Extending Dynamic Capabilities towards Lean Thinking in Humanitarian Supply Chains

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Abstract

Humanitarian supply chain (HSC) research is still in its infancy and remains an enigma, due to its profound differences with the much-researched field of global supply chains. Thus, humanitarian operations (HO) remain obstinately difficult to manage, despite attempts by key stakeholders to keep abreast of all the contemporary challenges. A key concern is wastage of disaster relief materials along the supply chain, which strains already scarce resources. Moreover, humanitarian research is plagued by a dearth of theory development and redeployment of existing theories from other fields, which are critical in enhancing methodological rigour. To address these gaps, we undertake an in-depth qualitative study which draws on data from humanitarian organisations that responded to the major earthquake in Nepal (2015). Using a novel approach, we adapt the theory of constraints (TOC) and dynamic capabilities to conduct our investigation. First, we apply TOC at an analytical level to unearth the constraints perturbing HO. Second, using dynamic capabilities as an overarching theoretical lens, we draw insights which contribute towards effective HSC management. To conclude, our study contributes by extending the dynamic capabilities theory for *Lean* thinking in HO. We achieve this by proffering *'sustaining'* as a key extension of dynamic capabilities in HSC.

KEYWORDS Humanitarian Supply Chains, *Lean* Thinking, Dynamic Capabilities, Humanitarian Operations, Theory of Constraints, Nepal Earthquake

1. Introduction

The 21st century continues to suffer vicious and recurring cycles of disasters, which consequently produce untold human suffering. Thus, scholars are hard-pressed to generate solutions for various humanitarian operations (HO) challenges (Besiou and Van Wassenhove, 2020; Heaslip, 2018). At each turn, relevant stakeholders have attempted to learn and improve operational efficiency and effectiveness to alleviate the humanitarian caseload (Besiou, Pedraza-Martinez and Van Wassenhove, 2018). The coronavirus (COVID-19) pandemic has reinvigorated the debate surrounding lean philosophies in supply chain management (SCM). Food shortages during COVID-19 have prompted criticism that supply chains have become too lean resulting in slow response to sudden demand influxes (Weissman, 2020). Opposingly, COVID-19 has consequently exposed the need for lean adoptions in SCM with huge amounts of waste e.g. food generated due to high surpluses of perishable items (The Guardian, 2020).

One major challenge that has been less investigated for humanitarian supply chain (HSC) management is waste, which remains a critical problem and requires special attention (Wagner and Thakur-Weigold, 2018). It is a double-edged sword: first, it denies victims much-needed relief while simultaneously causing economic loss and costs to stakeholders, e.g. governments, non-governmental organisations (NGOs) and donors (Singh, et al., 2018). Furthermore, it violates the triple-bottom-line (TBL) approach, which underpins supply chain sustainability. TBL focuses on achieving sustainable economic, social and environmental operations along the supply chain (Touboulic and Walker, 2015). Therefore, wasting relief resources is a financial loss that can cascade and cause negative impacts in HSC. For instance, wasting food, as in when it rots in warehouses due to poor storage, becomes a social issue which cascades to an environmental challenge when it is not disposed of properly (Li, et al., 2019).

The aim of humanitarian relief operations is to reduce or circumvent loss to human life and property from disasters by appropriately planning and responding rapidly to attain effective recovery for affected people. Thus, Taylor and Pettit (2009) point out that the theory underpinning commercial supply chains is not always easily transferable to HSC, due to the main sorts of outcomes. Hence, they (Taylor & Pettit, 2009) advocate the importance of adopting certain *Lean* logistics principles to improve HSC effectiveness and efficiency. For instance, in Haiti, after the 2010 earthquake and cholera outbreak that followed, a huge amount of medical aid was donated (USAID, 2014). However, some of the medical aid was past its expiry date and some never reached its intended victims, creating a huge amount of pharmaceutical waste: this is an example of a TBL humanitarian problem. Humanitarian relief can itself lead to negative impacts on the environment. For instance, the Kosovo refugees in Kukes, Albania, suffered from severe waste dumps when relief materials with poor packaging, disposable sanitary products and human waste caused an environmental crisis (Kelly, 2004). Thus, we will investigate the implementation of a *Lean* thinking approach to detect and eliminate waste in HO, thereby increasing efficiency.

Another key issue in HO research is a gap in theory development and redeployment of existing theories from other fields, which is critical in enhancing methodological rigour and advancing humanitarian research (Kovacs and Moshtari, 2019). Hence, Oloruntoba, Hossain and Wagner (2019) advocate the importance of borrowing and deploying relevant theories to ensure that humanitarian focused research is grounded and yields better outcomes that are relevant to contemporary challenges. Acknowledging this theoretical gap, our study aims to borrow and apply two theories: (i) the theory of constraint (TOC) (Goldratt, 1990; Goldratt and Cox, 1984) and (ii) dynamic capabilities (Teece, Pisano and Shuen, 1997; Teece and Pisano, 1994). Therefore, to address the above-mentioned gaps, we are interested in investigating a) what are

the critical underlying constraints hindering effective humanitarian operations and b) in understanding how key stakeholders can integrate Lean thinking to address the identified constraints and attain effective HSC operations.

Our paper revisits the major earthquake of Nepal in 2015 and draws lessons for improving operational efficiency in HSC management. Accordingly, we apply TOC as a methodological tool to analyse and tease out the constraints perturbing humanitarian operations. Dynamic capabilities are applied as an overarching theory to evaluate stakeholder capabilities and create a framework suitable for addressing the identified constraints. Hence, our research approach is two-layered: first, we apply TOC to examine data from the Nepal earthquake in order to determine supply chain and logistical constraints (bottlenecks) in HO. Second, we use dynamic capabilities as an encapsulating theory to create a *Lean* thinking model aimed at addressing the identified constraints while simultaneously dealing with issues surrounding waste in HO. We also provide our empirical and theoretical contributions, which are to apply TOC to uncover HO constraints and the extension to dynamic capability theory. We introduce a new component, which focuses on *sustaining* to allow a cyclical process that extends dynamic capabilities to address constraints and waste through *Lean* thinking.

The structure of the remainder of the paper is as follows: in Section 2, we review the current problems encompassing waste in humanitarian operations and explain our rationale of combining TOC and DC to achieve the research goals. Section 3 explains the methodology and outlines the research methods applied in our study. This is then followed by a findings section. Section 5 focuses on our discussion based on the findings. We conclude by proposing future research avenues.

2. Humanitarian Supply Chains (HSC)

HSC research is still at an embryonic stage and requires further research in comparison to the more developed field of supply chain management (SCM) (Li, et al., 2019; Behl and Dutta, 2018). Unlike general SCM, HSC is characterised by high demand uncertainty, which requires humanitarian organisations to be able to generate robust logistics plans (Ben-Tal, et al., 2011). A fragment of this robust logistical planning includes setting up regional warehouses and prepositioning resources within local vicinities. However, Charles, et al. (2016) note in their research that most humanitarian organisations' motivation for resource location is often driven by opportunity, as opposed to logical decision-making. Hence, expediency complicates the ability to rapidly respond in a disaster, as transport considerations become more constrained by budgetary restrictions (Park, et al., 2018). While responding to rapid emergencies remains challenging, research indicates that demand forecasting for long-term development programmes is very beneficial (van der Laan, et al., 2016).

The location of the disaster is a critical factor contributing to the complexity of designing a logistics service network, as noted by Dufour, et al. (2018). These issues have elevated the importance of last-mile distribution issues, which are characterised by erratic supply and demand, making optimal operations difficult (Cook and Lodree, 2017). Another area that is problematic for HSC is the management of perishable goods (Ferreira, Arruda and Marujo, 2018). The inventory management of perishable products is also an issue that has created waste problems. Similarly, medical items are problematic due to shelf-life, some expiring within months of being manufactured or requiring cold-chain storage (Granados, 2015). Furthermore, transportation bottlenecks perturb HSC and require further research to better plan and prioritise protocols of vehicles in disaster relief zones (Gralla and Goentzel, 2018). Gralla, et al. (2016)

argue that field operation managers do not have the luxury of time and often rely on sensemaking to formulate and solve transportation problems.

Hence, when the devastating Indian Ocean tsunami of December 2004 occurred, it unearthed perilous shortcomings surrounding disaster preparedness and responsiveness, as noted in the United Nations Office for Disaster Risk Reduction (UNISDR) report (Leoni, 2014). In response to 227,000 fatalities from 14 countries across the Indian Ocean and an estimated USD$ 9.9 billion in economic damage, global stakeholders from 168 countries collaborated in Kobe, Hyogo, Japan, to draft and adopt the Hyogo Framework for Action 2005 – 2015 (HFA) (UNISDR, 2018). UNISDR was updated in 2015 to the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR). The main purpose of these frameworks is to help all stakeholders better identify and respond to the risk of natural disasters by building resilience at all levels (UNISDR, 2018). However, despite an attempt by global stakeholders to keep abreast of all the challenges perturbing humanitarian operations management (HOM), it remains obstinately challenging to manage, due to its unpredictable and uncertain nature (Tofighi, Torabi and Mansouri, 2016; Chakravarty, 2014).

For instance, the 2018 Indonesian earthquake and tsunami highlighted the devastating impact of poor decision making, coupled with inadequate technological capabilities in a crisis (BBC News, 2018). Though Indonesia has a functional but limited early warning system, a poor decision by the meteorological and geophysics agency to silence the alarm after only 30 minutes yielded disastrous consequences, with a death toll reaching 2,500 (Ellis-Petersen, 2018). The disaster highlights the myriad of challenges that make designing and managing HSC for disaster response a complicated undertaking (Behl and Dutta, 2018). Examples of these challenges and complexities include: uncertainty and dynamic conditions (Behl and

Dutta, 2018), urgent decision making (often with limited resources) and critically damaged infrastructure (Larson and Foropon, 2018; Ergun, et al., 2014).

Also, all these humanitarian operational challenges and complexities are often under the management of independent organisations, e.g. government and non-government organisations, which often have different aims and objectives and at times may hold competing ideologies (Besiou and Van Wassenhove, 2015; Kovács and Spens, 2009). However, empirical evidence from humanitarian organisations shows that *Agility* can reduce supply uncertainty through prepositioning kits and standardising software inputs and outputs (Granados, 2015).

Research has also been carried out into the effect of 'Mean Time Between Disasters' and prepositioning within humanitarian organisations, but uncertainty and data gaps mean that further research is required before it is actionable (Saputra, et al., 2015). Furthermore, non-medical items, such as generators, vehicles, blankets, communication kits, tents, etc. can range in value considerably, so prepositioning must be carefully considered to manage the cost of stock in hand. Humanitarian supply chains are unique and their logistical requirements are too broad (Holguín-Veras, et al., 2012), which in turn makes our research vital by drawing on the Nepalese context to untangle hidden insights that can advance research and practice. Current research indicates that 80% of humanitarian operational costs stem from logistics, with 40% of those wasted in poor planning and duplication of relief efforts (Gupta, et al., 2017). A viable solution is the capability to efficiently and rapidly manage volume, frequency and variety of data to achieve operational excellence (Prasad, et al., 2018). This can reduce forecasting challenges by incorporating big data to enhance the agility and leanness of HSC. Hence, forecasting for an emergency response is difficult, even with the rich input of big data, because of unpredictable dynamic environmental conditions (Chakravarty, 2014).

2.1. Waste in HSC

Humanitarian relief waste is a key challenge that continues to perturb HSC management. Key stakeholders grapple with effective methods to reduce and eliminate waste originating from disaster relief operations. Waste can be defined and classed in different ways; however, our study focuses on waste emanating from HO conducted by governmental and non-governmental organisations (NGOs) and other concerned stakeholders in response to disasters. It is critical to address this challenge, as it further compounds the issue of pre-existing waste following a major disaster, e.g. debris, human and animal remains etc. Dugar, et al. (2020) draw lessons for disaster waste management from the Nepal earthquake, which generated a vast amount of relief waste, e.g. clothes, tarps, blankets and food items. Hence, Smilowitz and Dolinskaya (2011) identify the distinguishing complexities of HSC flows by noting that not all donations and materials are 'useful, timely, or appropriate'; these materials can create high levels of waste. Increasing the level of difficulty in rectifying waste generated from HO is the lack of collaboration amongst key stakeholders, who are often working from scattered locations, which hampers the efficiency in the last-mile logistical operations (da Costa, Campos and de Mello Bandeira, 2012; Healslip, Mangan and Lalwani, 2010). For instance, Hurricane Maria in Puerto Rico witnessed grotesque levels of waste (see Figure 1), with containers abandoned at designated areas full of food, water and sanitary products (Boddiger, 2018). Airport hangers became infested with rats as the rodents ravaged through rotting food stockpiles. While many residents from Las Marias were sourcing water from streams and mountain springs, a runway in Ceiba was swamped by 20,000 pallets containing millions of unused bottles of water (Weir, 2018). The wastage is indicative of the waste issues perturbing HSC. A preliminary assessment by the US Federal Emergency Management Agency (FEMA) of the Puerto Rico humanitarian waste team identified that poor collaboration between stakeholders and a lack of

logistical capabilities by the Puerto Rican local authorities was the leading root cause (Weir, 2018).

Figure 1: Pictorial Evidence of Waste from: Nepal Earthquake, Hurricane Maria, Puerto Rico & Kenya

Photo courtesy: Agricultural Development Office (Nepal) as cited by Sangroula (2015), Eye Ubiquitous/Alamy Stock & CNN News (CNN, 2018; Hughes, 2018; Sangroula, 2015)

The waste incident is not an isolated case: in Kenya, food destined for refugees in war-torn regions in the Horn of Africa was left to rot in the open, as logistics providers failed to deliver the goods, citing security concerns (see Figure 1 above) (Hughes, 2018). The case highlights the issues surrounding transportation, which has the second-highest overhead costs after human resources (Pedraza-Martinez and Van Wassenhove, 2013; Martinez, Stapleton and Van Wassenhove, 2011). In Nepal, the Public Accounts Committee (PAC) of parliament had to intervene after the World Food Program (WFP) mistakenly distributed rotten rice in Gorkha and Kavre districts (Sangroula, 2015). This issue of waste in HSC requires comprehensive research to help humanitarian organisations reduce waste levels. In a crisis, resources are limited, and stakeholders cannot afford to lose any goods or materials. Therefore, our study aims to fill this gap in research by proffering a *Lean* thinking approach. *Lean* principles are scarce in HSC research. Cozzolino, Rossi and Conforti (2012) put forward a framework based

on *Agile* and *Lean* principles, specifically targeting actors in the operations and planning spheres of humanitarian logistics. *Lean* implementation has its roots in the manufacturing sector; for instance, Dora, Kumar and Gellynck (2016) investigated the determinants of and barriers to *Lean* principles in commercial small andmedium-sized (SME) food processors. In a comprehensive literature review by Negrão, Godinho Filho and Marodin, (2017) on the linkage between *Lean* practices and performance, the results showed that *Lean* is mainly applied in a fragmented way that ignores systematic connections. The majority of *Lean* applications have been in the production phase, regardless of industry, e.g. agrifood (Melin Barth, 2018), six-sigma application in aerospace production (Thomas, et al., 2016), and the textile industry (Hodge, et al., 2011). Based on our literature review, we adopt two main vital principles of *Lean* thinking: (i) waste elimination; (ii) alignment of supply and demand; both of these are fundamental in *Lean* thinking research (Lyons, et al., 2013).

Notably, Banomyong, Varadejsatitwong and Oloruntoba (2019) identify four distinct stages for disaster management, which key stakeholders manage in HSC: *(1) mitigation phase; (2) preparedness phase; (3) response phase; and (4) recovery phase*. Cozzolino, Rossi and Conforti (2012) investigated the most applicable stages to apply *Agile* and *Lean* principles. Their study concluded that *Agile* is most effective in the preparedness and response phase, while *Lean* principles are better suited to the recovery phase. However, due to the limited scope of *Lean* application in HOs (Cozzolino, Rossi and Conforti, 2012), it is important to further research how best it can be utilised to achieve better outcomes for victims. Hence, Shafiq and Soratana (2020) constructed a Lean Readiness Assessment Model (LRAM) to help organisations involved in humanitarian relief operations better achieve efficiency and sustainability through *Lean* management techniques. Scholars and practitioners are continually looking at various solutions to address contemporary issues, e.g. agility and resilience (Altay,

et al., 2018), collaboration (Wagner and Thakur-Weigold, 2018; Prasanna and Haavisto, 2018), vehicle and transportation issues (Pedraza-Martinez and Van Wassenhove, 2013) and innovative solutions like cash transfer programmes (Heaslip, Kovács, and Haavisto 2018).

2.2. Dynamic Capabilities (DC) in HSC Management

To the best of our knowledge, dynamic capability theory has been applied in a limited context within HSC research. Dynamic capabilities focus on *"the firm's ability to integrate, build, and reconfigure internal and external competences to address rapidly changing environments"* (Teece, Pisano and Shuen, 1997). Helfat et al. (2007) later evolved the definition of dynamic capabilities to include the ability of an organisation to "*purposefully create, extend, and modify its resource base"*. However, in humanitarian operations, we propound that the firm, as stated in dynamic capabilities theory definitions, can be substituted for humanitarian organisations. In our study, this translates to the disaster relief provided by humanitarian organisations to victims in the aftermath of the 2015 Nepal earthquake. Dynamic capabilities have mostly been applied to research agility concepts, e.g. studies by Altay, et al. (2018); L'Hermitte, et al. (2015); Blome, Schoenherr and Rexhausen, (2013). Hence, Dubey and Gunasekaran (2016) highlight dynamic sensing models as a key capability in their research, incorporating agility, which together with adaptability and alignment can build sustainability in HSC.

Dynamic capabilities can be applied to augment the resource-based view, as resources can be viewed as capabilities. Hence the 'resource base' is holistic and includes the *"tangible, intangible, and human resources"* (Helfat et al., 2007) available to humanitarian organisations that are unique to them and allow for specialisation in a type of disaster relief capability. This is underpinned by six critical principles, which are processes, learning, new assets,

transformation of existing assets, co-specialisation and asset orchestration (Teece, 2018; Teece, 2010).

The critical aspects of focusing on these tenets is that resources/competences - including dynamic capabilities - cannot easily be imitated. In a humanitarian relief scenario, different aid agencies or organisations will have diverse resources and competencies. This allows them to focus on specific missions/goals and build capabilities to accomplish them. These resources and competencies cannot usually be acquired easily, they must be developed over time (Teece, 2010). Hence, for humanitarian stakeholders to effectively evolve and co-evolve to the changing disaster relief environment, which has been worsened by climate change (Benevolenza and DeRigne, 2019), they must have the ability to align and realign their capabilities to the changing environment. Hence, sensing, seizing and transforming are critical attributes put forward by Teece (2018) as vital in enabling firms to evolve and co-evolve within their operational environment. Sensing can be viewed as the ability of humanitarian stakeholders' ability to identify opportunities to increase operational efficiency through *Lean* thinking, which could involve the use and application of technology. Seizing may be viewed as the ability of disaster relief organisations to design and refine their operating models to better achieve their goals. Transforming would involve realigning the structure and culture of disaster relief stakeholders to fully utilise existing capabilities while investing in additional capabilities.

2.3. Theory of Constraint (TOC)

The Theory of Constraint (TOC) is a management paradigm first propositioned by Dr Eliyahu Goldratt in 1984 and mainly adopts a simple but powerful assumption that most problems within organisational systems can be traced back to one or more root constraints in the process (Goldratt, 1990; Goldratt and Cox, 1984). Therefore, it is both a philosophical and methodological approach to managing constraints, which argues for organisations to identify

and manage these constraints in order to achieve operational excellence (Goldratt, 2008). TOC puts forward five cyclical steps that aim to identify a constraint, followed by prescriptive measures to subdue and eliminate the constraint (Goldratt, 1990). TOC is a cyclical process, repeated until the system has achieved the highest possible throughput. However, Goldratt (1990) notes that physical constraints are much easier to identify and manage in comparison to policy constraints, which tend to be hidden and embedded within organisational culture. Due to its power, versatility and ease of use, TOC application is common in many management research paths, e.g. operations management (Boer, et al., 2015; Gupta and Boyd, 2008; Watson, et al., 2007), production planning/scheduling (Golmohammadi, 2015), supply chain management (Puche, et al., 2016), healthcare management (Cox III and Boyd, 2018; Bisogno, et al., 2017; Nematipour, et al., 2014) and tourism services (Pérez Campdesuñer, et al., 2017). Within supply chain, there remains a gap in the application of TOC to combat the dynamic challenges of 21st-century business operations. This is evident from the comprehensive bibliometric review conducted by Ikeziri, et al., (2018), which identifies the application of TOC principles but argues for more research to yield the total benefits of this theory. Its benefits are evident in the study conducted by Modi, et al. (2018), which provides a comprehensive explanatory case study of the application of the TOC thinking process in improving the supply chain performance of one of the largest manufacturers of locks and security systems in India. TOC has also been widely applied to supply chain collaboration research (Gupta & Andersen, 2018; Puche, et al., 2016; Tsou, 2013; Simatupang, et al., 2004). TOC within collaboration research advocates for firms to realise synergies by collaborating to identify and manage constraints in the supply chain areas of inventory and replenishment management, production processes and distribution strategies. Although the potential benefits of TOC in developing strategies to enhance the performance have been under research for over a decade (Rahman, 2002), it remains a scarcity in humanitarian operations literature. Despite research by

Overstreet, et al. (2011), which applies TOC and information systems management to generate a framework for future research in humanitarian logistics, it remains a gaping hole. Therefore, we note that our study is novel in the field of HO, as we aim to address a theoretical gap by applying TOC as a methodological approach to redressing humanitarian logistical issues.

3. Methodology

3.1. Case Context: The Nepal Earthquake

The 7.8 magnitude earthquake (also referred to as the Gorkha earthquake) in Nepal in 2015 injured approximately 22,000 people and left close to 9,000 dead (WHO, 2018). It was a horrific, devastating natural disaster, the worst in Nepal since 1934. The quake's epicentre was east of Gorkha District at Barpak. The earthquake flattened villages and brought down multi-storey buildings, including UNESCO world heritage sites (UNESCO, 2016). The natural disaster led to the displacement of hundreds of thousands of people. The humanitarian crisis was further exacerbated by the hundreds of aftershocks that followed the initial quake, causing severe disruptions to disaster relief operations, consequently increasing existing risks (Bhattacharjee, 2016). Seventeen days after the initial earthquake, on 12th May 2015, another major earthquake measuring 7.3 on the Richter magnitude scale struck. According to the United Nations Development Programme (UNDP), eight million people were affected through the destruction of approximately 600,000 homes (UNDP, 2018). The most substantial impact of the quakes was in remote rural areas, which presented extremely challenging operational conditions for the disaster relief efforts (Bhattacharjee, 2016). HO were further hampered by the monsoon season from June to September, which caused landslides and increased the inaccessibility of mountainous regions. Also, poor visibility resulted in the limited use of air operations (Bhattacharjee, 2016). Due to the magnitude and the unique exogenous factors

present in the Nepal quake, we believe it provides an idiosyncratic opportunity to draw valuable empirically based insights to advance HO literature. For instance, Papadopoulos, et al. (2017) use big data from the Nepal earthquake to explain disaster resilience in sustainable supply chains and Baharmand, Comes and Lauras (2019) use data from Nepal to define network flexibility for HSCs and present a framework to measure its concepts.

3.2. Research Approach

Due to the unique nature of HSC, it is critical to use an evidence-based approach in attempting to advance knowledge (Banomyong, et al., 2019). To fulfil our research aim, we use a qualitative interpretative case study . We selected this research method because it allows for the researchers to directly interact with the participants and be intimately involved in all stages of the study from data collection to the analysis stages (Creswell and Poth, 2016; Andrade, 2009). Despite potential pitfalls concerning researcher biases which we addressed through multiple stages of thematic data analysis until consensus was reached amongest the researchers. Thus, we strongly contend that our research approach is appropriate and valid for addressing the identified HSC problems as it allows for inductive theory-building through unpacking the complexities and underlying issues in disaster relief operations (Bansal, Smith and Vaara, 2018). Our qualitative interpretative case study is underpinned by inductive theorizing which can be used to create new theories, however, in our study we apply it to elaborate the existing theories of TOC and dynamic capabilities. This method entails combining constructs and propositions to connect the constructs with the primary theoeratical tenets to uncover why those propositions can best explain the phenomenom under investigation (Gehman, et al., 2018).

Therefore, our investigation utilises 21 in-depth semi-structured interviews from INGO and NGO managers who were directly involved in the humanitarian relief activities in the earthquake aftermath. We use this powerful empirical approach as applied in previous HSC

studies (Prasanna and Haavisto, 2018) in order to draw out knowledge from frontline stakeholders involved in humanitarian operations. In-depth interviews are powerful data collection tools that can yield detailed descriptions and explanations of a phenomenon (Yin, 2014). This approach is akin to the explorative qualitative part of the pragmatic study conducted by Makepeace, Tatham and Wu, (2017) to draw meaning from the subjective knowledge and experiences of senior representatives in an INGO. Snowballing techniques were used to identify and recruit participants (Berg, 2001) for interviews from both INGOs and local NGOs senior management staff who were involved in humanitarian operations before and after the Nepal earthquake. Face to face, semi-structured, in-depth interviews were then conducted using a standardised interview protocol, thus participants were treated as 'knowledgeable agents. Snowballing techniques were continuously applied to recruit participants and undertake interviews until participants were no longer providing or yielding new insights, thus we considered this as the point of having reached data saturation (Guest, Bunce, and Johnson, 2006, p. 59). Table 1 shows the interviewees' profile indicating the participants' position, type of organisation, years of service and the specific sector of work their organisation specialised in.

Table 1: Interviewees position, organisation type, length of service and work sector

No.	Position	Organisation Type	Years	Sector of work
1.	Emergency Communications Manager	INGO	1 year	Children
2.	Supply Chain Manager	INGO	6 years	Poverty issues, feeding the children, vulnerable communities, humanitarian agencies
3	Child Protection Officer	INGO	2 years	Women and children
4	Head of Department, Logistics	INGO	2 years	Nutrition
5	Responsible for support service including logistics, finance, HR, Admin and IT	INGO	2 years	Rebuild
6	Chief Program Coordinator	INGO	4 years	Humanitarian organisation
7	Country Logistics Manager	INGO	7 years	Children and Humanitarian Organisation
8	Emergency logistic Coordination officer	INGO	NA	Infrastructure development; refugees
9	Head of Finance and Resource Management	INGO	27 years	Conflicts and disasters

10	Head Logistics	INGO	NA	Humanitarian Response
11	Logistics and Security Manager	INGO	8 years	Disable people; physical rehabilitation
12	Chairman	NGO	10 years	Social Transformation- human rights
13	Program Coordinator	NGO		Poverty Eradication- women empowerment; physical rehabilitation; social mobilisation
14	Executive Program Director	NGO	6 years	Empowering Youths and rebuilding
15 a	Program Manager for Housing Sector	NGO	9 years	Women empowerment
15 b	Program Manager	NGO	NA	Women empowerment
16	Religious Leader	INGO	NA	Humanitarian
17	Founder	NGO	2 years	Social Work
18	Program Officer	INGO	10 years	Fighting against poverty and exclusion
19	District Coordinator	NGO	2 years	Recovery
20	Executive Director	NGO	14 years	Community upliftment- food, water, sanitation, irrigation
Total Number of Interviewees				**21**

The interviews were conducted in the summer of 2016 over a six-week period. Some of the interviews with NGO staffers were conducted in Nepalese and had to be translated to English for the transcription. The average interview length was 60 minutes, with the shortest interview recording being approximately 30 minutes and the longest was over 90 minutes.

3.3. Data Analysis

A two-layered analytical technique was employed, using TOC to identify the constraints that various stakeholders involved in the Nepal earthquake encountered, and dynamic capabilities as an analysis tool to develop viable *Lean* thinking strategies. Interviews were transcribed verbatim and uploaded into NVivo for the first stage of analysis. The unit of analysis was the supply chain, with each humanitarian organisation being the subunit that was synonymous with research in this area (Fayezi and Zomorrodi, 2015). Therefore, the selected participants included supply chain managers, logistics managers, programme coordinators, etc., focusing on those with direct knowledge and control of strategic, tactical and operational decisions and activities. Using a thematic analysis, we interpret the data to tease out patterns and insights

regarding logistical and supply chain management constraints. Figure 2 illustrates the HSC tiers under investigation.

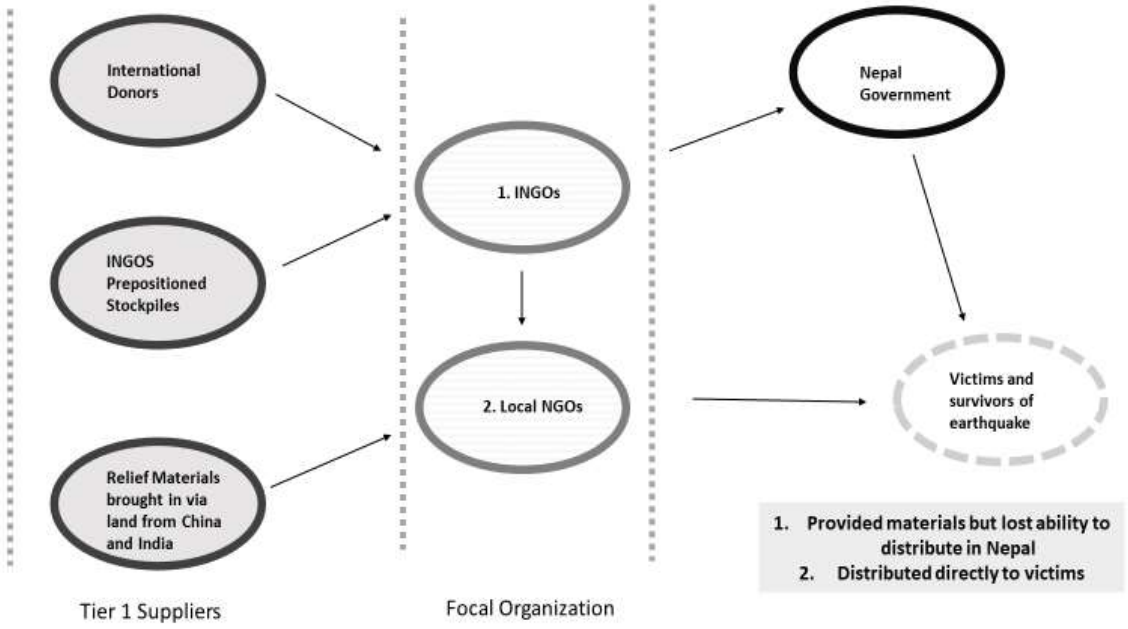

Figure 2: Nepal HSC tiers (units of analysis)

The first level of analysis involved thematic analysis to ensure rigour and validity. NVivo was used at this stage to sort out data. In the first level of analysis, all the researchers read and re-read the transcripts using NVivo to identify and mark out patterns in data. The researchers then met a number of times via SKYPE to conduct a data reduction exercise where they created categories that best answered the research problem. These codes were then combined to create themes that accurately answer the research question. The analysis applied the five critical steps outlined by Goldratt (1990) for conducting a practical TOC analysis. The second layer of analysis examined how the generated themes support the data and overarching dynamic capabilities tenets. Using researcher consensus among the authors, we reduce bias and define each theme and why it is considered interesting and appropriate to answer the research problem. This process allowed us to generate propositions which can be linked to the underlying

theoretical arguments of dynamic capabilities to develop a *Lean* thinking framework for humanitarian operations. Our analysis approach is shown in Table 2.

Table 2: TOC and DC analytical approach

TOC Principles	**Application to Humanitarian research**
1. Identify the System Constraints	This first stage is crucial and involves identifying constraints; these may be physical or policy constraints. To increase rigour and validity, the authors analysed the data and identified constraints. The authors then examined the data and generated a set of refined constraints. This rigorous process led to the final list used in this study to answer the research questions.
2. Decide How to Exploit the System's Constraints	Goldratt (1990) advocates that managers should attempt to obtain as much capability as possible from a constraining component, without exerting considerable financial investments or upgrades. At this stage, we provide effective methods for exploiting the constraints identified in the HSC during the Nepal earthquake.
3. Subordinate Everything Else to the Above Decision	The non-constraint components of the system need adjusting to a 'setting' that will enable the constraint to operate at maximum effectiveness (Goldratt, 2008). The process allows for practical evaluation of the Step Two process to ensure that exploitation of the obstacle is yielding positive results for the humanitarian operations. If the constraint is deemed eliminated, then managers/change agents can go to Step Five.
4. Elevate the System's Constraint	'Elevating' the constraint refers to undertaking any holistic action necessary to eliminate the constraint. This may include a system overhaul, significant capital investments or HSC redesign; the choice of rectification will be influenced by the limiting factor.
5. Return to Step One, if the Constraint Has Been Broken (Caution: Monitor & Avoid "Inertia")	As stated in Section 2 (literature review), TOC is a cyclical philosophy and methodology that advocates for continuous improvement. Therefore, TOC offers a strong warning to organisations against complacency (Goldratt, 1990) after identifying and eliminating constraints. There will always be new constraints arising. Therefore, it is essential to continuously aim to improve the SCP of humanitarian operations, repeating these steps.

Apply **dynamic capabilities** tenets to analyse the identified constraints and proffer a *Lean* thinking model for humanitarian research and operations. This will apply the principles of: (i) sensing, (ii) seizing, and (iii) transforming.

4. Findings

Our study revealed three dominant key actors in the humanitarian operations aimed at alleviating the suffering brought by the Nepalese earthquake. These three actors are the Nepalese government, international non-governmental organisations (INGOs) and local non-governmental organisations (NGOs). The government played an overarching role, and its policy decisions were crucial in setting the operating environment for humanitarian organisations. When the disaster occurred, the government was the official source of most of the information used by the relief agencies. This was evident in most of the responses obtained, where the managers interviewed indicated that their operations were planned based on data and figures collected from daily local government agency briefings. Furthermore, in our analysis, we make a clear distinction between INGOs and NGOs. The separation was necessary to draw a deeper understanding of the operations, and the approach, abilities and capabilities between these two groupings of organisations were vastly different. Thus, the bottlenecks and, consequently, resolutions required differ in some key areas. Figure 3 illustrates the Nepal HO framework, as deduced from the analysis.

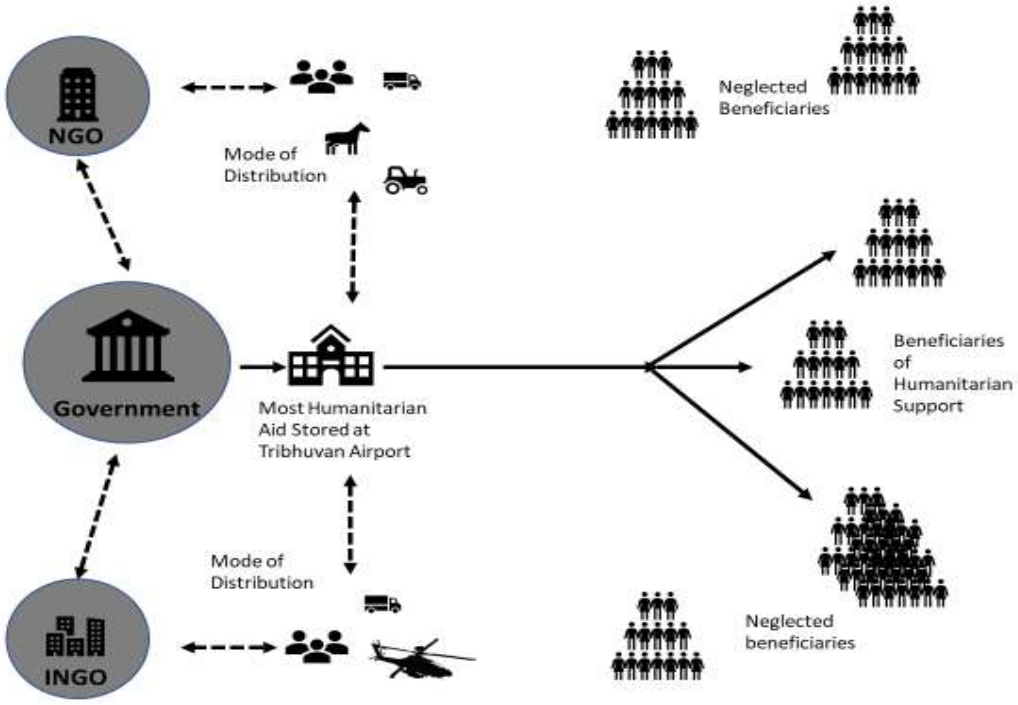

Figure 3: Humanitarian Operations Framework for the Nepal (2015) Earthquake

As illustrated in Figure 3, most of the relief materials came through the one and only international airport, which also doubled as the central warehouse and distribution centre for many humanitarian organisations. The airport was so crucial due to Nepal's geographical limitations; it is a landlocked, mountainous country, therefore the only two logistical options are air and land freight. Local NGOs' capabilities were severely limited by several factors, which included budgetary constraints and a lack of resources. There were many neglected areas where relief was not availed immediately. These constraints will be discussed in detail in the next section.

4.1 Constraints

The uncertainty that dominates HSC is uniquely different from global supply chains. One of the most critical pillars in delivering effective HOs are the people. However, it was clear, especially from the local NGOs, that in the immediate aftermath of the earthquake, some

organisations lost up to 70% of their workforce, as they were victims too. A logistics manager for a local NGO (I2) had to tell organisational employees first to assist themselves:

> *It was difficult because everyone was fearful – we had to say to the staff that if you can come to the office that's good but otherwise stay at home and assist your family because they are victims too, you are victims too.*

Does this create a conundrum of who shall help the helper? This is a unique problem to workforces situated in disaster zones. Also, most humanitarian organisations rely on local volunteers as they tend to know the geographical area and fully understand the culture and norms.

4.1.1 Fluid Information

In the aftermath of the earthquake, information was fluid, i.e. there was a lack of accurate and timely information. Information is critical for HSC management, as most operations are conceived and planned based on real data from field-damage assessments. As I4 stated:

> *After the earthquake, there was a huge gap in information; there was havoc; there was a lack of supplies availability for the relief distribution. Because people were panicking, the shops were closed, people were living in tents, there was no food, there was no medicine. There were no other supplies available for the affected population in the earthquake.*

The volatile environment created information loopholes, which made it difficult to gather data. These information loopholes make sensemaking and decision-making of key humanitarian

stakeholders extremely challenging, as they are strategizing critical operations through fluid information. We define 'fluid information' as rapidly changing data delivered in a drip-drip format (constantly changing every hour). For instance, most INGOs and NGOs were getting their information from the government regarding disaster zones, i.e. which areas to prioritise. However, an NGO programme coordinator (I6) expressed the fluidity of the information they had to work with as s/he recalled a District Disaster Rescue Committee (DDRC) briefing:

> *DDRC, in the morning, was saying there were 20,000 victims but after two hours they were saying 30,000 victims; the information was always changing.*

These information inconsistencies generate constraints for HSC, as it makes it difficult for humanitarian organisations to plan proper logistical operations. Furthermore, fluid information distorts the demand for goods and materials, which may end up causing over- and under-supplying, which leads to waste. To mitigate this information risk, one INGO resorted to having staff deployed to areas to source primary data. Furthermore, victims were able to request relief directly, which allowed for a more efficient HSC that reduces waste while getting the relief to those who need it the most:

> *To manage this issue, we sent staff to locations, and the people were able to request help directly and we could provide it directly to them.*

4.1.2 Lack of Planning and Prepositioning Issues

Planning and prepositioning refers to the emergency stockpiles prepositioned before the earthquake, and the replenishment procedures and protocols applied by HOs in the aftermath of the earthquake. From our analysis, the INGOs were better prepared for relief operations and to provide aid to earthquake disaster victims. Furthermore, they had clear prescribed

frameworks set up by their organisations on how to deal with emergencies. For instance, a manager at one of the INGOs (I12) stated:

> *We began responding to the earthquake from the second day. Our first day of distribution was in Bhaktapur, where we distributed 5,000 tarpaulins, though it was a little difficult to distribute during that time because everybody was demanding the tarps.*

The vast amount of prepositioning was done by INGOs, but the inventory quickly ran out, as demand was too high. Even the Nepalese government was sourcing materials from INGO stockpiles. As an INGO manager stated:

> *In the case of my organisation, as I said before, we had emergency stockpiles but used all the stored humanitarian goods quickly due to demand; for example, there was high demand for lifesaving medicines and nutrient supplement foods. Significantly, most of our inventory was depleted supplying the immediate needs requested by government and other humanitarian agencies from my organisation; for example, tents not only for normal ordinary citizens but for hospitals.*

Most INGOs had disaster plans in place and warehouses located in Europe and other strategic locations. When the earthquake struck, they were better-resourced and positioned to mobilise their resources and bring them into Nepal via air transportation. Prepositioning of emergency stock was mainly done by organisations like WFP, UNICEF, etc. However, both the positioning and stockpile quantity were not enough and were not entirely strategic enough to meet the immediate disaster relief demand. Furthermore, the prepositioning locations disenfranchised specific locations, as an INGO manager stated:

There was a stockpiling made in Kathmandu. But outside Kathmandu - in Gorkha, there was no preposition made for emergency relief materials.

Kathmandu had emergency stockpiles, while the Gorkha area had none. This indicates problems in the planning and prepositioning phase of the HSC. Operationally, it increased difficulty throughout the supply chain and, furthermore, disenfranchised those neglected areas.

4.1.3 Demand and Supply Challenges

Our analysis revealed an over- and undersupply of materials generating waste, e.g. rotten rice and market price fluctuations and distortions. This was caused by several factors. Firstly, the geography of Nepal exacerbates demand and supply fluctuations as it is a landlocked mountainous country with limited access. This made it difficult for local NGOs, who did not possess the leverage of INGOs in sourcing products. As an INGO manager (I10) stated:

Okay, the Nepalese market is very, very limited. There are limited suppliers – they supply goods. They have a system, so within INGOs, mostly we found—they supply to us and the other INGOs as well.

This was problematic, as Nepal's HSCs are heavily influenced by exogenous factors. Most of the materials must be sourced from China and India. Another issue making demand and supply a constraint was the oversupply in one area and undersupply in another. For instance, there was duplication in the supply of blankets, with one humanitarian officer noting that when he went to distribute, they [the victims] already had four or five blankets. However, they lacked other resources, e.g. food, thereby creating an oversupply of one resource while another was undersupplied. Another issue was that in the aftermath of the earthquake, most shops did not open for business. Most vendors were unavailable, which created massive shortages and spiked

demand. This caused enormous price fluctuations, with the few vendors on the market increasing their product prices. This mainly affected local NGOs, as INGOs had contractual agreements with vendors, which meant they could not spike their prices. Due to the fluidity of the information, most NGOs did not know which products were most needed, so most purchases were made on assumptions, i.e. what are the victims likely to need? This approach increased the demand-supply imbalance, as certain products were oversupplied while others were undersupplied.

Lack of Technological Applications

The humanitarian organisations operating in Nepal used simplistic everyday technology to coordinate their efforts, especially the local NGOs. They lacked advanced information systems (IS) capabilities and instead relied on radios, social media, telephones and intuition. As another NGO manager (I14) stated:

> *In the beginning, we didn't have any database or anything, we just had a personal relationship, we just felt this place were the most affected places, we heard that through the news, and through people around there, through the social media, in fact, we just went there very randomly. I use the telephone and social media mainly. I'd rather say social media is the best method I used, and that helped me.*

The lack of data gathering and analytical tools meant that strategic and operational decisions were based on social media, intuition and hearsay. These are not the most effective ways of mapping a relief plan and may have been factors in issues of oversupplying certain relief materials while some were undersupplied. However, it is also important to note the ingenuity of the humanitarian organisations in the Nepal earthquake. They were able to harness the power of social media and use it to their advantage, as noted by I14:

We used social media like Facebook and Viber, Viber for communication ... Viber and WhatsApp and Facebook obviously because we share our instructions with Facebook; these are the things even we need; as volunteers we go through the Facebook channel.

Though there was a lack of advanced IS capabilities, actors were able to coordinate, disseminate information and recruit via free social media platforms, which were open and easily accessible.

4.1.4 Transportation and Distribution Issues

Our analysis uncovered transportation issues as one of the significant problems hampering logistical activities in the Nepal earthquake. INGOs who had contractual arrangements with fleet companies beforehand had fixed rates as per the contractual agreement, however, and transport that was sought on an ad hoc basis was expensive. There were limited trucks and helicopters, so this increased the price due to demand, but reduced the distribution capacity. As an INGO manager (I10) stated:

Yeah, in the beginning couple of two or three weeks it was a problem. Because that time it was very challenging, but to get the fleet we did have that much of a problem because we had already known that framework contacts with more than 40 different vendors, no 40 transportations. 3 to 4 vendors were in our framework contract. We had previously agreed on the rates ... trucks, jeep, pickup vans and buses, everything.

There were limited trucks and helicopters, so this increased the price due to demand but reduced the distribution capacity. This also created opportunistic distribution tendencies, which meant that humanitarian organisations, especially local NGOs, were now distributing to convenient areas rather than to the neediest. As an NGO manager stated:

> *Gorkha was the epicentre of the first earthquake and then since we were very close to that location and [] at that time it was very difficult to move here and there, rather than being in a very fixed place and the place where I went, they didn't have any relief material for one week; I think they didn't receive anything from anybody. The first time that I visited and that gave me a boost that this place, you need to reach out. So, after meeting the group of us, we went there. It was based on the recommendation as well.*

As evidenced above, distribution was determined by word of mouth and convenient opportunism rather than accurate data. However, these areas were also neglected, as mentioned above; they had not received aid in a week. Furthermore, data analysis uncovered a massive difference between humanitarian distribution tactics employed by INGOs and NGOs. While the latter had close coordination with governmental agencies and other organisations, NGOs relied on local news and ease of access, which resulted in over- and under-distribution of relief materials. As a manager (I8) stated:

> *During these times, small donors like clubs, who do not have a wider network, they will go to accessible places with news channels - they would distribute wherever they want. However, our system is different in the sense that we have close coordination with the Government and other organisations.*

These distribution issues and lack of collaboration amongst NGOs created cascading issues, which led to high levels of waste.

4.1.5 Waste of Relief Materials

Waste, especially food waste, was a significant problem. Delayed distribution of food, especially rice, which was left to sit and rot in warehouses, was of concern. This type of thing is a double-edged sword, as both the victims and donors suffer losses. Waste issues were

evident from the interview, from the interview respondents who expressed concerns over problems regarding oversupply in some products and undersupply in others. For instance, an INGO manager stated:

> *We had issues with rice distribution, as most relief agencies had a lot of rice stock. So, in particular villages, there was over-distribution of rice, which led to locals making alcohol with excess rice.*

This was not a good scenario, as other villages were short on resources, including rice; others got too much and resorted to using the aid for a purpose it was not intended for. Communities that got the excess distribution of rice ended up fermenting the rice to brew alcohol because there was an excess distribution of that product. This is evident from the response by I9, obtained when focusing on issues surrounding food wastage:

> *For example, in XX District - in an area which is close to the highway - one family received 30 sacks of rice. We had that type of situation too. What this family did was - they will take rice and put those sacks in another house - and then he gets one sack every time distributors came.*

Food and resources given to disaster zones must be effectively used to accomplish the intended goal; otherwise, they become waste. Consequently, when waste is generated, it means there are victims who are not getting the help that was initially available but has gone to waste. Moreover, when there is duplication of relief materials, people will misuse them as stated in this quote by I19: "e*ven, rice was being sold to people who make alcohol"*.

The government's policies and regulations impacted the operational environment, resulting in more wastage of relief materials. Unlike in typical business environments, where policy tends to be stable, well-stated and slow to change, it was evident that in Nepal the government had to consistently adjust policies in line with changing conditions on the ground. These policies included imports for relief procedures, tax reliefs etc. While the government was naturally reacting to a volatile environment and evolving policies and regulations accordingly, this created operational uncertainty and led to wastage of relief materials, as highlighted by I16.

> *It was difficult for the customs to identify goods brought for the purpose of distribution. Those trucks that came from India, as they were on rent, they didn't like to wait there for more days. Who will give the rent then? Thus, they left the goods there and hence a lot of wastage happened.*

Thus, environmental risk makes the planning process very difficult. INGOs and NGOs found it challenging to make plans, as information and the factors on the ground kept changing.

4.2 Constraints Overview

Following the first stage of analysis using TOC, our examination unearthed key constraints that disrupted key stakeholders from delivering efficient and effective HSC operations during the Nepal earthquake. Thus, the identified constraints are critical in answering the first research problem, which aims to investigate humanitarian constraints in the context of the Nepal disaster. The fact that HSC operations are characterised by an unpredictable dynamic environment driven by high demand uncertainty is well-established; hence, Ben-Tal, et al.

(2011) advocate for robust planning processes. Part of this robust logistical planning includes setting up regional warehouses and prepositioning resources within local vicinities. However, our research concurs with Charles, et al.'s (2016)'s findings that most humanitarian organisations' motivation for resource location is often driven by opportunity, as opposed to logical decision-making. In our TOC analysis, we found the primary reason for resources location was the convenience, hence all aid was mostly stored and distributed from the national airport. This approach further complicates the ability to rapidly respond in a disaster as transport considerations become further constrained by budgetary restrictions, as noted by Park, et al. (2018).

As identified in the humanitarian operations analysis, waste was a critical problem mired with issues of over- and undersupply of relief materials leading to double distributions of certain materials, e.g. rice. Thus, humanitarian waste becomes a double-edged sword. First, it denies victims much-needed relief while simultaneously causing economic loss and costs to stakeholders, e.g. governments, NGOs and INGOs. Wasting resources is a financial loss, wasting food is a social issue as victims starve, and consequently, wasted food becomes an environmental problem. In Figure 3, below, we indicate the goals of disaster relief operations, which are to rapidly respond to a humanitarian crisis. In Nepal's case, the government, INGOs and NGOs all quickly responded; however, due to all the constraints deduced from the analysis, their efforts hit a bottleneck underpinned by the constraints. Thus, Figure 3 illustrates the effect that constraints have on attaining sustainable humanitarian operations through effectively managing the triple-bottom-line (TBL) of issues. These TBL issues are: first, the people suffer when relief does not reach them. Second, stakeholders suffer economic loss from wasted resources and mobilisation efforts. Third, the environment is damaged by all the waste

generated, which could lead to disease outbreaks and environmental degradation. Figure 4 depicts the effect of constraints on humanitarian supply chains.

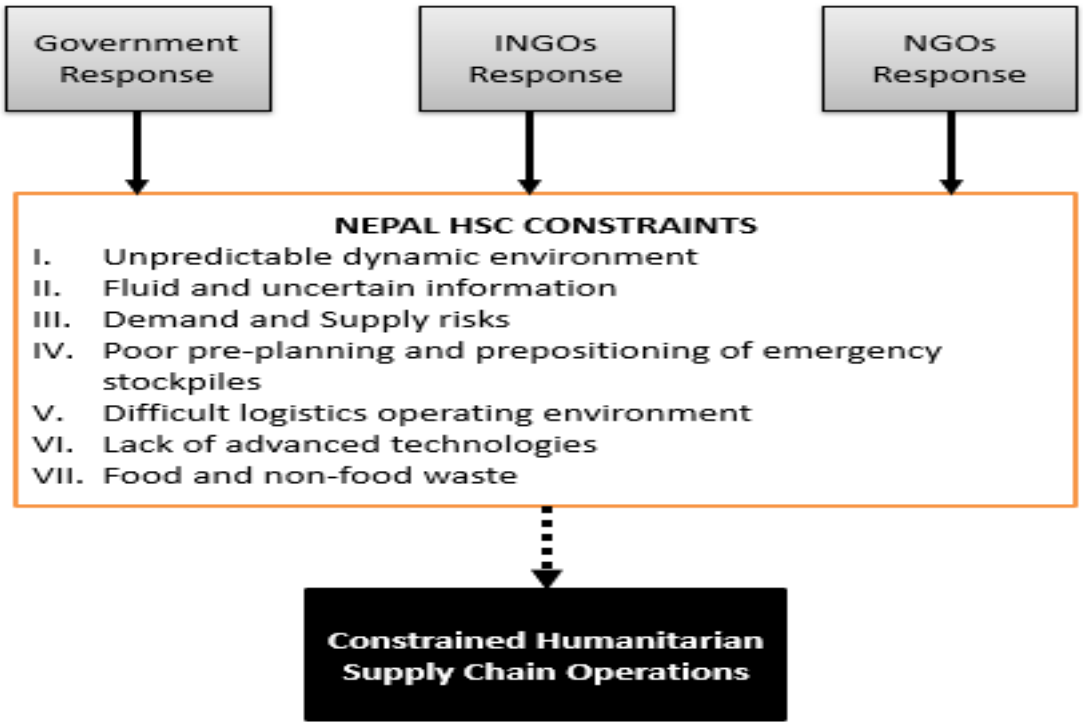

Figure 4: Key stakeholders in Nepal and identified constraints

To eliminate waste through *Lean* thinking, it is crucial to first understand the limitations of the supply chain and then devise a practical strategy to address the limitations. Therefore, in the next section we will discuss extensively how best to address these constraints through applying dynamic capabilities principles to generate an effective *Lean* thinking approach.

5. Dynamic Capabilities for *Lean* Thinking in HSC Operations

Drawing on Teece's (2018) key components of sensing, seizing and transforming, we analysed the identified constraints to examine how best *Lean* practices can be embedded in HSC operations. From our analysis, the first step was to identify the constraints. To address these

constraints, we apply the dynamic capability principle of 'sensing' to identify opportunities that humanitarian organisations can apply to increase operational efficiency. By key stakeholders applying sensing in regard to their operational environment and capabilities, they will be better able to identify opportunities, e.g. the use of social media in Nepal by aid agencies to identify areas of need due to lack of information relating to affected areas. Once humanitarian stakeholders identify opportunities to address the known constraints, they can apply 'seizing' as an approach to design and refine their operating models. At this stage it is critical that resources identified in the sensing stage are utilised in a timely and appropriate way to manage the constraints. Applying our thematic analysis to the Nepal earthquake data, we propose that 'transforming' in a humanitarian context would be focused on changing the current structure and culture of disaster relief operations to incorporate a *Lean* thinking culture. *Lean* thinking is a cyclical non-stop approach that requires constant identification of constraints so as to use the least amount of time, effort and resources to deliver aid to the needy. Therefore, we propose an extension to the dynamic capabilities' theory application in HO by submitting a new component - '*sustaining*'**.** By '*sustaining*', we advocate for humanitarian key stakeholders to create a long-term *Lean* thinking strategy that benefits all stakeholders by fully utilising existing capabilities while investing in additional identified capabilities. To extend the dynamic capabilities principles in HO we augment the steps of TOC to develop a *Lean* thinking approach, as displayed in Table 3.

Table 3: TOC with Dynamic Capabilities Application in HSC Operations of the Nepal Earthquake

STEPS	CONSTRAINTS	DYNAMIC CAPABILITIES
1. Identify the Constraint	*i.* Uncertainty *(Unpredictable dynamic environment)*	▪ Sense – Identify opportunities

	ii. Fluid Information *(lack of accurate and timely information; furthermore, it is continually changing)* iii. Planning and Prepositioning *iv.* Demand and Supply (*Over- and undersupply of materials generating waste, e.g. rotten rice and market price fluctuations and distortions)* v. Technological Application vi. Transportation and Distribution Strategy HSC Waste	
2. Exploit the Constraint	i. Effective contingency planning to account for the unpredictable environment ii. Collaboration underpinned by information sharing between government, INGOs and NGOs iii. Information sharing inventory management approach iv. Coordinating aid delivery and sharing information regarding demand and supply of certain products v. Apply a push-pull strategy to exploit the capabilities of government, donors and affected citizens vi. Manage waste through *Lean* thinking	▪ Seize – Design and Refine HSC Model: Ensure appropriate use of resources
3. Subordinate all Non-Constraints	Using collaboration, apply *Lean* thinking throughout the humanitarian supply chain to increase aid delivery while reducing waste	▪ Transform – Realign Structure and Culture
4. Elevate the Constraint	i. Use data to measure the effectiveness of humanitarian operations ii. Target the critical constraints at this stage, e.g. food waste, marginalised distribution iii. Implement immediate tactical actions for the constraint to improve performance iv. Evaluate constraint for potential design updates/upgrades, e.g. new communication technologies etc. Capital investment is considered at this stage - if the constraints have not been resolved with the prescribed solutions - as a last resort	▪ Transform – Realign Structure and Culture
5. Repeat the Process	At this stage, repeat the process to avoid complacency in the system and investigate if new constraints have emerged	▪ Sustain – Create a long-term *Lean* thinking strategy that benefits all stakeholders

5.1. Sensing and Seizing Opportunities in HSC Operations

In HO, we put forward sensing and seizing of opportunities as the ability of humanitarian organisations to effectively plan, preposition and seize the opportunity to apply a *Lean* thinking approach in their HSC. Drawing on the constraints identified in the first stage of analysis through applying TOC, we identify opportunities for humanitarian organisations to apply sensing and seizing. To effectively sense and seize opportunities, we propose that humanitarian organisations must be able to effectively plan and preposition resources, as well as apply available technologies to ensure adequate information sharing.

- Coordinating aid delivery and sharing information regarding demand and supply of certain products

Logistical coordination opportunities are essential to sense and seize in order to address distribution constraints induced by various issues like price inflation due to the volatile demand and supply of vehicles. Price fluctuations highlight the issues surrounding transportation, which has been identified in some research as having the second-highest overhead costs after human resources (Pedraza-Martinez and Van Wassenhove, 2013; Martinez, Stapleton, and Van Wassenhove, 2011). Similar to research by Pedraza-Martinez and Van Wassenhove (2013), this study found transportation demand to be a significant issue in HO: in particular, the need for 4×4 vehicles, which were the only effective means of access to certain areas due to Nepal's landlocked and mountainous geography. Hence, we advocate that when INGOs make contracts with fleet companies, they should create opportunities to allow smaller local NGOs to sign on, using their leverage. This promotes collaborations, which have been identified as an effective way of mitigating HSC constraints. Furthermore, there needs to be more sharing of information with regard to prices and to avoid overcharging of smaller actors who lack bargaining power. It was evident in the analysis that suppliers were charging different prices to different INGOs

and NGOs, depending on the presence of a supplier contract or bargaining power. While in a business environment this may be considered normal behaviour, in humanitarian disaster zones this defeats the purposes of getting relief to the victims as soon as humanly possible. However, through collaboration, INGOs, NGOs and government can ensure that transportation costs are even, to allow all agencies logistical access to deliver their aid.

- Effective contingency planning to account for the unpredictable environment

To address the issue of operating in an uncertain and very volatile environment, we emphasise the importance of preplanning and effective prepositioning of emergency stockpiles as a critical opportunity. While scholars have identified the importance of contingency planning (Behl and Dutta, 2018; Ben-Tal, et al., 2011), we emphasise the importance of using real data to sense and seize this capability. With IS capabilities increasing, disaster-prone areas should make use of these capabilities to better evaluate where best to preposition their resources. This is critical, as our analysis revealed how INGOs and NGOs used social media to seek victims and communicate with each other. Most citizens had access to a mobile phone, which allowed real-time dissemination of information regarding disaster zones and areas that needed urgent help. In a dynamic capabilities approach, this can be used for sensing to identify opportunities. Moreover, it is also paramount to consider exogenous factors when conducting contingency planning. In Nepal's case, it is a landlocked country; therefore, it should have a higher emergency buffer stockpile, because geographically it is much more challenging to access the country after a disaster. Thus, preplanning becomes a crucial first step and underpins the foundation of HO.

- Apply a push-pull strategy to exploit the capabilities of government, donors and affected citizens

Humanitarian stakeholders need to sense and seize the opportunities for effectively working together to ensure efficient distribution of materials. While humanitarian organisations tend to apply a push strategy and deliver straight to victims, it is essential to set up local stations via local government that allow victims to attend and state their needs. This will manage the demand and supply fluctuations by eliminating over- and undersupply. By prepositioning non-medical items, such as generators, vehicles, blankets, communication kits, tents, etc., a pull effect can then be created, where there is an opportunity for victims to attend relief centre-points while agencies also conduct relief missions. This reduces logistical costs and allows for faster aid distribution. Humanitarian supply chains are unique and their logistical requirements too broad (Holguín-Veras, et al., 2012), which makes our research vital by drawing on the Nepal context to untangle hidden insights that can advance research and practice.

5.2. Transforming HSC Operations

Transforming within the context of dynamic capabilities involves the ability of humanitarian stakeholders to realign their structures and culture in order to achieve effective and efficient HO. This may require the realigning of existing capabilities or investing in additional resources to ensure that the HSC is *Lean* and waste is reduced. In our analysis, we identified two major transformers of HSC structures and culture: collaboration amongst stakeholders and the application of technology.

- Collaboration underpinned by information sharing between government, INGOs and NGOs

It was evident from our analysis that collaboration between stakeholders in a disaster zone was problematic, as humanitarian organisations - including government bodies - frequently have

diverging areas of focus and often competing goals or ideology. This makes collaboration a challenging undertaking, especially amongst the local smaller NGOs. This is a phenomenon noted by Prasanna and Haavisto (2018), who investigated the impact of organisational culture on collaboration within HSC. In their findings, they identify trust, commitment, information sharing and mutual respect as crucial factors underpinning collaboration. Thus, this study builds on this critical research by taking a holistic view of collaboration. The results indicate that while most INGOs have collaboration frameworks, it is essential to enhance this with collaboration with local NGOs as they hold localised knowledge and understanding of both the terrain, culture and customs. This will help foster trust and understanding. Collaboration becomes a critical aspect for both INGOs and NGOs, boosting their ability to coordinate with their suppliers. This supports Wagner and Thakur-Weigold's (2018) research on the criticality of collaboration and its impact on enhancing the efficient use of resources, thereby optimising operations.

- Use IS and Big Data for HSC Transformation

One of the significant limitations faced by disaster relief agencies in their operations in Nepal was the limited availability of advanced technologies. Therefore, our analysis reviewed that INGOs and NGOs had an over-reliance on intuition, social media and word of mouth. While responding to rapid disasters remains challenging, this can be exacerbated by a lack of viable tools, i.e. adequate technology to undertake the relief efforts efficiently. Current research indicates that demand forecasting for long-term development programmes can be very beneficial (van der Laan, et al., 2016). Therefore, we propose the use of advanced technology as a dynamic capability, e.g. demand forecasting, in the planning and prepositioning of emergency inventory. This will allow a more even and robust placement, rooted in real data. It was clear from analysing the humanitarian waste that one of the significant causes of waste

was uneven aid prepositioning. This resulted in certain areas getting more while others got less. Thus, other villages began to ferment alcohol with excess rice, while others had no relief.

5.3. Extending Dynamic Capabilities in HSC through *'Sustaining'*

Figure 4 portrays the application and adoption of dynamic capabilities (Teece, 2018; Teece, 2010) for *Lean* thinking in humanitarian operations. Sensing is critical for the dynamic capability of planning and prepositioning of resources to enhance response capacity. From our analysis, uncertainty emerged as a major constraint to planning and propositioning capabilities. Consequently, this created high levels of waste, as food and other resources were either over- or undersupplied in disaster relief operations. Hence, technology application and use has been identified as a critical dynamic capability. Seizing can be achieved through effective contingency planning, which is underpinned by information sharing. These are critical dynamic capabilities that enhance the efficiency of operations and allow for *Lean* strategies to be achieved. Transforming would involve realigning the structure and culture of disaster relief stakeholders to both fully utilise existing capabilities while investing in additional capabilities through enhancing collaboration. Thus, in the event of a disaster, government, NGOs and INGOs must collaborate to effectively reduce waste and increase efficiency. We proffer *'sustaining'* as a critical addition to the dynamic capability model for HSC.

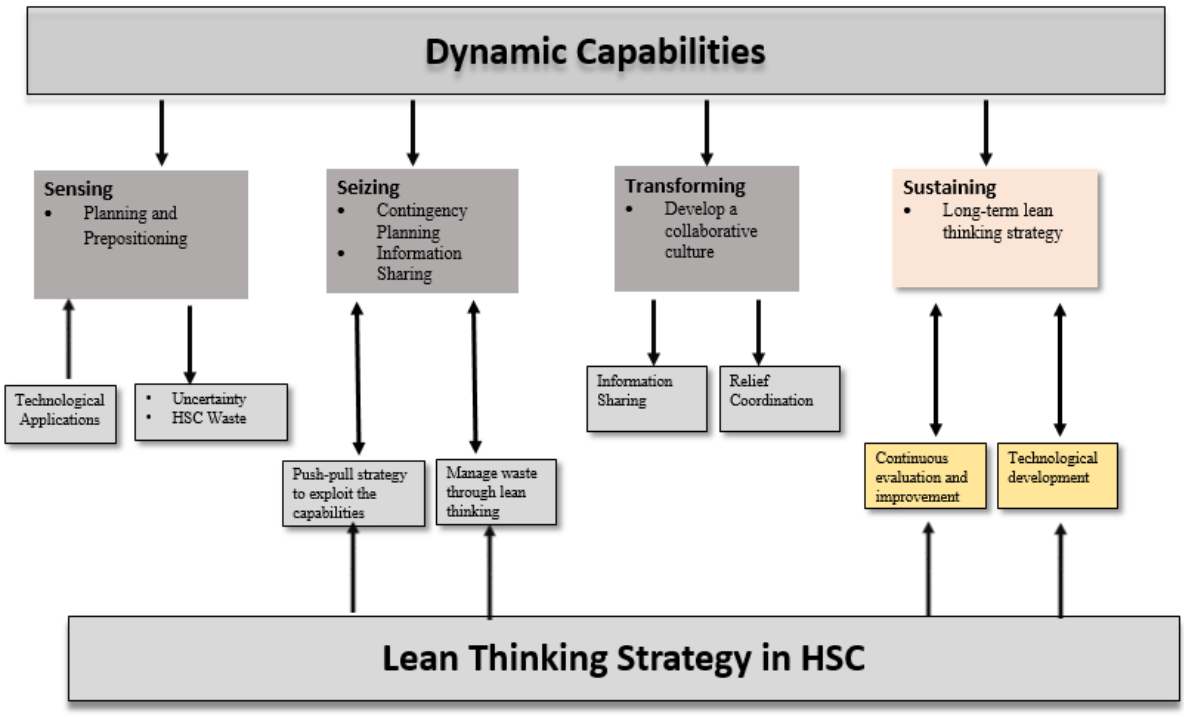

Figure 5: Dynamic Capabilities for Lean thinking Strategies in Humanitarian Operations

Sustainability of humanitarian operations is critical, as depicted in Figure 5. Sustaining must be underpinned by a continuous learning process that allows for the evaluation and identification of constraints. These must be addressed by deploying suitable dynamic capabilities. Hence, we argue that these tenets are critical in order for humanitarian organisations to design and implement effective and efficient operating models. From our findings, we submit that dynamic capabilities can be applied to design and implement a *Lean* thinking model. A key requirement will be the ability of humanitarian organisations to coordinate their resources with other stakeholders (government, NGOs, INGOs, local business, etc.) in order to achieve timely and appropriate disaster relief activities. The strength of key stakeholders' dynamic capabilities will be instrumental in their ability and agility to synchronise resources with an operational *Lean* thinking model. Hence, Teece (2018) argues

that the ability of an organisation to maximise its dynamic capabilities is contingent on their ability to continually sense and seize opportunities, and to systematically transform organizational operations. This facilitates the creation of an organisational culture that encourages proactive realigning of resources to tackle opportunities and threats in a timely manner (Altay, et al., 2018). Hence, our study extends this theory by proffering that humanitarian stakeholders need to adopt a long-term *Lean* thinking approach in order to sustain their ability to effectively address operational constraints.

6. Contributions

Lean implementation has been mainly applied in the manufacturing sector (Dora, et al., 2016); however, we argue that the principles can be adapted to significant effect within HSC, and we refer to this concept as '*Lean* thinking'. In a comprehensive literature review by Negrão, et al. (2017), on the linkage between *Lean* practices and performance, the results showed that *Lean* is mainly applied in a fragmented way that ignores the systematic connections. Thus, our study advocates for a holistic application in HOs to reduce the high levels of humanitarian relief waste. Based on our literature review, we adopted two main critical principles of *Lean* thinking: (i) waste elimination, (ii) alignment of supply and demand; these are referred to in *Lean* thinking research (Lyons, et al., 2013). By concentrating on increasing humanitarian relief flows while reducing waste through collaboration, a *Lean* thinking culture can be created and cemented. First, we identified the constraints present during the 2015 Nepalese earthquake. Second, using a dynamic capabilities lens, we proffered ways and means to exploit the constraints.

6.1. Theoretical Contributions

- *TOC as an analytical lens for HSC operations*

Our study shows that TOC can be effectively applied as a methodological and analytical tool to unearth constraints in HSC operations. Hence, a critical factor required by HSC stakeholders to subordinate all constraints is the ability to measure performance and ensure that humanitarian targets are reached. On a global scale, stakeholders from 168 countries collaborated in Kobe, Hyogo, Japan, to draft and adopt the Hyogo Framework for Action 2005 – 2015 (HFA) (UNISDR, 2018). This has now been updated with the Sendai Framework for Disaster Risk Reduction 2015-2030 (SFDRR). The main thrust of these frameworks is to help all stakeholders better identify and respond to the risk of natural disasters by building resilience at all levels (UNISDR, 2018). Therefore, it is critical that countries prone to disasters generate their relief framework and make it available and ready for use by all stakeholders. This can be viewed as a dynamic capability drawn from past lessons (Teece, 2018). However, it is vital that this framework is measurable, and after any disaster, the stakeholder must be able to measure their performance against that specific plan. For instance, Nepal should not only rely on the above-mentioned frameworks, but must develop its own disaster framework that can be measured and adjusted after every disaster to ensure continuous improvement. Despite an attempt by global stakeholders to keep abreast of all the challenges perturbing HOM, it remains obstinately challenging to manage, due to its unpredictable and uncertain nature (Tofighi, et al., 2016; Chakravarty, 2014).

Furthermore, HSC stakeholders can subordinate all constraints by using collaboration and applying *Lean* thinking throughout the HSC to increase aid delivery while reducing waste. This can be achieved in humanitarian operations through the diversion of resources to mitigate the constraints. Resources are a critical dynamic capability. For instance, government, INGOs

and NGOs can all collaborate in information sharing, including the sharing of technologies. Many constraints, as stated in Section 4, can be alleviated through collaboration and resource sharing. This allows for the subordination of resources to help mitigate the constraints. Constraints are elevated through continuous re-evaluation. This was evident from the daily meetings held at the local government offices by INGOs, NGOs and government officials. While there were complaints that some of the information provided by the government was not always reliable, this was a crucial step in elevating constraints. From our data analysis, we identify the following four-step process as essential in addressing constraints in HSC:

I. Use data to measure the effectiveness of humanitarian operations;
II. Target the critical constraints at this stage, e.g. food waste, marginalised distribution;
III. Implement immediate tactical actions for the constraint in order to improve performance
IV. Evaluate constraint for potential design updates/upgrades, e.g. new communication technologies etc.

During the Nepalese disaster, there was an over-reliance on intuition, social media and word of mouth to communicate and coordinate. Therefore, the same methods were used to evaluate and assess the effectiveness of relief operations. In the four-step process, the first step we advocate is the use of data to measure the effectiveness of HOs. While new technology often requires monetary injection, capital investment is only considered as a last resort. Thus, if the four-step process fails, at this stage, if the constraints have not been resolved with the prescribed solutions, then the capital investment is undertaken as a last resort. It is critical to target identified key constraints, e.g. over- or undersupply of relief material, which causes wastages. This constraint often involves monetary solutions but requires evaluation, re-

evaluation and undertaking necessary adjustments and readjustments. Furthermore, it is always important to continually evaluate technology and equipment so as to seek opportunities to upgrade. Often, upgrades and reconfigurations are cheaper than purchasing new equipment and technologies. To attain a *Lean* thinking culture, post-distribution evaluation is required. Key stakeholders should follow up on aid delivery and ensure that the objectives were satisfied. Then the process must be repeated to find any constraints still in the system and address them accordingly. Hence, we propose an HSC-TOC framework to identify and manage constraints effectively, as illustrated in Figure 6.

Figure 6: HSC-TOC Framework for Lean HSC

The HSC-TOC Framework for Lean HSC, as depicted above, illustrates the integration of TOC with *Lean* thinking and how this could be applied to stakeholders conducting disaster relief operations. Figure 6 depicts the HSC-TOC Framework for *Lean* HSC, developed from analysis of the Nepal earthquake to assist HSC stakeholders to better assess prevailing constraints and

apply *Lean* thinking to mitigate them. Figure 5 depicts the *Lean* Framework for HSC, developed from analysis of the Nepal earthquake. The framework is further combined with dynamic capabilities to yield a theoretical contribution.

- *Applying Dynamic Capabilities to Augment TOC*

HO research needs further examination due to its uniqueness, which generates operational complexities for key stakeholders along the supply chain (Besiou, et al., 2018; Banomyong, et al., 2019). In this paper, we attempt to move the field forward by examining two critical components of HSC operations: logistics and waste. To fulfil this aim, we apply the theory of constraints (TOC) (Goldratt and Cox, 1984; Goldratt, 1990) and dynamic capabilities (Teece, 2018; Teece and Pisano, 1994), a novel approach in the field of HO research. We applied TOC to the Nepal earthquake on a methodological and analytical level to better draw out the constraints in the HSC. Using thematic analysis from a dynamic capabilities' lens, we proposed the introduction of '*sustaining*' as a key contribution to both theory and managerial practice. Our study makes an essential contribution to the academic field of HSC by introducing a framework that utilises both the philosophy and methodology of TOC and dynamic capabilities to develop a *Lean* thinking strategy. The model is a novel way of addressing multiple problems that are perturbing HSC. First, we drew on the principles of TOC (Goldratt, 1990) and applied these to the Nepal disaster relief efforts. We identified seven key constraints, namely: Uncertainty, Fluid Information, Planning and Prepositioning, Demand and Supply, Technological, Transportation and Distribution Strategy, and HSC Waste. To eliminate these constraints, exploitation steps were put forward, using a dynamic capabilities approach.

Our research outcomes build on previous research (Gupta and Andersen, 2018; Puche, et al., 2016; Tsou, 2013; Simatupang, et al., 2004), which shows that TOC is useful in managing constraints through collaboration. Our dynamic capabilities approach aims to tackle the issues within HSC by identifying them and attempting to limit them, while simultaneously controlling for exogenous factors. Through *Lean* thinking, the aim is to increase humanitarian aid flow while simultaneously reducing waste. As Chakravarty (2014) points out, uncertainty is a defining feature of HSC and theory should match this dynamism and our proposed approach aims to achieve this. HSC waste is a triple-bottom-line problem (Touboulic and Walker, 2015) as it affects the environment, people and causes monetary loss. Therefore, our model advocates for the continuous measurement of performance, as disaster relief aid is distributed to avoid complacency in the system, which inevitably leads to waste, e.g. dumped and rotting food. Therefore, to make our theoretical contribution, we use TOC to identify constraints and dynamic capabilities in order to create a *Lean* thinking strategy. We advance DC theory in humanitarian research by adding the pillar of '*sustaining*'. This is depicted in Figure 5. Adapting Teece's (2018) dynamic capabilities model for businesses, we develop a model for humanitarian stakeholders. We therefore proffer *Lean* thinking strategies based on Teece's (2018) dynamic capabilities as a novel but robust theoretical advancement in the field of HSC.

6.2. Contributions for practice and change agents

Our study makes two critical contributions for change agents and practitioners operating within HSC. By using an evidence-based approach from the earthquake in Nepal, we apply TOC to unearth the constraints and dynamic capabilities tenets in order to attain a *Lean* thinking strategy. This will allow humanitarian stakeholders to both identify and (reduce or) eliminate constraints, thereby reducing waste. We propose a *Lean* thinking model for humanitarian operations. This is a crucial systematic framework that humanitarian organisations can adapt

and use to conduct a comprehensive examination of the supply chain and thereby identify critical constraints. We indicate how to deal with these constraints through exploitation, subordination and elevation in the context of HSC. We further highlight the issue of waste, which is a fundamental problem for humanitarian stakeholders. It is a double-edged sword that has devastating effects on the supply chain. Its effects are a triple threat affecting the people, environment and economic resources. By conjoining the Figures 4 & 5 of TOC and Dynamic Capabilities in HSC operations, we generate *Lean* thinking for the HSC model, as depicted in Figure 7.

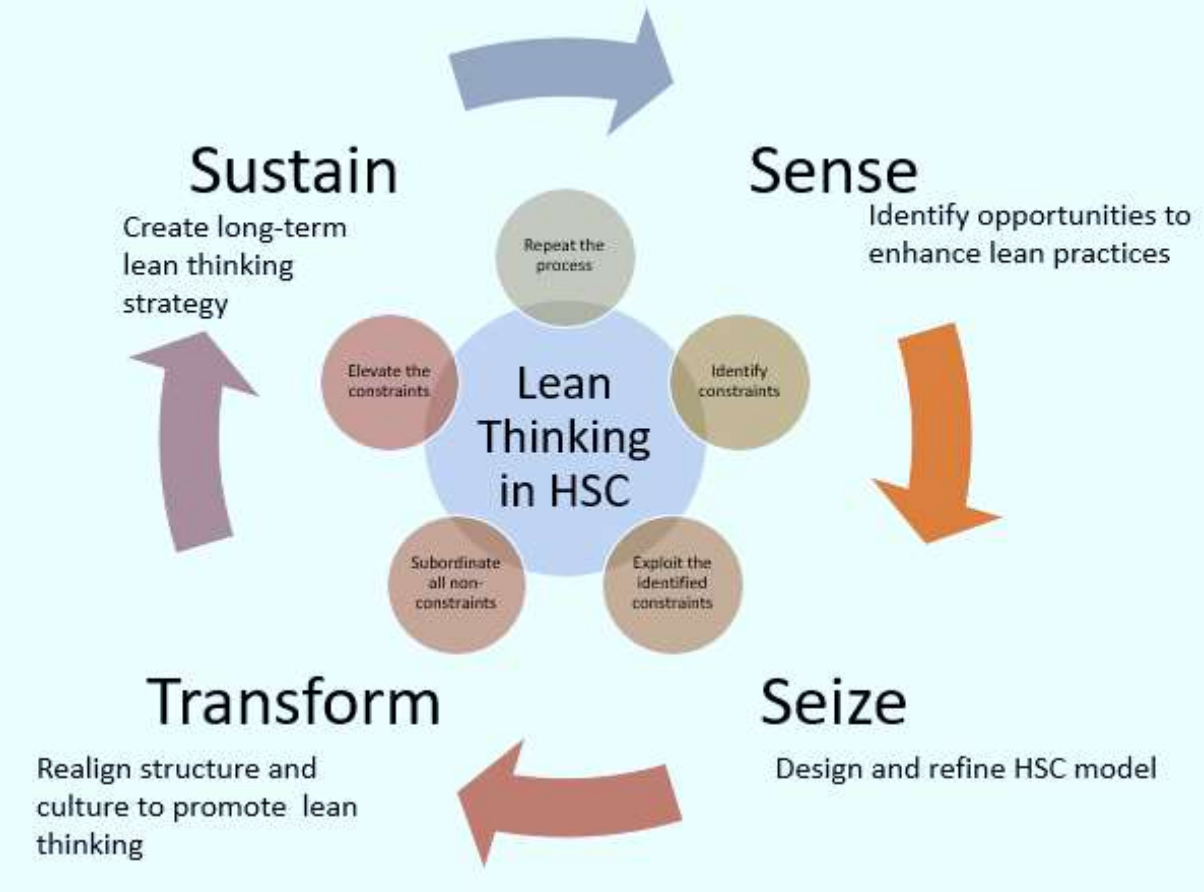

Figure 7: Lean thinking in HSC operations

Lean implementation has been mainly applied in the manufacturing sector (Dora, et al., 2016); however, through our study we argue that the principles can be adapted to make HSC

operations more efficient and effective. We extend dynamic capabilities theory by submitting '*sustaining*' as a means of creating a long-term *Lean*-thinking culture that will allow key stakeholders to achieve their humanitarian goals with the least amount of time, effort and resources. Hence, Negrão, Godinho Filho and Marodin (2017) point to the linkage between *Lean* practices and performance, which showed that *Lean* is mainly applied in a fragmented way that ignores the systematic connections. Thus, our study contribution advocates for a holistic application of *Lean* thinking in HSC operations to increase efficiency and reduce the high levels of waste. Based on our study, we adopted two main critical principles of *Lean* thinking: (i) waste elimination; (ii) alignment of supply and demand; these are referred to in *Lean* thinking research (Lyons, et al., 2013). We argue that applying our *Lean*-thinking model will increase efficiency and reduce humanitarian waste, leading to improved relief material distribution. Consequently, we advise humanitarian stakeholders and agents of change to focus on a holistic approach that incorporates '*sustaining*' *Lean* thinking through a continuous application of their organisational capabilities.

7. Conclusion

Our study aim was twofold; first, we applied the theory of constraints (TOC) to examine data from the Nepal earthquake in order to determine supply chain and logistical constraints (bottlenecks) in humanitarian operations (HOs). Second, we used dynamic capabilities to develop a *Lean* thinking model for HSC. The model was developed to assist HSC stakeholders to better assess prevailing constraints and apply dynamic capabilities and *Lean* thinking strategies to mitigate bottlenecks in HSC. Furthermore, the model is an essential step in addressing the identified constraints while simultaneously dealing with issues surrounding waste in HOs. We extend the dynamic capabilities approach by including '*sustaining*' as a critical addition to the *Lean* model for HSC. We argue that sustainability of HSC is critical,

and this must be underpinned by a continuous learning process that allows for the evaluation and identification of constraints. We proffer a cyclical method of identifying constraints and deploying suitable and appropriate capabilities to address them. Therefore we answer two key research questions: 1) what are the underlying constraints in humanitarian operations? 2) How could *Lean* thinking approaches be used to provide *Lean* HSC? Though we accomplished our research aim, our study does have limitations. For instance, this study was only conducted in the context of Nepal. Every disaster is different and, therefore, is perturbed by various constraints. It would be beneficial for future studies to conduct a multiple case study. In addition, quantitative research which pulls data from numerous disaster variables would be critical to allow for generalisations. Thus, the identified constraints could be further investigated quantitatively.

Finally, we point out the key areas that are crucial in moving HSC research and humanitarian operations further. Hence, we identify the issue of waste as a research avenue that requires both scholars and HO practitioners to collaborate in generating viable solutions. HSCM is hampered by many problematic inefficiencies, but waste is not only an operational issue, but it is also an ethical one. People cannot starve while food decays in warehouses and rodents' barrow through tonnes of bottled water. Another problem requiring our attention as humanitarian academics is that of information systems (IS), more specifically, big data. The use of social media in Nepal was effective in communicating and achieving complex operations. However, there are untapped opportunities in harvesting and applying big data in HSC operations. Thus, this paper has applied TOC to uncover humanitarian constraints and dynamic capabilities in order to generate a *Lean* thinking approach to the field of HSC operations. We argue that TOC can be a versatile theory and methodological approach for

tackling current issues in HSC operations. In conclusion, we extend the theory of dynamic capabilities for embedding *Lean* thinking in HSC operations.

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