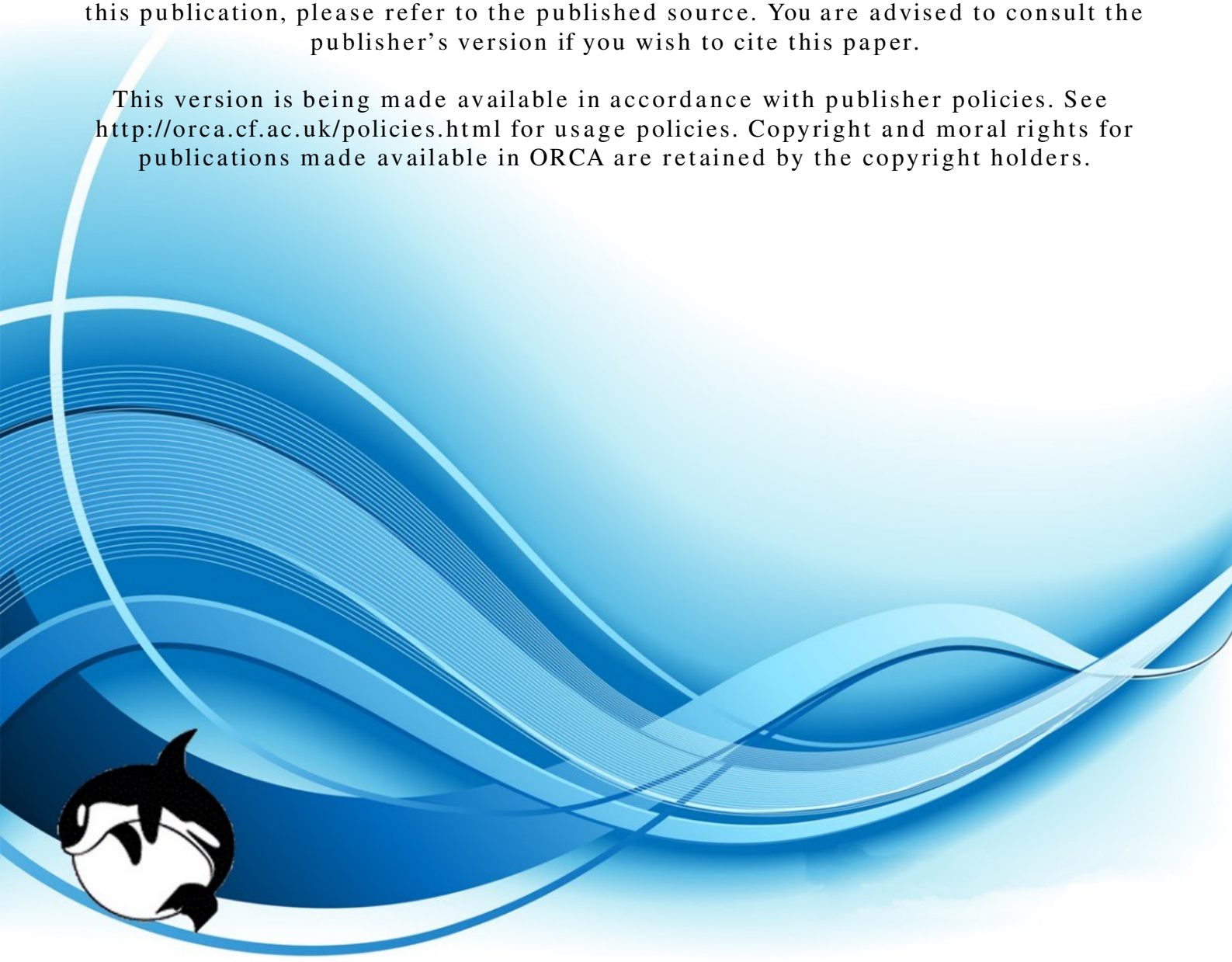

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Humanitarian Aid Logistics: An evolutionary perspective on Cases, Structures and Prospects

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Humanitarian Aid Logistics: A Cardiff University Research Perspective on Cases, Structures and Prospects

Purpose

This paper provides a contextualised review of research in the area of humanitarian and emergency relief logistics, providing insights with particular emphasis on lessons learned. The paper tracks the evolution of research against the development of partner networks and key global events; information was collated and assimilated from cross-cutting themes such as disaster preparedness, emergency response structures and the transferability of commercial-world concepts and principles (such as sustainability) into volatile and fragile environments. It concludes by suggesting possible future challenges which could steer both humanitarian response on the ground, and will influence the path of academic research going forward.

Design/methodology/approach

The paper provides a general review of work undertaken in the area of Humanitarian Logistics. Use is made of vignettes of case studies in order to provide focus to the discussion and to highlight key issues that emerged from the research reviewed.

Findings

The findings show that there are several new areas of research which will need to be addressed in the humanitarian logistics arena. The discussion demonstrates that research into crisis response is arguably even more important today than it has been previously. Research is therefore likely to need to be expanded considerably over the next decade and beyond.

Originality

This paper contextualises and synthesises past research into humanitarian logistics responses, highlights key themes and suggests areas for further research.

Keywords: Humanitarian Aid Logistics, Cases, Research Evolution, Critical Success Factors, Transport

1. Introduction and Scope

This paper first presents a reflective review of research carried out, primarily by Cardiff University and its partners, in the area of humanitarian and emergency relief logistics. The paper provides insights into this emergent and important field with particular emphasis on lessons learned. Information has been collated and assimilated from cross-cutting themes such as disaster preparedness, emergency response structures and the transferability of commercial-world concepts and principles (such as sustainability) into volatile and fragile environments where conditions are rarely, if ever, exactly repeated. In the second part of this paper, use is made of particular case studies in order to provide focus to the discussion and to highlight key issues as they arose in the field.

Lastly, this paper attempts to envisage the kind of crises and emergency events which may emerge, or which are already emerging, to which organisations including governments, non-governmental organisations (NGOs, United Nations (UN) bodies and private sector operators will be required to respond (Wells, 2020). Of particular interest is the fast-changing global conflict environment which is increasingly complex and exposed to international scrutiny at both formal and informal levels, especially via media platforms, analytic tools and surveillance.

One of the consequences of this is that the conduct of military bodies is mostly, but not always, government-led and is open to examination by a global audience in an unprecedented level of detail. The rapidly changing role of armed forces has tended towards smaller, more agile, multi-skilled units which are still designed for battle-fighting, or for aggressive defence. But the core principles of agility and flexibility, coupled with rapid response capability, often fit the humanitarian needs of communities in a disaster-hit environment remarkably well (Cross,

2014). This is especially true where human security or security of aid materials is paramount (Haavisto et al, 2016).

2. Historical Context

Humanitarian aid includes the provision of food, water, sanitation, medical supplies and shelter during or following some form of disaster (Kelly, 1995). The origin of humanitarian aid emergency relief logistics research at Cardiff can be traced back to two crises, both in Africa, that caught the world's attention. During the mid-1960s, in a little recognised west African region known as Biafra, economic and political fragility combined with tribal and territorial tensions to bring about the first true humanitarian crisis which was recognised as such (Encyclopaedia Britannica, 1992). Water and food shortages, and disease, led to starvation and the death of up to 4 million people, mainly young Biafrans, and enforced migration triggered a large-scale international response by, for example, Cote D'Ivoire, Gabon, Tanzania and Zambia. Emergency supplies, including medicines were flown in or air-dropped, as the region under maximum stress was landlocked. The cost and unsustainable nature of this response was widely acknowledged (Desgrandchamps et al, 2020).

The vulnerability of sub-Saharan Africa was exposed again less than 10 years later as a long-term drought hit a number of states which share a semi-desert environment across the full width of the continent. This quickly became known as the 'Sahel Drought' which, directly or indirectly, provided the motivation for accelerated research into climate change, its causes, impacts and possible remedies. The establishment of a growing number of research centres (such as the Climatic Research Unit [CRU] at the University of East Anglia) was, at least in part, justified by the apparent increase in climatic variability and by the broadening consensus that global warming and desertification were both real and accelerated by human activities (Calder, 1974; Schove, 1977; Vincent et al, 1979). The cutting-edge work of the CRU and other centres provided the impetus for the next phase of research which was focused on first-hand fieldwork in East Africa during 1978; this was sponsored by the Royal Society and the Kenyan Government. The fieldwork was focused on water resources and climate variability in Kenya and the wider region (Beresford et al, 1981; Vincent et al, 1989).

The value of the research lay in clarifying the spatial patterns and temporal trends in rainfall, river flow, lake levels and atmospheric variation. These cause-effect linkages could help to

explain drought frequency, water resource availability and changes in other life-supporting elements (Vincent et al, 1979; Davies, et al, 1985). Research into the climatology and climatic vulnerability of sub-Saharan Africa gained further traction when, in the mid 1980s, the Ethiopian famine pricked the world's conscience and highlighted the need for a strategic approach to humanitarian and crisis response (World Vision, 2018). The repeat pattern had become all too obvious. These patterns had not, of course, gone unnoticed by the wider academic community, respective governments, the NGOs or the larger organisations such as the United Nations. The works of Mbohwa et al (2018) and DeVilliers (2018) provide excellent examples of the efforts made to better understand where crises occur, how often they tend to happen, how they can be best prepared for, and responded to. Table 1 presents a summary of the early work which formed the platform for subsequent Cardiff University research, with a classification of the work by keyword and output type.

Table 1 here

The trajectory of the climate change agenda, and of the succession of summit meetings since the late 1970s / early 1980s has confirmed the validity and importance of this early research (IPCC, 2021; COP26, 2021). So much so, that in recent years, the issue has been referred to as a climate emergency (UNEP, 2021). The early work of the Cardiff team has, if anything, become more rather than less important with the passage of time, and feeds into the debate on climate change in general, and into issue-specific regional approaches to natural disasters and emergency response.

Following this earlier work on the potential effects of climatic change, came the development of Humanitarian Aid Logistics and Supply Chain Management research through the Transport and Shipping Research Group at Cardiff University. The first studies were focused on the transport systems of Southeast Asia, Africa, Asia and Latin America. While the main focus of this research was on commercial or trade activities, many of these geographical areas were environmentally stressed and affected by a variety of slow-onset disasters (e.g., drought), rapid-onset events (e.g., flooding, storm) or complex disasters (e.g., war). In the mid-1990s work for the Rwandan government on trade and transport rehabilitation led to specific consideration of humanitarian aid logistics and supply chain performance. As work for the UN in Rwanda had

taken place in the immediate aftermath of the Rwandan civil war, initial research examined the relationship between non-military and military organisations in responding to the various disaster types (Pettit and Beresford, 2005). At around the same time, floods in east Africa, which had centred on Mozambique, led to consideration of aid flows and how they might be better served by more effective logistics and supply chain systems (Beresford et al, 2002). It should also be noted that during the period up to the early 2000s very little research in this area had taken place (Kovacs and Spens, 2007), apart from some early studies by, for example, Oloruntoba and Gray (2002). The research being conducted at Cardiff was therefore at the forefront of reflections on humanitarian aid logistics and supply chain management issues. This work, at that time, paralleled the development of research in this area with that of Hanken Business School and Cranfield University, which were themselves emerging as centres of excellence for research within these emerging fields.

Central to any humanitarian response is the delivery of aid, with speed often a more important consideration than necessarily cost or, potentially, waste. However, a large proportion of aid agencies annual budgets for emergency and disaster relief are used to support logistics and supply chain management activities (Beresford and Pettit, 2012; Tatham and Christopher, 2014. Relief activities are further complicated by the unique nature of each crisis with the combination of circumstances, and operating environments differing each time. This paper thus considers some of these issues and how Cardiff's research has contributed to developing a better understanding of humanitarian aid logistics processes. In crisis situations the movement of aid supplies whether food, medicine or equipment is a prerequisite, often requiring unique solutions, unorthodox means and political and cultural awareness to access at-risk populations. The research thus offers lessons in managing volatile and fragile supply chains in unsustainable situations (Tatham and Christopher, 2014; 2018).

Outputs from the group have largely fallen into two main groups and have included a variety of journal papers and other scholarly work. The first group has considered theoretical dimensions, for example, the role of military organisations in emergency relief (Pettit and Beresford (2005), Critical Success Factors in Humanitarian Aid logistics (Pettit and Beresford, 2009), the relevance of lean supply chain concepts for humanitarian aid provision (Taylor and Pettit, 2009), Humanitarian Logistics Supply Network Management (Tatham and Pettit, 2010), warehouse pre-positioning for humanitarian relief (Roh et al., 2015); and supply chain integration (Kim et al, 2017; 2018). The most recent work in this area has considered locational

issues for the positioning of relief goods in relation to where earthquakes are most likely to occur (Nikolopoulos et al., 2020). The second group of outputs relate largely to understanding emergency relief and humanitarian aid in the field, for example responses to the 2004 Indian Ocean Tsunami (Banomyong et al, 2009; Pettit et al, 2011; Beresford and Pettit, 2009; Pettit et al, 2014); post Rwandan civil war reconstruction (Choi et al, 2010); the Wenchuan and Haiti Earthquakes (Beresford and Pettit, 2012), and delivery of aid to Iraq (Al Hashimi et al, 2016). Table 2 details a selection of the main outputs from Cardiff University covering key themes in humanitarian aid logistics and related subjects. A number of additional relevant papers based on high citation frequency are also included as they are appropriate to the context of the discussion.

Table 2 here

3. Case Event Vignettes

In order to highlight some of the key issues identified through this corpus of work, the following section presents a number of vignettes from the work that Cardiff has undertaken, highlighting key aspects of humanitarian and emergency relief logistics and supply chain management in a selection of specific case events. Specifically, the key aspects of the cases discussed are summarised in Table 3. The table highlights the key aspects of the disaster, the date of the event itself and the period over which study took place.

Table 3 here

One of the first major projects undertaken was in relation to the on-the-ground situation in Rwanda in the post- civil war period, where key aspects of supply chain operations in volatile and fragile environments were addressed. When this work was first undertaken in the mid 1990s little academic consideration had been given to such operating conditions, the existing literature having generally considered commercial vulnerability where business environment

uncertainties cause demand fluctuation. The literature tended to focus much less on non-commercial vulnerability, however, where uncertainties are more extreme and derived from external shocks such as terrorism or natural events (e.g., earthquakes). This work therefore presented the opportunity to examine the operation of emergency relief supply chains both in the extreme conditions which existed in the immediate aftermath of the Rwandan civil war between 1994 and 1996, and then again during the more stable period rebuilding phase that followed (Beresford, 1998; 1999).

Specifically, an assessment of the effectiveness of emergency aid movements both to and within Rwanda in the post-civil war period considering Kenyan road-based logistics and port operations, Tanzanian railways and the role of other service providers in neighbouring countries, was undertaken (Beresford, 2012). Three surveys were undertaken covering the initial post-civil war relief period (1994/1995), the rebuilding phase (1997/1998) and the post-crisis recovery period (2004/2005). Both physical and non-physical internal and external barriers to aid distribution were identified. It was clear that the region suffered from fragile physical logistics systems (for example roads in very poor condition both in terms of construction and surfaces, unstable rail track bedding, weak bridges) and volatile operating conditions (fluctuating freight rates, unpredictable transit schedules through Kenya and Tanzania) and a wide range of other uncertainties such as political instability (Beresford 1998; 1999). Nonetheless it is shown that opportunities for service development arise from the uncertain operating conditions, and these are exploited by companies willing to bear high levels of risk. Their response is typically to charge a risk premium for services, consistent with literature focusing mainly on non-emergency environments.

While Rwanda was clearly a conflict / post-conflict disaster the first natural disaster addressed by Cardiff academics was the response to the Mozambique Floods where it was apparent that the on-the-ground situation led to significant difficulties in the distribution of aid. This led to early considerations of response mechanisms and an attempt to map the processes followed in the response phase of a disaster (Jennings et al, 2000; Beresford et al, 2002). In February 2000 southern Africa was hit by tropical cyclone Eline which led to three weeks of severe rainfall, resulting in significant flooding which devastated large areas of Mozambique. It was estimated that more than 100,000 people needed to be evacuated with further complications such as several thousand people having to be rescued from trees. (BBC, 2000a). While there was already substantial development work taking place in the country,

the cyclone changed the emphasis over the next few months to provision of aid to sustain the displaced population (BBC, 2000b; Jennings et al, 2000).

While the mapping of the Mozambique flood response was addressed in relatively qualitative way it nevertheless started a process of consideration about how the logistics and supply chain management challenges of post-disaster situations should be addressed. The opportunity to extend thinking in this area came about following the December 2004 Indian Ocean Tsunami which had significant impacts in Southeast Asia, and Cardiff's work sought to highlight lessons which could be learnt from a logistical perspective. The event made it tragically clear that the countries in the region completely lacked the infrastructure, knowledge, capacity and capability to deal with the aftermath of such an event. Further, the work supported the notion that logistics is often the forgotten dimension of humanitarian crises while being central to the delivery of relief aid. Thus, effective logistics is important in the overall response of humanitarian programmes and without it aid provision will either fail, or be perceived to fail, and fragile emergency supply chains in extreme conditions increase the dependence of humanitarian aid distribution on reliable supply. Further, logistics costs including procurement and transport form significant elements of aid operation (see also, for example, Kovacs and Spens, 2007). Subsequently aid organisations began to give more attention to the issues related to large scale emergencies including prevention, planning and emergency relief operations. The lessons learned from the response to the tsunami encouraged countries and organisations to reconsider how to better respond to such emergencies (Banomyong et al, 2009; Pettit et al, 2011).

It was clear that countries in the region lacked both the communication and logistics infrastructures and capabilities to deal with the aftermath of such an event. The tsunami had raised many issues relating to how countries respond to large scale humanitarian disasters, including the level of preparedness and the management of logistics and supply chain activities in volatile conditions such as those immediately following the tsunami strikes. In April 2012 further earthquakes in the region occurred, with epicentres approximately in the same location as the 2004 earthquake. These earthquakes led to Tsunami warnings being issued and the need for residents and holidaymakers in the affected area to be evacuated to higher ground. A Cardiff study showed that, in Thailand, the warning systems, evacuation mechanisms and chains of responsibility established at local level meant that large numbers of people could be moved quickly to safe zones. However, several systemic weaknesses

were shown to be potentially critical, with evacuation route signage being inconsistent, leadership in crisis conditions being weaker than required, and provision of correct information being less than optimal with substantial room for improvements in the tsunami response system being necessary (Pettit et al, 2014).

Sandwiched between these tsunami related events were two significant earthquakes which allowed the strength of the response mechanisms in countries with vastly different economic and political makeups to be assessed. The Wenchuan earthquake (May 2008) took place in a region of China landlocked both geographically and politically, while the Haitian earthquake (January 2010) was theoretically accessible to international external aid provision via air or sea. The initial Wenchuan earthquake response and needs assessment was entirely internal to China. It was not until the Chinese authorities had established the scale of response required that international assistance was permitted and several multimodal solutions were devised to minimise the risk of supply breakdown. In contrast, the response to the Haitian earthquake relied entirely on external aid and logistics support, with organisational and infrastructural weaknesses making the supply chain extremely vulnerable with significant mismatches between aid volumes and logistics capability initially hindering 'last-mile' distribution. Cardiff's work highlighted the extreme challenges faced by logistics and supply chain operations, with both requiring both military and non-military engagement. The responses to these events showed that non-standard logistics solutions could meet the requirements for effective aid distribution in extreme environments, but with high levels of cost (Beresford and Pettit, 2012).

4. Cross Cutting Research and Collaboration

Through these case-specific studies came a recognition that there was a need to ensure that emergency relief supply chains are both appropriate and effective. Work which had started in Cardiff around 2006 (Lu et al, 2006) was developed to address understanding of how 'Critical Success Factors' are necessary for effective humanitarian aid logistics and supply chain responses. The work identified the factors which are important for organisations in providing successful responses in crisis situations, and also the important variables which contribute to their effectiveness. The ten factors fall into three groups: planning and strategy (3); management (4) and others (3). This clearly suggest that the weight of responsibility is on management to plan and prepare for conditions in the immediate and longer-term future. The 'Critical Success Factors' themselves split into a variety of decision-making elements focused

primarily on current and future performance. The work also demonstrated how such factors can support strategic improvements, response mechanisms and the development of humanitarian aid supply chain assessment (Pettit and Beresford, 2009).

More recent work has addressed two further aspects of the humanitarian aid response, being the prepositioning of aid to facilitate more effective and rapid aid delivery, and the integration of aid agencies and their suppliers which, in part, supports aid prepositioning. During the 2000s, the pre-positioning of aid as a mechanism to support better preparedness gained increasing importance as humanitarian supply chains became more sophisticated, with pre-purchased stock situated in pre-positioned warehouses often being the preferred option. Cardiff's work, in common with that elsewhere, identified key factors for humanitarian relief pre-positioning warehouses using multi-criteria techniques to analyse the structure of the location selection problem and determine the most appropriate location for aid storage (Roh et al, 2015; De Villiers, 2018). Further, the large number and range of aid actors involved in responses to disasters including supranational aid agencies, governments and governmental organisations, and non-governmental organisations often international in nature, large and small means that issues relating to coordination, collaboration and integration cannot be easily resolved (Kovács and Spens 2009). With most aid organisations having their own agendas and methods of delivering aid, they are often in direct competition with each other both for funding and necessary access to disaster areas. The integration of supply chains between aid actors is thus seen as central to humanitarian supply chain management (Thomas and Kopczak, 2005; Chen et al. 2009).

Networks for moving aid closer to possible risk areas are already used by, for example, UNHCR, UNICEF and the IFRC[1], and such locations offer a workable compromise between proximity to disaster-prone areas and sustainability of facilities from operational and security perspectives (Roh et al, 2015). More recent research into the relationships between participating organisations has suggested that better integration is required. Cardiff's work has explored integration from the perspective of major humanitarian aid actors, in particular when they deal with sudden onset natural disasters, considering the roles of each aid actor, and both their commonalities and how they differ (Kim et al, 2017; 2018).

[1] UNHCR – United Nations High Commissioner for Refugees; UNICEF - United Nations International Children's Emergency Fund; IFRC – International Federation of the Red Cross

Disasters are commonly classified into four types: sudden-onset, natural (e.g., flooding, storm, earthquake); human derived or triggered (e.g., military attack, coup d'état); slow-onset, natural (e.g., drought, famine); or human-made (refugee crisis) (Van Wassenhove, 2006). In practice, however, emergencies are often more complex than this simple two-by-two classification would suggest. One type of event, for example, may lead to a second, such as a drought leading to political instability which then leads to military action triggering a refugee crisis or 'complex emergency'. Thus, any natural disaster or civil/military conflict may create a situation where both the short-term (immediate post-event) situation and long-term consequences, will be significant for the population (Pettit and Beresford, 2005; Choi et al., 2010; Cross, 2014). The Syrian conflict is a case in point where regional destabilisation followed an insurgency leading to population displacement in several directions (BBC, 2021). Other examples of such complex emergencies include Afghanistan and Myanmar, each with their particular mix of human displacement, instability, resource shortage and political complexity (BBC, 2018)

The evidence suggests that, however it is measured, the number of natural and man-made emergencies has risen steadily over a period of several decades (Roh et al., 2008; Haavisto et al., 2016). Notwithstanding the 'repeat' nature of natural and man-made emergencies, it was identified by organisations such as the Fritz Institute that aid delivery system failures tend to replicate shortcomings observed in response to preceding events. Such system failures result, for example, in high aid materials wastage rates which have been observed to reach as high as thirty percent loss stemming from logistics inefficiency or insecurity leading to accidental loss, theft, spoiling or damage (Fritz Institute, 2005; Choi et al., 2010). In such cases, it is difficult to create a generalisable supply chain system and there will be a need for institutional learning to minimise the most unstable period following the crisis. (Pettit and Beresford, 2005). In an attempt to address instability from a logistics perspective, Kwak et al. (2017) classified supply chain risks in a commercial context into a hierarchy in order to improve understanding of risk-handling in stable environments. The classification could potentially be readily extended to volatile, fragile and emergency environments.

The multidimensional nature of such crises, often translating into humanitarian emergencies, points towards the need for collaborative response and by nature collaborative research. In order to strengthen its network accordingly, Cardiff University collaborated initially with UN

bodies, notably UNCTAD, UNDP, and UNESCAP[2] (Beresford and Rugamba, 1996; UNESCAP, 2003), and subsequently with academic and practitioner institutions to advance understanding of logistics and supply structures, and operational methods in the humanitarian field. Cardiff have interacted with the UK military and the UK Government's Department for International Development through research funded by the Chartered Institute of Logistics and Transport (2005) and the Cardiff-Cranfield Humanitarian Logistics Initiative, established in 2007 (Tatham and Pettit, 2010; Wells, 2019). Partner organisations have also included: from 2004 Thammasat University, Thailand (Beresford and Pettit, 2009;) the HUMLOG [Humanitarian Logistics] Institute at Hanken Business School (Wells, 2019); and HELP – an independent group representing UK Humanitarian and Emergency Logistics Professionals. Other work has included participation in the inaugural meeting of the Stephenson Centre for Disaster Management (Baton Rouge) in respect of emergency response following Hurricane Katrina in 2005; and work with Griffith University, Australia (Tatham and Christopher, 2014)..

5. Conclusions and Possible Areas for Future Research

The genesis of humanitarian aid logistics research, particularly from the perspective of that undertaken in Cardiff, began from the broader issues associated with climate change and environmental science, notably drought frequency, water shortage and the humanitarian crises stemming from these. Key outputs from research underpinning subsequent research were outlined in Table 1. Over the following four decades, the role of climate change and the impact of environmental issues has been increasingly recognised. The potentially catastrophic consequences of environmental events on humanity is now at the forefront of research at a global level in this area. The two-by-two matrix referred to earlier (Tatham and Christopher, 2014) provides a framework for understanding the form of an emergency. Classifying events into sudden / slow-onset and natural / man-made provides a starting-point, but disasters and emergencies in practice typically exhibit a mix of characteristics. These become inputs which require expertise, which is well outside the capability of most organisations operating alone. This is especially true when a crisis is international, involving two or more countries and hence multiple governments; in such cases collaboration and cooperation become paramount. If a crisis involves a degree of conflict, or even war, response mechanisms are at their most

[2] UNCTAD – United Nations Conference on Trade and Development; UNDP – United Nations Development Programme; UNESCAP – United Nations Economic and Social Commission for Asia and the Pacific

complex and logistics and distribution solutions are at their most fragile (Pettit and Beresford 2005; Cross, 2014).

A review of high-profile emergencies was presented earlier. The first-time large-scale humanitarian crises was recognised was arguably in Biafra, which at the time was part of Nigeria. This was quickly followed by the sub-Saharan (Sahel) drought of the 1970s which triggered famine across a wide area of that region of Africa. In subsequent years drought hit Ethiopia and triggered a high-profile famine which in turn partly contributed to conflict between Ethiopia and Eritrea. In all these cases which can be seen as complex emergencies, the logistics of humanitarian aid became central to the survival of extremely large numbers of people located in refugee camps or displaced into informal, resource starved, communities. During the mid 1990s the Rwandan Genocide of 1994 led to the external displacement of at least one million people, mainly to neighbouring Uganda, Tanzania, and eastern Congo. The concentrations of extremely large numbers of refugees again focused attention on the logistics of aid supply to inaccessible and unstable parts of east and central Africa. Logistics was again critical for the survival of up to two million refugees when internally displaced persons are included. Ten years later the 2004 Indian Ocean Tsunami posed unprecedented challenges mainly because of the sheer scale of its impact. The lack of preparedness of both government and coastal communities highlighted the need for a major overhaul of warning systems and logistics processes. It further highlighted the need to evacuate large numbers of people quickly if a Tsunami occurred, in effect the need for 'human' logistics became the focus of attention (Banomyong, 2009; Pettit et al, 2011; 2014).

The 2008 Wenchuan and the 2010 Haitian earthquakes provided examples of the need for both traditional and unique logistics solutions on an unprecedented scale. Although only a natural disaster in the case of Wenchuan the surge mobilisation of considerable military resources was important but was nonetheless ultimately augmented by over a dozen other countries to make up for capacity shortfall. Notable were the combinations of transport modes and methods required to reach the affected area which was both landlocked and virtually inaccessible in the post disaster period and were probably the most complex ever employed. The Haitian earthquake, in contrast, was essentially maritime. However, the event was so destructive that the affected area, primarily the capital Port-Au-Prince, was only accessible from the sea which required both military and non-military resources built on a collaborative approach in a hitherto

isolationist environment. Conventional means of aid transport and distribution were simply not possible.

The direction of travel of both humanitarian crises themselves, and of research into these crises from a logistics point of view is hard to foresee. However, recent events have highlighted the need for public, private and third sector organisations to be ever-more imaginative in rising to challenges and combating resistance. For humanitarian research going forward there are several new areas which will need to be addressed: the outbreak of a pandemic which poses primarily non-physical challenges; reconfiguration of borders and border controls; sovereignty and decision making (including disease control, travel restrictions and decision making hierarchies); freedom of movement (asylum seeking versus economic migration); the role of military bodies in security, health and safety; the general blurring of humanitarian definitions, concepts and principles (humanitarian issues versus a broader concept of social stress) (Wells, 2019; Wells et al, 2020). The scope for research into these areas is considerable and likely to increase. The humanitarian research discussed in this paper demonstrates that research into crisis response especially in the field is arguably even more important than it has been previously. Research into these valuable areas is therefore likely to expanded considerably over the next decade and beyond.

The research outputs from Cardiff University and its research network partners discussed in this paper splits into six main areas: the transferability of commercial supply chain operations to the humanitarian environment; the interrelationships between participating organisations immediately following a disaster or emergency; the respective roles of governments and private operators and the relationship between the two; the requirement for preparedness, the immediate response to a crisis and the longer term recovery processes; the establishment of short and medium term structures required for maximum emergency response effectiveness; and the resilience of existing transport networks to shocks such as humanitarian emergencies.

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Table 1. Key References on Climate Change and Environment

Reference	Lake Levels	Climate Change	Glaciers	Rainfall	Upper atmospheric wind	Kenya	East Africa/Africa (A)	Seasonality	Drought	Environment	Output Type
Johnson, 1962				X					X		Journal
Nakamura, 1969				X	X				X		Journal
Calder, 1974		X	X							X	Book
Kidson, 1977		X		X			X (A)				Journal
Schove, 1977		X			X		X (A)			X	Report
Vincent et al, 1979	X	X			X						Journal
Farmer, 1981					X		X			X	PhD
Beresford et al, 1981	X	X	X				X				Journal
Beresford, 1982	X	X		X	X	X	X	X			PhD
Davies et al, 1985				X		X		X			Book Chapter
Vincent et al, 1989	X	X	X	X			X (A)	X			Journal

Source: Authors

Table 2. Humanitarian Outputs from Cardiff University and Selected Frequently Cited Context Papers, 1996 - 2020

Year	Authors	Title	Publication Type	Key Themes
1996	Beresford and Rugamba	Evaluation of the Transport Sector in Rwanda	Report	Rwanda, Transport, Rehabilitation
1998	Beresford	Re-evaluation of the Transport Sector in Rwanda: An assessment of Policy	Report	Rwanda, Transport, Trade Corridors, Multimodal
2000	Jennings, Beresford and Banomyong	Emergency Relief Logistics: A Disaster Response Model	Working Paper	Humanitarian, Emergency Relief, Logistics, Model
2003	UNESCAP	Transit Transport Issues in Landlocked and Transit Developing Countries,	Report	Landlocked, Transit Transport, Trade, Multimodal, Model
2005	Fritz Institute.	Logistics and the effective delivery of humanitarian relief	Report	Humanitarian Aid, Emergency Relief, Logistics
2005	Pettit and Beresford	Emergency relief logistics: An evaluation of military, non-military and composite response models	Journal Paper	Humanitarian Aid, Emergency Relief, Logistics, Military, Models
2006	Lu, Pettit and Beresford	Critical Success Factors for emergency relief logistics	Journal Paper	Emergency Relief, Critical Success Factors, Logistics
2006	UNESCAP	Integrated International Transport and Logistics System for North-East Asia	Report	Africa, Transport, Logistics, Trade, Multimodal, Model
2007	Kovacs and Spens	Humanitarian logistics in disaster relief operations.	Journal Paper	Humanitarian Aid, Disaster Relief, Logistics
2008	Roh, Beresford and Pettit	Humanitarian Aid Logistics: Response Depot Networks.	Conference Paper	Humanitarian Aid, Logistics, Prepositioning, Depot Networks
2009	Beresford, Jennings and Pettit	Emergency relief logistics: An evaluation of military, non-military and composite response models	Journal Paper	Humanitarian Aid, Emergency Relief, Logistics, Military, Non-military, Models
2009	Pettit and Beresford	Critical Success Factors in Humanitarian Aid logistics	Journal Paper	Humanitarian, Critical Success Factors, Logistics
2010	Choi, Beresford, Pettit and Bayusuf	Humanitarian Aid Distribution in East Africa, A study in supply chain volatility and fragility	Journal Paper	East Africa, Humanitarian Aid, Volatility, Fragility
2010	Tatham and Pettit	Transforming Humanitarian Logistics – The Journey to Supply Network Management	Journal Paper	Humanitarian, Logistics, Networks
2011	Pettit, Beresford, Whiting and Banomyong	The 2004 Thailand Tsunami reviewed: lessons learned	Book Chapter	Thailand, Tsunami
2012	Beresford and Pettit	Humanitarian Aid Logistics: The Wenchuan and Haiti Earthquakes compared	Book Chapter	Wenchuan, Haiti, Earthquake, Humanitarian Aid, Logistics
2012	Knight, Pettit and Beresford	Agility in Humanitarian Aid Supply Chains	Conference	Humanitarian Aid, Supply Chain, Agility
2012	UNESCAP	Time/Cost-Distance Methodology	Report	Transport, Time-Cost-Distance, Model
2014	Pettit, Beresford, Whiting,	The 2004 Thailand Tsunami and the April 2012 Tsunami warning: were lessons learned?	Book Chapter	Thailand, Tsunami Warning, 'Human' logistics

	Banomyong, and Beresford			
2014	Cross	Disaster agencies and military forces: not such strange bedfellows after all!	Book Chapter	Disaster relief, military, structures
2015	Roh, Beresford, Pettit and Harris	The pre-positioning of warehouses at regional and local levels for a humanitarian relief organisation.	Journal Paper	Humanitarian, Logistics, Prepositioning, warehouses
2016	Knight, Pettit, Beresford, and Sohn	Humanitarian Aid logistics: a new area for the public service agenda?	Book Chapter	Humanitarian, Logistics, Public Service
2017	Kim, Pettit, Beresford, and Harris	Towards a better understanding of Humanitarian Supply Chain Integration	Book Chapter	Humanitarian, Supply Chain, Integration
2018	Kim, Pettit, Beresford, and Harris	An Exploration of Horizontal Supply Chain Integration for Humanitarian and Disaster Relief	Book Chapter	Humanitarian, Supply Chains, Horizontal Integration, Disaster Relief
2018	Kwak, Sanchez-Rodrigues, Mason, Pettit and Beresford	Risk interaction identification in international supply chain logistics: developing a holistic model,	Journal Paper	Logistics, risk, Supply Chain, Model, Decision hierarchies
2020	Nikolopoulos, Petropoulos, Sanchez-Rodrigues, Pettit and Beresford	A disaster response model driven by spatial–temporal forecasts	Journal Paper	Disaster, Forecasting, Model

Source: Authors

Table 3. Selected Case Vignettes and their key features

Case	Event Date	Study Period	Type	Key Features
Post Rwandan Civil War	1994/95; 1997/98; 2004/05	1994/95; 1997/98; 2004/05	Complex emergency; Sudden onset	triggered by political instability and tribal rivalry; landlocked country Positive impact of post-war rehabilitation and recovery phase
Mozambique Floods	2000	2001	Natural disaster; medium onset	exacerbated by poverty; scale; inaccessibility
Indian Ocean Tsunami	2004;	2005;	Natural disaster; sudden onset;	Poor level of preparedness; vulnerable evacuation systems; unclear chain of responsibility
Thailand Tsunami warning	2012	2012	Potential natural disaster	Warning systems in place but vulnerable to misinterpretation at local level
Wenchuan earthquake	2008	2009	Natural disaster; sudden onset	landlocked region; inaccessibility; strong centralised command structure; domestic followed by international response
Haiti earthquake	2010	2010	Natural disaster; sudden onset	weak political governance exacerbated by poverty; entirely international response; sea-based