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ORIGINAL ARTICLE

Analyzing ICT Issues in Humanitarian Supply Chain Management: A SAP-LAP Linkages Framework

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Abstract *This study sets out to highlight the importance of information and communications technology (ICT) in the humanitarian supply chain management (HSCM) and to understand the present status of use of ICT in the HSCM in India. The study develops a situation-actors-process, learning-action-performance (SAP-LAP) linkages framework in order to analyse various learning issues related to enhancing the use of ICT in HSCM, particularly in the Indian context. The developed framework considers the inter-relationships amongst all elements of different components of the SAP-LAP framework by developing assessment, self-interaction and cross interaction matrices. The results suggest that strategic and proactive planning is essential in enhancing the use of ICT in HSCM. This may motivate the actors to introduce education or training programs to increase awareness around the importance of ICT in HSCM. These results also support the view that the role of government is crucial in enhancing the use of ICT in HSCM. An effective, transparent workflow policy, allied with the use of knowledge management system and donor commitment, would maximise the benefits of ICT and would further enhance the performance of the HSCM. This study is a pioneering attempt, containing a qualitative research foundation and reflective observation analysis, to assess various strategic issues used to enhance the use of ICT in HSCM in order to improve the efficiency of relief operations.*

Keywords Humanitarian supply chain management · India · Information technology · SAP-LAP linkages

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Introduction

The frequency and occurrence of disasters are on the rise all over the world (EM-DAT 2010) and are expected "to increase by a further multiple of five over the next 50 years" (Thomas and Kopczak 2007). In particular, India is extremely vulnerable to disasters due to the geo-climatic and socio-economic conditions within the country (USAID 2006). According to the Ministry of Home Affairs, India (MHA 2011), when considering the entire Indian land mass, around 60, 8 and 68 % of the country is susceptible to earthquakes of different intensities, cyclones and drought, respectively. In the past, India has witnessed various devastating natural disasters such as the Gujarat earthquake in 2001, the tsunami of 2004 and flash floods in Uttarakhand in 2013. An illustration of the losses due to disasters during the period of 2001–2010 is given in the Appendix (Table 11).

Humanitarian supply chain management is mobilised 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 (Oloruntoba and Gray 2006; Costa et al. 2012). 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." After the disaster resulting from the tsunami in 2004, humanitarian logistics have received greater attention from both the humanitarian and academic worlds (Kovács and Spens 2007; Christopher and Tatham 2011). A typical humanitarian supply chain (HSC) showing supports from the government, individual donors through to international agencies and non-governmental organizations (NGOs) is illustrated in Fig. 1.

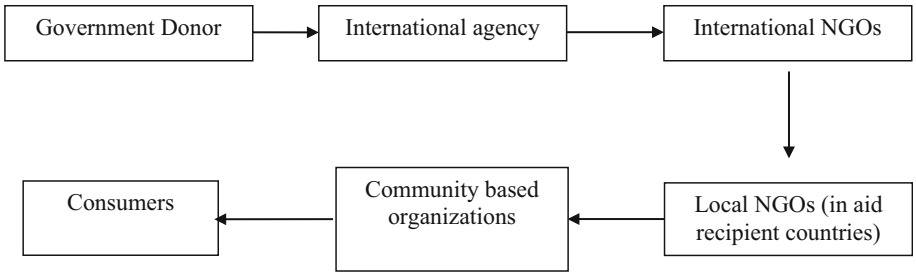

Fig. 1 A typical humanitarian supply chain (*Source* Oloruntoba and Gray 2006)

Disasters are unavoidable. However, the impact of a disaster can be reduced by the effective use of information and communications technology (ICT) such as specific decision support systems, communications and information systems for key tasks (Pettit and Beresford 2009). Information and communications technology is defined as "a diverse set of technological tools and resources used to communicate and to create, disseminate, store and manage information" (Singh 2009). For the purposes of this paper, ICT 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 (Maiers et al. 2005). The use of ICT 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 (Stephenson and Anderson 1997; National Research Council Washington 1999 and 2000; Telleen and Martin 2002; Chan et al. 2004; Jefferson 2006; Overstreet et al. 2011) 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 (Lee and Zbinden 2003; Whybark 2007).

Various researchers have previously noted that the use of ICT can enhance the efficiency of relief operations (Cate 1994; Kehoe and Boughton 2001; Gustavsson 2003; Patterson 2005; Carleen and Nicolai 2006; Roh et al. 2008; Pettit and Beresford 2009; Tomasini and Van Wassenhove 2009). Information and communications technology 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 (Beaumaste 2002; Roh et al. 2008; Pettit and Beresford 2009). The utilization of ICT within the supply chain makes it possible to react more quickly and more effectively with the available information in 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 ICT in effective and efficient management of past disasters, but there are few studies that discuss the strategic issues related to enhancing the use of ICT in HSCM; particularly in the Indian context. Hence, there is a strong need to analyse and highlight the importance of ICT 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, the objectives of the study are

- To highlight the importance of ICT in HSCM and to understand the present status of the use of ICT in HSCM in India.
- To develop a SAP-LAP framework by defining the relevant elements of SAP and LAP in order to analyse various learning issues.
- To analyse the interaction between elements of SAP and LAP leading to a discussion on ways to improve the present situation.

The rest of the paper is organized as follows. Section "SAP-LAP Framework" explains the SAP-LAP framework. The discussion on SAP-LAP linkages framework features in Sect. "SAP-LAP Linkages Framework". Finally, Sect. "Conclusion" outlines the overall contribution of this study, noting some limitations, and highlighting scope for future research.

SAP-LAP Framework

Sushil (2000a, b) has developed the SAP-LAP framework. The development of this SAP-LAP framework consists 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 (Sushil 2000a; Thakkar et al. 2008; Singh and Shalender 2014). Finally, the synthesis of SAP (situation, actor and process) leads to LAP (learning issues, recommended actions for improving the situation, anticipated improvement in performance) as illustrated in Fig. 2.

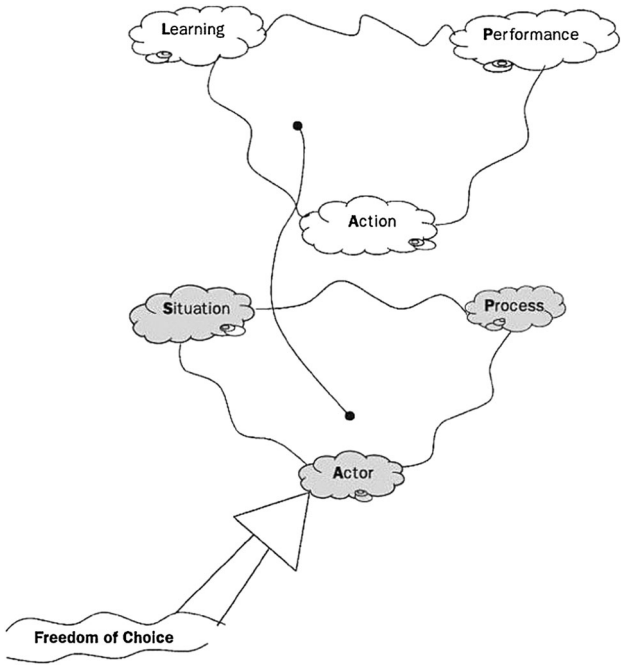

Fig. 2 SAP-LAP model of inquiry. (*Source* Sushil 2000a, b)

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 and management practices (Sushil 2001; Palanisamy 2001; Husain et al. 2002; Kak and Sushil 2002; Gupta 2003; Thakkar et al. 2008; John and Ramesh 2012; Charan 2012; Palanisamy 2012; Mahajan et al. 2013; Rizk 2014; Yadav and Sushil 2014; Nasim and Sushil 2014). In this study, SAP-LAP framework has been developed to sharply define the elements (Table 1) in order to explore various strategic issues to enhance the use of ICT in HSCM.

A structured set of questions was used (Table 12 in Appendix) to explore different strategic issues aimed at enhancing the use of ICT in HSCM in India. This study is based on personal semi-structured interviews with different humanitarian actors involved in relief activities "which seek to understand a person's perspectives as they experience and understand an event, relationship, program, emotion" (Leedy 1997). This was akin to the researcher's interest and Saunders et al. (2007) also supported the view that semi-structured interviews is 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. Sessions lasted from 30 min to just over 1 h and all the interviews were transcribed verbatim after each discussion.

The interviews were conducted with five experts (two academics, one ICT professional, one practitioner, and one logistics officer). A brief profile of these experts is given in Table 13 in Appendix. 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 ICT 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 et al. (2002) and Yin (2003). This is also cited by Thakkar et al. (2008), Garg and Deshmukh (2010), Kabra and Ramesh (2013a) and Scholten et al. (2014). All of these strategies positively contribute to the criteria of a good qualitative study according to Lincoln and Guba (1985).

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 interactions or inter-relationships among different elements of SAP-LAP, which was the major drawback in the traditional SAP-LAP framework. 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

In this study, the SAP-LAP linkages framework was developed by making specific enquiries related to "use and adoption of ICT" in HSCM to enhance the effectiveness and efficiency of relief activities. 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 analysed 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 matrices, 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. 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.

Table 1 Sharply defined SAP-LAP elements

Situation		
S1	Lack of funds for investment in IT	Long and Wood (1995), Gustavsson (2003), Lee and Zbinden (2003), Maiers et al. (2005), Van Wassenhove (2006), Kovács and Spens (2007), Sheu (2007), Maspero and Ittmann (2008), Balcik et al. (2010), McLachlin and Larson (2011), Sandwell (2011), Kabra and Ramesh (2013a)
S2	Poor IT infrastructure	
S3	Low use of IT	
S4	Lack of trust between actors	
S5	Inadequate information sharing	
S6	Disparity in IT facility of different actors	
S7	Inadequate assessment and planning	
S8	Duplication of effort	
Actors		
A1	Donors	Oloruntoba and Gray (2006), Kovács and Spens (2007), Balcik et al. (2010), Steets et al. (2010), John and Ramesh (2012)
A2	Logistics providers	
A3	HROs	
A4	Media	
A5	Military	
A6	Government	
Processes		
P1	Funding and request for donation	Fritz Institute (2005), Maiers et al. (2005), Fugate et al. (2006), Kabra and Ramesh (2013a)
P2	Borrowing of experts from commercial sectors	
P3	Sometimes commercial organizations and humanitarian actors are working alone	
P4	Spreading awareness about the situation	
P5	Training focuses on general training, less focused on IT	
Learning		
L1	Low level of supply chain understanding	Odedra-Straub (1993), Gustavsson (2003), Thomas (2003), Fritz Institute (2005), Maiers et al. (2005), Mbarika et al. (2005), Murray (2005), Thomas and Kopczak (2005), Oloruntoba and Gray (2006), Van Wassenhove (2006), Kovács and Spens (2007), Pettit and Beresford (2009), Whiting and Ayala-Öström (2009), Balcik et al. (2010), Schulz and Blecken (2010), Thevenaz and Resodihardjo (2010), McLachlin and Larson (2011), Sandwell (2011), Agostinho (2013), ICHL (2013)
L2	Top management commitment	
L3	Ineffective planning	
L4	Low awareness about importance of IT	
L5	Low level of investment in IT	
L6	Resistive nature of employees to change to IT enable	
L7	Inefficient training	
L8	Shortage of experts i.e. IT and logisticians	
Actions		
A1	Strategic planning for IT	Byman et al. (2000), McEntire (2002), DeJohn (2005), Maiers et al. (2005), Balcik et al. (2010), Schulz and Blecken (2010), Agostinho (2013), Kabra and Ramesh (2013b)
A2	Increasing awareness	
A3	Investment in IT	
A4	Transparent work flow policy	
A5	Strategic tie up with actors	
A6	Strengthen training for IT	
Performance		
P1	Enhances quick exchange of information, products and funds	McEntire 2002, Gustavsson (2003), Fritz Institute (2005), Maiers et al. (2005), Van Wassenhove (2006), Kovács and Spens (2007), Balcik et al. (2010), Steets et al. (2010), Agostinho (2013)
P2	Enhance coordination between actors	
P3	Improves actors agility and flexibility	
P4	Better decision support system	
P5	Improves responsiveness	
P6	Improves efficiency	

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–very important), as advocated by Singh and Shalender (2014). The assessment matrix for the situation, actors and process is given in Table 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 2 Assessment matrix for situation, actor and process (on a 5 point scale)

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

Situation

The self-interaction matrix consisting of both the binary and interpretive relations for the situation is given in Table 3. Information and communications technology 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 recent (June 2013) disaster that occurred in Uttarakhand (a Northern State in 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). As per experts' view, "Although the use of ICT 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 ICT contributes to the underdeveloped infrastructure, which further leads to the ineffective use of ICT that is available. Lack of trust between actors acts as a multiplier effect in the low use of ICT. McEntire (1999) also supported the suggestion that trust related issues are common in HSCM. Disparity in the ICT facility of different actors also contributes significantly in resisting the use of ICT (Schulz and Blecken 2010; Maiers et al. 2005). This can further lead to duplication of effort and reduces the performance of relief operations (Raju and Becker 2013).

Actor

The self-interaction matrix for actors is given in Table 4. As per the experts' suggestions, donors are seen as the main source of funding for the actors in HSCM. A donor in

Table 3 Self-interaction matrix for situation

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							
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							

Table 4 Self-interaction matrix for actors

Binary matrix					
1	1	1	1	1	A1
0	1	1	0	A2	
0	1	1	A3		
0	1	A4			
1	A5				
A6					
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					

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 people 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

Table 5 Self-interaction matrix for processes

Binary matrix				
1	1	0	0	P1
1	1	1	P2	
1	1	P3		
1	P4			
P5				
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				

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).

Process

The self-interaction matrix consisting of both binary and interpretive relations for the process is given in Table 5. Disaster management is the responsibility of the local administration, under the direction of the State Government, supported by the Government of India. 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 and 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 and Ramesh 2012).

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 SAP and LAP are represented by a cross-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 cross-interaction matrix."

Cross-Interaction Matrix of Situation (S) X Actor (A)

Cross-interactions among the elements of situation and actor are given in Table 6. The commercial sector has the expertise to make best use of advanced ICT systems at each level. By way of contrast, the humanitarian sector lacks the professionals' expertise in key areas such as logistics, ICT 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; Kabra and Ramesh 2013b). 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 (Thomas and Kopczak 2005; Agostinho 2013).

Cross-Interaction Matrix of Actor (A) X Process (P)

The cross-interaction matrix for actor and process is given in Table 7. To realize the benefits of the use of ICT, especially in the uncertain and high-stress environment of disasters, gaining the experience through routine use, such as training, drills and exercises, is essential (Maiers et al. 2005; Thomas and Mizushima 2005; Agostinho 2013). 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 (Ponomarov and Holcomb 2009; Balcik et al. 2010). The coordination and collaboration among the actors in HSCM and commercial organizations facilitates in addressing the training issues of volunteers.

Table 6 Cross interaction matrix of situation (S) 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
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 7 Cross interaction matrix of actor (A) X process (P)

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
Interpretive matrix					
A1		Provide donation			Supports in form of 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

More awareness programs are needed to improve the efficiency of relief operations (John and Ramesh 2012; Agostinho 2013; Kabra and Ramesh 2015a).

Cross-Interaction Matrix of Process (P) X Learning (L)*

This matrix depicts the relationship between the components of process and learning (Table 8). 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.

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

Table 8 Cross interaction matrix of process (P) and learning (L*)

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
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

strategically in the enhancement of ICT infrastructure (Maiers et al. 2005). Van Wassenhove (2006) also states 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 ICT 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. HROs will need to invest more in not only disaster prevention, but become more aware of disaster risk reduction.

"Resistance to change" is one of the most important challenges in enhancing the use of ICT in relief organizations. ICT often represents a completely new tool for many people working in the organizations. The perception that utilization of ICT could be a possible reason for downsizing of their jobs introduces fear into their minds and creates significant resistance to change (Beaumaste 2002). Lack of awareness about the use and importance of ICT is the most significant barrier to enhancing the use of ICT in HSCM. Field workers are not aware of the benefits of ICT. 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).

Cross-Interaction Matrix of Learning (L) X Action (A*)*

The cross-interaction matrix between the elements of learning and action is given in Table 9.

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 ICT systems in the relief operations (Van Wassenhove 2006). The first step towards enhancing the use of ICT in HSCM is investment in ICT systems. To support any investment, it is necessary to properly analyse the situation. To encourage investment in ICT, 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 (Al-Mutawah et al. 2009; Patil and Kant 2014; Kabra and Ramesh 2015b). The government must take the role of the central authority in any relief activities.

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 ICT by demonstrating its usefulness in effective and efficient management of disaster (ICHL 2013). The

Table 9 Cross interaction matrix of learning (L*) X action (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
	A1	A2	A3	A4	A5	A6
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 professional and donors		Attracts professional and donors	Attracts professional and donors	Attracts professional and donors	Attracts professional and donors
	A1	A2	A3	A4	A5	A6

government of the country should seek to provide all possible resources for enhancing the use of ICT 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 ICT (ICHL 2013).

Cross-Interaction Matrix for Action (A) X Performance (P*)*

The cross interaction matrix between action and performance is given in Table 10.

Discussion The maximum utilization of ICT in the humanitarian sector is an involved and complicated process and requires strategic planning (Maiers et al. 2005; Pettit and Beresford 2005; Kovács and Spens 2007; Natarajarathinam et al. 2009; Schulz and Blecken 2010; Moshtari and Gonçalves 2012; Agostinho 2013). 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 ICT system. Strategic planning is essential for the successful utilization of ICT 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 ICT 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

Table 10 Cross interaction matrix for action (A*) X performance (P*)

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
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		Reduce resistive nature and Fast solutions
	P1	P2	P3	P4	P5

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

Conclusion

In recent years, the use of ICT has been shown to be a successful strategy in improving the performance of HSCM. This paper, with its field based qualitative research, presents the first attempt in India to analyse various strategic issues related to enhancing the use of ICT in HSCM. Firstly, the SAP-LAP framework highlights the importance of ICT and helps in classifying different issues related to enhancing the use of ICT in HSCM. Thereafter, a SAP-LAP linkages framework has been used to analyse the whole scenario to enhance the use of ICT in HSCM in the Indian context. The findings of this study not only offer a meaningful base to deepen understanding with regard to enhancing the use of ICT, 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 ICT in HSCM in India. This may provoke the actors to start education or training programs to increase awareness around the importance of ICT 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. This helps them to understand, analyse 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 ICT and suggests ways of how this can be improved in HSCM in India. Despite these contributions, the present study is also not free from limitations. The first limitation is the identification of interface. This is based on the opinions of experts, but is only a subjective judgment and is open to bias. The actual person who is judging the barriers and outcomes might influence the result. 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 existing barriers. Further study can be carried out to make a hierarchy-based model in order to explore the mutual relationships among the existing

barriers to develop an understanding of how these barriers influence each other, so that the decision makers can focus on overcoming these barriers and realize the benefits of ICT in HSCM in India.

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Appendix

See Appendix Tables 11, 12, 13.

Table 11 Losses due to different disasters during the last 10 years in India (*Source* MHA 2011)

Year	Lives lost humans (in no.)	Houses damaged (in no.)	Cropped area affected (in lakh hectares)
2001–2002	834	346,878	18.72
2002–2003	898	462,700	21.00
2003–2004	1,992	682,209	31.98
2004–2005	1,995	1,603,300	32.53
2005–2006	2,698	2,120,012	35.52
2006–2007	2,402	1,934,680	70.87
2007–2008	3,764	3,527,041	85.13
2008–2009	3,405	1,646,905	35.56
2009–2010	1,677	1,359,726	47.13
2010–2011	2,310	1,338,619	46.25

Table 12 A template for queries with reference to ICT issues in HSCM

Who were the actors involved in the HSCM?
What do you think that needs to be done to improve the efficiency of relief operations?
How the use of IT in HSCM addresses the issue of coordination in HSCM?
How the use of IT in HSCM will address the needs of the emergency situation?
What do you think that needs to be done to enhance the use of IT in HSCM?
What are the obstacles that need to be removed to enhance the use of IT in HSCM?
Which is the most important learning issue that need to be addressed on priority to enhance the use of IT in HSCM?
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?
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?
What type of skills, abilities are expected in the volunteers to use the IT in relief operations?
What do you think needs to be done to address the issue of "improper funding" in the area of humanitarian sector so that money would be available for investing in preparedness measures for the relief operations?
Who is the most important actor in the relief operations to support the process of enhancing the use of IT in HSCM?

Table 13 Brief profile of experts

S. no.	Designation	Years of experience	Qualification
1.	Professor	20	B.tech, M.tech, Ph.D.
2.	Professor	20	B.tech, M.tech, Ph.D.
3.	IT professional	15	BE, ME
4.	Practitioner	10	Post Graduate
5.	Logistics officer	10	BE, Ph.D.

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Key Questions

1. How the use of ICT can enhance the efficiency of Humanitarian Supply Chain?
2. What are the challenges in enhancing the use of ICT in Humanitarian Supply Chain and how these can be removed?

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