**Humanitarian Supply Chains: “What’s in IT for me?”**

**Summary**

Humanitarian Supply Chains (HSCs) deliver aid to those in need once a disaster strikes (Whybark, 2007). Sometimes referred to as “temporary supply chains”, they exist only for the period of the relief operation (Merminod et al., 2014) and consequently comprise of numerous non-government organisations (NGOs) that have almost certainly never previously worked together. These NGOs are tasked with managing the preparation and response activities to counter such disasters under ever tightening budgets, and as a result have begun investigating initiatives that offer increased efficiencies and reduced costs. One such initiative is the adoption of information technology (IT); IT has been proven to offer numerous advantages but is currently under utilised by NGOs operating in HSCs. This paper investigates the benefits of increased IT adoption in HSCs, the barriers to IT adoption within HSCs as well as a number of IT solutions that are most suited to the needs of HSCs.

**Track:** Operations Logistics and Supply Chain Management

**Word Count:** 5758 words

**Introduction**

Humanitarian Supply Chains (HSCs) are supply chains (SC) that deliver goods and services to those in need after a disaster strikes (Beamon and Balcik, 2008). Academic interest in this field has been piqued mainly by the increased number and magnitude of natural disasters in recent years, and also by the fact that the vast majority of disaster relief projects are deemed unsuccessful due to the numerous and multi-faceted challenges these supply chains face (Fawcett and Fawcett, 2013). Examples of these challenges include uncertainty over supply and demand locations after the disaster strikes, limited access to accurate information from those in the field, duplication of effort by the multiple NGOs operating in the same location, damage to local infrastructure in the affected area, shortage of skilled workers on the ground, and the multitude of stakeholders involved in these operations (each with their own cultural and political nuances and mandates), to name just a few.

A suggested method of reducing the challenges faced by HSCs is increased use of Information Technology (IT), especially given the proven efficiency and effectiveness it offers commercial supply chains (Beamon and Balcik, 2008). Successful IT adoption has been proven to increase agility within organisations, and the constant decrease in implementation costs makes adoption increasingly affordable for non-governmental organisations (NGOs) (Scholten et al., 2010). As a result, the important role that IT plays in HSCs has long been recognized (Pettit and Beresford, 2009), with some suggesting that IT is the “single most important factor in determining the success or failure of a disaster relief operation” (Kovacs and Spens, 2007) leading to its status as a “must have” tool within HSCs (Özdamar and Ertem, 2015).

The strength of IT is its ability to store and manage vast amounts of information; the importance of information in HSCs cannot be underestimated, with managers needing to know the demand for all goods and services across the SC, their current location and their destination as well as the options available for distribution (Baldini et al., 2012). Understanding these requirements in commercial SCs is difficult enough, but the complexity of HSCs makes managing this information even more difficult (Baldini et al., 2012) further highlighting the need for strong IT systems for storing, managing and disseminating information.

While there is evidence of increasing IT adoption within HSCs (Whybark, 2007), the application of technology remains relatively ineffective, with NGOs tending to use numerous incompatible and unconnected systems that rely on manual input, thereby severely limiting the accuracy of the information they posses (Ilhan, 2011; Overstreet et al., 2011; Pettit and Beresford, 2005). Similarly, limited evidence exists of NGOs utilizing IT to effectively manage the relief inventories and this is an obvious area for improvement (Whybark, 2007).

The literature suggests that several benefits can be achieved by increasing IT usage in numerous aspects of disaster relief operations; examples include tracking and tracing of goods from origins to beneficiaries (da Costa et al., 2012), managing relief inventories (Whybark, 2007), and coordinating communication between all parties of the HSC (Kovacs and Spens, 2007). This study aims to identify the benefits that IT can offer HSCs, the barriers to its adoption in HSCs, and the specific IT tools that are most suited to the needs of HSCs. With this in mind, this study aims to answer the following research questions:

1. What benefits can increased IT adoption offer HSCs?
2. What barriers to IT adoption exist within HSCs?
3. Which technologies are particularly well suited to increase the efficiency and effectiveness of disaster relief operations?

**Methodology**

This study is conceptual in nature and adopts a literature review approach. The HSC literature was reviewed with a particular focus on investigating the role IT plays in these supply chains. Given that only a small number of previous studies have focused exclusively on IT in HSCs, our review was not limited to specific search terms around IT; instead we reviewed the HSC literature as a whole, drilling down on aspects that mentioned IT in HSCs. As previous work in this field is published in a multitude of diverse journals, the authors searched for literature across the core management databases of Scopus, Science Direct, Emerald, and Business Source Complete.

 Upon reading the identified papers, the authors identified first order codes related to the use of IT in these supply chains. The authors then used the NVivo software package to analyse these codes and convert them into the themes of Benefits of applying IT to HSCs, Barriers to IT adoption in HSCs, and Specific IT Tools Most Suited to HSCs.

**Findings**

In an attempt to answer the 3 research questions, this section is split into the three identified themes of Benefits of applying IT to HSCs, Barriers to IT adoption in HSCs, and Specific IT Tools Most Suited to HSCs.

## *Benefits of applying IT to HSCs*

Preliminary analysis of the data highlighted a number of benefits of applying IT to HSCs such as cost savings (Baldini et al., 2012; Ergun et al., 2014), improved decision making (Chandes and Pache, 2010a), increased coordination throughout the HSC (Jaeger et al., 2007), increased donor awareness (Day et al., 2012; Fawcett and Fawcett, 2013), increased SC capacity (Rietjens et al., 2007) and increased SC agility (Scholten et al., 2010) to name just a few.

The main benefit of IT usage in HSCs involves the improved sharing of information it offers, as well as the increased security of the distribution of this information (Baldini et al., 2012). Collecting all information in one central place and sharing it across all actors in the SC increases the accuracy of the information made available to all (Jensen, 2012), allowing for more effective performance measurement, increased inventory savings and increased control of the entire supply chain (Pettit and Beresford, 2009). The improved visibility and transparency this offers across the SC has the added benefit of increasing accountability, thereby reducing “theft, losses, or manipulation of aid” (Tomasini and Van Wassenhove, 2009). Not only do IT systems increase the level of information exchange across the HSC, they also increase the speed with which the information can be exchanged (Rietjens et al., 2007). Disseminating accurate information to those in the field is therefore far easier, as information related to the emergency response can easily be sent to mobile phones, tablets and other communication devices via text message, e-mail and Internet messages e-mail (Jaeger et al., 2007) leading to a more efficient and effective response to the disaster.

IT also enables improvements in the data collection process; firstly, data from the field can be collected rapidly and in vast quantities using devices such as mobile phones and tablets, allowing NGOs to quickly and easily recognize patterns, thereby coordinating their response to better suit these patters (Jaeger et al., 2007). Secondly, this information can be collated from multiple actors (emergency responders such as army and police personnel, medics, victims, civilians) and places (satellite imaging, CCTV cameras), allowing for a more accurate picture of the current situation (Jaeger et al., 2007). Having access to an increased amount of information (from multiple sources and in multiple formats) allows for more accurately informed decisions to be made in a much quicker timeframe (Yates and Paquette, 2011). Pairing this with a decision support tool allows decision makers to create a set of recommendations based on the experiences of past disasters (Chandes and Pache, 2010a), with this being particularly valuable in decisions around logistics operations (Chandes and Pache, 2010b).

Increased IT usage also increases the efficiency of coordination within the entire HSC (Chandes and Pache, 2010b; Kabra et al., 2015; Rietjens et al., 2007) by allowing for more numerous and more effective communication; the use of the Internet, mobile communication technologies and social media allows for improved coordination and communication between both victims and those responding to the disaster (Holguin-Veras et al., 2012; Jaeger et al., 2007). Advancements in battery technology (particularly alternative sources of energy such as solar-power) as well as wireless and satellite technology have also enabled increased communication opportunities in a disaster hit area, whereby communication can occur regardless of the impact the disaster has made on the local infrastructure (Sandwell, 2011). As coordination between the numerous parties within HSCs is extremely difficult, the ability to have real-time communication across the large number of diverse and disparate actors involved in the HSC is seen as a huge benefit in HSC operations (Jaeger et al., 2007; Kovacs and Spens, 2007), with some seeing it as the most important factor of effective coordination (Pettit and Beresford, 2009).

 Similarly, the use of IT tools to share information across boundaries removes the bureaucratic structures that usually prohibit knowledge sharing between organisations (Yates and Paquette, 2011). Whilst previously information was only shared during private formal meetings, IT has enabled increased visibility throughout the organisation (and also across organisations) by allowing users to log on to a system to access all relevant information as well as search for the exact information that is required (Yates and Paquette, 2011). This allows all parties to have access to the same information sources, thereby permitting them to identify (and subsequently reduce) duplication of effort as well as use the same information for multiple requirements (Yates and Paquette, 2011).

Increased awareness is another benefit; the Internet (and social media in particular) has allowed us to become more aware of the impact of a disaster in real time (Day et al., 2012). The distress of those affected by disasters is showcased on TV, mobile phones, tablets and laptops / PCs, allowing us to witness the pain and suffering of the victims, as well as understand their immediate needs (Fawcett and Fawcett, 2013). In this sense, IT has the potential to increase the amount of donations contributed by donors whilst also allowing NGOs to quickly and easily communicate the exact requirements of victims, thereby minimizing the detrimental impact of unsolicited donations (Balcik et al., 2010).

Finally, IT has the potential to increase the efficiency of individual NGOs as well as the entire relief operation (Ergun et al., 2014). IT has been shown to increase agility within commercial SCs, and some believe it has even greater potential for HSC, given that agility is such an essential requirement for these SCs (Scholten et al., 2010). IT also allows for increased capacity to process information across the HSC (Rietjens et al., 2007), as well as the ability to improve the processes within HSCs; Sheppard et al (2013) found that adopting a common IT system across all parties in the HSC helped to “drive commonality of logistic processes”. Solutions such as tracking and tracing of goods and services also have the additional benefit of reducing the opportunities for criminals to steal the highly important items (that are highly difficult to replace due to them being in short supply) while they are being transported to their destinations (Baldini et al., 2012).

## *Barriers to IT Adoption in HSCs*

Despite the various benefits of IT adoption within HSCs (and the apparent awareness and willingness to adopt these tools from those in the field (Scholten et al., 2010)), barriers exist to impede successful implementation. In fact Kabra et al (2015) found that the effective management of HSCs is most affected by the significant barriers to IT adoption; this is perhaps why the use of IT is still not prevalent within HSCs (Özdamar and Ertem, 2015).

Incompatibility of technologies across the HSC is one such issue (Jaeger et al., 2007; John and Ramesh, 2012) with each party in the SC using their own software dictated to them by their headquarters. For those in the field, having a multitude of systems is important (particularly for communication) as this increases their resilience and capacity by reducing their reliance on one particular system. However, having too many systems available has the potential to lead to compatibility issues as well as “black holes” in coverage whereby some areas are well served but others are not (Pettit and Beresford, 2009).

 Familiarity with the system can also be an issue; communication problems can easily occur if users are not sufficiently experienced in using the systems, and people are reluctant to spend time learning a new piece of software rather than conducting their work activities, especially in the time-sensitive environment HSCs operate in (Wakolbinger et al., 2013). Given the stressful conditions encountered by those working in HSCs, familiarity is a must if users are going to use the technology effectively and efficiently (Jaeger et al., 2007), especially as electronic communications (e-mail, text messages etc.) are misinterpreted as much as 50% of the time (Wakolbinger et al., 2013). Given what is at stake during these relief operations, these types of mistakes need to be minimised, and most staff will therefore require training on new systems in order to use them effectively (Jensen, 2012).

One of the biggest barriers to IT adoption in HSCs is the lack of sufficient funds to invest in new technologies owing to the ways in which NGOs are funded (Ergun et al., 2014; Maon et al., 2009). While IT systems can reduce the uncertainty associated with complex environments, they only increase costs if used for more simple activities in a more discernable environment (Rietjens et al., 2007). Training staff in new IT systems is prohibitively expensive for NGOs, as are the implementation costs when attempting to install new systems in an area that has just recently been hit by a natural disaster and therefore cannot guarantee a sufficient electricity supply (Sandwell, 2011). The lack of electricity and subsequent Internet access in the affected area during the immediate aftermath of a disaster results in an overreliance on battery-operated technology (Jaeger et al., 2007) which can be prohibitively expensive. The ensuing bandwidth restrictions can also limit the amount of information exchanged (Jaeger et al., 2007), severely impacting the coordination effort.

Another issue is the sheer volume of data that is created during HSC operations. Having IT systems accessible by multiple stakeholders for the purpose of sharing information is obviously a great advantage, however Yates and Paquette (2011) suggest that when the ownership of the information is shared across multiple parties, the management of the information becomes increasingly ambiguous. For example, if all users are contributing content to the systems without formal structures or naming conventions, the systems can quickly become unwieldy, with information overload making it extremely difficult for users to find the specific information they are after. Conflicting information from multiple data sources is a common occurrence; as the accuracy of the information available is of the highest importance in HSC operations, a huge task ensues to check and validate all the information present in the IT system which leads to questions about the “manageability, usability and perceived value of the system” (Yates and Paquette, 2011).

A final issue surrounds the security of the information stored in the IT systems, particularly given that the vast majority of NGOs utilise standalone software that runs on laptops and makeshift networks with limited security settings (Scholten et al., 2010; Whiting and Ayala-Öström, 2009). Some fear that criminals could easily hack into these systems to steal identities or even take advantage of at risk populations, or that government agencies could abuse their power by invading the privacy of those involved in the disaster response (Yates and Paquette, 2011).

## *Which technologies are particularly well suited to increase the efficiency and effectiveness of disaster relief operations*

The literature suggests a number of areas of IT that are particularly suited to increase the efficiency and effectiveness of HSCs. One such opportunity involves the use of IT for increased tracking and tracing of both goods and services within the HSC (da Costa et al., 2012; De la Torre et al., 2012). Pettit and Beresford (2009) believe that utilising IT for tracking and tracing has the potential to increase the efficiencies of the HSC as well as minimise the level of waste within the SC; they cite the example of the World Food Programme (WFP) gaining benefits of improved network, warehouse, vehicle and spare part management simply by adopting the IT systems utilised in the commercial sector. Some authors have suggested the use of Radio Frequency Identification (RFID) for this task due to the opportunities it offers in terms of improving tracking and tracing within the SC (Baldini et al., 2012). RFID offers the benefits of increased data security when compared to more traditional technologies such as barcode and has also been proven to improve the operational efficiency of commercial SCs (Baldini et al., 2012). It appears that such tracking and tracing software is available to those in HSCs and is being used by some NGOs but its use is not widespread; some NGOs have actually begun developing their own specialised software for tracking and tracing (as well as fleet management) and have even begun offering this software to other parties in the SC to improve HSC efficiency (Kovacs and Spens, 2011). One such example is SUMA, a simple piece of software that can be used on laptop computers in order to track and trace donations from point of origin to point of consumption, allowing those in the field to be more organised in terms of knowing what they currently have and where it is needed (Chandes and Pache, 2010b). Inventory tracking systems such as this allow NGOs an overall picture of all the purchases (and donations) that come in to the HSC, and can also automatically produce reports highlighting goods received and dispatched, the outstanding requirements for the beneficiaries per area as well as detailing the parties responsible for the delivery of the aid (Tomasini and Van Wassenhove, 2009).

John and Ramesh (2012) suggest another opportunity in terms of a central database holding details of previous disaster relief activities; information contained in such a database could include the type of disaster, the NGOs involved, the suppliers used (and their associated reliability, quality, and lead time ratings), the volunteer organisations involved, and the locations and associated capacities of warehouses among other things. The authors suggest that attaching such a database to a decision support system (DSS) would allow for more rapid and accurate decisions to be made, empowering those in the field. Such a database could also be used to match the needs of victims with individual donors in order to facilitate more rapid donation income as well as reducing the amount of unsolicited donations received (Tomasini and Van Wassenhove, 2009).

The use of satellite technology is another frequently suggested opportunity; the use of VSAT (very small aperture terminal) services seems appropriate, particularly where local communication infrastructure is damaged or destroyed (Ergun et al., 2010; Tapia et al., 2012). These small satellites are highly portable (some can be transported in a small suitcase) and can be used to allow Internet access in remote areas. Although rather expensive, Tapia et al (2012) suggest that NGOs could come together to jointly purchase and maintain such a solution. A similar opportunity is that which is offered by the ability to develop bespoke applications (or “apps”) for smart devices such as mobile phones and tablets that can lead to increased resiliency and scalability in the HSC (Wakolbinger et al., 2013). The use of satellites is not only restricted to communication; satellite imaging gives those in the field an accurate picture as to the state of the transportation network as well as allowing them to identify the locations of beneficiaries and the optimum routes to get there (Holguin-Veras et al., 2012). Having access to this information that is both current and highly accurate is incredibly helpful to those in the field (Crooks and Wise, 2013).

 An opportunity that has gained a large degree of interest is the use of Web 2.0 / social media for HSC operations; the importance of social media (in particular social networks) in disaster relief has gained traction in the literature (Yates and Paquette, 2011), particularly as some have already found that social media usage can improve HSC coordination (Holguin-Veras et al., 2012). The proliferation of social networking sites allows NGOs to track victims’ activities before, during and after a disaster hits, whilst also allowing victims to report incidents that are occurring in real-time; victims are also able to receive up-to-date emergency information from government agencies and NGOs, allowing for a more coordinated response (Pateman et al., 2013). In this regard, established social media platforms such as Facebook and Twitter allow NGOs to gain a highly accurate understanding of the situation in the affected area in a short space of time, allowing them to assess the damage to the infrastructure for transportation purposes as well as the relative security situation in the area and the number (and associated needs) of those affected by the disaster (Crooks and Wise, 2013).

Other applications for social media include searching for missing relatives, fundraising for NGOs, and matching donations with demand (Kovacs and Spens, 2011). The use of social media fundamentally changes the nature of donations; rather than asking for donations, NGOs can now ask for people’s time through crowdsourcing initiatives whereby individuals assist in the HSC operation by tagging photos, marking areas of interest on satellite images, and also offering vital information on local cultural norms and other background information (Yates and Paquette, 2011). The first recorded use of social networks and crowdsourcing occurred during the Haiti earthquake in 2010, whereby citizens, NGOs, the armed forces, technical experts and government organisations utilised these tools extensively to help coordinate the HSC operations in real time, with these tools now being used regularly in HSC operations to fill the information gap (Crooks and Wise, 2013). Both NGO and military personnel took hundreds of photographs that were then uploaded on to wikis so that everyone involved in the operation could understand the current situation on the ground; all users were then able to comment on the usefulness of these photographs (Yates and Paquette, 2011). Crooks and Wise (2013) suggest that this increased use of Web 2.0 tools has facilitated a move from Disaster Relief 1.0 to Disaster Relief 2.0; Web 2.0 is characterised as the use of tools that allow for user-generated content, therefore Disaster Relief 2.0 can be characterised as the numerous parties involved in the HSC utilising such tools to help fill the gaps in information almost instantaneously.

Yates and Paquette (2011) believe that the HSC environment is the perfect testing ground for social media applications as knowledge management platforms. Firstly, social media encourages frequent small contributions of information that can be acquired, shared and used easily; disaster response information is sent via images, text messages, blog / wiki posts, web links and short videos. Secondly, social media applications allow for users with different expertise and backgrounds to be brought together in an ad-hoc manner by providing a common interest; HSCs are a perfect application for this, as they require coordination among participants from a multitude of cultural and professional backgrounds. Finally, social media has the ability to “create order from chaos” by organising knowledge into clusters through use of comments on wikis and blog posts or tagging on images; given the chaotic nature of HSC operations, decision makers are in desperate need of information that is contextualised in such a way, thereby minimising misunderstandings and allowing for more accurate decisions to be made.

A final opportunity for increased IT usage in HSCs is cloud computing. Schniederjans et al (2016) found that some NGOs are already using cloud computing to enable them on demand access to data storage and services such as joint writing of proposals, transferring data to suppliers and government agencies, geo-tagging images for those in the field, and appealing for donations from corporations. The ability to scale-up computing capacity on demand is extremely helpful given that the remote location of humanitarian disasters (and their associated uncertain environment in terms of aftershocks etc.) often results in limited availability for powerful servers in the local area (Schniederjans et al., 2016). Cloud computing also offers NGOs the ability to back up data over the Internet, ensuring information security as well as increasing information transparency and availability by allowing large amounts of data to be shared globally and instantaneously (Schniederjans et al., 2016). Finally, cloud computing offers opportunities for NGOs to obtain internal efficiencies; not only does outsourcing IT solutions offer the advantages of cost reduction and reduction of effort over managing and maintaining their own data centres and servers, it also allows NGOs to focus more on the quality of the data being collected and processed and transferring this data effectively to supply chain partners, thereby facilitating increased collaboration efficiencies throughout the HSC (Schniederjans et al., 2016).

**Conclusion**

It is predicted that the number of disasters will increase dramatically over the next few years, while funding for aid relief is likely to diminish (Sandwell, 2011; Schulz and Blecken, 2010). It is therefore obvious that HSCs need to increase their efficiency and agility in order to make themselves more cost-effective. IT offers the opportunities to achieve these goals, and the increased insight this study offers into the benefits and opportunities of particular IT adoption within HSCs is therefore important.

Based on the analysis of the findings, the study suggests a number of IT tools that can be implemented by NGOs in order to increase the efficiency and effectiveness of their operations as well as the entire HSC. This is particularly relevant after suggestions from previous scholars who believe that adopting tools and techniques from the commercial sector could give significant benefits to those in HSCs (Chandes and Pache, 2010a; Jahre et al., 2009). Alongside this, the study identifies opportunities for future IT development in the area of HSCs. This study is relevant to supply chain managers due to the relative lack of previous research on the benefits of IT adoption for HSCs, especially given the comparative infancy of the topic when compared to commercial supply chain IT implementation. The study makes a practical contribution to the field by providing a rationale for adopting specific IT tools and techniques as well as identifying a clear focus for areas of IT that can or should be implemented in HSCs in the near term. It also makes a theoretical contribution by suggesting a number of new IT solutions that could be investigated by future research; the use of social media, RFID and cloud computing solutions in particular should be investigated to see if they hold any advantages for NGOs. Similarly, barriers to the adoption of these particular IT tools could be investigated from the perspective of those in the field through use of semi-structured interviews, focus groups and/or questionnaire surveys.

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