followed. In addition, the research has been designed to empirically validate this model, with a framework of research instrument development procedure being presented. These steps include the research design, data collection methods, scaling techniques, questionnaire design, sampling design and data analysis procedure. Various reliability and validity tests have been conducted for the refinement and validation of the scale. In addition to this, hypothesis testing was also performed by using Smart PLS software. Finally, discussions and implications of the study have been discussed. This study would enable the policy makers or decision makers in Indian HSCM to understand relationship between different factors to enhance the utilization of IT. This study will prove to be very useful in improving the utilization of IT in HSCM.

The majority of organizations does not have the aptitude, knowledge and dynamism required to tackle coordination and technology-related problems that would enhance efficiency. In addition, they do not have enough funds available as their main source of funding is temporary. Despite this, top management can still create awareness about the importance of advanced systems that can enhance the performance of HSCM by organizing workshops and advertising through websites and blogs. In the past, these kind of activities were very rare. Furthermore, there are no existing policies to advance coordination among the organizations. There needs to be more drive by management to take initiatives forward.

Chapter 6

Case Study on Uttarakhand

Preview

In the previous chapter, a conceptual model which considers the factors affecting the utilization of IT in HSCM. This chapter examines the utilization of IT in humanitarian supply chain management of the disaster that occurred in the Uttarakhand (a Northern state in India) on June 14, 2013. In addition, Situation-Actors-Process (SAP), Learning-Action-Performance (LAP) framework followed by SAP LAP linkages framework is presented, to analyse various strategic issues to IT enablement of HSC using a case based method.

6.1 Introduction

Information technology makes it much easier to integrate various activities of supply chain such as transportation, logistics, and procurement. It also provides useful and immediate information for the effective management of relief activities (Beaumaster, 2002; Pettit & Beresford, 2009; Roh et al., 2008). Various researchers have previously noted that the use of IT could enhance the performance of HSC (Cate, 1994; Patterson, 2005; Pettit & Beresford, 2009; Roh et al., 2008; Tomasini & Van Wassenhove, 2009).

The utilization of IT within the supply chain makes it possible to react more quickly and more effectively with the available information to hand and to access relevant supports from a greater number of sources. There is a substantial amount of literature available on the importance and use of IT in effective management of past disasters, but there are few studies which discuss the strategic issues related to IT enablement of HSC, particularly in the Indian context. Hence, there is a strong need to analyse and highlight the importance of IT in HSCM from a broader perspective. This requires critical analysis of present supply-chain situations, various supply-chain actors and different supply-chain activities. Therefore, this chapter sets out to highlight the importance of information technology in the HSCM and to understand the present status of the use of IT in HSCM in India.

This chapter will develop a SAP LAP framework followed by SAP-LAP linkages framework, to analyse various strategic issues to maximize the utilization of IT in HSCM. The SAP LAP linkages framework considers the inter-relationship amongst all elements of different components of the SAP LAP framework by developing assessment, self-interaction and cross interaction matrices.

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6.2 Need for Case Study

R. K. Yin (2008, pp. 14) describes a case study as "an empirical enquiry that investigates a contemporary phenomenon within its real life context." Simons (2009) argued that in-depth case study research is more effective in addressing what is currently happening within an industry and why it is happening when compared to more traditional analysis, which often describes what has happened in the past. Case studies should be of particular interest if the overall aim of the research is to gain a rich understanding of the process being studied (Creswell, 2013) also cited by Saunders, Saunders, Lewis, and Thornhill (2011). Saunders et al. (2011) go on to suggest that case study research is more often than not used in explanatory and exploratory research which is aimed at addressing the question why?

"*A strategy for doing research which involves an empirical investigation of a particular contemporary phenomenon within its real life context using multiple sources of evidence*"

(Robson, 2002, p.178)

The case based research method has been adopted since it offers an in-depth and relatively unstructured approach to develop theories and frameworks. It also provide a good platform for understanding various interrelated issues (Eisenhardt, 1989; Gerring, 2004; Sandeep Munjal, Gaur, & Chapnerkar, 2015). R. K. Yin (2013) noted that case studies are also useful when the boundaries between context and phenomena are not clearly evidenced and context is deliberately part of the design. However, what is clear is that the case study continues to be an important part of research in the fields of management and social science. Indeed numerous supply chain management text books are populated with case studies, both long and short, for instructional purposes (see for example (Chopra & Meindl, 2007; Lysons & Farrington, 2006; Mangan et al., 2008)). Moreover, it is argued that the in-depth case study approach allows for greater insight into the field of study within a real life context and that the method is especially useful for analysing various stages of a supply chain (Soosay, Hyland, & Ferrer, 2008). Case study has numerous advantages such as:

- It helps in developing the grounded theories that are relevant and practical
- Inferences in causal relationship can be made with more validity due to the availability of long term observations
- It provides a broad holistic pattern of the phenomenon in real world setting

For the purpose of preparing the case study data were collected by the interview with disaster victims, several experts, and newspapers articles and from various actors who organized rescue operations, restoration of communication, and transport, mass casualty management, and informal discussions with local residents. In a similar vein, outlining potential areas of research within the humanitarian field, Kovacs and Spens (2011a) suggested that "Humanitarian logistics requires good and applicable research with empirical data being gathered through the use of case studies or other qualitative methodologies."

As discussed in earlier chapters, a strong argument in favour of the inductive approach is that it offers the potential to answer not only the research question but also questions not originally asked (Partington, 2000); the contention being that when research is conducted from the perspective of the informant, and the researcher remains open to surprise rather than seeking to confirm expectations, ever more interesting insights can emerge from field work. Qualitative case studies allow for the adoption of an integrated method approach, not only to improve rigour, but also to explore and understand a specific topic while allowing the researcher to develop the best possible methodology for their given area of research (Cameron & Price, 2009; Saunders et al., 2011; R. K. Yin, 2008).

Within the context of this study, the case study approach allowed to investigate and examine the studied phenomena within a real life context and explore why and what was happening in a current situation (R. K. Yin, 2008). Case studies also provide the opportunity for a holistic view of what is happening within a business, enabling the researcher to see the whole picture. Finally, this method was chosen as it is considered to be one of the most effective means of obtaining a broad range of rich data (Saunders et al., 2011).

The Uttarakhand (a Northern state in India) experienced a devastating flood on June 14, 2013 that significantly affected local residents, visitors and the economic growth of the state. The emergency phase has passed and the survivors have restarted their everyday lives. In addition to the immense loss of life, damage to the infrastructure and personal property, many people lost the means for rebuilding their livelihoods and dealt a severe blow to the states lucrative religious tourism industry. There are several studies such as Gebremichael, Krajewski, Morrissey, Huffman, and Adler (2005); Gebremichael, Vivoni, Watts, and Rodríguez (2007); Haile, Rientjes, Gieske, and Gebremichael (2009), that analysed the spatial pattern and temporal dynamics of rainfall but there seems to need to analyse various strategic issues to IT utilization in HSCM. Therefore, the objectives of this study are:

- To present a first-hand description of disaster, that occurred in the Uttarakhand, India and its prompt management
- To understand the process of managing disasters in Uttarakhand, India
- To analyze various strategic issues to maximize the utilization of IT in HSCM

6.3 Need for SAP LAP Linkages Framework

SAP LAP linkages framework is the extension of traditional SAP LAP analysis. SAPLAP framework is an analytical framework which is used to diagnose the major organizational issues / phenomena that have a major impact on the way the organizations function to achieve goals / targets. The SAPLAP framework has been considered as the diagnostic instrument of organizational analysis. SAP-LAP framework that are developed are naive or atomic models treating the basic components of SAP-LAP framework independently without explicitly considering their

interdependence or interrelationships as illustrated in Figure 6.1. This limitation has been overcome by SAP LAP linkages framework that analyze the interaction between elements of SAP and LAP leading to a discussion on ways to improve the present situation.

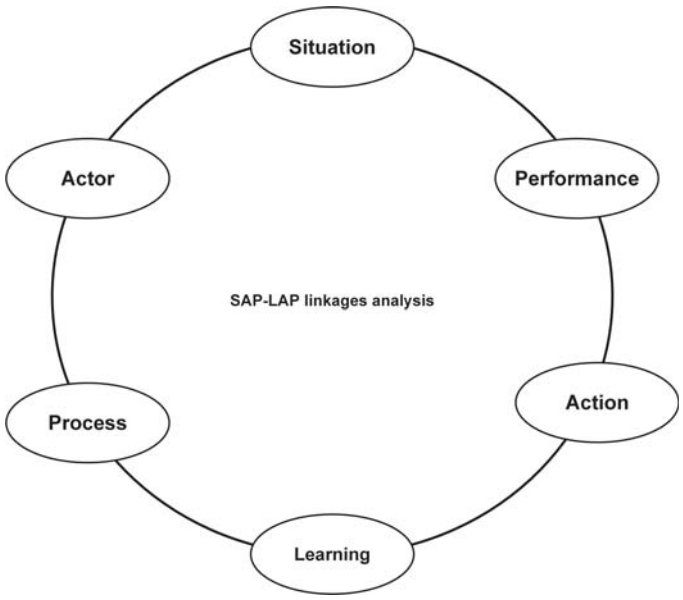

Figure 6.1: SAP-LAP Linkages Framework

6.4 Background of Case

Uttarakhand (a Northern state in India) formerly known as Uttaranchal (see Figure 6.1), is also known as “the abode of the Gods” or referred to as ”Heaven on Earth”. Uttarakhand, known for the natural beauty of the Himalayas is situated on the southern slope of the Himalaya range. The climate and vegetation vary greatly with elevation, from subtropical forests at lower elevations to glaciers at the highest elevations. It is largely a hilly State, sharing boundaries with Nepal in the East and China (Tibet) in the North. The state is divided into two divisions, Garhwal and Kumaon. Uttarakhand is the 20th most populous state of the country. Details about Uttarakhand are given in the Table 6.1.

Uttarakhand is one of the main tourist spots in India and has huge tourism potential in adventure, eco-tourism and leisure due to the presence of various ancient temples, national parks, timber reserves, mountain heights, hill stations and nationally protected monuments. Oak Grove School in Uttarakhand is on the proposed list of World Heritage Sites. The Ganga and Yamuna, among the most holy rivers in Hinduism also originate in Uttarakhand. Many Hindu temples and pilgrimage centers are located in the state.

Uttarakhand by virtue of its geological, topographical, geomorphological and seismic situation is a disaster prone state and part of the young Himalayan Mountains, prone to landslides, erosion and flash floods and has the highest ash flood fatality rate in India (Pande, 2010). The entire area between Gangotri and Uttarakhasi (around 100 km and approximately 88 villages fall in this

Figure 6.2: The Location of Uttarakhand in India

stretch), is the catchment area of a Bhagirathi river and belongs to an ecosensitive zone of the state. Flash foods are the most common and widespread of all weather-related natural disasters in Uttarakhand (see Table 6.2 for past disasters in the state).

Table 6.1: Details about Uttarakhand

Latitude	2843’ N to 3127’ N
Longitude	7734’ E to 8102’ E
Area	Geographical Area: 53,483 km, (of which 46035 km is the hill area and 7448 is plain). Forest: 34651 km.
Population	101.17 lakh comprising 51.54% males and 49.63% females, with 70.26% of the population living in rural areas.
Population	189 people per km2.
Density	(India average: 374.8 per km2)
Language	Garhwali and Kumaoni whereas Hindi is the most widely spoken language.
No. of districts	13
Capital	Dehradun
Literacy	79.63%
Telephone density	74 .6 %
Number of vehicles registered	22.90%

Table 6.2: History of disasters in Uttarakhand

District	Year	Causalities
Pithoragarh, Uttarkashi, Rudraprayag, Chamoli	2013	More than 5000*
Rudraprayag	2012	76
Uttarkashi	2012	39
Uttarkashi, Pithoragarh, Chamoli, Rudraprayag	2010	65
Chamoli	2005	11
Uttarkashi	2003	More than 30
Tehri	2002	28
Pithoragarh	2002	5
Uttarkashi, Tehri, Chamoli	1999	110
Pithoragarh	1998	300
Chamoli	1998	69
Uttarkashi	1991	1000
Uttarkashi	1978	Several deaths

6.4.1 Uttarakhand Flood in 2013

Between June 14-17 2013, the state received more than 13 inches of rainfall, which is above the normal benchmark of 65.9 mm rainfall during a normal monsoon. The multi-day cloudburst, heavy rainfall for four successive days (June 14-17, 2013), as well as melting snow precipitated heavy floods in the state created unprecedented difficulties for the local residents. In addition to the immense loss of life, damage to the infrastructure and personal property, many people lost the means for rebuilding their livelihoods and dealt a severe blow to the states lucrative religious tourism industry.

6.4.2 Effect of 2013 Flood on Uttarakhand

The massive loss of human life and property due to the flash floods in the state was an unfortunate coincidence of an early monsoon burst during the peak pilgrimage season that flooded the river valley along a key pilgrim route. The floods triggered landslides, which damaged several houses and structures and killing those who were trapped. It was also reported that more than 60,000 people were stuck elsewhere in Uttarakhand, many of them pilgrims who wanted to visit the four religious sites or 'Char Dham' in the State, namely, Gangotri, Yamunotri, Kedarnath and Badrinath. The heavy rains resulted in intense flash floods and massive landslides. Entire villages and settlements such as Gaurikund and the market town of Ram Bada, a transition point to Kedarnath were obliterated, while the market town of Sonprayag suffered heavy damage and loss of life. The impact of disaster on Kedarnath, one of the pilgrimage centers in Uttarakhand, is given in Figure 6.3.

Figure 6.3: Pre and Post Disaster Satellite Image of Kedarnath area in Uttarakhand
Source: Uttarakhand Application Centre, Dehradun 2013

Many people were trapped in various pilgrimage centers due to damaged or blocked roads. People in other important locations like the Valley of Flowers, Roopkund and the Sikh pilgrimage centers Hemkund were stranded for more than three days. National Highway 58, an important link connecting the region, was also washed away at various places. Since a higher number of tourists visit during the summer, which starts in April and continues until the end of June, a large number of tourists and pilgrims were trapped without water and foods or survived on very little water and food for more than three days.

The roads were completely damaged at more than 400 places, resulting in huge traffic jams, while many cars and other vehicles were washed away by the flood. Washed awaybodies were found in distant places like Bijnor (around 100 km), Allahabad (around 800 km), Bulandshahr (around 250 km) and in Uttar Pradesh (another state in northern India). Sample of the view of experts about the impact of the disaster are given below:

"*It is feared that thousands could be dead and missing and state could take years to get back to normalcy.*"

"*The devastating floods in Uttarakhand have strangled the booming tourist industry too in the picturesque mountainous state and recovery will take a long time.*"

"*Natural calamity in Uttarakhand: Insurers peg losses up to Rs 3,000 crores.*"

"*Uttarakhand the state known for its scenic beauty and Hindu religious centres, has been pushed at least a decade back in its development cycle.*"

"*Floods in Uttarakhand have not only destroyed tourist infrastructure like hotels, bed and breakfast inns and restaurants but given a blow to tourism, pushing the sector backwards by at least five years.*"

6.5 SAP LAP Framework

Sushil (2000) has developed the SAP LAP framework. The development of SAP LAP framework consist of two steps. Initially, SAP analysis was conducted whose interfaces are situations (S), actors (A) and processes (P). The "situation" is defined as any internal or external context that "examines the past, present or the expected future." The "actors" are key persons or organizations who deal with the situation or any other persons working for the betterment of the situation. The "process" is the mechanism used to manage output while input is regarded as the way in which key persons are handling the situation (N. Singh & Kumar, 2014; Sushil, 2000; Thakkar, Kanda, & Deshmukh, 2008). Finally, the synthesis of SAP leads to LAP(learning issues, recommended action for improving the situation, anticipated improvement in performance).

There is a large amount of literature available where researchers have used SAP LAP framework for analysing various supply chain related problems, strategic performance management, ICT and other issues in organizations such as management practices (Charan, 2012; John & Ramesh, 2012; Mahajan, Jadhav, Kalamkar, & Narkhede, 2013; Nasim & Sushil, 2014; Palanisamy, 2001; Rizk, 2014; Sushil, 2000; Thakkar et al., 2008).

A structured set of questions was used (Table 6.3) to explore different strategic issues aimed at enhancing the use of IT in HSCM. This study is based on personal semi-structured interviews with different humanitarian actors involved in past relief activities which seek to understand a persons perspectives as they experience and understand an event, relationship, program, emotion (Leedy, 1997). This was akin to the researchers interest, Saunders et al. (2011) also supported the view that semi-structured interviews are the best method, compared to a questionnaire, to understand the strategic issues. Managers are more willing to answer detailed questions, especially when the interview topic is relevant to their current work and can be of use to them. Interview sessions lasted from 30 minutes to over 1 hour.

Table 6.3: A template for queries with reference to IT issues in HSCM

Q1	Who were the actors involved in the HSCM?
Q2	What do you think that needs to be done to improve the performance of HSCM?
Q3	How the use of IT in HSCM will address the needs of the emergency situation?
Q4	How the use of IT in HSCM addresses the issue of coordination in HSCM?
Q5	What are the challenges to proliferation of IT in HSCM?
Q6	What could be done to improve the utilization of IT in HSCM?

to be cont'd on next page

Table 6.3: A Template for Queries with reference to IT issues in HSCM

Q7	Which is the most important learning issue that need to be addressed on priority to enhance the use of IT in HSCM?
Q8	What do you think that needs to be done to enhance the awareness of the volunteers and actors towards the benefits of IT in HSCM?
Q9	What are the resources that need to be available to the actors so that they can take the advantage of IT for the betterment of the society?
Q10	What type of skills, abilities are expected in the volunteers to use the IT in relief operations?
Q11	What do you think needs to be done to address the issue of "improper funding" in the humanitarian area so that money would be available for investing in preparedness measures for the relief operations?
Q12	Who is the most important actor in the relief operations to support the process of enhancing the use of IT in HSCM?

The interviews were conducted with five experts (two academics, one IT professional, one practitioner and one logistics officer). Various published papers, reports and information related to the programmes used for disaster victims were circulated among the experts beforehand. In this way, the experts could give their own opinions and insights on the pre-determined issues related to the use of IT in HSCM. The primary and secondary data has been collected using multiple strategies/sources such as published papers, newspaper articles and discussions with experts as advocated by Voss, Nikos Tsikriktsis, and Mark Frohlich (2002) and R. K. Yin (2013). This is also cited by Garg and Deshmukh (2010); Ilyas, Banwet, and Shankar (2005, 2007); Ilyas, Shankar, and Banwet (2007); Mohammed, Shankar, and Banwet (2008); Scholten, Scott, Fynes, Scholten, and Scott (2010); Thakkar et al. (2008). All of these strategies positively contribute to the criteria of a good qualitative study according to Lincoln and Guba (1985).

6.5.1 Situation

It is not possible to predict accurately the occurrence, nature, the scale of disaster and the needs or demands during the disaster. The demand arises due to disaster does not follow any trend. There is a proper mechanism for disaster management but the unpredictability of the occurrence of disaster creates various challenges in the planning of disaster management. The people also complicate the issues by not responding to the warnings issued by the authorities.

The use of IT plays an important role before and after the occurrence of the disaster, For example, probable impact of natural disaster can be estimated, before its occurrence with the help of computer simulation and impact of disaster can be seen with the help of computer graphics (Patterson, 2005). Nowadays the use of IT in relief activities is increased, but the adoption of use of advanced or sophisticated technologies is slower in India as compared to other countries. The

low use of IT was also reported by Ramachandran (2013) in the relief operation of the disaster that occurred in the Uttarakhand (a Northern state in India). It is evident that many humanitarian organizations have incompatible information technology systems in the field. Information still kept in silos which limits the use of many humanitarian logistics operation metrics (Maspero & Ittmann, 2008). An effective logistics information system (like Helios) is therefore required to centrally collect data on humanitarian logistics actor effectiveness (Chikolo, 2006).

Developing countries are far behind as compared to developed countries in terms of education, funding, and equipment to reduce their vulnerability. The vulnerability of developing countries to various disasters is higher, due to their impoverished living conditions and weak warning systems. Weakness is seen in building rules and their implementation in developing nations. India must develop better ability to forecast disasters and India still had miles to go in mastering disaster management (ICHL, 2013).

Information technology systems usually used in relief operations includes shared/ relational databases, Geographic information systems, Inventory control systems and decision control systems (Maitland et al., 2006). Communication technologies generally used in relief operations are fixed or wireless satellite internet connection, satellite phones and radio. In particular, the commercial organizations are using technology in almost every stage of their supply chain but the use of technologies in HSC is low.

The recently occurred Uttarakhand disaster served as a wake-up call for disaster management systems in India. It is high-time that real-time technologies like these are institutionalized into official disaster management systems of the country. The successful launch of INSAT-3D (launched by ISRO) to enhance Indias capability in the field of weather forecasting and disaster warning system after Kalpana-1 and INSAT-1A, the two existing geostationary satellite rendering weather data service for last decade. INSAT-3D will place India in a better position to improve the weather forecast and also will help mitigating the loss of life and property caused by oods and natural calamities.

6.5.2 Actor

In recent years there has been an strong emphasis to improve the whole structure and efciency of humanitarian aid (Steets et al., 2010) and there has been an increase in the numbers of stakeholders in disaster management. Various actors from both government and private sectors are involve in relief activities such as Donors, humanitarian relief organizations (HROs) and Aid Agencies, the Government, Military, Media, Society/ Social Workers, Logistics providers, private companies, various other organizations (Kovacs & Spens, 2007). Management of humanitarian relief activities also becomes complex due to increase in the number of stakeholders who may have a high degree of heterogeneity in terms of capacity, interests, culture, purposes, mandates and logistics expertise (Balcik et al., 2010). The interaction between various actors in the HSC is given in Figure 6.4. The role of these actors is discussed below in detail.

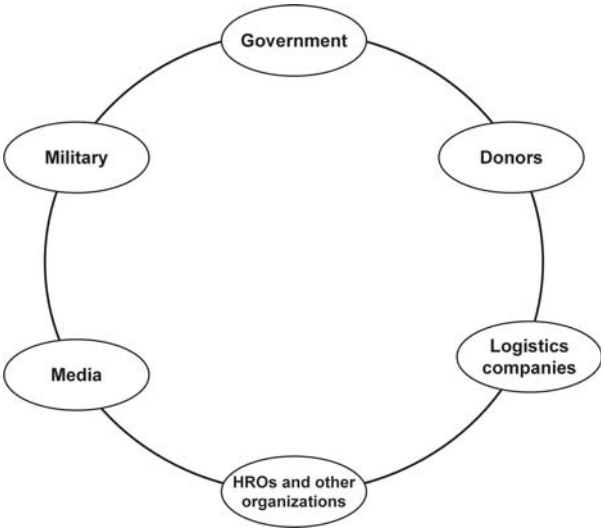

Figure 6.4: An Interaction among Actors in HSCM

Donors

A donor in general is a person, group of individuals, corporations, governments and other organizations who donate something voluntarily. The donors are one of the most important actors of the HSC. They provide with funds, aid materials, volunteers, etc. to the agencies for helping the disaster affected peoples.

HROs and Aid Agencies

The HROs and the aid agencies working for the welfare of the disaster victims are the next most important actors of the HSC. The purpose of HROs is to provide support to the government in the relief activities and to act as a mediator between the government and the aected population. Immediately after the occurrence of disaster they assemble their volunteer manpower quickly, for independent and government supportive relief work. HROs have the capacity to react quickly at local level and due to their localized scope of operations they have the ability to reach the interior locations of the area. With the help of HROs and aid agencies, donors donation reaches the beneciaries.

Government

The central government of the disaster affected country is the first organization to act at the time of disaster. After the beneficiaries themselves, the government can be considered as the second most important stakeholder in the HSC. The role of the government during disaster is to mitigate damages and place the affected residents into the position they were before the disaster, provide civility, protection and service emergency response to the needs of the people. By mobilizing the required funds, with the help of the military and the paramilitary forces, the government provides necessary infrastructure required by other organizations, to set up their relief activities, etc.

Military

The military forces play the most important role in both pre and post disaster phase. They come to the scene first and lead the rescue activities. Generally, they are called upon to manage various tasks which include evacuation, maintenance of essential services, Distributing of essential sup-

plies in remove and marooned areas, Transport of relief materials, Medical aid, Management of relief camps. The Gujarat earthquake in 2001; the Kashmir earthquake in 2005; the Ladakh ash oods in 2010; the Sikkim earthquake in 2011; Uttarkhand oods in 2013; and various dierent ood relief operations emphasize that the military is one of the effective disaster response force in the country.

Media
Media also plays the most important role in disaster management by providing clear and correct information at every stage starting from, before the occurrence of disaster, through the heart of the disaster situation, and during the post-disaster recovery phase. It brings pictures or exact situation of the disaster into living rooms around the world and makes the suffering and needs of the disaster victims visible to the other and thus encourages the general public, organizations, or society to come forward for the help of the disaster affected peoples in any manner they can.

Logistics providers
Logistics plays very important role in relief activities which makes the logistics providers too important. The logistics providers main role is to manage the relief supply chain by providing the right product, to the right place, at the right time when logistics infrastructure such as roads, rail etc are damaged or destroyed by the disaster.

6.5.3 Process

India is divided into various states and each state is divided into many districts. The administrative head of each district is the Collector and District Magistrate (the same person performs both the duties). Although India has a separate judicial system, certain judicial powers are given to administrators, like Collectors. Disaster management is the responsibility of the local administration under the direction of the State Government and supported by the Government of India. The Ministry of Home Affairs is the nodal Ministry for coordinating relief, response and the overall management after a natural disaster (MHA, 2011).

After the disaster occurred, the local administration enacted emergency plans. There was no delay in the rescue and relief operations from the local administration and later, other actors joined the relief activities. Aid agencies made certain assumptions based on their intuition, past experience or limited information coming from the disaster site from local actors regarding the needs of the disaster victims. Based on the information received from the disaster site, local and global actors started to raise funds and other relief materials required at the disaster site, requests for funds were made with the donations coming immediately after the request, even before an accurate estimate of the scale of the disaster was made.

In the meantime, volunteers start arriving at the disaster site. During the relief operations, local actors, police, well-equipped emergency medical systems, well trained; and equipped relief workers, the Army, Navy, Air Force, Border Security Force, Indo-Tibetan Border Police, public works department, representatives from the state and the central government, many humanitarian

relief organizations (HROs), individuals and private organizations worked together (see Figure 6.5). Several thousand soldiers, many helicopters, and approximately 40 naval divers were deployed for the relief activities. They faced operational problems due to bad weather or continuous raining, but their response was impressive and quick. Air dropping was used in many places to provide basic emergency needs to disaster victims.

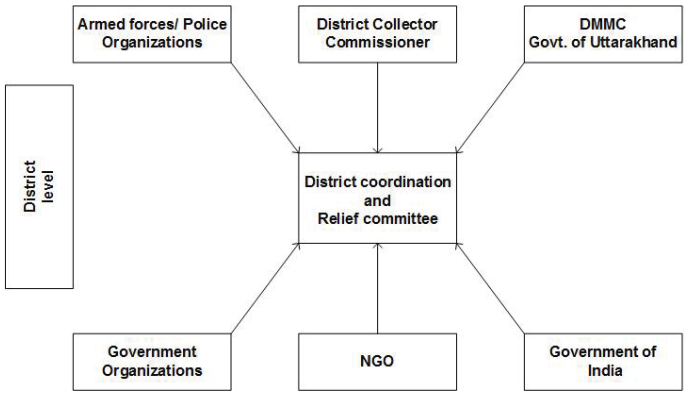

Figure 6.5: Disaster Management in Uttarakhand, India at District Level

Immediately after the floods, the media provided clear and correct information at every stage. Social networking websites such as Facebook and twitter were used to bring pictures, disaster update into living rooms around the world and makes the suffering and needs of the disaster victims visible to encourage the general public, organizations, and society to come forward and help of the disaster victims in any manner they can. A facebook page called Operation connect was created to find missing people and a similar initiative was taken by Google with People Finder to reunite and aid in the search missing people. The Indian Army also launched the website ”suryahopes.in” to provide minute-by-minute updates on the rescue operations in Uttarakhand following the flash floods of June 16, 2013. The site provides location-wise data on people stranded at various places and provides a list of individuals rescued from specific sites such as KedarGhati, Harshil and Gaurikund. All information related to the current situation of the disaster site, losses of human life and property was available on the websites. In addition, helpline numbers were also flashed on the web for the benefit of those still searching for loved ones.

6.5.3.1 Removal of the Debris

The search and removal of the debris from the disaster affected areas was a high cost and time consuming exercise. Delays in the removal of debris could increase the probability of an epidemic breakout, obstruct important transportation route and survivors may have been trapped under the debris. A major problem during the removal of debris was limited information about the number of people in a particular area, information related to the extent of loss due to the flood was not available and a scarcity or abundance of resources in various places. This information was used by the government in effective and efficient planning of relief and rehabilitation measures after a disaster and monitoring the effectiveness of relief activities from time to time.

6.5.3.2 Restoration and Reconstruction

The Uttarakhand relief activities did not end with the search and recovery of affected people, removal of debris and providing aid materials, but continued with restoring, relocating and reconstructing the lives of the affected people and families. Uttarakhand disaster brought untold destruction loss of life and loss of property that left many people severely injured in many cases the primary income provider was lost. Therefore, financial and moral support was needed for disaster victims to restart their lives. The resettlement objectives aimed at placing families and individuals in local communities with a socially, culturally and economically self-sustaining environment that includes appropriate housing and civic amenities, and to address issues related to essential infrastructure (Pande and Pande, 2007).

6.5.4 Learning

The chances for the occurrence of disasters are increasing everywhere, but the type of disasters is different for each country and depends on their geography. Casualties in developed countries are less as compared to developing countries. Their vulnerability is lower because of their ability to acquire and employ greater resources (EMI, 2013).

There are various challenges in support of effective and efficient delivery of relief materials to the disaster affected peoples during complex emergencies. These challenges are not only technology related, they are often relating to core organizational issues of mission, culture, environment, and communication (Maiers et al., 2005). IT infrastructure is well established in developed countries as compared to developing countries (Mbarika et al., 2005). Odedra-Straub (1993) also supports the poor IT infrastructure issue in developing countries and highlighted that due to poor IT infrastructure peoples are not able to gather information and coordinate with each other to solve their problems.

The major problem highlighted by academicians and practitioners in disaster preparedness measures is the behaviour of donors. Murray (2005) highlighted that the behaviour of donors reect that their money should be used to help affected peoples after the occurrence of an event, donors prefer to spent their money on tangible rather than non-tangible relief activities such as enhancing the IT infrastructure, logistics infrastructure (Oloruntoba & Gray, 2006) despite its importance in enhancing the effectiveness of relief activities (Whiting & Ayala-Ostrm, 2009) and which also means that avoidance techniques or disaster risk reduction techniques are often ignored, mainly by developing countries (Kovacs & Spens, 2007). Apart from these challenges, various other challenges also exist in the IT enablement of HSC in India, that are explained below

Low level of Investment in IT

The investment in IT systems is generally considered as an overhead cost rather than as a fundamental activity in the organizations involved in the relief operations (Maiers et al., 2005). Hence, investment in IT is not on their priority list. Kapucu and Garayev (2012) also supported the view

that the utilization of IT called for more investment in IT infrastructure. (Van Wassenhove, 2006, p.482) also states that "the main issue holding back many humanitarian organizations is nding the funds to nance the training and procedures that will lead to better preparedness and therefore more effective logistical operations."

Lack of supply chain understanding

Supply chain involves various activities such as procurement, warehousing, transportation and inventory management (Chopra & Meindl, 2007). The commercial sector has separate experts for each of these activities, but there is a lack of expertise in HSCM before the occurrence of disaster. During the disaster, experts from the commercial sector work with actors in HSCM to reduce the impact, but once their work is completed, they often return to their parent organizations (Maiers et al., 2005). In addition, the majority of leaders of the organizations involved in relief operations do not have experience of handling the supply chain as their background is mainly in social science or law (Van Wassenhove, 2006).

Shortage of knowledge workers

Knowledge workers are the key workers who are expert in their own particular areas. There is a shortage of knowledge workers such as IT professionals and logisticians in the humanitarian sector. Logisticians are experienced and comfortable working in commercial logistics, but this is completely different to the work involved in the humanitarian sector (Gustavsson, 2003; Maiers et al., 2005; Oloruntoba & Gray, 2006; Sandwell, 2011).

Ineffective planning

The lack of strategic planning in organizations involved in relief work means that they either do not have any vision for the future, or are not working on the implications of that vision. The short-term focused planning of many organizations also complicates the long term IT infrastructural issues (Maiers et al., 2005). There is reportedly a lack of a common language, practical methods and tools for disaster risk reduction (DRR). Finance for DRR, and capacity building are identified as one of the most pressing challenges (Byman et al., 2000), notably because inter alia: emergency funding is prioritized; DRR is more difficult to sell than response funding; and funding pools for response and recovery are separated. Proper strategic planning for implementation of IT is required to cope up with the other interdependent barriers (Byman et al., 2000; Maiers et al., 2005).

Inefficient training

The training given to the volunteers generally focuses on first aid and general knowledge in disaster management, paying little attention to IT, logistics or verbal/analytical training. Hu and Kapucu (2014) elaborated on the inefficient training issues in the organizations involved in HSCM. The shortage of knowledge workers has also increased due to the above training issues.

Low awareness about importance of IT

Field workers are not aware of the benefits and advantages of the utilization of IT in HSCM (Maiers et al., 2005), that it provides an opportunity to create, store and quickly share relevant information with top management. It is necessary for the right kind of help to be provided at

the right time and at the right place (Maiers et al., 2005). For example, Kapucu (2006) demonstrated that during the emergency response to the 9/11 disaster, use of IT support was crucial in coordinating communications across geographical and sectorial boundaries. GIS also provided mapping and analysis tools for examining the effects of the disaster on different areas.

Resistive nature of employees to change to IT enable

Resistance to change is one of the most important challenges in the implementation of IT in relief organizations. IT often represents completely new for many peoples working in the HROs. While working in the same kind of environment, volunteers reaches a certain comfort level related to their abilities and work processes, The perception of an employee that advanced technologies represent a daunting curve and possible chances that they can lose their job introduces fear into their mind about IT and creates significant resistance to change (Beaumaster, 2002).

Top management commitment

The utilization of IT in HSCM needs a large amount of funds, effort, time, support and commitment from top management, starting from the first phase. However, top management regard investment in IT systems as an overhead cost (Maiers et al., 2005), so the utilization of IT in HSCM is not a priority for organizations.

6.5.5 Action

Investment in Information Technology

The first step towards the adoption or implementation in IT is the investment. It is required to properly analyze the situation and strategically invest in IT. Gustavsson (2003) also cited that investment in IT is required for effective and efficient relief activities. Huge funds are required for the implementation or enhancing the use of IT, so it is needed to make donors aware about the benefits of IT in HSC. Hiring of expert logisticians and IT experts is mandatory for proactive behavior and strategically planning.

Transparent work flow policy

Transparent work flow would reduce the problems of information flow within different levels in the supply chain and ensures agility, flexibility, and alignment in the supply chain (Al-Mutawah, Lee, & Cheung, 2009). To encourage the investment in IT, it is needed to make the financial supply chain enough accountable to the donor so that they come to know that the money they have given for the welfare of people or to increase the efficiency of relief activities is utilized properly.

Strategic Planning for IT

Implementation of IT in the Humanitarian sector is an involved and complicated endeavor and requires strategic planning. It is not possible that in a short period of time and without any strategic planning, one can automate clerical tasks and transfer huge amount of data into the computer. Strategic planning is required for the successful implementation of IT in the humanitarian area and this will required the support from all end of the sector. Strategic planning is also required

in streamlining the activities of CSC and HSC, to ensure long term commitment of the Private sector.

Increasing awareness
Huge amount of funds is required for enhancing the use of IT in HSC. It is required that donors should come forward, but it is also needed to encourage the donors towards the implementation of IT in HSC by projecting the usefulness of IT in effective management of disaster. More initiatives are needed to be taken by the government and HROs for increasing the awareness of the benefits of IT such as organizing the workshops, conference, seminars, conclave, etc.

Strengthen training for IT
Benefits of investment in IT systems cannot be successfully realized unless gaining the experiencing through routine use. Training, drills, and exercises plays a vital role in the introduction of advanced technologies into organizational practice. The competence and confidence required to successfully use IT systems especially in the uncertain and high-stress situation of disasters, can be best developed through the proper training to volunteers.

Strategic tie-ups between actors
HSC has a large number of stakeholders, from both the government and the private sector. All stakeholders work for the same cause and it is required that all stakeholders work in a coordinated manner, because their collaboration can bring valuable change in relief activities. The private sector has all the expertise who can manage the IT function of the humanitarian sector at different levels i.e. strategic, tactical and the operational levels, while the public sector can provide the required infrastructure for the implementation of IT. Collaborative efforts of the public and private sector can help in developing effective and efficient strategies for the implementation of IT in the humanitarian sector.

6.5.6 Performance

Improve responsiveness
HSC comes into the picture after the occurrence of disaster. IT can improve the performance of the HSC by reducing the responsiveness time. The database can provides information about previously occurred disasters, strategy used to handle those disasters, details about earlier donors, so that the mistake done previously would not be repeated again, whereas the decision support system helps in making the immediate decisions based on past experiences. The government can sends the appeal globally with more specific demands, reducing the issue of the unsolicited donations, thus reducing the bottlenecks in the entire supply chain.

Enhance coordination between actors
The collaboration between actors involved in relief activities avoids the competition among them for already scarce resources like transportation facilities for the last mile distribution, funds from the donors etc. The coordination between actors would bring the dynamic change in relief activities. This collaboration can also help in the management of limited resource since sometime one

actor is having transportation facility but lacks aid materials while at the same time one is having aid material but not have enough transportation facility, this situation can be easily solved by tie ups between the actors.

Improves efficiency
Situational awareness is most important in different phases of disaster management in order to enhance the success of relief activities. Situation awareness includes information related to a incident, such as the location of place severely affected in terms of human life, infrastructure etc. and way to reach that place in less time. IT will help in providing the better situation awareness or latest information at the ground about disaster so that the right kind of help can be send at the right place in less time.

Enhances quick exchange of information, products and funds
IT can enhance needs assessment by providing information to the field staff related to what supplies are available for beneficiaries, how much time is required to provide the supply in particular place. An effective use of IT can offer possibilities of reducing the constraints due to underdeveloped or destroyed physical infrastructure. If the field staff at an emergency site is able to communicate easily to organizations involved in relief activities, it will improve the efficiency of the relief effort for e.g. If field staff is able to communicate about the present condition of roads i.e. which roads are wiped out, then relief materials can reach the disaster site quickly.

Better decision support system
Situation awareness provides reliable and relevant information to the decision makers while the decision support system focuses on assisting them in formulating prospective actions helping them to understand analyses and assess advantages and disadvantages of alternative courses of action and help them to follow-up on their decisions, by providing feedback loop mechanism.

Improves actor flexibility and agility
IT enable and motivate relief organizations to incorporate changes in their structures and processes (e.g., more distributed decision making). Agility is the key in disasters because none of the organizations is capable of handling any kind of situation or problems that can arise in disaster management. IT has also motivated various organizations to come forward and building the relationship among peoples or different organizations, who do not share a history of cooperation.

The Figure 6.6 explains the way actions to be performed to reduce challenges in the implementation of IT in order to achieve enhanced performance in HSCM.

6.6 SAP LAP Linkages Framework

The SAP LAP linkages framework was developed by Sushil (2009). The SAP LAP linkages framework is holistic in nature and considers the interaction or inter-relationship between different elements of SAP LAP i.e. Situation, Actor, Process, Learning, Action and Performance,

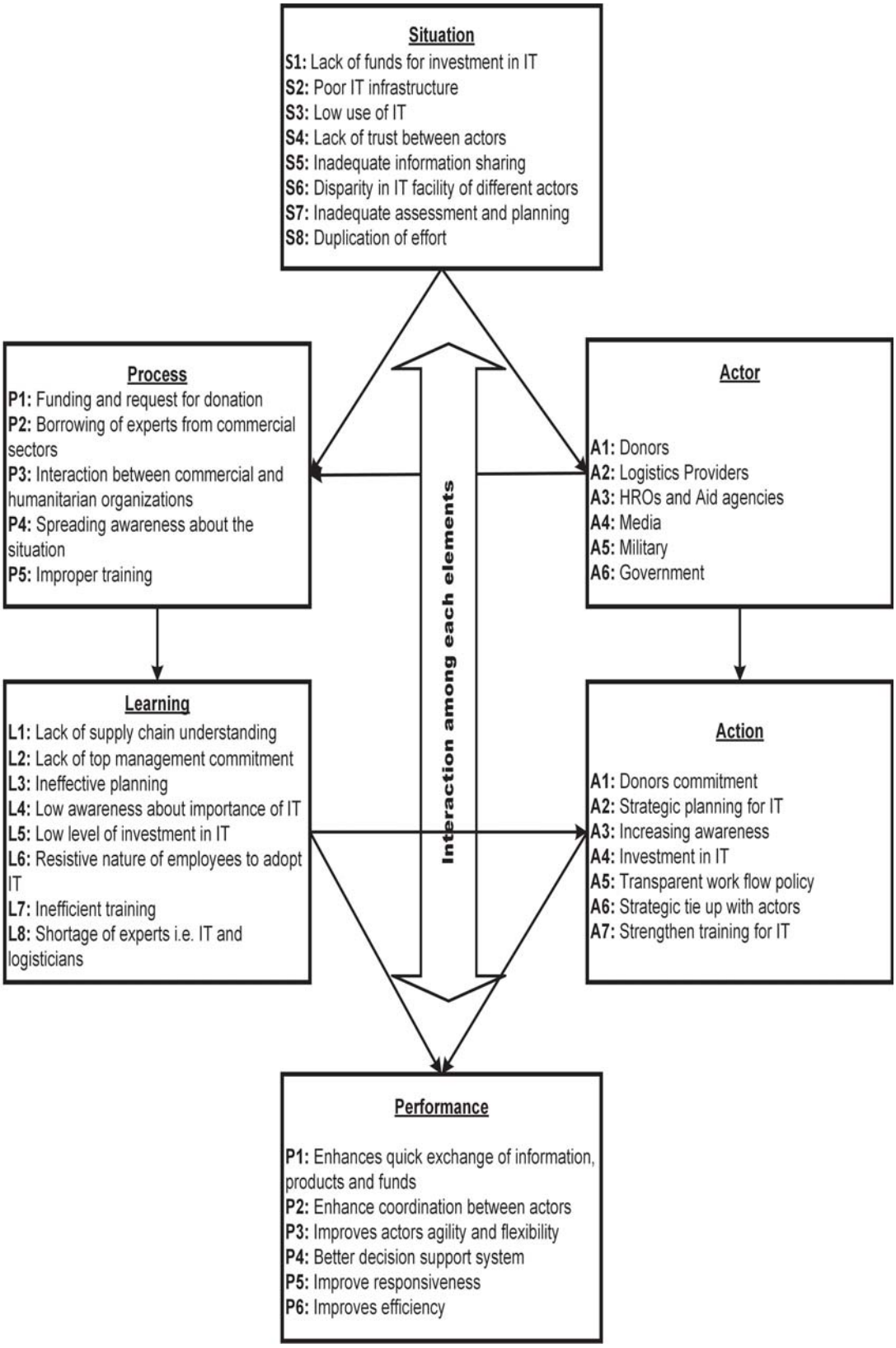

Figure 6.6: SAP LAP Framework

which was the major drawback in a traditional SAP LAP framework. In this study, SAP LAP framework has been developed to sharply define the elements in order to explore various strategic issues to enhance the use of IT in HSCM. The various steps for the SAP LAP linkages framework are given below:

Step 1: Develop SAP LAP framework
Step 2: Sharply define the elements of SAP LAP
Step 3: Develop scale and assess the elements in assessment matrix
Step 4: Develop binary and interpretive self-interaction matrices for the elements
Step 5: Develop cross-interaction matrices
Step 6: Interpret the relationships

This chapter develop SAP LAP linkages framework by making specific enquiries related to "use and adoption of IT" in HSCM. A 5-point Likert scale has been used with an average of these responses calculated to determine the values in the assessment matrix. Thereafter, the observations are then analyzed with the help of SAP LAP methodology in order to finally arrive at the result. Three types of matrices are developed in SAP LAP linkages framework, i.e. assessment matrices, self-interaction and cross-interaction matrices. The development of self-interaction and cross-interaction matrices are based on the qualitative judgment of experts. Either 1 or 0 is recorded in respective cells. The binary relationship (1, 0) means that 1 is assigned if two elements in a component are interrelated; otherwise 0 is assigned. An assessment matrix is used to gauge the overall state of the elements of the framework, while self-interaction and cross interaction matrices are used to depict the inter-relationships among the elements of SAP LAP. This is further explained in the following subsection.

6.6.1 Assessment Matrix

This matrix considers the multiple situation and contexts with qualitative and quantitative measurement (Sushil 2009). The assessment matrix has been developed using a Likert scale (not important to very important), as advocated by N. Singh and Kumar (2014). The assessment matrix for the situation, process and actors is given in Table 6.4.

6.6.2 Self-interaction Matrix

The self-interaction matrix depicts the relationships among the various elements of the SAP LAP framework. It consists of two matrices i.e. a binary and interpretive matrix. A self-interaction matrix is used for the elements of a particular component of situation, actor and process. The binary relationship (1, 0) means that 1 is assigned if two elements in a component are interrelated; otherwise 0 is assigned. In addition, the nature of interaction is qualified in an "interpretive self-interaction matrix."

Table 6.4: Assessment Matrix for Situation, Actor and Process

Situation	
Situation elements	Assessment of state
S1	3
S2	4
S3	3
S4	3
S5	3
S6	4
S7	3
S8	3
Actor	
Actor	Score
A1	3
A2	3
A3	4
A4	3
A5	4
A6	3
Process	
Process	Score
P1	2
P2	3
P3	3
P4	2
P5	2

6.6.2.1 Situation

The self-interaction matrix consisting of both the binary and interpretive relations for the situation is given in Table 6.5. IT plays an important role before and after a natural disaster. The probable impact of a natural disaster can be estimated before the occurrence with the help of computer simulation, while the impact of a disaster can be examined with the help of computer graphics (Patterson, 2005). The disaster that occurred in Uttarakhand, India was one of the deadliest in the current era. In the relief and rescue phase, the Indian Army launched a website "suryahopes.in" to provide minute-by-minute updates on rescue operations, while the state government supplied up to date information related to the changing situation in the disaster sites. This included details of losses in terms of human life and property, contact telephone numbers of relevant authorities and sources of help as well as facilities for inquiry purposes. The Uttarakhand government also created a Facebook page to help trace missing people, entitled "Operation connect". A similar initiative was made available on Google with the launch of "People Finder", with the aim of searching for missing people and reuniting them (The Hindu, 2013).

The local actors start the relief and rescue operations at the wake of disaster and later on global actors joined the relief activities. The aid agencies made certain assumptions related to the need of the disaster victims based on their intuition, past experience or limited information coming from the disaster site from the local actors. Based on the received information from the disaster site, local and global actors start to source the required funds and other relief materials required at the disaster site.

Immediately after the disaster, requests for funds are made to the donors with the help of IT and other medium, donations starts coming immediately after the request received by them, even before the accurate estimate of need and demand. During the emergency situation, several actors work in a coordinated manner to mitigate the impact of disaster on concerned society. Geographic information system (GIS) systems are widely used in relief activities.

In the initial phase of relief operations the information coming front the disaster site and various HROs was added to the already existing database or information system i.e. GIS with the pre disaster information from the government and communication centre. This help in the clear visualization of the particular area by generating maps about the current condition of the disaster site related to the wiped roads etc. After this the gathered information and the generated maps were published online to help the third parties to view the information and better analyse the situation. This collected and shared information about the impact of the disaster paved the way for further coordination between various actors involved in relief activities and motivates the donors to come forward for the welfare of the disaster affected peoples in any manner they can.

According to experts “Although the use of IT in relief activities has increased, the utilization of advanced or sophisticated technologies in HSCM in India is lacking, compared to the commercial supply chain.” According to Ramachandran (2013) “the recently occurred disaster in Uttarakhand begs the question: are we missing out on opportunities to deploy new technology-driven ways of collecting and processing information to help people in that State, as they struggle to come to terms with the massive destruction and loss of life caused by the floods?”.

As per the experts suggestion, lack of funds for investment in IT contributes to the underdeveloped infrastructure, which further leads to the ineffective use of IT that is available. Lack of trust between actors acts as a multiplier effect in the low use of IT. McEntire (1999) also supported the suggestion that trust related issues are common in HSCM. Disparity in the IT facility of different actors also contributes significantly in resisting the use of IT (Maiers et al., 2005; Schulz & Blecken, 2010). This can further lead to duplication of effort and reduces the performance of relief operations (Raju & Becker, 2013).

Non availability of supply chain experts is the most important IT barrier in HSCM. Absence of clear policies to support the adoption of IT significantly affects the performance of HSCM. Non availability of IT experts and lack of awareness about the benefits of IT in HSCM also resists the process of IT adoption.

Table 6.5: Self-interaction Matrix for Situation

(a) Binary matrix							
1	1	1	0	0	1	1	S1
0	0	1	0	0	0	S2	
1	1	0	0	1	S3		
1	1	0	0	S4			
0	0	1	S5				
0	0	S6					
1	S7						
S8							
(b) Interpretive matrix							
Contributes	Adds to uncertainty	Multiplier effect			Multiplier effect	Contributes	S1
Adds to uncertainty	Adds to uncertainty	Contributes			Adds to uncertainty	S2	
Multiplier effect	Multiplier effect	Contributes	Contributes	Multiplier effect	S3		
Adds to uncertainty	Contributes		Multiplier effect	S4			
Contributes	Contributes		S5				
		S6					
Multiplier effect	S7						
S8							

6.6.2.2 Actor

The self-interaction matrix for actor is given in Table 6.6. As per the experts suggestions, donors are seen as the main source of funding for the actors in HSCM.

Table 6.6: Self-interaction Matrix for Actors

(a) Binary matrix					
1	1	1	1	1	A1
0	1	1	0	A2	
0	1	1	A3		
0	1	A4			
1	A5				
A6					
(b) Interpretive matrix					
Provides donation	Provides donation		Provides donation		A1
Collaboration	Collaboration	Supports		A2	
Supports and Team work	Supports and Team work	Information flow	A3		
Information flow	Information flow	A4			
Team work	A5				
A6					

A donor in general is a person, a group of individuals, corporations, governments or other organizations who donate something voluntarily. Logistics providers bring support to the military, the government and other volunteers in relief operations. The main role of logistics providers is to manage the relief supply chain by providing the "right product", to the right place, at the right time when logistics infrastructure such as roads, rail, etc. are damaged or destroyed by the disaster.

Media supports the process by providing clear and correct information at every stage starting from before the occurrence of disaster, through to the heart of the disaster situation, then during the post-disaster recovery phase. It brings pictures or provides details of the disaster into living rooms around the world and makes the suffering and needs of the disaster victims visible, thus encouraging the general public, organizations, or groups to come forward to help the disaster affected peoples in any manner they can. After the beneficiaries themselves, the government could be considered as the second most important stakeholder and the first organization to act at the time of disaster. The role of the government during the disaster is to mitigate damages, try to place the affected residents into the position they were in before the disaster, provide support, protection and an emergency response to meet the needs of the people. With the coordination and collaboration of other actors, such as the military and paramilitary forces, the government

can mobilize the required funds and provide the necessary infrastructure required by other organizations to support relief operations (Balcik et al., 2010; Dolinskaya et al., 2011).

6.6.2.3 Process

The self-interaction matrix consisting of both binary and interpretive relations for the process is given in Table 6.7.

Table 6.7: Self-interaction Matrix for Process

(a) Binary matrix				
1	1	0	0	P1
1	1	1	P2	
1	1	P3		
1	P4			
P5				
(b) Interpretive matrix				
Facilitates	Facilitates			P1
Improves efficiency of training	More effective awareness programs	Helps in developing coordination	P2	
Improves efficiency of training	Enhance knowledge sharing	P3		
Improves efficiency of training	P4			
P5				

After the occurrence of disaster, local actors start the relief and rescue operations with global actors joining the relief activities at a later date. Aid agencies make certain assumptions related to the need of the disaster victims based on their intuition, past experience or limited information coming from the local actors at the disaster site (Beamon, 2004; Tomasini & Van Wassenhove, 2004). Based on the available information from the disaster site, local and global actors start to source the required funds and other relief materials required on the ground. Immediately after the disaster, requests for funds are made to potential donors with the help of websites, blogs and other media such as newspapers, radio and television. Donations may start coming in immediately after an appeal is made, even before the scale of need and demand is determined (John & Ramesh, 2012). Several IT tools were used during the relief operations of the disaster. This include GIS,GPS Remote sensing, Social media, Drones for Search and Rescue Efforts, mobile applications, etc. Social networking websites such as Facebook, Twitter also play the major role in relief operations.

6.6.3 Cross-interaction Matrix

The cross-interaction matrix depicts the relationships among the cross elements of the SAP LAP framework such as situation and actor, actor and process, process and learning, learning and action and finally, action and performance. Here again, the relationship between the elements of a SAP and LAP are represented by a self-interaction matrix. A pairwise comparison is made and a binary relationship (1, 0) is used, meaning that 1 is assigned if two elements in a component are interrelated; otherwise 0 is assigned. Also, the nature of interaction is qualified in an "interpretive self-interaction matrix."

6.6.4 Situation X Actor

Cross interaction between the elements of situation and actor is given in Table 6.8. The commercial sector has the expertise to make best use of advanced IT systems at each level. By way of contrast, the humanitarian sector lacks the professionals expertise in key areas such as logistics, IT, etc. (Gustavsson, 2003). There is a problem with the lack of information flow between them. This leads to lack of coordination and unsatisfactory collaborative efforts by both sectors (Balcik et al., 2010). Low levels of transparency and inefficient accountability in the financial supply chain also acts as a major hurdle to information flow and trust among the organizations (Agostinho, 2013; Thomas & Kopczak, 2005).

6.6.5 Actor X Process

The cross interaction matrix for actor and process is given in Table 6.9. Disaster management is the responsibility of the local administration, under the direction of the State Government, supported by the Government of India. However, the joint working between actors could also improve the efficiency of relief operations. To realize the benefits of the use of IT, especially in the uncertain and high-stress environment of disasters, gaining the experience through routine use, such as training, drills and exercises, is essential.

A case based learning, which means learning from mistakes in earlier disasters or implementing a feedback mechanism to learn from previous mistakes, is essential for the development of the overall process so that mistakes can be avoided in the future (Balcik et al., 2010; Ponomarov & Holcomb, 2009). The coordination and collaboration among the actors in HSCM and commercial organizations facilitates in addressing the training issues of volunteers. More awareness programs are needed to improve the efficiency of relief operations (John & Ramesh, 2012). The financial supply chain needs to be accountable and transparent so donors can see how the money that donate is utilized (Agostinho, 2013; Balcik et al., 2010; Thomas & Mizushima, 2005). It is essential to view the process of disaster management holistically instead of a short-term view.

Table 6.8: Cross Interaction Matrix of Situation and Actor

(a) Binary matrix						
S1	1	0	1	0	0	1
S2	0	0	1	0	0	1
S3	0	0	1	0	0	1
S4	0	0	1	1	0	1
S5	0	0	1	0	0	1
S6	1	0	0	0	0	1
S7	1	0	0	0	0	1
S8	0	0	0	0	0	1
	A1	A2	A3	A4	A5	A6
(b) Interpretive matrix						
S1	Transparent financial SC		Transparent financial SC			Awareness and Motivation
S2			Investment in IT			Investment in IT
S3			Investment in IT			Investment in IT
S4			Regular meetings	Information flow		Regular meetings
S5			Regular meetings			Regular meetings
S6	Investment in IT					Investment in IT
S7	Transparent financial SC					Information flow
S8						Information flow
	A1	A2	A3	A4	A5	A6

Table 6.9: Cross Interaction Matrix of Actor and Process

(a) Binary matrix					
A1	0	1	0	0	1
A2	0	0	0	1	0
A3	1	1	1	1	1
A4	1	0	1	1	0
A5	0	0	1	0	0
A6	1	1	1	1	1
	P1	P2	P3	P4	P5
(b) Interpretive matrix					
A1		Provide donation			Provide donation
A2				Case based learning	
A3	Transparent financial SC	Investment	domestic strategy	Case based learning	Investment
A4	Motivation		Motivation	Motivation	
A5			Global strategy		
A6	Transparent financial SC	Investment	Strategic tie up	Organizing conference, workshops	Investment
	P1	P2	P3	P4	P5

6.6.6 Process (P) X Learning (L*)

This matrix depicts the relationship between the components of process and learning as given in Table 6.10. Process denotes the way in which various activities, such as procurement and distribution, are managed and assessed in order to enhance performance. Learning represents the key insights to improvement of the existing process. The insights are useful in improving the overall effectiveness and efficiency of relief operations. The relief activity does not include only proving aid materials but also includes relocating, restoring and reconstructing the life of the disaster victims. Despite of the fact that relocation and restoration activities begins at the end, they are considered as one of the most important activities after saving the life of the people.

The restricted and short-term nature of donor funding also complicates strategic investment to enhance IT infrastructure. Donors hesitate to provide funding for enhancing the basic facilities needed for the full utilization of IT due to the absence of transparency and accountability mechanisms in HSC. Therefore, a performance evaluation mechanism is needed to analyze the strengths and weaknesses of relief operations, which can motivate donors to give more generously for the welfare of disaster victims (Agostinho, 2013; Thomas & Kopczak, 2005).

Table 6.10: Cross Interaction Matrix of Process and Learning

(a) Binary matrix								
P1	0	0	1	0	1	0	0	1
P2	1	1	1	1	1	1	1	1
P3	1	1	1	0	0	1	1	0
P4	0	1	1	1	1	1	1	0
P5	1	1	1	0	1	1	1	1
	L1	L2	L3	L4	L5	L6	L7	L8
(b) Interpretive matrix								
P1			Lack of accountability towards donors		Lack of accountability towards donors			Lack of accountability towards donors
P2	Lack of accountability towards donors	Inexperience	Inexperience	Inexperience	Lack of accountability towards donors	Lack of accountability towards donors	Lack of accountability towards donors	Lack of accountability towards donors
P3	Low coordination	Low coordination	Low coordination			Low coordination	Low coordination	
P4	Reactive not proactive	Reactive not proactive	Reactive not proactive	Reactive not proactive	Reactive not proactive	Reactive not proactive	Reactive not proactive	
P5	Inefficient training	Inefficient training	Inefficient training		Inefficient training	Inefficient training	Inefficient training	Inefficient training
	L1	L2	L3	L4	L5	L6	L7	L8

6.6.6.1 Discussion

The donors are willing to donate, but the controlled and immediate nature of funding after the occurrence of disaster makes it difficult for the actors to invest more strategically in the enhancement of IT infrastructure (Maiers et al., 2005). Van Wassenhove (2006) also state that "the main issue holding back many humanitarian organizations is finding the funds to finance the training and procedures that will lead to better preparedness and therefore more effective logistical operations." The Humanitarian Relief Organizations (HROs) mobilize only when disaster occurs; they do not try to establish the necessary IT infrastructure, including agreements, policies and practices for a disaster situation before the event (Maiers et al., 2005). There is a strong need to change to a new way of thinking.

"Resistance to change" is one of the most important challenges in enhancing the use of IT in relief organizations. IT often represents a completely new tool for many people working in the organizations. The perception that utilization of IT could be a possible reason for downsizing of their jobs introduces fear into their minds and creates significant resistance to change (Beaumaster, 2002). Lack of awareness about the use and importance of IT is the most significant barrier to enhancing the use of IT in HSCM. Field workers are not aware of the benefits of IT. With the help of appropriate technology, they can easily store the data, share information and enrich communication channels with management and other agencies. This enables the right kind of help to be provided at the right time to the right place (Maiers et al., 2005).

6.6.7 Learning (L*) X Action (A*)

The cross interaction matrix between the elements of learning and action is given in Table 6.11.

6.6.7.1 Discussion

Preparedness for any disaster leads to better responses. The key to being better prepared in HSCM is to make forward plans for better use of IT systems in the relief operations (Van Wassenhove, 2006). The first step towards enhancing the use of IT in HSCM is investment in IT systems. To support any investment, it is necessary to properly analyze the situation. To encourage investment in IT, there needs to be a commitment to make the financial supply chain accountable and transparent to the donor so that everyone can see that the money that has been provided to increase the performance has been utilized properly (Agostinho, 2013). A transparent work flow would reduce the problems of information flow within different levels in the supply chain and ensures agility, flexibility and alignment in the supply chain (Patil & Kant, 2014). The government must take the role of the central authority in any relief activities.

Table 6.11: Cross Interaction Matrix of Learning (L*) X Action (A*)

(a) Binary matrix						
L1	1	1	1	1	1	1
L2	1	1	1	0	0	1
L3	1	1	1	1	1	1
L4	1	1	0	0	1	0
L5	1	0	1	0	0	1
L6	1	1	1	0	0	1
L7	1	0	1	0	1	1
L8	1	0	1	1	1	1
(b) Interpretive matrix						
L1	Improves	Improves	Improves	Improves	Improves	Improves
L2	Improves	Improves				Improves
L3	Improves	Improves	Improves planning	Improves planning	Improves planning	Improves planning
L4	increase awareness	increase awareness			increase awareness	
L5	Increase investment		Technology absorption			
L6	Reduce resistive behavior	Reduce resistive behavior	Reduce resistive behavior			Reduce resistive behavior
L7	Improves training		Improves training		Improves planning	Improves planning
L8	Attracts donors		Attracts donors	Attracts donors	Attracts donors	Attracts donors
	A1	A2	A3	A4	A5	A6

It is essential that donors should not only be encouraged to come forward, but information should also be provided to emphasize the importance of the correct implementation of IT by demonstrating its usefulness in effective and efficient management of disaster (ICHL 2013). The government of the country should seek to provide all possible resources for enhancing the use of IT in HSCM such as more awareness campaign programmes, educating the local population, providing enough funds, training of field workers and providing a necessary infrastructure to support utilization of IT (ICHL, 2013).

6.6.8 Action (A*) X Performance (P*)

The cross interaction matrix between the elements of action and performance is given in Table 6.12.

6.6.8.1 Discussion

The maximum utilization of IT in the humanitarian sector is an involved and complicated process and requires strategic planning (Agostinho, 2013; Kovacs & Spens, 2007; Maiers et al., 2005; Moshtari & Gonçalves, 2012; Natarajarathinam et al., 2009; Pettit & Beresford, 2005; Schulz & Blecken, 2010). It is not possible that in a short period of time and without any strategic planning, administrative tasks can be allocated and huge amounts of data can be transferred into an IT system. Strategic planning is essential for the successful utilization of IT in the humanitarian sector and this will require the support of all involved parties. Almost every commercial organization is actively involved in social responsibility programmes. It makes more sense to redesign these programmes by incorporating humanitarian activities. Streamlining of CSC and HSC provides better learning opportunities for both sectors to manage emergency situations, since the effects of a disaster are no longer localized, but can also affect the global supply chain (UNESCAP 2013).

The effective coordination among the actors also reduces the competition for already scarce resources such as transportation facilities for the last mile distribution and funds from donors. Balcik et al. (2010) also cited the funding issue. A strategic tie-up is essential not only for last mile distribution, but also at the global level where a large number of donors are working together for the betterment of relief activities rather than trying to contribute individually and achieving less (McEntire, 2002).

An effective use of IT can offer the possibility of reducing the constraints due to an underdeveloped or damaged physical infrastructure. If field staff at an emergency site are able to communicate easily to the organizations involved in the relief activities, it will improve the efficiency of the relief effort. For example, if field staff are able to give regular updates about the present condition of roads, i.e. which roads are not in use, then relief materials can reach the disaster site more quickly. Even though it is not possible to change the physical conditions instantly, a

well-planned, strategic utilization of IT in HSCM can contribute to a more successful response to emergencies and disasters Maiers et al. (2005).

Table 6.12: Cross Interaction Matrix for Action (A*) X Performance (P*)

(a) Binary matrix					
A1	1	1	1	1	1
A2	1	1	1	1	1
A3	1	0	1	1	1
A4	1	1	0	1	1
A5	1	1	1	1	1
A6	1	0	1	0	1
	P1	P2	P3	P4	P5
(b) Interpretive matrix					
A1	Better technological solutions	Better technological solutions	Better technological solutions	Better technological solutions	Better technological solutions
A2	Better solutions	Better solutions	Better solutions	Better solutions	Better solutions
A3	Improved Knowledge Management		Better technological solutions	Better technological solutions	Fast solutions
A4	Supports Information Sharing	Supports Information Sharing			Supports Information Sharing
A5	Supports Information Sharing	Supports Information Sharing	Improved Knowledge Management	Better technological solutions	Fast solutions
A6	Reduce resistive nature		Reduce resistive nature		Fast solutions
	P1	P2	P3	P4	P5

6.7 Managerial Implications

IT can play the vital role in the success of relief activities. HROs can improve decision making, reduce the response time for relief activities and can enhance the coordination between the various actors with the help of tracking systems or softwares providing the real time updated information. Biometrics for identifying authorized persons, wireless communication, social media for increasing awareness and promoting donations, and advancement in medical technologies are some of the examples of the use of technology in relief activities.

IT can also help in rehabilitation and rebuilding process in HSCM, For example, there were reports of people have to walk long distances to get food, water and other necessary items, but with the help of crisis map and information coming in directly from the ground through any communication medium; it would be easier to provide the right kind of relief at the place where it is most needed. But the most important is to highlight the importance of such technologies, and India is well known as the IT hub but still there is low use of IT in HSC in India, for this purpose SAP LAP model has been used to identify the barriers in enhancing the use of IT.

Coordination between government, different HROs, the private sector and other international bodies is required for creating awareness and disseminating information. It is the responsibility of the central government of the country to provide all resources possible for the implementation of IT in HSCM, like providing enough funds, training to field workers, providing the necessary infrastructure, promote coordination between commercial organizations, HROs and other actors of HSC to name a few.

For the successful implementation of IT in HSCM of India it is required that everyone should come forward, not only those who are visible on the ground but digital volunteers also in different communities to join hands for a better targeted response. This chapter has following managerial implications:

- Disaster management in India needs to be more professionalized by institutionalizing lessons of preparedness, emergency response protocols and simulation exercises from armed forces and the best practices from developed countries.
- It is required to view the disaster management process holistically instead of short term oriented. The short term oriented behaviour of the donors complicates the implementation of IT in HSC of India.
- There is strong need to highlight the importance of IT in HSCM to different actors involved in relief activities, and analyze the bottlenecks in low use and adoption of IT in HSCM of India. This required the analysis of the present situation, the actors capability to adopt IT and various activities involved in HSC.
- It is required to have a performance evaluation mechanism in place to analyse the strength and weakness of the current relief activities and to motivate the donors it is needed to make the financial supply chain of relief organizations to be enough accountable and transparent to the donors, so they come to know that money which they have given for the welfare of affected people is utilized properly.
- The government of India should organize more sessions, workshops, seminars, conference about the importance of IT in HSC to enhance the awareness about the benefits of IT in the mind of actors involved in HSC.
- Training and routine use of IT is the most effective way for capacity building of the volunteers, as training is the only medium through which the fear or their resistive behaviour can be removed about the use of IT.

- There is strong need to enable and motivate relief organizations to incorporate changes in their structures and processes for the implementation of IT. Agility is the key in the effective and efficient management of disasters because none of the organizations is capable of handling any kind of situation or problems that can arise in disaster management.

6.8 Summary

In recent years, the use of IT has been shown to be a successful strategy in improving the performance of HSCM. This chapter, with its field based qualitative research, presents the first attempt in India to analyze various strategic issues related to enhancing the use of IT in HSCM in order to improve the efficiency of relief operations. Firstly, the SAP LAP framework highlights the importance of IT and helps in classifying different issues related to enhancing the use of IT in HSCM. Thereafter, a SAP LAP linkages framework has been used to analyze the whole scenario to enhance the use of IT in HSCM in the Indian context. The findings of this chapter not only offer a meaningful base to deepen understanding with regard to enhancing the use of IT, but also provide a path to develop an effective way to enhance the use of IT in a stepwise manner.

The developed framework has considered the relationship between various elements of SAP LAP by developing the assessment, self-interaction and cross interaction matrices. The viability of a SAP LAP linkages framework can be acknowledged from an examination of the present deployment of IT in HSCM in India. This may provoke the actors to start education or training programs to increase awareness around the importance of IT in effective aid management. The findings also support the view that regular meetings between the actors in the humanitarian and commercial sectors could be the simple solution for improving the performance of relief operations. But to achieve this, strategic planning is required to streamline the activities of both sectors to ensure the long term commitment of the commercial sector. Strategic planning will also enable the actors to develop a better decision making support system which will assist them in formulating prospective action. An effective, transparent workflow policy, allied with the use of knowledge management system and donor commitment, would maximize the benefits of IT and would further enhance the performance of the HSCM.

This helps them to understand analyses and to assess advantages and disadvantages of alternative courses of action, allowing them to follow-up on their decisions by providing a feedback loop mechanism. The developed SAP LAP linkages framework provides early insights about the use of IT and suggests ways of how this can be improved in HSCM in India. The results suggest that strategic and proactive planning is essential in enhancing the use of IT in HSCM.

Chapter 7

Contributions and Implications

Preview

This chapter presents a contribution to the literature which include summary and conclusions. This chapter also presents practical implications for the academicians, managers and policy makers, provide answer to the research questions and to provide additional insights into research within HSCM. The chapter closes by pointing out potential areas for further research.

7.1 Introduction

The ultimate aim of any study such as this is to spell out the final significant contribution to knowledge. Consequently, the overall aim of this thesis is to make a theoretical contribution to academic perspectives and a functional contribution to existing humanitarian supply chain practice. The research presented in this thesis is designed to fill the identified gaps (established within Chapter 2) in the knowledge surrounding the effective planning and preparedness of the provision of emergency logistics and in doing so answer the following research question:

When considering the effective planning and preparedness to disasters what are the key drivers within the HSC that will help to enhance the utilization of IT?

Many researchers (Christopher, 2005; Dyer, Cho, & Chu, 1998; Kalafatis, 2002; Lysons & Farrington, 2006; Sadler, 2007) advocated an aligned or joint approach for the effective management of the supply chain. This was also fully appreciated and supported by practitioners involved in the field of humanitarian relief. The data also offer support to the view that SCM techniques are becoming more prevalent within the humanitarian sector and that theoretical views offered on the drive to encompass cross-functional and inter-agency approaches (Oloruntoba & Gray, 2006; Tomasini & Van Wassenhove, 2009) should be extended to include the humanitarian sector. Moreover, participant experiences also contributed to the traditional theoretical position that planning and coordination would always make the supply chain more effective and efficient by helping to reduce overall waste (Slack et al., 2010).

A strategic tie up between actors involved in relief activities can have a positive influence on the performance and knowledge sharing capabilities of the organizations (McEntire, 2002). Top management commitment and an effective performance management system are vital in order to overcome the problem of funds, strategic planning, awareness, trust and other related issues. The mutual learning of commercial and humanitarian organizations is crucial to enhance the competence of the actors involved. The major stumbling block in the HSC is not the availability of supplies but that of money and people. There is agreement with the broader concept of a highly flexible and adaptable supply chain (Chopra & Meindl, 2007; Christopher, 2005; Harrison et al.,

2005) but administrative procedures used to distribute funds to relief organisations are slowing the relief effort down and are, therefore regarded as unsuited to the sectors requirements. Furthermore, there is also support for the assertion that the right level of coordination and management within the humanitarian supply chain will make it possible to introduce a combined approach across all phases of the relief effort (Thomas & Kopczak, 2005).

The restricted and short-term nature of donor funding also complicates strategic investment to enhance IT infrastructure (Maiers et al., 2005). Donors hesitate to provide funding for enhancing the basic facilities needed for the full utilization of IT due to the absence of transparency and accountability mechanisms in HSC (Agostinho, 2013; Thomas & Kopczak, 2005). Therefore, a performance evaluation mechanism is needed to analyze the strengths and weaknesses of relief operations, which can motivate donors to give more generously for the welfare of disaster victims (Agostinho, 2013; Balcik et al., 2010; Thomas & Kopczak, 2005).

The research also outlines some of the suggestions to improve the present situation and to enhance the utilization of IT by organizations involved in HSCM. The possible solutions to reduce the intensity of the factors affecting the utilization of IT in HSCM are more subsidy programmes, more awareness campaigns, a need to open more training institutes, increased investment in research and development (R&D) programmes, efforts to make the financial supply chain more transparent and accountable to donors, hiring of more knowledge workers, a feedback mechanism to learn from previous disasters and most importantly, to enhance coordination and collaboration among stakeholders of both the commercial and humanitarian area.

7.2 Contributions of Research

Understanding the factors affecting the utilization of IT in HSCM in Indian context and their influence on the performance of HSCM is important for two major reasons. First, India is a well-known IT hub and significantly utilizes IT in the CSC; however there is lack of utilization of IT by the organizations involved in HSCM. Second, India is a developing economy but the frequent occurrence of disasters have hampered the growth rate of the country. Because the IT sector plays the important role in the development of the country, it is imperative to analyze various strategic issues affecting the utilization of IT in HSCM in Indian context. For the purpose, this research has attempted to fill some of the gaps in the contemporary research in the area of HSCM. The main works undertaken in this research include the followings:

- An extensive literature review has been conducted to identify the gaps and relevant research issues in the HSCM
- SAP LAP analysis and SAP LAP linkages analysis has been conducted to analyze the interaction among the component of SAP and LAP
- The integrated framework of Fuzzy AHP and Fuzzy TOPSIS has been used to prioritize the solutions to the factors affecting the proliferation of IT; based on the weight of the barriers

- Based on literature review and discussions with the academicians and industry personnel, a set of research hypotheses were formed. The questionnaire was designed to elicit the responses from the respondents of the organizations involved in the past relief operations in order to test the proposed hypotheses
- The statistical analysis of the questionnaire is followed by the case study on the disaster that occurred in the Uttarakhand (a Northern state in India) on June 14, 2013

The research presented in this thesis makes several contributions to the practitioners on the ground and the academicians involved within the field. The findings have strengthen the HSCM literature and adds the new knowledge to the HSCM area. The next sections discusses the contributions of this research.

7.2.1 HSCM Literature

The research presented in this thesis offers significant advancement to the current literature. This research, with its field based qualitative research, presents the first attempt in India to analyze various strategic issues related to enhancing the use of IT in HSCM in order to improve the efficiency of relief operations. The result contributes to the HSCM literature in three major ways. First, barriers to the proliferation of IT in HSCM identifies through extensive literature review were empirically verified through the inputs from the middle level managers involved in the relief operations of the disasters. Then, these barriers are prioritized on the basis of their severity with the help of Fuzzy AHP. The results of the survey analysis and the expert opinions are in line with each other. This supports the theoretical arguments of various researchers that lack of supply chain understanding is amongst the most important factors that affects the utilization of IT in HSCM. This would further affects the performance of HSC.

Second, there are barriers to the utilization of IT exists but their counter enabler also exist to improve the present situation. Therefore, through the rigorous review of literature, enablers to overcome the barriers to the proliferation of IT in HSCM were identified and empirically verified through the inputs from the middle level managers involved in the relief operations of the disasters. Further the Fuzzy TOPSIS has been used to prioritize the solutions to overcome the barriers to the utilization of IT. Fuzzy TOPSIS considers the ambiguity of the data rather than crisp value. Thus this study significantly answers the following question that why should and how could the stakeholders effectively improve the utilization of IT in the area of relief supply chain?

Third, the research addresses the gap in literature pertaining to the lack of empirical studies in the HSCM area in Indian context. This study is among the first study in Indian context that empirically examines the factors affecting the utilization of IT in HSCM. An integrated technology adoption model based on technological and organizational (TO) framework, interorganizational relationships (IOR), and unified theory of acceptance and use of technology (UTAUT) model is proposed and empirically validated. This study is based on the premise of F. T. Chan et al. (2012) that the utilization of IT in SCM goes through a series of phases commencing from IT adoption

in an organization, to inter and intra SC processes followed by inter-organizational relationships. Networking with other organizations will bring all members of the SC onto the same platform through IT integration. This will help in further improving the performance of HSC.

The research presented in this thesis also contributes to the knowledge development by identifying measures for factors affecting the IT utilization in HSCM. These factors can be used in the future empirical research. The high cronbachs alpha values for the measures confirmed their internal consistency. Reliability and validity of these measures have also been established in this research.

7.2.2 Methods and Modeling Techniques

The research presented in this thesis makes a methodological contribution by employing different qualitative and quantitative techniques. Qualitative tool such as Focus group discussion, brain storming session, interview method, and SAP-LAP analysis has been used for data collection. Nonetheless, a survey has been used to provide an exploratory snapshot of the actors in HSCM in context. Quantitative statistical tools to be used in the research include correlation analysis, regression analysis, factor analysis, structural equation modeling, fuzzy AHP, fuzzy TOPSIS and hypothesis testing, in addressing issues relating to factors affecting the utilization of IT in Indian HSCM.

This study developed and validated the conceptual model that examines the factors affecting the utilization of IT in HSCM. This study makes an important contribution to existing literature by examining the perceptions of managers toward the utilization of IT in the context of HSCM. The questionnaire survey is structured to elicit response on various strategic issues related to HSCM in India. The research also employs a case study based research method which is appropriate for investigating a contemporary research phenomenon. Case study offers in-depth and relatively unstructured approach to develop theories and frameworks. Case study method would be used in conjunction with survey research to develop explanations for some of the findings in a more comprehensive way. The Uttarakhand (a Northern state in India) was selected as the region for conducting the case based research as it is the most disaster prone state in India.

In summary, the research presented in this thesis is both timely and pertinent as it investigates themes and issues that have significant implications for the policy makers; practitioners; academicians; and researchers in order to enhance the performance of the HSC.

7.3 Research Overview

This thesis contributes to research on HSCM in general, and addresses the gap that exists with regard to IT issues in particular. An research summary is given in the Table 7.1.

Table 7.1: Research Summary

Gap	Description	Tools & Techniques	Objective	Research Contribution
Gap-1	Further research is needed on investigating the factors affecting the maximum utilization of IT in HSCM in Indian context	Questionnaire analysis, Fuzzy AHP	To identify and prioritize the barriers to the proliferation of IT in HSCM	This chapter provides a more effective, efficient and systematic method to prioritize the barriers to utilization of IT in HSCM. Therefore, to assist the organizations involved in HSCM, this chapter explored and prioritized 25 barriers that hampers the utilization of IT. These were then grouped into five categories, i.e. strategic barriers (SB); organizational barriers (OB); financial barriers (FB); human barriers (HB); and technological barriers (TB). This chapter is a pioneering attempt to understand the issues that affects the utilization of IT in HSCM and to classify them, on the basis of their severity in order to realize the benefits of IT in HSCM.
Gap-2	Further research is needed on investigating and prioritizing the solutions to overcome the barriers to the proliferation of IT in HSCM in Indian context	Fuzzy TOPSIS	To identify and prioritize the solutions to overcome the barriers to the proliferation of IT in HSCM	This chapter identifies and prioritize the 19 solutions to overcome the barriers affecting the proliferation of IT on the basis of the weight of the barriers estimated by using fuzzy AHP. The results indicate that developing a long-term relationship with commercial organizations, exchange programs and training for humanitarian logisticians in the commercial realm, and strategic tie-ups with organizations that have corporate social responsibility programs are important to improve the performance of HSC. There is also a need to develop new coordination mechanisms, optimize the usage of scarce resources to reduce the suffering of the beneficiaries.

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Table 7.1: Research Overview

Gap	Description	Tools & Techniques	Objective	Research Contribution
Gap-3	Existing literature lacks a framework that analyze various factors affecting the utilization of IT in HSCM	Questionnaire analysis, Structural equation modeling (SEM)	To examine the relationship among the factors that affect the utilization of IT in HSCM	(1) This chapter examines various factors affecting the utilization of IT from various perspectives, such as technological and organizational (e.g., Technology readiness, managerial obstacles), user perceptions (e.g.performance expectancy, effort expectancy), inter-organizational (e.g., mutual trust, information sharing). (2) This chapter highlights that stakeholders of HSC should plan strategically to utilize the advantages of IT in the coming years. The plan should be aligned with their goals as they have limited resources in terms of capital, time and human resources. An important implication is to avoid the same kind of training for all types of disaster, given that the scale and region where it occurs may differ every time. Governmental departments also need to pay special attention to providing adequate training and support to the organizations involved in HSC.
Gap-4	More research is required within the field to analyze the issues affecting the performance of HSCM particularly with respect to developing countries	Case study, SAP-LAP linkages analysis	To analyze various strategic issues affecting the utilization of IT in HSCM, with special emphasis on disaster that occurred in the Uttarakhand, India.	This chapter highlight the importance of IT in the HSCM and explain the present status of the use of IT in the HSCM in India. This chapter develops a SAP LAP linkages framework in order to analyse the interaction between elements of SAP and LAP leading to a discussion on ways to improve the present situation by developing assessment, self-interaction and cross interaction matrices.

7.4 Implications of the Research

The occurrence of natural disasters and its severe impact are on rise throughout the world. Humanitarian supply chain management (HSCM) activates immediately after the occurrence of disaster with the aim to reduce the impact on society. In recent years, the use of IT has been shown to be a successful strategy in improving the performance of HSCM. This study, with the combination of its field based qualitative and quantitative research, presents the first attempt in India to analyze various strategic issues related to enhancing the use of IT in HSCM. This study is an pioneering attempt to analyse various strategic issues to utilization of IT in HSCM, particularly within Indian context. This study will prove to be very useful in enhancing the utilization of IT in HSCM. The developed model suggests the interrelationships (interactions with each other) among these barriers to enhance the utilization of IT in HSCM. This model is very useful for policy makers to grasp an understanding of the interrelationship among the barriers in advance, so that they can focus on the whole system, not only on one or two factors. This model will reduce the chance of overlooking any barriers that impede the utilization of IT, but at the same time it may heighten some barriers rather than reduce them.

7.4.1 Implications for Academicians

- The research presented in this thesis will serve as a roadmap for further studies in the area of HSCM
- The literature review presented in this research and identified gaps in the literature may prove as a basis for the future research
- The comprehensive questionnaire developed in this research can be used as an instrument for further empirical studies in the area of HSCM and other similar areas
- In this research, SAP LAP linkages framework has been applied to analyze various strategic issues to IT enablement of HSC, particularly within Indian context. This may motivate academicians to apply SAP LAP linkages framework in other related decision making areas
- In this study, an integrated Fuzzy- AHP and Fuzzy TOPSIS methodology has been applied to prioritize solutions to overcome IT barriers on the basis of the weight of barriers to IT in HSCM, particularly within Indian context. This may motivate other researchers to apply an integrated Fuzzy- AHP and Fuzzy TOPSIS in other similar areas in SCM
- The research presented in this thesis also explains the process for literature review in the area under investigation. The explained process can be applied for reviewing the previous published work in other areas
- The bibliography presented in the thesis may be used for further research in the area of HSCM

- This work offers an initial framework for conducting further research either theory building or theory testing in the area of HSCM in India
- This work also suggests the ways to perform statistical analysis using questionnaire by developing a scale for the issue under investigation

7.4.2 Implications for Managers

The use of technology in HSCM has speeded up in the last years and the future appears promising. However, the speed of the process of IT enablement of HSCM can be enhanced by removing the identified barriers. The decision makers face many challenges in pinpointing and working on these barriers that impede the effects and benefits of the utilization of ICT. Several barriers have been identified in this study and mutual relationships among them have been established using ISM methodology. The work of Gustavsson (2003) and Van Wassenhove (2006) is supported by verifying that the top management of actors involved in HSCM lack the necessary supply chain understanding. They emphasized the value of having experienced and expert professionals from the commercial sector as they can play an important role in nurturing the organizations to achieve success by enhancing the coordination among them in HSCM.

The institutions engaged in enhancing the efficiency of actors in relief operations need to interact more frequently and improve the intra and inter coordination systems for the welfare of the society involved. Furthermore, it is necessary to initiate joint action between governments and private organizations to improve the coordination of the major players. The government or the central authority responsible for the management of disaster related activities should show their willingness to lead as any policy and regulatory initiatives alone are not sufficient to effectively address the issues. The critical problems such as finance, information sharing, use of technology and attitude of the organizations need to be addressed on a priority basis. Some proposed solutions to eliminate or reducing the intensity of barriers are:

Enhance coordination and collaboration
Experts strongly advocate holding regular meetings of the various organizations so that the obstacles in the improvement of process could be explored in advance. Regular meetings can address this and also help in formulating better planning. This would increase the efficiency of relief operations through the coordination of an overall policy. The process of enhancing the use of IT in HSCM should be viewed holistically and a radical change is needed to change the current ad hoc coordination efforts. This shift may be brought about by a coordination of efforts from all of the agencies and people involved, including the government of the country.

Transparent financial supply chain
Donors are among the most important actors in the humanitarian supply chain as they provide vital funding for relief operations. A huge amount of finance is required for the successful implementation of IT in HSCM but the lack of transparency and accountable mechanisms in HSCM restricts the involvement of some potential donors. A performance measurement system and

greater transparency in the use of funding that is already available, would reassure donors that money is being used effectively in the utilization of IT.

Hiring of more knowledge workers
The actors involved in relief operations should propose and implement an attractive retention policy for knowledge workers to overcome the shortage of skilled personnel in the humanitarian sector.

Joint Training Initiatives
Analysis of data gathered evince support to calls for a joint approach to training within the humanitarian sector (Goffnett, Helferich, & Buschlen, 2013; Heaslip, Kovács, & Spens, 2011). Moreover, analysis of the data also reflect discussion within Chapter 2 on the significance of local engagement within the supply chain (Porter, 1998), and triangulation of the findings corroborate theoretical calls for the inclusion of local organisations and governments within training strategies. Hence, part of the final contribution is to add to the current academic trajectory, by providing empirical evidence to support the extension of current thinking considering the implementation of integrated training strategies within the sector, which encompass all members of the humanitarian supply chain.

Feedback mechanism
A feedback mechanism is required to facilitate learning, so that mistakes made previously are not repeated in future. For example, disasters of any type can occur e.g. flood, earthquake, volcano, eruptions, violence against people, violence against buildings etc. Each of these situations will create its own set of problems and each will need an appropriate set of responses.

7.4.3 Implications for Policy Makers

Knowledge transfer from the commercial sector to humanitarian sector is essential for enhancing the utilization of IT in HSCM. The government should organize a wide range of knowledge transfer activities including regional and sub-regional training workshop programmes, seminars, conferences, exhibitions and expert group meetings. The overall objectives should be to improve the volunteers management skills and help to transfer knowledge and skills learned from training into practice. This will enable volunteers not only to enhance their existing skills but to apply them into life-saving situations. For example, workers must know the importance of the information which is to be transferred first to strategic headquarters at the time of disaster. Additionally, policy makers should take following actions to enhance the the utilization of IT in HSCM

Subsidy programmes
The government can introduce more subsidy programmes such as indirect tax benefits, monetary benefits etc. to support the process of more utilization of IT by those organizations involved in HSCM. The government could support the process by providing reliable infrastructure and basic facilities such as free internet, mobile technologies etc. needed to enhance the utilization of IT.

Research and development (R&D) programmes

R&D programmes can play an important role by designing government policies which are essential to enhance the use of IT in HSCM. Strong, targeted and globally joint R&D programmes should be started to exploit the full potential of technology in HSCM. The government should support this process by providing sufficient funds for R&D work at the university/institution level. Further R&D programmes are also needed to ensure that IT systems can continue to operate at less power, as the maintenance of a power supply in a disaster affected area is a difficult task.

Training Institutes

The use of advanced technology in HSCM is severely restricted due to lack of knowledge workers such as expert logisticians and IT professionals. There is a strong need for the government to open more training institutes to reduce the fear of new technology in volunteers. As an additional benefit, these institutes also spread awareness about the benefits of IT while opening up new job prospects. They can provide relevant training to enhance the skills and abilities of volunteers, accelerating the process of producing more effective and technically trained people to work in the field.

Awareness campaign

The economy is developing into a knowledge economy running on silicon, computers and networks, but only a few organizations involved in HSCM have first-hand experience of the technology in use. For the volunteers from the organizations in the field, this raises questions regarding reliability, stability, trustworthiness and security. The government should promote initiatives such as organizing conferences, learning-training sessions and publishing articles on a regular basis to make volunteers aware of the use and benefits of IT. To spread awareness about the use and benefits of the use of IT among the local population and volunteers, there is a strong need to introduce educational programmes, starting from primary school level through to secondary school and on to university and college level.

Finally, an in-depth or mindful learning from other disasters is suggested through the adoption of a learning culture so that individuals and organizations are better prepared to deal with disasters that will inevitably strike. Above all, the foremost stakeholder in the HSCM is the Government. Thus, the motive, commitment and the willingness of the Government to remove obstacles in the process of IT enablement of HSCM is crucial.

7.5 Limitations of the Research and Scope for Future Work

In common with all research this study suffered from a number of limitations. Whilst these limitations did not detract from the overall significance of the findings, it was right to comment them in the final reporting stage. Moreover, whilst the final research strategy proved on the whole to be successful, the present study is also not free from limitations. The first limitation is the weight of the actors. The weights of all the actors involved in relief activities and their interfaces

are assumed to be equal, but a pairwise comparison is recommended to understand the relative importance of each actor. The second limitation is this study is limited to an Indian context. For further research, this study can be extended to other countries. Finally, the case used for study is small and limited only to the disaster that occurred in the Uttarakhand. It may be interesting to compare the results with other disaster cases to seek out any potential generalisations that would further increase our ability to guide future recovery policy and practice.

The research presented in the thesis offers specific examples that supplement ongoing discussion on the lack of understanding and appreciation amongst humanitarian workers in respect of the roles and contribution of all organisations within the sector. Hence, the final contribution also calls for an extension of the current theoretical debate on how practical understanding, and in particular that between military and humanitarian organisations operating within the humanitarian supply chain can be improved. The limited number of domains under consideration during this research has already been discussed and acknowledged as a limitation. Hence, a repeat of this methodology across a wider section of the humanitarian relief community which encompasses more participant organizations from different countries, would serve as a test of the contended generalizability and triangulation of the final contribution and research proposition. Therefore, it could be considered as an scope for future work.

7.6 Conclusion

The findings of this study not only offer a meaningful base to deepen understanding with regard to enhancing the use of IT, but also provide a path to develop an effective way to enhance the use of IT in a stepwise manner. The findings of this study will contribute to the body of the literature on HSCM.

Above all else this study has demonstrated the significance of the IT in order to enhance the effectiveness of the humanitarian relief supply chain. The lack of awareness and trust amongst the actors involved in the humanitarian supply chain identified within this thesis, and the confirmation of a corresponding unwillingness to adopt collaborative working is having a negative effect on what is the bottom line for the humanitarian sector; which, in the final analysis is improved efficiency and effectiveness within the humanitarian supply chain leading to reduced response times, the delivery of more aid and ultimately an increase in the number of lives saved. In short, organizations working within the humanitarian relief area would be well advised to put aside their differences and implement IT systems in their business process with no delay.

This study emphasizes that a series of milestones, general operating policies and key performance indicators (KPIs) are required to establish a system to monitor the performance of the relief operations. This will enable an organization working for the betterment of disaster affected people to learn from their previous mistakes, ensuring that mistakes would not be repeated in future. This will create an environment of mutual and case based learning for the actors in HSCM.

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Appendix

Covering letter

Date: June 21, 2014

Subject: Survey on "**Modelling and Analysis of Information Technology issues in Humanitarian Supply Chain Management**"

Dear Sir, I, Gaurav Kabra working as a doctoral student in the Department of Management Studies, Indian Institute of Technology, Roorkee (IITR), Uttrakhand, India. I am pursuing my doctoral research work in the area of Humanitarian Supply Chain Management. As a part of my doctoral research, I am conducting a survey on "Modelling and Analysis of Information Technology issues in Humanitarian Supply Chain Management". The objective of the research is to investigate the factors affecting the utilization of IT in humanitarian supply chain management (HSCM) in India. Your feedback in this regard will be a significant input to this study.

I would be grateful if you could spare some of your precious time to answer the questionnaire. The objective of the survey is purely research and academic, therefore, all the responses will be kept strictly confidential and will be used only for this academic work.

I am aware that you have a busy schedule of work but I do hope that you would be able to spare some time to help us in the fulfillment of this study.

Sincerely yours,

Gaurav Kabra
Doctoral Student

Correspondence address
Gaurav Kabra
Department of Management Studies
Indian Institute of Technology Roorkee
Roorkee, Uttarakhand-247667
Email ID: kabraddm@iitr.ac.in, kabraiiitm@gmail.com
Phone No.: +91-7579079611

Research Supervisor: Dr. A. Ramesh
Department of Management Studies
Indian Institute of Technology Roorkee
Roorkee, Uttarakhand-247667
Email ID: ram77fdm@iitr.ac.in
Phone No.: +91-7579076291

A.1 Questionnaire-I (Verification of IT Barriers)

Please rate following attributes on the scale of 1-5 (**5=Strongly Agree**, **4=Agree**, **3=Neutral**, **2=Disagree** and **1=Strongly Disagree**) and would appreciate your views and opinions on the same to know.

Please tick (✓) in appropriate box.

Sr.	Statements	Rating				
1	Lack of top management commitment	5	4	3	2	1
2	Lack of strategic planning	5	4	3	2	1
3	Lack of supply chain understanding	5	4	3	2	1
4	Lack of clear policies to support the adoption of IT	5	4	3	2	1
5	Lack of awareness about IT	5	4	3	2	1
6	Lack of mutual trust among the actors	5	4	3	2	1
7	Non availability of IT experts	5	4	3	2	1
8	Non availability of supply chain experts	5	4	3	2	1
9	Lack of interaction with industry players	5	4	3	2	1
10	Lack of policy for retention of skilled and experienced employee	5	4	3	2	1
11	Lack of funds for investment in IT	5	4	3	2	1
12	Lack of donor support towards adoption of IT	5	4	3	2	1
13	Lack of industry support toward adoption of IT	5	4	3	2	1
14	Lack of in-kind financial support	5	4	3	2	1
15	Lack of transparency in financial supply chain	5	4	3	2	1
16	Lack of motivation to adopt IT	5	4	3	2	1
17	Lack of education and training to the employees	5	4	3	2	1
18	Inadequate information sharing among employees	5	4	3	2	1
19	Lack of willingness to adopt and use IT	5	4	3	2	1
20	Lack of IT skills in employee	5	4	3	2	1
21	Lack of technical assistance to the employee	5	4	3	2	1
22	Disparity in IT facility among actors involved	5	4	3	2	1
23	Lack of proper IT infrastructure	5	4	3	2	1
24	Lack of IT supporting facilities such as power	5	4	3	2	1
25	Lack of R&D research	5	4	3	2	1

A.2 Questionnaire-II (Prioritization of IT Barriers)

Please rate the following attributes on the scale of 1-5 (**5=Strongly Agree**, **4=Agree**, **3=Neutral**, **2=Disagree** and **1=Strongly Disagree**).

A.3.1 This section of questionnaire aims to measure the relation among the main attributes to coordination issues in HSCM.

With respect to the main objective "Compare the influence of decision making attributes" on the scale of Very high influence (VH) = 4, High influence (H) = 3, Low influence (L) = 2, Very low influence (VL) = 1, No influence (No) = 0. Please tick ($\surd$) in appropriate box.

With respect to:*The Overall Goal*	**Compare the influence of one main attribute over another**																								
	Strategic barriers					Technological barriers					Cultural barriers					Individual barriers					Organizational barriers				
	VH	H	L	VL	N	VH	H	L	VL	N	VH	H	L	VL	N	VH	H	L	VL	N	VH	H	L	VL	N
Strategic barriers																									
Management barriers																									
Financial barriers																									
Human barriers																									
Technological barriers																									

A.3.1.1: This section of questionnaire aims to measure the relation among the sub-attributes (strategic barriers) to IT issues in HSCM.

Criterion	SB1	SB2	SB3	SB4	SB5
Lack of top management commitment (SB1)					
Lack of strategic planning (SB2)					
Lack of supply chain understanding (SB3)					
Lack of clear policies to support the adoption of IT (SB4)					
Lack of awareness about IT (SB5)					

A.3.1.2: This section of questionnaire aims to measure the relation among the sub-attributes (Organizational barriers) to IT issues in HSCM.

Criterion	OB1	OB2	OB3	OB4	OB5
Lack of mutual trust among the actors (OB1)					
Non availability of IT experts (OB2)					
Non availability of supply chain experts (OB3)					
Lack of interaction with industry players (OB4)					
Lack of retention policy for skilled & experienced employee (OB5)					

A.3.1.3: This section of questionnaire aims to measure the relation among the sub-attributes (Financial barriers) to IT issues in HSCM.

Criterion	FB1	FB2	FB3	FB4	FB5
Lack of funds for investment in IT (FB1)					
Lack of donor support towards adoption of IT(FB2)					
Lack of industry support toward adoption of IT (FB3)					
Lack of in-kind financial support(FB4)					
Lack of transparency in financial supply chain (FB5)					

A.3.1.4: This section of questionnaire aims to measure the relation among the sub-attributes (Human barriers) to IT issues in HSCM.

Criterion	HB1	HB2	HB3	HB4	HB5
Lack of motivation to adopt IT (HB1)					
Lack of education and training to the employees (HB2)					
Inadequate information sharing among employees (HB3)					
Lack of willingness to adopt and use IT (HB4)					
Lack of IT skills in employee (HB5)					

A.3.1.5: This section of questionnaire aims to measure the relation among the sub-attributes (Technological barriers) to IT issues in HSCM.

Criterion	TB1	TB2	TB3	TB4	TB4
Lack of technical assistance to the employee (TB1)					
Disparity in IT facility among actors involved (TB2)					
Lack of proper IT infrastructure (TB3)					
Lack of IT supporting facilities such as power(TB4)					
Lack of R&D research (TB5)					

A.3 Questionnaire-III (Verification of Solutions to Overcome IT Barriers)

Please rate following attributes on the scale of 1-5 (**5=Strongly Agree**, **4=Agree**, **3=Neutral**, **2=Disagree** and **1=Strongly Disagree**) and would appreciate your views and opinions on the same to know.

Please tick (✓) in appropriate box.

Sr.	Statements	Rating				
1	Commitment from top management	5	4	3	2	1
2	Strategic tie-up among the commercial and humanitarian organization	5	4	3	2	1
3	Effective policy for IT adoption	5	4	3	2	1
4	Employee motivation	5	4	3	2	1
5	Build trustworthy environment among the actors in HSCM	5	4	3	2	1
6	Retention of skilled and experienced workers	5	4	3	2	1
7	Donor support	5	4	3	2	1
8	Access to financing and capitalization	5	4	3	2	1
9	Establish a transparent work flow or open door policy	5	4	3	2	1
10	Long term focused planning	5	4	3	2	1
11	Government support	5	4	3	2	1
12	Industry funding	5	4	3	2	1
13	Feedback mechanism to facilitate learning from prior experiences	5	4	3	2	1
14	Coaching/training to the employees	5	4	3	2	1
15	Onsite disaster management process expert	5	4	3	2	1
16	Supply chain expert	5	4	3	2	1
17	Information technology expert	5	4	3	2	1
18	Enhance awareness about the benefits of IT in HSCM	5	4	3	2	1
19	Coordination among the actors during all phases of disaster management	5	4	3	2	1
20	Lack of IT skills in employee	5	4	3	2	1
21	Lack of technical assistance to the employee	5	4	3	2	1
22	Disparity in IT facility among actors involved	5	4	3	2	1
23	Lack of proper IT infrastructure	5	4	3	2	1
24	Lack of IT supporting facilities such as power	5	4	3	2	1
25	Lack of R&D researche	5	4	3	2	1

A.4 Questionnaire-IV (Empirical Validation of Conceptual Model)

Please rate the following on the scale of 1-5 (**5=Strongly Agree**, **4=Agree**, **3=Neutral**, **2=Disagree** and **1=Strongly Disagree**). Please tick (✓) in appropriate box.

Sr.	Statements	Rating				
1	Making the necessary organizational changes for IT implementation	5	4	3	2	1
2	Integrating IT to your overall SCM strategy and business process	5	4	3	2	1
3	Lacking staff with IT expertise	5	4	3	2	1
4	Lacking staff with SCM expertise	5	4	3	2	1
5	Lacking staff with DM expertise	5	4	3	2	1
6	My organization has sufficient funds to implement IT	5	4	3	2	1
7	My organization has a dedicated budget head for IT implementation	5	4	3	2	1
8	My organization has sufficient number of computers to use IT in our supply chain	5	4	3	2	1
9	My organization has sufficient number of IT professionals to adopt IT in our supply chain	5	4	3	2	1
10	My organization has sufficient resources to adopt IT in our supply chain	5	4	3	2	1
11	We have the necessary knowledge to use IT	5	4	3	2	1
12	A specific person (or group) is available for assistance with difficulties in using IT.	5	4	3	2	1
13	The policies made by the Government support the process of adoption of IT.	5	4	3	2	1
14	The subsidies provided by the Government support the process of adoption of IT.	5	4	3	2	1
15	The use of IT is useful in my job.	5	4	3	2	1
16	The use of IT enables me to accomplish tasks more quickly.	5	4	3	2	1
17	The use of IT enables me to increase my productivity.	5	4	3	2	1
18	The use of IT enables me will increase the supply chain performance.	5	4	3	2	1
19	My interaction with the system would be clear and understandable.	5	4	3	2	1
20	It would be easy for me to become skillful using IT.	5	4	3	2	1
21	I would find IT tools easy to use.	5	4	3	2	1
22	Learning to use IT tools is easy for me	5	4	3	2	1
23	People who influence my behaviour think that I should use IT tools.	5	4	3	2	1
24	People who are important to me think that I should use IT tools	5	4	3	2	1
25	The senior management of the organization business has been helpful in the use of IT tools	5	4	3	2	1
26	In general, the organization has supported the use of IT tools.	5	4	3	2	1

to be cont'd on next page

Sr.	Statements	Rating				
27	My organization utilize IT for inter-organization information transfer	5	4	3	2	1
28	My organization utilize IT for intra-organization information transfer.	5	4	3	2	1
29	My organization utilize IT to create and store the information for future use	5	4	3	2	1
30	My organization utilize IT for management of relief materials.	5	4	3	2	1
31	My organization has strong confidence that other stakeholders will provide the best advices in regard to our businesses for our sake.	5	4	3	2	1
32	My organization is able to provide a sincere aid to our suppliers.	5	4	3	2	1
33	My organization partners keep their words with our firm.	5	4	3	2	1
34	My organization believe that other stakeholders provide mutually beneficial decision-making as well as reliable performance outcomes	5	4	3	2	1
35	We regularly share your knowledge base with other stakeholders.	5	4	3	2	1
36	We regularly share your expertise knowledge with other stakeholders	5	4	3	2	1
37	We regularly share your experiences in the relief operations	5	4	3	2	1
38	We regularly share your mistakes done in the relief operations.	5	4	3	2	1
39	We solve potential problems that may arise with your partner more quickly	5	4	3	2	1
40	Our IT tools are electronically integrated with our internal databases and information systems.	5	4	3	2	1
41	Our organizations databases and information systems are electronically integrated with those our suppliers.	5	4	3	2	1
42	Our organizations databases and information systems are electronically integrated with other stakeholders	5	4	3	2	1
43	Our organizations use enterprise resource planning for managing/coordinating supply chain activities	5	4	3	2	1
44	Our organizations use supply chain planning software for managing/coordinating supply chain activities	5	4	3	2	1
45	Response time after disaster was quick	5	4	3	2	1
46	Proper medical facilities were available	5	4	3	2	1
47	Proper management of aid materials	5	4	3	2	1
48	Enough amount of relief material was available	5	4	3	2	1
49	Improve level of customer service	5	4	3	2	1

List of Publications

International Journal

1. **Kabra, G**., Ramesh, A., & Arshinder, K. (2015), Identification and prioritization of barriers of coordination in humanitarian supply chain management, *International Journal of disaster risk reduction*, ISSN: 2212-4209 (Elsevier).

2. **Kabra, G.**, & Ramesh, A. (2015), Analyzing drivers and barriers of coordination in humanitarian supply chain management under Fuzzy environment, *Benchmarking: An International Journal*, Vol. 22 No.4, pp.559 - 587. ISSN: 1463-5771 (Emerald).

3. **Kabra, G.**, & Ramesh, A. (2015). An empirical investigation of enablers in humanitarian supply chain management in India: A case study. *Journal of Advances Research in Management*, Vol. 12 No.1, pp.30-42. ISSN: 0972-7981 (Emerald).

4. **Kabra, G.**, & Ramesh, A. (2015). Analyzing ICT issues in humanitarian supply chain management: A SAP LAP linkages framework, *Global Journal of Flexible Systems Management*, Vol. 16 No.2, pp.157-171. ISSN: 0974-0198 (Springer).

Book Chapter

1. **Kabra, G.**, & Ramesh, A. (2015), Exploring the challenges in implementation of IT in Humanitarian Relief Organizations in India: A qualitative study, in Sahay, B.S; Gupta, S and Menon, V.C. (Eds), Managing Humanitarian Response, Springer publications.

2. **Kabra, G.**, & Ramesh, A. (2016), An analysis of the interactions among the enablers of information communication technology in supply chain management: A fuzzy based relationship modeling approach, in Kumar, A; Trivedi, S.K; Dash, M.K and Panda, T.K. (Eds), Intelligent Techniques and Modeling Applications in Marketing Analytics, IGI Global publications (Forthcoming).

International Conference

1. **Kabra, G.**, & Ramesh, A. (2015), Segmenting critical factors for implementation of IT in Humanitarian Supply Chain Management, *XVIII Annual International Conference of the Society of Operations Management*, Indian Institute of Technology Roorkee, India. The paper was published in Procedia-Social and Behavioral Sciences, (Elsevier).

2. **Kabra, G.**, & Ramesh, A. (2013), Exploring the challenges in implementation of IT in humanitarian relief organizations in India: A qualitative study, *International Conference on Humanitarian Logistics*, Indian Institute of Management Raipur, India.

3. **Kabra, G.**, & Ramesh, A. (2013), Coordination in Humanitarian Supply Chain Management in India: Modeling the Barriers, *Thirteenth Global Conference on Flexible systems Management*, Indian Institute of Technology Delhi, New Delhi, India.

4. **Kabra, G.**, & Ramesh, A. (2016), Response and Resilience Strategy of the Tourism Industry after the Disaster: Evidence from India, *International Conference on Tourism and Hospitality Management*, Tourism Research Institute, Athens, Greece (Abstract submitted).

International Journal (Under Review)

1. **Kabra, G.**, & Ramesh,A. (2016). Prioritization of barriers to the proliferation of information technology in humanitarian supply chain management, *Computers in Human Behavior*, (Elsevier).

2. **Kabra, G.**, & Ramesh, A. (2016). Evaluating the critical factors to coordination in humanitarian supply chain management under fuzzy environment, *International Journal of Production Research*, (Taylor and Francis).

3. **Kabra, G**., & Ramesh, A., (2016). Humanitarian supply chain management: A literature review, framework and future research agenda, *International Journal of disaster risk reduction*, (Elsevier).

4. **Kabra, G.**, & Ramesh,A. (2016). Factors affecting the utilization of information technology in humanitarian supply chain: An empirical investigation, *Service Science*, (INFORMS).

5. **Kabra, G.**, & Ramesh, A. (2016). Analysis of Information and Communication Technology barriers in Humanitarian Supply Chain Management, *International Journal of Disaster Resilience in the Built Environment*, (Emerald).

6. **Kabra, G.**, & Ramesh, A. (2016). Information technology, mutual trust, flexibility, agility, adaptability: Understanding their linkages and impact on humanitarian supply chain management performance, *Risk, Hazards & Crisis in Public Policy*, (Wiley).

Author Vitae (Brief)

GAURAV KABRA

CONTACT

Present Address: Room No.-F-02
Azad Bhawan
Indian Institute of Technology Roorkee
Roorkee (Uttarakhand) - 247667.

Permanent Address: D-26, Kanchan City
Jhalawar (Rajasthan)-326001.

RESEARCH INTERESTS

- Supply Chain Management
- Humanitarian Logistics
- Application of IT in Business
- Empirical research in Operations Management

EDUCATION

Ph.D. (Under Process) [Humanitarian Supply Chain Management],

Thesis Title: ***Modelling and Analysis of Information Technology issues in Humanitarian Supply Chain Management***
Department of Management Studies (DoMS), Indian Institute of Technology Roorkee, India
Research Supervisor: Dr. A. Ramesh, Assistant Professor, DoMS, IIT Roorkee, India

5-Year integrated B.Tech. [Information Technology] and MBA, July 2006 - June 2011

ABV-Indian Institute of Information Technology & Management Gwalior, India
CGPA:7.73/10 (B.Tech: 7.6/10, MBA: 8.0/10).

CONFERENCE/WORKSHOP ATTENDED

1. *XVIII Annual International Conference of the Society of Operations Management* held at Indian Institute of Technology Roorkee, Roorkee, India.
2. *3rd International Conference on Vedic Foundations of Indian Management* held at Indian Institute of Technology Delhi, New Delhi, India.
3. *International Conference on Humanitarian Logistics* held at Indian Institute of Management Raipur, Raipur, India.

4. *Thirteenth Global Conference on Flexible systems Management* held at Indian Institute of Technology Delhi, New Delhi, India.
5. *National Conference on Reinventing Businesses: Shifting Paradigms and Seizing Opportunities* held at IMM New Delhi, New Delhi India.
6. 2-day workshop on *Big Data analysis for improving Business Performance* at Continuing Education Centre, Indian Institute of Technology Roorkee, Roorkee, India.

PERSONAL DETAIL

Father's Name	: Shri M.M.Kabra	Mother's Name	: Smt. Usha Kabra
Date of Birth	: December 02, 1987		
Nationality	: Indian	Passport No.	: N4764105

Place: Roorkee **Gaurav Kabra**