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Innovation in Humanitarian Supply Chains: A Systematic Review

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Résumé/Abstract

Purpose – This paper aims to identify gaps in the literature on innovation in humanitarian supply chains, and to develop an appropriate framework for future research through a systematic literature review.

Design/methodology/approach - The authors use a systematic literature review approach and synthesise the discussion of innovation in humanitarian supply chains after reviewing 32 papers. The synthesis identifies the different contexts for and outcomes of innovation in humanitarian supply chains.

Findings – The findings indicate that research on innovation in humanitarian supply chains is an underdeveloped topic. Gaps we identified in regards to the humanitarian context are: (1) a limited discussion of the contribution by the beneficiary to the supply chain; (2) a limited discussion of reconstruction innovations; (3) a lack of study on field application for complex innovations; (3) the lack of discussion of the role of individual knowledge in humanitarian supply chain innovation and finally (5) a lack of study of position innovations where humanitarian organisations use supply chains as a way to market effectively towards donors.

Originality/value – This paper develops a comprehensive framework for the classification of innovation in humanitarian supply chains and highlights gaps in the literature. Through this, it integrates innovation concepts and findings from the literature, to provide an overview of the current state of the literature on innovation in this particular context.

Mots clés/Keywords: Humanitarian Supply Chains; Innovation; Humanitarian Logistics

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Introduction:

Humanitarian logistics and supply chain management play a crucial role in preparation for, and response to, both disasters and complex emergencies, and the alleviation of the suffering of vulnerable people. According to the organisation Global Humanitarian Assistance, 2016 saw 65.6 million people displaced by conflicts, while a further 661 million people were living in extreme poverty in environmentally vulnerable or fragile countries, with the resulting funding for humanitarian aid exceeding US$27.3 billion (GHA, 2017). However, this funding is prone to shortfalls – for example in 2013 consolidated funding appeals across the sector raised, at best, 77% of their funding target, and at worst 21% (Smith & Swithern, 2014). To improve the effectiveness of their supply chains and to maximise the efficient use of their funds, humanitarian organisations have begun developing a range of innovative solutions for humanitarian supply chains. For instance, the 'Garage48 Tech for Humanity Hackathon' in June 2017 included 'better logistics solutions' as one of the crucial problems to be addressed (Garage 48, 2017). Other examples include the collaboration between the Government of Malawi and UNICEF which has led to the first humanitarian drone testing corridor in Africa (UNICEF, 2016) as well the implementation of blockchain technology by WFP to replace cash vouchers to deliver assistance more effectively (WFP, 2017).

This developing interest in innovation is found across the humanitarian sector as exemplified by the announcement in February 2012 of a new strategy from the UK Department for International Development (DFID). One of the aims of which is "to support innovation and promote more evidence-based responses to improve response and increase resilience" (DFID, 2014, p 10). Such policy changes are relevant for other countries (e.g. Finland, or the Netherlands) and as well as other donors (e.g. the Bill and Melinda Gates Foundation). Apart from governments, also humanitarian organisations have set up their innovation centres (e.g. UNICEF's Global Innovation Centre and even innovation fund), and humanitarian organisations have also joined forces in developing innovation centres together, such as the Global Humanitarian Lab, or the Humanitarian Innovation Fund. The latter aims to "ensure that the outcomes of research, innovation, professionalisation processes and partnership building impact humanitarian action to improve humanitarian effectiveness" (ELHRA, 2014, p. 1). In addition to the interests of practitioners and stakeholders, there is also an increasing focus on research relating to innovation in the humanitarian sector from academics. Although such research is scant in spite of its relevance when it comes to humanitarian supply chain management (HSCM) (Su, et al., 2011; Munksgaard, et al., 2014; Pedrosa, et al., 2015).

Research on innovation in humanitarian supply chains does exist, but it is scattered and difficult to find. With this in mind, this paper conducts a systematic literature review (SLR) to identify relevant literature, to categorise it, and to identify the gaps in research to guide the next generation of humanitarian innovation research towards filling those gaps. The overall aim of the paper is to develop a conceptual framework for the classification of this literature.

Importantly, the challenge facing the humanitarian logistician is, arguably, more complex than that found in the 'for profit' environment given its multiple stakeholders and the prominence of non-government organisations (NGOs), United Nations agencies and the Red Cross movement, and governmental actors. Humanitarian organisations face an unknown demand regarding location, quantity and timing as well as physical and communications infrastructure challenges.

Additionally, there is a need for a swift response as the failure of the supply chain can lead to death or unnecessary suffering rather than simply reduced profits (Kovács & Spens, 2007; Tatham & Pettit, 2010). These characteristics lead to volatile and unstable supply chains with multiple actors which, at least in theory, need to coordinate their response. Also, there are challenges of operating in a crisis or complex emergency (which often takes place in a contested environment) and which not only impacts on the logistician but also adds a further dimension to the achievement of access to the beneficiaries.

These particularities of the humanitarian supply chain would hint to a different approach to supply chain innovation than in the private sector. Indeed, Flint et al. (2005) highlight the importance of customer clue gathering activities and negotiating and clarifying activities that lead to inter-organisational learning and logistics innovation. This logistics innovation process contrasts to the humanitarian context where the customer is a beneficiary with little negotiating power over the services provided. Furthermore, Grawe et al. (2009) in a review of logistics innovation highlight environmental factors such as regulation of logistics based inter-firm competition and a shortage of capital created a need for innovation. Although humanitarian organisations compete over funding, they do not follow a similar model of competition through logistics found in the private sector as humanitarian organisations actively try to coordinate supply chain activities. The potential for different approaches to supply chain innovation as well as increasing interest from practitioners and academics create a need to understand the current state of the literature and help orient further research and which this paper tries to address.

Definitions

Supply chains play a dual role about innovation in that (a) innovation transforms supply chains, and (b) supply chains can facilitate the spread of innovations between organisations. Thus, in one of the first papers to discuss innovation in logistics, Flint et al. (2005, p.114) offered the following definition: "[...] any logistics related service from the basic to the complex that is seen as new or helpful to a particular focal audience." Indeed, this approach in which innovation is defined as "newness" as innovation is found more broadly in the literature, (e.g. Rogers, 1995). Therefore the above definition of innovation will be used in this paper, not least as it will avoid artificially constraining the subsequent review of the literature. For HSCM, we adopt the frequently quoted definition of humanitarian logistics put forward by Thomas and Kopczak in 2005 where:

> *Humanitarian logistics is 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 meeting the end beneficiaries' requirements. (Thomas & Kopczak, 2005, p. 60)*

Also, following the disaster relief cycle, we include preparedness and reconstruction activities across different geographic locations and through multiple stakeholders in our understanding of HSCM.

Methodology

Systematic literature reviews (SLRs) aim to synthesise findings and draw comparisons from a collection of studies especially in the case of heterogeneous data (Tranfield, et al., 2003), and this

research method has been adopted in logistic and supply chain management research across a wide range of topics. Table 1 highlights a series of examples of articles that use systematic reviews as well as the topic they try to address.

Table 1: Examples of SLRs in supply chain management:

Article	Topic
Touboulic and Walker (2015)	Review theories in sustainable supply chain management.
Wong et al. (2015)	Review of the integration of environmental management in supply chains.
Hoehenstein et al. (2015)	Review of the phenomenon of supply chain resilience.
Olhager et al. (2015)	Review of the design of global production and distribution networks.
Durach et al. (2015)	Review of the antecedents and dimensions of supply chain robustness.
Habib et al. (2015)	Review of the strategic responses to power dominance in buyer-supplier relationships.
Meixell and Luoma (2015)	Review of stakeholder pressure in sustainable supply chain management.

All of these SLRs follow a Denyer and Tranfield's (2009) structure, which consists of five steps: (1) question formulation, (2) locating studies, (3) study selection and evaluation, (4) analysis and synthesis, and (5) reporting and using the results.

This structure guides the rest of this paper. To meet the aim of identifying gaps and developing an appropriate framework for future research the literature review begins with the formulation of two questions:

- Which factors affect humanitarian supply chain innovation?
- How does humanitarian supply chain innovation help improve the performance of such supply chains?

This rest of this methodology section lays out the steps relevant to the Denver and Tranfield (2009) 'study selection and evaluation' and the 'analysis' element of the 'analysis and synthesis' stages before moving to the next section of findings and discussion.

The relevant literature was selected based on a series of specific criteria, with searches undertaken for scholarly peer-reviewed articles on the Proquest, EBSCO, Emerald Insight and Science Direct databases. The search period covered the dates of 1990/01/01 to 2017/31/07. The date of 1990 was selected as humanitarian organisations were "[...] becoming bureaucratized, developing spheres of

competence, and rules to standardise responses and to drive means-ends calculations. Professionalism followed, with demands for actors who had specific knowledge, vocational qualifications that derived from specialised training, and the ability to follow fixed doctrine" (Barnett, 2005, p. 729).

An initial search was undertaken to narrow down the articles and target those specifically focused on innovation using the following keywords in the whole text: (innovat* AND humanitarian AND (supply chain* OR logistic*)), thereby identifying articles where the word innovation was present. However, this search excluded papers where innovation is discussed but not mentioned as through the word "innovation". Thus, to extend the review to capture these potential articles an additional search was carried out. This new search was done on the paper's abstract to include and focused on three new type of keywords. The first type of keywords focused on the principle of innovation as "newness" and as a transformation of something which can sometimes include technology or knowledge. The second types of keywords follow the '4P' (product, process, position and paradigm) model of innovation developed by Francis and Bessant (2005). Finally, the third type of keywords aimed to expand the HSCM context to include disasters, relief and operations. This additional search used the following Boolean operators: ((innovat* OR new* OR novel* OR Technolog* OR knowledge* OR transform* OR improv* OR change OR process* OR paradigm* OR product* OR service* OR position*) AND (humanitarian* OR disaster* OR relief*) AND (operation* OR supply chain* OR logistic*)). From the initial selection of 26 articles a trend in innovation topic was identified, and a third search was done to cover the relevant topics according to the following keywords: ((Radio frequency identification) OR (Building Back Better Communities) OR (Unmanned aerial vehicle) OR (Vehicle-sharing) OR (Radio frequency identification) OR (Volunteered geographic information) OR (Technology transfer) OR (Cloud computing) OR (Fourth-party logistics) OR (Mobile phone) OR (Mobile technologies) OR (Information systems) OR (Additive manufacturing) OR (Unmanned aerial system) OR (Hybrid cargo airships) OR (Information Systems) OR (Radio frequency identification) OR (Crowdsourcing) OR (4pl) OR (BBBC) OR (UAV) OR (RFID) OR (3D printing) OR (RFID) OR (Unmanned aerial vehicle) OR (Remotely piloted aircraft systems) OR (Drone) OR (Satellite technology)) AND (humanitarian* OR disaster* OR relief*) AND (operation* OR supply chain* OR logistic*)

When combined, these searches resulted in a total of 8,915 articles first evaluated on their titles, and this led to the down-selection of 620 articles. The evaluation of the abstract of each of these articles resulted in a final selection of 32 articles based on the definitions set out previously in the paper which represent a broad range of innovation in humanitarian supply chains. The articles were then reviewed and coded by a team of researchers.

An initial framework was developed based on one of the first literature reviews on logistic innovation done by Grawe (2009) in which the author highlights the importance of the antecedents and outcomes of logistics innovation. Grawe's framework discusses the role of both environmental and organisational factors, and how they can lead to logistics innovation and subsequent competitive advantage. This paper adapts Grawe's framework in three ways: First, we replace the organisational factors by factors relevant to the humanitarian context based on the literature review

developed by Kovács & Spens (2007) which highlight the importance of disaster phases, stakeholders and a geographical perspective. The framework of these authors emphasizes the linkage between stakeholders, the disaster phase(s) and a geographical perspective. Second, to obtain a further level of detail in the analysis of innovations, the type of innovation is identified based on the '4P' model of product, process, position and paradigm from Francis and Bessant (2005). Third, instead of focusing on competitive advantage, this paper considers performance outcomes – a necessary adjustment that reflects the reality that, unlike their 'for profit' counterparts, competitive advantage is not the goal of humanitarian organisations. Figure 1 illustrates the initial framework.

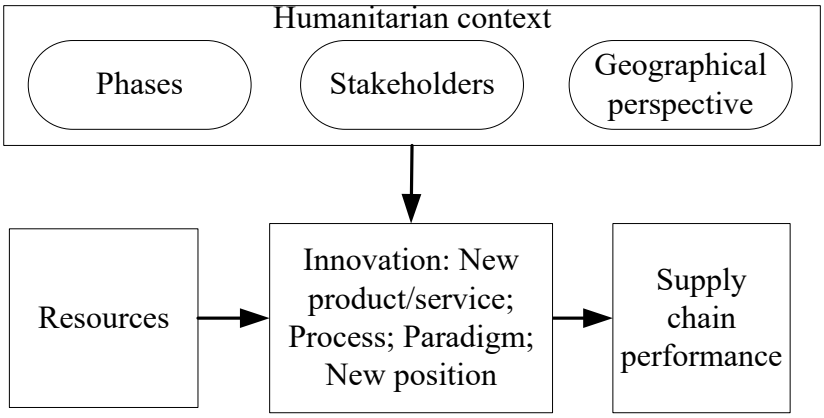

Figure 1: Initial framework to guide the literature review

Several different methods have been used to develop literature reviews, with the main approaches being: aggregation, integration, interpretation and explanation (Rousseau, et al., 2008). The "synthesis by integration" approach was selected for this research as it is most appropriate for literature reviews which include multiple data collection methods, and which employ pre-determined questions and selection criteria (Rousseau, et al., 2008). Synthesis by integration aims to collect and compare evidence across multiple data collection methods and employs predetermined questions and selection criteria. Both judgement and interpretation are crucial with this approach, and the outcome helps develop both declarative knowledge (what are the facts) as well as procedural knowledge (how to use the facts). This duality of knowledge creates an understanding of what factors constitutes humanitarian supply chain innovation, how these factors interact and what outcomes they create.

The coding process follows, a two-step process. First, the themes put forward in the initial framework (Figure 1) help develop a thematic coding approach. Second, an open coding approach help organize emerging themes to identify the areas of focus of the innovation and the different types of innovation outcomes an open coding approach. Certain themes were present in only a single article but are still put forward as relevant to the overall findings.

Descriptive analysis

As indicated earlier, the search process led to the selection of 32 articles and, although this was undertaken across the period 1990/01/01 to 2017/31/07, there are no relevant papers before 2011. Figure 2 shows the distribution of papers for the period 2011-2017 where the topic of innovation in humanitarian supply chains, although remaining limited, has increased slightly over time. Table 2 identifies the journal for the selected papers; the range of these journals highlights the background and cross-disciplinary context of humanitarian supply chain innovation. Indeed, there are eleven papers from logistics and supply chain management journals, eight from operations management journals, three from Procedia Engineering conference submissions and one from a general management journal. Furthermore, the literature review identifies five relevant papers in information and technology journals, three in disaster management journals and one in a health journal.

Figure 2: distribution of publications per year:

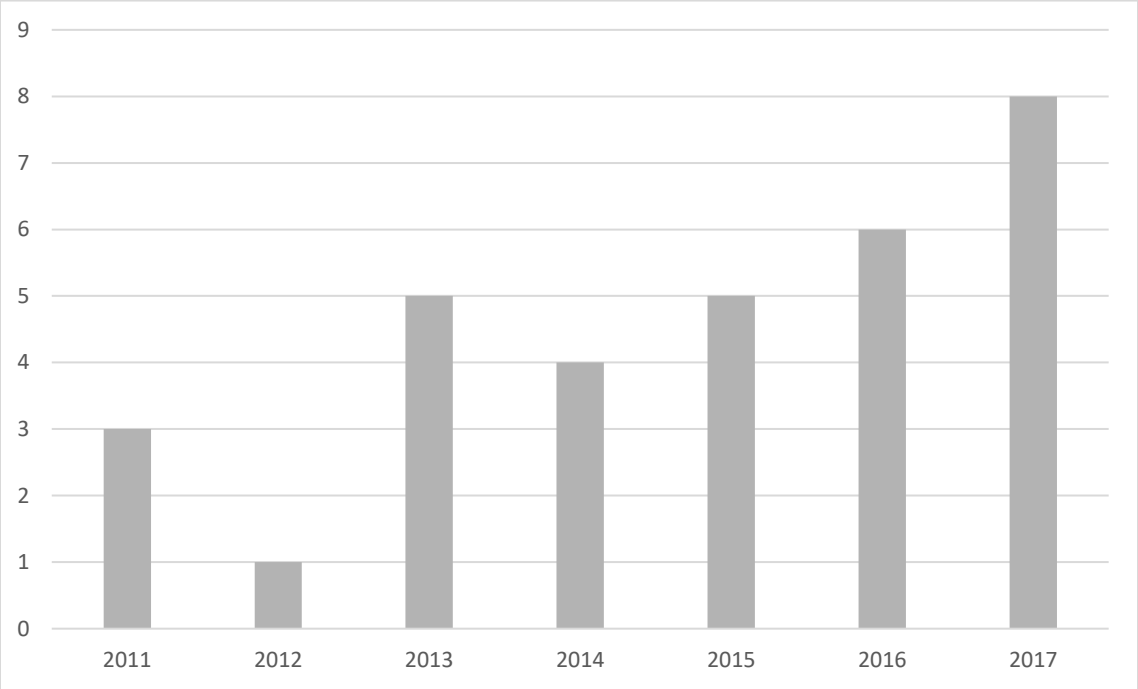

Table 2: Journals and their respective number of selected papers:

Journal	Number of papers per journal
Journal of Humanitarian Logistics and Supply Chain Management	10
Procedia Engineering	3
Production and Operations Management	3

Transportation Research Part C	2
Annual Reviews in Control; Automation in Construction; Disaster Prevention and Management; European Journal of Operational Research; Info; Information Technologies & International Development; International Journal of Production Economics; International Journal of Disaster Resilience in the Built Environment; International Journal of Disaster Risk Reduction; Journal of Network and Computer Applications; Omega; Supply Chain Management: An International Journal; Thunderbird International Business Review; Vaccine	1 each

Findings

To understand the factors that affect humanitarian supply chain innovation as well as how such innovations help to improve humanitarian supply chain performance, this review analyses the contribution of the 32 selected papers. It is not only the type of innovation but also the general context for innovation that does much to shape the resulting outcomes. Haavisto & Kovács (2015) even noted that the impact of innovation is not necessarily positive as innovation in one sector could even hamper the resilience of another area with regards to HSCM. Thus the categorisation of innovation in humanitarian supply chains needs to pay attention to the type of innovation itself, the context of the innovation, as well as its potential impact.

Table 4 identifies four characteristics- disaster phase, actor, location and focus area- as relevant aspects of the humanitarian context for each type of innovations. As for the innovation itself, the categorisation in Table 4 follows Francis & Bessant's (2005) 4P model. However, given that the HSCM literature includes a stronger logistics service focus, we further separated products and services in the table. Furthermore, one may, of course, debate whether an unmanned vehicle is a new product or a new technology; in any case, it supports relief distribution rather than being a relief item. Even so, it is possible to furthe.r subdivide the "new product" category into innovations with regards to relief items vs innovations that support the delivery of relief items. Given that our SLR has focused on HSCM, not surprisingly, our findings are geared towards innovations supporting logistical activities (i.e. new types of vehicles) rather than new relief items.

While the 4P model was useful in understanding innovations in the humanitarian supply chain, as the analysis shows, some articles discussed innovations that included multiple categories of the 4P model at the same time. For example, 3D printing (Tatham et al., 2015), in itself a new manufacturing process, also leads to a paradigm shift in the thinking about humanitarian supply chains concerning their supply chain configuration, the choice of suppliers, and the delivery mechanism. When faced with an important change that, because of one or multiple innovations creates a new supply chain paradigm, the category put forward is that of a new paradigm instead of a split across multiple innovations. Other innovations such as tracking and tracing also include a duality where a new product (such as a RFID chip) enables new services to improve tracking and tracing, in such cases the application is considered a new service in Table 4.

Table 4: Four characteristics of humanitarian context by innovation type

Innovation type (Francis & Bessant, 2005)	**Disaster phase (1)**	**Actors (2)**	**Locations (3)**	**Focus area(4)**	**Examples from articles**
New product	Immediate response	Humanitarian organisations	Field (last-mile)	Relief distribution; Relief items	UAVs/drones (Chowdhury et al., 2017; Haidari et al., 2016; Tatham et al., 2017a); autonomous vehicles (Mosterman et al., 2014); medical maggots (Tatham et al., 2017b); hybrid cargo airships (Tatham et al., 2017c).
New service	All phases; primarily preparedness and immediate response	Logistic service providers; humanitarian organisations; beneficiaries.	All locations; regional; field.	Collaboration; relief distribution; pre-positioning.	4PL services (Abidi et al., 2015); tracking & tracing (Baldini et al., 2012; Delmonteil & Rancourt, 2017; Ergun et al., 2014; Ozguven & Ozbay, 2013; Ozguven & Ozbay, 2015; Yang et al., 2011); inventory pre-positioning (Dufour et al., 2017); web-based service for evacuation (Hadiguna et al., 2014).
New process	All phases; primarily preparedness and immediate response.	Beneficiaries; humanitarian organisations; donors.	All locations; HQ; field; regional.	Relief distribution; inventory management; needs assessment; procurement.	GIS for pre-positioning equipment (Chen et al., 2011); public procurement for innovation (Haavisto & Kovács, 2015); management of medical technology transfer (Santos et al. 2016); new funding mechanism for inventory allocation (Natarajan & Swaminatha, 2017); cloud computing for information sharing (Schniederjans et al., 2016); decision making through mobile phones (Serrato-Garcia et al., 2016); information systems implementation management in the field (Tussime & Byrne, 2011); information gathering through voice-enabled technology (Waidyanatha et al., 2013); order facilitation for stressful environments (Barnes et al., 2014).
New paradigm	All phases.	Donors; beneficiaries.	Field.	Beneficiary; supplier management; donors.	Paradigm shift through cash transfer programmes (Abushaikhaa & Schumann-Bölsche, 2016), or 3D printing (Tatham et al., 2015); best practice design (Bornstein et al., 2013); sharing economy for relief distribution (Hirschinger et al., 2016); use of local knowledge / capacity in humanitarian logistics (Sheppard et al., 2013; Sodhi & Tang, 2014).

The disaster phase column indicates the phase an innovation targets in disaster relief, based on Kovács & Spens' (2007) phase model of preparedness – immediate response – reconstruction. For example, the use of drones is primarily put forward for needs assessment and relief distribution in the immediate response phase of disaster relief. In contrast to the use of drones for distribution during response, innovations for tracking and tracing with RFIDs are present in all phases (Yang, et al., 2011; Baldini, et al., 2012; Ozguven & Ozbay, 2013; Ozguven & Ozbay, 2015). Solutions pertinent to all phases are often complex and require a central management function to oversee the implementation of relevant standards across the supply chain; this in turns makes the innovation present at multiple locations across the supply chain.

Next, the table indicates which actors an innovation is targeted at, using Heaslip et al.'s (2012) differentiation across actors and stakeholders in disaster relief. There are some articles which address other actors than humanitarian organisations. One article on new services discusses the role of logistics service providers for the humanitarian context (Abidi, et al., 2015). Another two articles discuss the role of donors, one through a new process of inventory financing (Natarajan & Swaminatha, 2017) and another through a new paradigm where the donors organise a contest as a request for proposal to find the best design for reconstruction (Bornstein, et al., 2013).

Interestingly, some of these innovations include the beneficiaries. For example, Hirschinger et al. (2016) discuss the use of sharing economy principles for relief distribution by beneficiaries themselves. The inclusion of beneficiaries as "actors" is somewhat surprising as this approach itself is disputed in HSCM literature (Heaslip et al., 2012). Usually, the literature identifies beneficiaries only as aid recipients, yet several examples from the innovation in HSCM literature grant them more in-depth roles. Innovations in this category can be new processes which offer different approaches to obtaining needs information through the use of mobile phone applications (Waidyanatha, et al., 2013; Abushaikha & Schumann-Bölsche, 2016; Serrato-Garcia, et al., 2016).

Another approach for beneficiary involvement considers potential paradigm changes involving the activities undertaken by the beneficiaries where the beneficiary could take on a role in the supply chain of humanitarian organisations. One such article discusses the use of micro-retailers and cash vouchers to organise the immediate response and to improve last-mile distribution to affected communities (Sodhi & Tang, 2014). Another article focuses on increasing the involvement of local populations with a systemic change to funding, training, and command and control (Sheppard, et al., 2013). The articles that advance the concept of co-opting the beneficiary argue that the beneficiary is best placed to know what is required in the context of a humanitarian crisis as well as provide resources about supply chain activities. This co-optation results in a paradigm shift as, in this model, the beneficiary is directly involved in making decisions about the resources that should be prepositioned or distributed and this, in turn, simplifies the decision-making by humanitarian organisations. Such an approach would lead humanitarian organisations to relinquish some of the control of their supply chain to let the beneficiary manage a particular aspect of the aid flow.

Additionally, Table 4 shows the geographical location for the innovations. Some are decidedly for the headquarters (HQ) levels of organisations, while those focusing on last mile relief distribution are dedicated to field logisticians. Kovács and Spens (2007) highlight the importance of regional and extra-regional actors which undertake different roles during preparedness but interact during

the response. However, in the literature review, the regional perspective was not highlighted. Rather, apart from the literature that focused on including the beneficiary, distinctions about the location of an innovation centred on an organisational perspective: the headquarters level, regional levels, and the field level, as well as across all levels. At the headquarters level, the literature considered preparedness activities with new processes for improving procurement activities (Haavisto & Kovács, 2015). At the regional level, there was a discussion of new processes relating to IT implementation activities (Tusiime & Byrne, 2011), as well as new services for regional warehouse activities (Dufour, et al., 2017).

Innovations in the field which do not cover all phases include new paradigms as well as new products. New products are often relevant in the context of transportation towards the last mile with the example of UAVs found in multiple articles (Chowdhury et al., 2017; Haidari et al., 2016; Tatham et al., 2017a). Another innovation which is field specific is paradigm changes which include activities with the beneficiaries such as beneficiary co-optation into the supply chain. Finally, an innovation that is field specific and falls into the new process category focuses on needs assessment where technology helps reaching out to the beneficiary for information.

Last but not least, the table shows the different logistical focal areas for the innovations; whether they are to assist and support needs assessment, relief distribution, pre-positioning, inventory management, or the collaboration between humanitarian organisations. For example, new processes include a new form of donor funding to improve inventory availability (Natarajan & Swaminatha, 2017) and information management through cloud computing (Schniederjans, et al., 2016).

Notably, two of the 32 articles focus on innovation diffusion (Haavisto & Kovács, 2015; Santos et al., 2016), while two others do not directly discuss a particular innovation. Anjomshoae et al. (2017) propose a dynamic balanced scorecard for supply chain for humanitarian organisations that includes innovation management as part of perspectives on learning and innovation. Özdamar & Ertem (2015) review the use of mathematical models and geographic information systems for routing purposes and their relation to different disaster phases.

Table 5: Organisational resources and supply chain outcome for innovation types

Innovation type	Resources	Expected performance
New Paradigm	Local knowledge; Financial incentives; Technology	Improved livelihood; Service; Resilience; Effectiveness; Efficiency
New process	Financial incentives; Collaboration; Technology	Service; Efficiency; Innovation diffusion; Effectiveness, Flexibility, Information Management
New product	Technology	Flexibility; Effectiveness; Efficiency; Service
New service	Technology; Collaboration	Efficiency; Effectiveness; Flexibility; Security; Information Management; Service

Beyond the environmental characteristics of the humanitarian context, there are also organisational factors that, based on the resources available, will influence supply chain innovation outcomes. Table 5 puts forward the organisational resources and supply chain outcomes identified for each innovation type. Grawe (2009) in his review of logistics innovation identifies knowledge, technology, relationship networks, financial resources and management resources as different organisational factors that drive innovation. Similar factors are present within a humanitarian organisation's management of supply chain innovation. These resources include networks, technology, financial resources and knowledge which may/may not be combined.

For new paradigms where the beneficiary is involved in the innovation, the primary factor is the local knowledge from the beneficiaries who are perceived to have better knowledge of their capacity and need (Sheppard, et al., 2013; Sodhi & Tang, 2014; Hirschinger, et al., 2016). The new paradigm that concern 3D printing uses a particular technology (Tatham, et al., 2015) while the new paradigm which focuses on supplier management includes the use of financial incentives by donors to promote their innovative ideas (Bornstein, et al., 2013). Donor financing (and its limitations) can also create new processes through funding availability shortcomings prompting humanitarian organisations to search for new funding mechanisms (Natarajan & Swaminatha, 2017). Finally, financial incentives are also used to apply pressure on suppliers to obtain innovative solutions (Haavisto & Kovács, 2015).

Another resource is a network of actors which collaborate to implement a new process. Such networks can revolve around the sharing of technology such as medical equipment (Santos, et al., 2016) or sharing of information through IT systems (Serrato-Garcia, et al., 2016). New processes which focus on information management might also be developed using only IT systems with services available such as the use of cloud computing (Schniederjans, et al., 2016). New processes for information also include the development of simple applications to simplify the process of accessing beneficiary information (Waidyanatha, et al., 2013), or to improve internal processes of tracking and tracing (Tusiime & Byrne, 2011).

Except for those new processes which include financial incentives as well as complex information systems such as Cloud Computing, all new processes are developed internally by new organisations to reorganise their activities. Turning to new products, these can reflect multiple technology systems integrated together, for example automated and/or remotely controlled vehicles (Mosterman, et al., 2014; Haidari, et al., 2016; Chowdhury, et al., 2017; Tatham, et al., 2017a; Tatham, et al., 2017b). New products can also come as complete solutions such as hybrid cargo ships (Tatham, et al., 2017c). New services include IT systems with the development of decision-making tools for disaster response (Hadiguna, et al., 2014) and managing the UNHRD network depot (Dufour, et al., 2017). Another approach is to develop relevant services offers through external 4PL services (Abidi, et al., 2015). Finally new services will also focus on tracking and tracing and extensive and resilient technology networks for multiple solutions with RFID systems (Yang, et al., 2011; Baldini, et al., 2012; Ozguven & Ozbay, 2013; Ozguven & Ozbay, 2015) and satellite technologies (Delmonteil & Rancourt, 2017).

The outcomes of innovations vary across the literature, and not all articles highlight a supply chain transformation as their innovation. For instance, in the case of new processes to manage innovation

in procurement, the outcome is innovation diffusion (Haavisto & Kovács, 2015). One result of some new processes or services is an improvement in information management with an increase in the scope of coverage or the quality of the information provided (Tusiime & Byrne, 2011; Yang, et al., 2011; Waidyanatha, et al., 2013; Serrato-Garcia, et al., 2016; Delmonteil & Rancourt, 2017). The assumption is that improving information management will help a humanitarian organisation make better decisions and enhance its performance. Innovations can also have multiple performance outcomes combined with efficiency, effectiveness, flexibility, service level, livelihood improvements and resilience. Effectiveness focuses on the proper use of resources, efficiency focuses on managing costs, while flexibility focuses on being responsive to unexpected events. Furthermore, an innovation that focuses on service levels can cover different issues such as beneficiary access, the speed of response or specific health outcomes. Innovations which include resilience and improved livelihoods are linked to new paradigms where the local population is involved (Sodhi & Tang, 2014; Hirschinger, et al., 2016). Outside of this association, there is no clear link between the area of focus or type of innovation which relates to a particular performance outcome.

While limited, there are a few articles which discuss potential barriers to innovation implementation. Ergun et al. (2014) put forward the role of costs of technology which influences the adoption. Delmonteil and Rancourt (2017) also suggest costs as well as lack of skill and training needs, resource investments and cooperation with technology providers. Dufour et al. (2017) highlight the lack of capital, storage capacity or need for buying large quantities in the context of a regional warehouse service. Santos et al. (2016) specifically study the role of barriers to technology transfer between organizations and they highlight the following issues: difficulties with compliance to standards, lack of supply and servicing, lack of appropriate testing, uncertainty on the local setting and changes of priorities, challenges for transportation and implementation, lack of expertise and training, lack of equipment use, partial media coverage, non-adherence to humanitarian principles, creation of aid dependency and unclear processes for transition. There is only one article showing an example of a failed innovation which concerns the use of a request for proposal for BBBC reconstruction where proposed solutions did not match relevant beneficiary requirements as the beneficiaries were not involved (Bornstein, et al., 2013). This negative outcome highlights the importance of beneficiary involvement in reconstruction activities.

Finally, two articles discuss innovation management approaches. The first article by (Tusiime & Byrne, 2011) goes in depth on the issue of innovation adoption and discusses the multitude of adoption perspectives which usually follow step by step phases of evaluation, awareness, initiation and pre-adoption. However, Tusiime & Byrne (2011) note that the unique characteristics of the humanitarian context require to go beyond traditional innovation adoption phase models and adopt a translation model. In this type of model, innovations encompassing different network actors shape the outcome. This approach is relevant to the humanitarian context where field implementation can have different challenges from location to location.

The second article by Anjomshoae et al. (2017) proposes a dynamic balanced scorecard for supply chain for humanitarian relief organisations' performance management. This dynamic balanced scoreboard includes innovation management as part of perspectives on learning and innovation. The authors put forward two ways that innovation management can help humanitarian organisations: 1) information capital and knowledge management for continuous improvement and adoption of best practices and 2) human resource management for staff training and management

and organisational capital to nurture leadership and improve coordination. These perspectives aim to improve the service quality and depend on proper budget, cost and fund management. (Anjomshoae, et al., 2017).

Figure 3 offers a comprehensive framework based on our analysis; its use makes it possible to understand both the context and resources that shape innovations in humanitarian supply chains and also to identify the output of the innovation process and the barriers which hinder innovation. In doing so, the framework highlights the different area of focus for innovation in humanitarian supply chains as well as the multiple potential outcomes of such innovations.

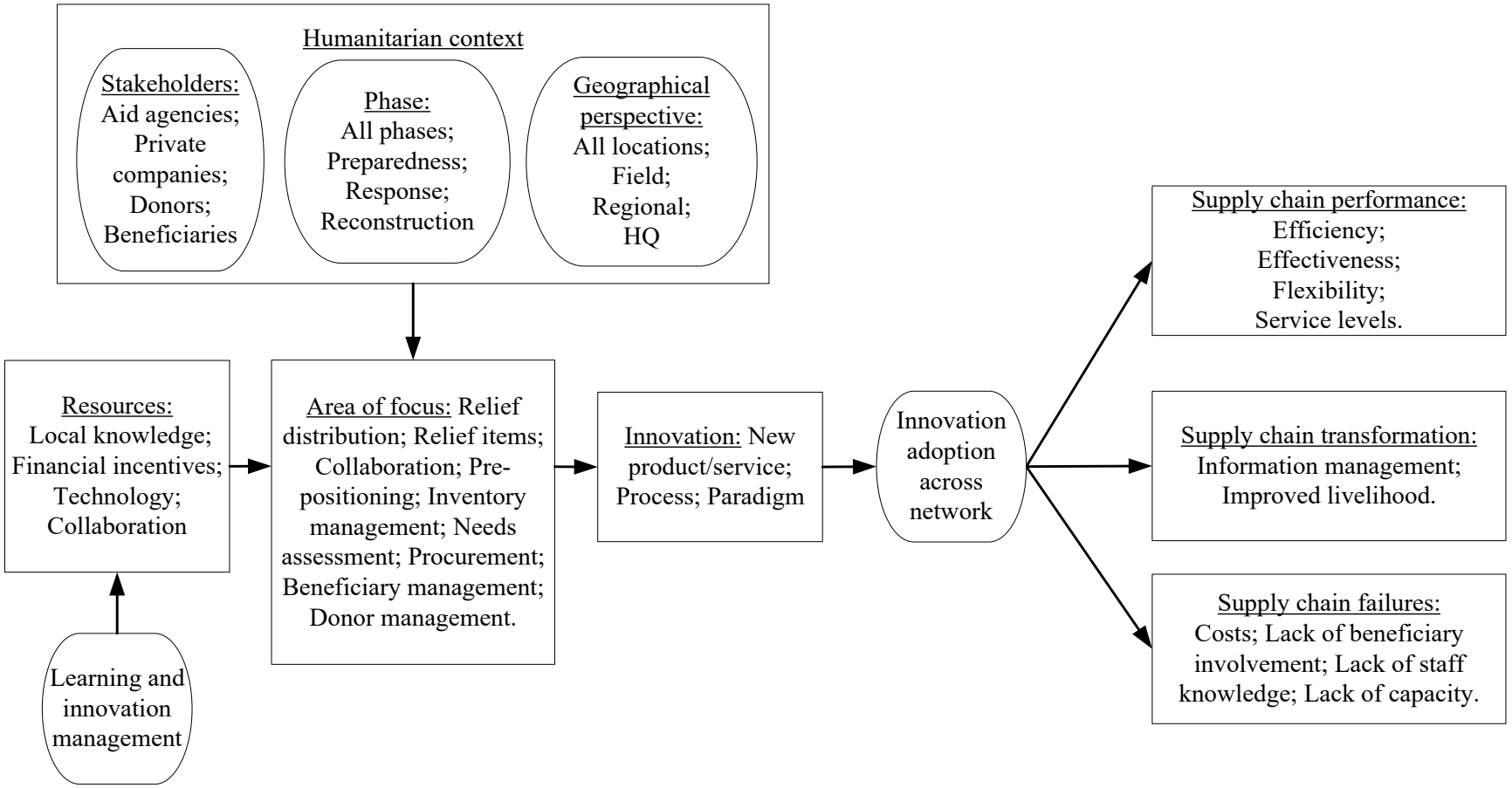

Figure 3: comprehensive framework for innovation in humanitarian supply chains

Discussion

The systematic review presented in this paper analyses the content of literature which details innovation in humanitarian supply chains; this section summarises our findings. The first observation is the general paucity of literature on this topic, with only thirty-two articles uncovered. Thus, there are significant gaps in some topic areas, while in other cases, only a small number of articles cover a 25 year period.

One clear gap when it comes to innovation types is a lack of innovation concerning 'position'; this is not surprising given its link to marketing but in light of the inevitable need for humanitarian supply chains to continue to develop, further consideration of position innovation would seem to be warranted. Indeed, as a general statement, current donor practice is to punish mismanagement of funds (the big stick approach) but, in future, donors might express a preference for supporting organisations which can demonstrate a high level of efficiency (the carrot approach) (Beamon & Balcik, 2008). In this respect, the management of the supply chain could play a vital role in positioning an organisation in ways that meet the donor's aspirations and creating an improved internal organisation model that delivers the desired operational improvements. Another gap found about innovation types is related to new paradigms, more precisely the lack of "inner-directed paradigms" which focuses on how the organisation perceives itself (Francis & Bessant, 2005). All new paradigms are "outer-directed" paradigms which focus on how the supply chain interacts with its environment. Further research on how organisational identity changes impact supply chain or how supply chain impacts organizational identity could help understand new paradigms created internally.

A new development in the humanitarian context is the appearance of new stakeholders with the co-optation of beneficiaries as supply chain actors; usually, beneficiaries are considered simple aid recipients. However, these new stakeholders play a role in offering the relevant capacity to complement humanitarian organisation supply chains; this, in turn, redefines the boundaries of the supply chain. Interestingly, in some senses, this brings humanitarian supply chains closer to their 'for profit' counterparts in that it reinforces the role of the beneficiary as a pseudo-customer (with aims, aspirations, desires, etc.). Since the beneficiary is not usually the one accountable to donors, this new paradigm can potentially create a difficult trade-off for humanitarian organisations between beneficiary co-optation and ensure appropriate last mile distribution. This trade-off is exacerbated further by the fact that co-optation implies that humanitarian organisations surrender some control of the supply chain to let the beneficiary manage a specific aspect of aid flow.

An additional gap in regards to the beneficiary is the lack of articles which highlight ways to include the beneficiary to shape innovations which do coopt them. Indeed, Flint et al. (2005) highlight the importance of gathering customer clues to help generate relevant logistics innovations. Developing a better understanding of the role of the beneficiary in the success of supply chain innovations is thus relevant especially when considering that one article highlights the failure of innovation through procurement because of the lack of beneficiary involvement (Bornstein, et al., 2013).

There is also a gap in the absence of discussion of the role of volunteers that support and organise data entry for geographic information systems and technologies. With the advent of Web 2.0 Technologies, volunteers are now being involved in generating and analysing information during

a crisis (Roche, et al., 2013). This type of activity is useful for stakeholders to obtain data to support decision-making and update maps which are relevant for logistics activities when elaborating emergency plans and scenarios or when immediate access to geographic information is required.

When it comes to the issue of phases, the literature review reinforces the notion that supply chains act as a bridge between preparedness, response and reconstruction. Indeed, certain innovations are relevant across all phases as they contribute to integrating activities in the whole supply chain. Although the geographic reach of the supply chain is under consideration with innovation spanning multiple locations, there is a limited discussion of the role of local NGOs or local implementing partners. Furthermore, the articles reviewed take an organisation centric perspective, and this leaves a gap concerning research on innovation which explores the interplay between regional and extra-regional actors. These regional actors and their links to extra-regional humanitarian organisations can influence the overall humanitarian supply chains and, thus, might well impact innovations and their implementation.

An additional finding in regards to both phases and geographic context is that innovations which span a wider range of phases and locations are, unsurprisingly, more complex than innovations that focus on a single location or phase. However, such innovations offered by academia often involve the use of complex technologies, and this raises clear questions over the viability of the proposed solutions in a field setting. As a result, further research should focus on understanding the field-based implementation of complex solutions in humanitarian supply chains. Field-based research would bring additional insights and help translate proposed academic innovations into applied outcomes.

The review has also identified a range of relevant resources which help with the development of innovations. Even though the role of the beneficiaries' local knowledge is perceived to be important, there is a limited discussion of the role of individual staff knowledge. That said, there is some research into competencies and skills in humanitarian supply chains (Kovács, et al., 2012; Allen, et al., 2013), but this area would appear to merit further investigation. In addition to the study of staff knowledge, further research is required to understand how humanitarian organisations manage innovation cycles in order to implement and develop multiple supply chain innovations, as well as to identify the distinctions between, and the impact of, incremental or radical innovations.

Concerning the types of innovation, there is some discussion around the role of products and services in shaping the supply chain either through adding new requirements, improving its performance or modifying information sharing activities. Process innovation also features, and the findings confirm their importance, of collaboration and coordination in the field with a good proportion of articles focusing on the processes to achieve this. Finally, paradigm innovation is also present, with most of these articles highlighting innovations that change the dynamics of supply chains either through reconfiguring it (e.g. 3D printing) or by transforming the decision-making model with the attendant implications for the beneficiary.

Concerning the external drivers of innovation, the research findings reinforce the notion that there is a lack of innovations developed specifically for humanitarian organisations by the private sector. Further research on incentives to underpin the development of solutions emanating from the private sector would appear to be warranted. However, there is also an important difference

regarding the origin of the innovation, with innovations through a new process often depicted as coming from inside the organisation whereas innovations through new products as coming from external solutions. This simple dichotomy by type of innovation is limited and needs to evolve as the adoption of new products often comes with new processes through changes in policies and procedures by the organisation (Tusiime & Byrne, 2011). Future research should thus focus on the mechanisms of adoption by humanitarian organisations as well as the integration of the innovation and its impact on the organisation.

There is also a gap regarding performance measurement, and this not only applies to articles which fail to offer a clear expected performance outcomes for the supply chain. Performance objectives which relate to maintaining the quality of the material in the supply chain through proper sourcing and avoiding adulterated goods are not present. Another performance issue for humanitarian supply chains which is relevant for future innovation is the role of sustainability and environmental responsibility.

Conclusion

This paper aims to identify gaps in the literature on innovation in humanitarian supply chains and to develop an appropriate framework for future research through a systematic literature review. This research provides a solid baseline for future studies with the initial framework and the findings highlighting the breadth and depth of the existing gaps.

This paper also highlights both the breadth as well as the paucity of the discussion of innovations in this field. When it comes to the role of context and available resources, this paper argues for a greater emphasis on the role of the beneficiary's supply chain capacity and relevant knowledge. In addition to this new stakeholder, certain innovations emphasise the need for integration across multiple phases. Both these perspectives demonstrate how innovation can help widen and integrate the scope of humanitarian supply chain beyond their current bounds of stakeholders, location and phase. In addition to the findings related to context and resources that shape innovation, the paper also identifies different types of innovation outcomes which focus on performance, transformation and failures. However, we acknowledge that further research would improve the presented framework through the study of internal knowledge management and innovation cycles in humanitarian organisations as well as through the study of complex innovation adoption in a field setting.

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