The Objectives and factors affecting Performance of last mile Relief Distribution in Post-Disaster operations: The case of India

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ABSTRACT:
The world has witnessed an increasing number of natural disasters in recent years affecting large populations. The logistical operations to deliver relief to these populations are complex requiring careful planning and execution especially during the Last Mile Relief Distribution (LMRD), the ultimate phase in these operations. LMRD is the phase where the disaster logistics chain directly connects with the affected communities and whose performance is affected by many factors. The aim of this paper is to evaluate the impact of relevant factors on LMRD performance in the context of India, the most affected country in the world by natural disasters. The research was conducted interviews with International NGOs and Indian government, national, and international NGOs involved in disaster relief operations in the country to determine the factors affecting LMRD operations. The qualitative phase findings identified coordination as the most significant factor affecting LMRD operations performance in India and established an outline, which will be used as a planner of LMRD before decision-making process in India. This research identifies coordination as a major factor of LMRD operations in India. Its impact is evaluated through the development of a conceptual model, which provided empirical evidence of the magnitude of LMRD performance improvement by adopting new coordination policies. The research provides suggestions for new ways on how to achieve better coordination and implement these successfully in Indian LMRD operations.

KEYWORDS: Disaster Management; Operations Management; Emergency Logistics; Last Mile Relief Distribution; India.

INTRODUCTION:
Natural disasters such as earthquakes, floods, and cyclones are occurring with a higher frequency all over the world. In 2015, 198 natural disasters were registered globally, the highest number recorded in a single year (1). These disasters have caused a significant human and economic damage. A report by the United Nations office for disaster risk reduction (UNISDR) found the direct economic cost of disasters between 1998 and 2017 to be 2,908 Billion USD. The human cost was also tragic as 1.3 million people lost their lives and 4.4 billion were injured, rendered homeless, displaced, or in need of emergency assistance (2).

Natural disasters create, in a very short time, a dramatic change to the environment and the normal life of large populations. Supply of basic utilities such as electricity and water are interrupted or severely reduced due to infrastructure damage. Large sections of the population are displaced as it is not possible or safe for them to stay in their homes. The ability of people to get basic needs such as food, medicine, and hygiene and cleaning items is significantly constrained as normal supply chains and retail operations are disrupted (3, 4). Given these consequences, the primary objective following a natural disaster is to maintain a certain degree of "normal" life by providing affected people with food, water, medicine, shelter, and medical care. "Disaster relief operations" represent the activities and processes of supplying and distributing relief items to disaster affected populations with the objective of doing this in sufficient quantities and in a timely manner (5).

Disaster relief operations are challenging and their success depends on the strength of the "emergency logistics" system underpinning these operations (6). Emergency logistics, which account for about 80% of total expenditure in disaster relief operations (7), is different from and more complex than commercial logistics. Demand in commercial logistics is known in terms of type of items, quantities required, and when and where items need to be delivered. In emergency logistics, demand is random and unpredictable because of the inherent uncertainty in disaster situations as it is difficult to determine the size of the population affected, where the population is located, and what type of relief is required (8). In commercial logistics, the level of storage and transportation capacities are known, whereas in emergency logistics, it is difficult to determine this because of the destruction taking place in and the challenges to access disaster areas (9). Commercial logistics generally benefits from well operating information systems, but in a disaster situation, lack of information is a key constraint to emergency logistics managers (10). Performance in commercial logistics is measured mainly by financial indicators (cost, profit), but in emergency logistics, the main objective is to fulfil the needs of the disaster affected population within a minimum possible time (9).

The storage infrastructure underpinning emergency logistics operations includes three levels: (i) primary hubs, which are central national level warehouses; (ii) regional warehouses, which are storage facilities located in regions and districts; and (iii) local distribution centres, which are close to the populated areas. In the aftermath of a disaster, relief items are received at the closest primary hub (s) to the disaster area. Next, they are moved to the regional warehouses and from there to the local distribution centres before they are distributed to the affected populations (11). Last Mile Relief Distribution (LMRD) is the ultimate stage in the emergency logistics chain where relief providing organisations connect directly with the disaster affected population (12). As such, LMRD operations include the storage of relief items in local distribution centres and the processes of their transportation and distribution to the disaster affected population (11). Whilst the processes of transportation to and storage of goods in primary hubs and regional warehouses involve only the organizations providing relief, LMRD operations include interactions between these and the affected population. This makes LMRD the most complex phase in the emergency logistics chain due to the challenges of the disaster affected landscape (landslides, flooded areas, destroyed infrastructure, damaged transportation and communication networks,…), uncertainties about the location of the affected populations and demand for relief items, and the difficulties of coordination between the different organizations providing relief (government departments, national NGOs, international NGOs,..).

Previous research on LMRD focused mainlyon operational management aspects such as vehicle routing, transportation fleet management(11, 13-16), and tactical decision making to improve cost, material coverage and delivery time performance (17-19). This is narrow compared to the scope and complexity of LMRD operations and there is a need to broaden the research agenda to build understanding on how these operations could be better managed and improved. For example, (12) highlighted issues such as better identification of the most affected areas, reduction of oversupply, shortages, and unmet demand, enhanced information gathering, storage, and sharing processes, and improved coordination between organizations involved in LMRD operations as important drivers of performance. These aspects require further investigation and, therefore, there is a need for a more holistic approach to analyse LMRD operations and identify the factors and drivers affecting their performance.

The aim of this research is to address this gap by investigating the factors and drivers affecting LMRD operations performance. The context of the study is India, one of the most natural disaster-prone countries in the world, which witnessed a total of 431 natural disasters during the period 1980-2010 causing more than 140,000 deaths (20). Between 1997 and 2018, the cumulative financial loss due to natural disasters was estimated at 79.5 Billion USD, the fourth in the world (2). India faces also challenging socio-economic conditions including high population density, widespread poverty, and fragile infrastructure, which exacerbate the impact of natural disasters and complicate relief operations. The focus is specifically on earthquakes because of their high frequency in the country, the large geographical areas and populations they affect, the

substantial damage they cause to infrastructure, and the significant challenges they create to the management of relief operations in general and LMRD in particular.

LITERATURE REVIEW:
Emergency Logistics
The Fritz Institute defines emergency logistics as "the process of planning, implementing and controlling the efficient, cost-effective flow and storage of goods and materials as well as related information, from point of origin to point of consumption for the purpose of meeting the end beneficiary's requirements" (6, p 2). Emergency logistics encompasses a range of activities, including preparedness, planning, procurement, transport, warehousing, tracking and tracing, and customs clearance (6, p 2).

Although research in the field of logistics is well established, the interest to emergency logistics is relatively new (21). Examples of this research include evacuation operations and casualty transportation (22), relief items stock pre-positioning (23, 24), facility location (24, 25), and relief distribution (26).

Performance measurement is another area, which attracted significant attention in emergency logistics research as it has far reaching implications for the design and implementation of logistics systems. In line with general logistics, performance is measured through two main dimensions, namely effectiveness and efficiency. Effectiveness represents the objective of the logistics system, for example fulfilment on time or in-stock availability of goods, whereas efficiency represents the ratio of resources utilised against the results achieved (27). In emergency logistics, effectiveness is evaluated through the availability of relief items to meet demand and their supply to the affected population in a timely manner. Efficiency is captured through a number of indicators including response time during disaster situation, fill rate of relief items, percentage of demand supplied to the affected population, and the extent to which donors' expectations are met (9, 28).

LMRD in emergency logistics:
LMRD is the ultimate stage of emergency logistics operations where relief providing organisations connect with the affected populations. In a disaster situation, the primarily objective is to supply the accurate amount of relief items in a timely manner and to the correct places to meet affected individuals' needs (12). LMRD operations play a critical role in achieving this objective, but they are fraught with difficulties because of the inherent uncertainties and complexities in disaster contexts (e.g. unpredictable demand, lack of information about the location of the affected populations, damaged transportation infrastructure, reduced or non-availability of communication networks,). Consequently,

organisations delivering relief need to overcome these difficulties and develop a clear "picture" of the situation in the disaster area so that LMRD operations can be rapidly and efficiently organised (12).

Against this importance and complexity of LMRD operations, it is surprising that research so far has been narrow and has not covered many aspects related to these operations. The dominant and most recurrent topic in LMRD research is transportation and a number of quantitative models have been developed for this purpose. Examples of these models include a stochastic programming optimisation model of the LMRD transportation network under conditions of uncertainty regarding transportation capacity, state of transportation network, and demand for relief items (29). (11) presented a heuristically solved optimisation model to minimise the total transportation cost for unsatisfied and late satisfied demand for different types of relief items. (15) developed a model to analyse the agility, adaptability and alignment for LMRD vehicle management to improve cost performance. Other research investigated resource allocation and vehicle routing in earthquake disasters (16) and LMRD fleet allocation in large scale disaster situations using Agent Based Simulation modelling (30). Beyond transportation, there have been some research addressing other aspects of LMRD research including agility and adaptability to sudden changes in the disaster area and the cost effectiveness of relief delivery operations (11, 12, 30-32).

However, there are several other challenges to LMRD operations, which have been barely touched in past research. This include lack of disaster relief qualified staff and resources, inadequate use of technology to support logistics operations, lack of institutional learning, limited collaboration between organisations involved in relief operations, and poor field operational planning (12). Furthermore, LMRD research does not distinguish between different types of disasters (earthquakes, cyclones, floods,..) and this is an important limitation as different disasters have unique characteristics, which may affect organisation and management of LMRD operations (33).

Given these research limitations, it is important to adopt a holistic perspective to LMRD operations and develop a wider understanding of the factors affecting their performance. This will enable a more targeted research to be carried out to address these factors' shortcomings and improve disaster response operations.

METHODOLOGY:
This research is conducted through a qualitative research methodology as the aim is to develop an understanding of the factors affecting LMRD operations. The

methodology is adequate as the factors are explored from the perspective of individuals with significant experience in natural disasters LMRD operations. The knowledge and expertise of these individuals are explored to build an understanding of the LMRD phase including their interpretation of the events and the experiences they went through as they were involved in real world disaster relief operations.

Study design:
The study was conducted in two phases. The first phase involved participants from international organisations with significant experience in disaster relief operations including the United Nations, Red Cross, and Oxfam to develop an understanding from an international multi-agency perspective of LMRD operations and validate the themes to be explored in the second phase. The latter phase involved participants from India with significant expertise in the management of earthquake relief operations as the study focused on this specific category of disasters.

CONTEXT OF THE STUDY:
The research took place in India as it is one of the most natural disaster-prone countries in the world. Around 59% of the country's landmass is prone to earthquakes with 12%, 8%, and 2% suffering from floods, cyclones, and landslide respectively **(34).** These natural characteristics of the country are exacerbated by its challenging socio-economic conditions including high population density, widespread poverty, and fragile infrastructure (3, 35-38). The cost of these disasters is considerable and reached a total value of 79.5 Billion USD during the period 1997-2018, the fourth in the world (2).

Disaster response in India is organised centrally under the responsibility of the National Disaster Management Agency (NDMA), which reports to the Ministry of Home Affairs. The NDMA is supported by a number of central government departments and agencies (local and international NGOs, international organisations), and provides relief through local district Emergency Operations Centres. However, this structure is very complex and creates significant management and

coordination challenges given the size of the country and the high number of stakeholders involved.

India has formal policies, plans, and guidelines for disaster management guided by a national plan approved by the country's Prime Minister. The national plan is broken down first at a regional level through the state disaster management plan and then further at a local level through the district disaster management plan. According to these plans, when a disaster occurs, a quick assessment of its severity is performed locally and this determines the scale of response, the agencies (government departments, local, national and international relief organisations) to mobilise to provide relief, and the types of relief items needed.

Data collection methods:
Data collection methods in this study included a combination of semi structured interviews and analysis of published documents. Interviews are adequate and widely used to collect data under a qualitative research methodology as they provide rich information from the perspective of participants. The interview questions were informed by the literature review and directly related to the aims and objectives of the study.

The data collection took place over the two phases of the study as per the following:

First phase: International organisations:
Twenty interviews were organised involving participants from organisations such as the United Nations (UN), World Health Organization (WHO) and the Red Cross. Participants had various roles in disaster management (disaster response officer, coordination manager, capacity development officer, shelter development officer,). The interviews took place during one of summer schools of the International Association for Information Systems for Crisis Response and Management, which focused on improvement to emergency logistics in earthquakes. This was directly relevant to the focus of this study as participants has extensive experience in this category of disasters. These participants are referred to as "generic case study (GCS)" participants in the remaining sections of the paper and their list is presented in Table 1.

Table 1: List of participants in data collection from international organisation

International Context	Interviewee	Role and experience
GCS	GCS- Practitioner1	Position: Coordination Manager in an International Non-Governmental Organisation Experience: 10+ year experience in relief distribution
GCS	GCS- Practitioner2	Position: Response Officer In an International NGO Experience: 25+ year experience in Response during disaster
GCS	GCS- Practitioner3	Position: Physician Experience: 20+ year experience in disaster management at health sector level mostly response
GCS	GCS- Practitioner4	Position: Response officer in an International Non-Governmental Organisation Experience: 20+ year experience in relief distribution
GCS	GCS- Practitioner5	Position: Project Manager in an International Non-Governmental Organisation

		Experience: 5+ year experience in relief distribution
GCS	GCS- Practitioner6	Position: Information Coordination officer in an International Non-Governmental Organisation Experience: 15+ year experience in relief distribution
GCS	GCS- Practitioner7	Position: Doctor Experience: 30+ year experience serving beneficiaries during emergency situation
GCS	GCS- Practitioner8	Position: Response manager in an International Non-Governmental Organisation Experience: 10+ year experience in relief distribution
GCS	GCS- Practitioner9	Position: Field officer in an International Non-Governmental Organisation Experience: 10+ year experience in relief distribution
GCS	GCS- Practitioner10	Position: Capacity development officer at armed force Experience: 25+ year experience in relief distribution
GCS	GCS- Practitioner11	Position: Shelter coordinator in an International Non-Governmental Organisation Experience: 3+ year experience in emergency situation
GCS	GCS- Practitioner12	Position: Coordination manager in an International Non-Governmental Organisation Experience: 10+ year experience in emergency situation
GCS	GCS- Practitioner13	Position: Response manager in an International Non-Governmental Organisation Experience: 7+ year experience in emergency situation
GCS	GCS- Practitioner14	Position: Coordination manager in an International Non-Governmental Organisation Experience: 15+ year experience in emergency situation
GCS	GCS- Practitioner15	Position: Information management officer in an International Non-Governmental Organisation Experience: 10+ year experience in relief distribution
GCS	GCS- Practitioner16	Position: Response manager in an International Non-Governmental Organisation Experience: 20+ year experience
GCS	GCS- Practitioner17	Position: Senior logistical officer in an International Non-Governmental Organisation Experience: 10+ year experience
GCS	GCS- Practitioner18	Position: Logistical manager in an International Non-Governmental Organisation Experience: 5+ year experience
GCS	GCS- Practitioner19	Position: Coordination director in an International Non-Governmental Organisation Experience: 25+ year experience
GCS	GCS- Practitioner20	Position: Logistical manager in and International NGO Experience: 15+ year experience in relief distribution

Table 2: List of participants in data collection from India

Indian Context	Interviewee	Role and experience
ICS	ICS- Practitioner1	Position: Executive Director at Governmental Organisation Experience: 30+ year experience in relief distribution
ICS	ICS- Practitioner2	Position: Professor at Governmental Organisation Experience: 25+ year experience in policy development for Indian Government
ICS	ICS- Practitioner3	Position: Professor at Governmental Organisation Experience: 20+ year experience in response operation
ICS	ICS- Practitioner4	Position: Response officer at in Governmental Organisation Experience: 20+ year experience in relief distribution
ICS	ICS- Practitioner5	Position: Consultant of the response Division at Governmental Organisation Experience: 20+ year experience in relief distribution
ICS	ICS- Practitioner6	Position: Consultant of the response division at Governmental Organisation Experience: 15+ year experience in relief distribution
ICS	ICS- Practitioner7	Position: Faculty position at Governmental organisations Experience: 10+ year experience serving beneficiaries during emergency situation
ICS	ICS- Practitioner8	Position: Response manager in an International Non-Governmental Organisation Experience: 10+ year experience in relief distribution
ICS	ICS- Practitioner9	Position: Head of the Inter-Governmental Organisation Experience: 30+ year experience in relief distribution
ICS	ICS- Practitioner10	Position: Programme management specialist at International NGO Experience: 25+ year experience in relief distribution
ICS	ICS- Practitioner11	Position: Consultant of the Inter-Governmental Organisation Experience: 23+ year experience in emergency response operation
ICS	ICS- Practitioner12	Position: C.E.O and head of the National NGO Experience: 30+ year experience in Relief operation
ICS	ICS- Practitioner13	Position: Head of Disaster Response team in an International Non-Governmental Organisation Experience: 27+ year experience in emergency situation
ICS	ICS- Practitioner14	Position: Response manager in an International Non-Governmental Organisation Experience: 5+ year experience in emergency situation
ICS	ICS- Practitioner15	Position: Eastern Region head of a national Non-Governmental Organisation Experience: 30+ year experience in relief distribution
ICS	ICS- Practitioner16	Position: Field officer in a national Non-Governmental Organisation Experience: 20+ year experience
ICS	ICS- Practitioner17	Position: Logistical officer in an International Non-Governmental Organisation Experience: 10+ year experience
ICS	ICS- Practitioner18	Position: Response manager in a local NGO

		Experience: 5+ year experience
ICS	ICS- Practitioner19	Position: Field officer in a national Non-Governmental Organisation Experience: 15+ year experience
ICS	ICS- Practitioner20	Position: Senior Logistical manager in an International NGO Experience: 25+ year experience in relief distribution
ICS	ICS- Practitioner21	Position: Response officer in a national Non-Governmental Organisation Experience: 10+ year experience
ICS	ICS- Practitioner22	Position: Field officer in an National Non-Governmental Organisation Experience: 10+ year experience
ICS	ICS- Practitioner23	Position: Responders in a local NGO Experience: 5+ year experience
ICS	ICS- Practitioner24	Position: Field officer in a national Non-Governmental Organisation Experience: 25+ year experience
ICS	ICS- Practitioner25	Position: Senior Response Officer in a national NGO Experience: 25+ year experience in relief distribution

In addition, 16 documents obtained from the same organisations (UN, WHO, Red Cross) were analysed during this phase. The documents covered reports on previous earthquake disaster response operations, lessons learnt, challenges faced by the responders, and organisational mandates during these operations.

Second phase: Organisations from India:
During this phase, a total of 25 interviews were conducted with 9 participants from government department and 16 participants from national and international organisations with previous experience in disaster relief operations in India. The participants held different positions including executive director, response officer, response manager, and logistics coordinator and belong to organisations such as the National Institute for Disaster Management, Office for the Co-ordination of Humanitarian Affairs, UN, SEEDS (Indian NGO), Church's Authority for Social Action, and the Red Cross. The interviews were conducted in the towns of New Delhi and Kolkata and the participants are referred to as "Indian case study (ICS)" participants in the remaining sections of the paper and their list is presented in Table 2.

Additionally, 19 reports from previous earthquake disaster response operations covering lessons learnt, problem area faced by responders, and organisational mandates were obtained from the same organisations and analysed to develop a more comprehensive picture about the management of earthquake response in the country.

Data analysis method:
The data from the documents and the interviews was analysed through a mix of content and thematic analysis to identify and explain the various factors affecting LMRD operations and performance (Marks and Yardley, 2004; (39). The analysis started by the identification of codes from the documents and interviews and these were then fit into themes. The latter were subsequently checked to make sure that the codes and sub-themes are well aligned with the identified themes.

FINDINGS:
The data analysis yielded rich information regarding the expectations of experts and practitioners on the objectives of LMRD and the factors affecting its performance and ability to achieve the objectives. The findings are summarized in the following:

Objectives of LMRD:
Minimise the response time to deliver relief
Time is a key issue during an emergency as stakeholders' (donors, relief workers) primary aim is to get and deliver relief items to the disaster affected areas within the shortest possible time. One participant stated that "in the response, the operation time is a major problem, as it is necessary to provide relief as soon as possible to the affected community to save their lives" (GCS- Practitioner 9). Another participant confirmed this by referring to the negative impact of delayed response stating that "it is necessary to serve relief items to all the affected population within the minimum time. But because of improper planning and fewer resources, some of the communities need to wait and suffer because of lack of relief items" (ICS- Practitioner 5).

Coverage of all the affected areas:
An important aim following a disaster is to cover all the affected areas and supply relief to all those in need. One participant highlighted the challenges of achieving this stating that "the cause of the delay to reach most of the affected area during distribution time, is sometimes the shortage of relief items (food, medicine, shelters and others) at the participating agencies" (GCS- Practitioner 1). Similarly, another participant commented that "it is hard to reach all the affected areas during an emergency situation because of road blockage, the absence of personnel during relief distribution or bad weather situation" (GCS- Practitioner 8).

Reduce the distance to deliver relief:
The total distance covered to deliver relief is of vital importance during LMRD operations. According to one participant "to cover all the affected areas, relief suppliers need to choose the shortest route, but it is hard as in a disaster scenario the availability of routes is

limited because of the damages to the road network" (GCS- Practitioner 2).

Satisfaction of demand for relief items:
Satisfaction of demand is another key objective of LMRD operations. During the ultimate phase of relief distribution, it is critical to replenish the stock of relief items to cover the needs of affected populations, satisfy demand in a timely manner, and minimise shortages and unmet demand. The importance of this was highlighted by a participant who said "the identification of correct demand is the most important aspect for a successful response operation, but having sufficient quantities to meet the demand is another challenge, as after an earthquake sometimes reaching the most affected population is a major challenge for us" (GCS-Practitioner 9). This issue is important as relief operations may need to take place over an extended period of time as one participant noted that "the most vulnerable and poor communities generally migrate and live in hazardous lands and under unsafe shelters. They lose everything after an earthquake, so continuous demand for relief over an extended time period always occur" (ICS- Practitioner 1).

Correct allocation of relief items and resources:
Correct allocation of relief items, personnel, and vehicles are important for a successful relief operation. In this context, one of the participants highlighted that "the correct allocation of personnel and relief items are essential for successful relief distribution operations but during a disaster situation, it is really hard to manage relief items and volunteers as there are sudden and unpredictable spikes in demand" (GCS- Practitioner 13).

Reduction of relief distribution operations cost:
The primary objective of relief providing organisations is to save lives and care for those affected by the disaster. However, the cost of providing relief is also important especially to NGOs as donations are their main financial resource. One of the participants explained that "the cost is a very important factor for us NGOs as we are able to operate because of the donors, so we always need to show how efficiently we manage the total cost" (GCS-practitioner 6). Another participant confirmed the importance of controlling cost stating "though in disaster situation the agencies are coming with relief items and supplying these to the affected population, to continue relief operations in the long term, the agencies need to consider minimising the cost as NGOs are funded by the donors" (ICS- Practitioner 2).

Prioritisation of service:
It is important to prioritise the service in line with the needs of the affected populations. An important question is always: which relief items should be distributed first and where? According to one participant "correct

identification and prioritisation of the services (e.g. hot food, water, medical service, other relief items and services) for the affected community are vital for successful response operations" (GCS-practitioner 13).

Securing relief items supplies:
Considerations of security has also an impact on LMRD performance. According to one participant "for me the first priority is security as it is very easy to lose control during relief distribution. Lack of security can lead to relief items and material getting stolen leading to shortages and chaos in relief operations" (GCS-Practitioner 17).

Factors affecting LMRD performance:
Correct needs assessment
Successful LMRD operations are contingent upon a clear understanding of what relief is needed and where. According to one practitioner "it is necessary to understand the situation of the affected community for a sound needs assessment and an effective response operation" (GCS-practitioner 19).

Needs assessment is important as it provides clear information for operational planning during relief operations in an emergency situation (40). Precise identification of the affected community and its exact needs enable effective relief distribution operations, hence the performance of LMRD.

Involvement of local community members:
After a disaster, the affected community always acts as first responders as they have information about the locally available resources, most affected neighbourhoods, and most immediate priorities regarding relief items. In this context, one participant noted that "after a disaster, local community members are always the first responders as they have the best knowledge about the most affected people and vulnerable areas" (GCS-practitioner 11). This is why it is important that government and NGOs engage in communication and training activities with local community to improve knowledge and build capacity regarding delivery of relief operations (41). This was confirmed by the majority of participants, who said that the involvement of local community members was very helpful as they provided valuable information about the state of local areas following disasters, which improved the performance of relief distribution operations.

Cultural considerations:
Taking account of cultural aspects is essential for the success of disaster relief operations. According to Kunz and Reiner (42) "the type of the economy, the presence of local suppliers, the level of education of the population, the local culture and religion will oblige relief organisations to adapt their operations to the

context, and can affect the performance of humanitarian logistics" (42, p 120). Every geographical region has its own cultural norms such as food and clothing habits. For example, in northern Indian regions, food and clothing habits are totally different from the southern Indian ones. In this context, one of the participants stated that "during the South Asian Tsunami in 2005, relief organisations were sending plenty of flours to South India but the affected community refused to accept it, as they were more used to rice in their food" (GCS-practitioner 10). Another participant draw attention to the five key factors for an efficient relief distribution operation and they are "accurate assessment of the situation, prioritisation of the needs, understanding of the cultural aspects where the disaster happened, engaging the host country population in the relief distribution operation, and communicate the plan to the host country population" (GCS-practitioner 12). It is essential to understand the disaster affected region's culture to supply the correct type of relief items. Local community members can provide accurate information to non-local national and international organisations about the local culture and needs, reducing wastage of valuable relief items and improving LMRD performance.

Accurate information about the disaster area:
Relief organisations' knowledge about the state of the disaster area prior to the occurrence of the disaster and/or just after it are important for LMRD performance as it allows relief operations to start without delay. This was confirmed by one participant, who commented that "if you have suitable knowledge and data regarding the situation in the affected area when the disaster strikes, then you have something to begin with. You have some information to act quickly in the first 48 hours following the disaster. From that you can extrapolate, you can do estimation. You can use the knowledge you have to make a good projection. Then you can continue to collect the information, which will be more accurate. But still, in disaster preparation, I will say that a very important factor is the exact knowledge to understand the needs to begin your work in the affected area" (GCS-Practitioner 5).

Knowledge and competence of staff providing relief:
The knowledge of relief staff in using information about the state of the disaster area and competence in managing relief operations have a significant effect on their success. One participant stated that "during relief distribution operations, suitable knowledge of responders is necessary, for example how to manage distribution operations, exact knowledge of logistical issues, proper use of technologies, and understanding of data and information about the disaster area" (GCS- Practitioner 3). This is in line with previous research claiming that inadequate use of technologies, lack of information and

data, and of logistical knowledge are challenges which decrease the efficiency of relief distribution (43).

Competing attitudes of relief organisations:
Disaster relief is a collective endeavour involving local, national, and international organisations. However, as many organisations, namely NGOs, are completely funded by donations, they feel pressurised to demonstrate to the donors that funds are adequately used (44). In many cases, they do this by trying to provide relief and services to a maximum number of affected individuals and this creates an attitude of competition between NGOs. One participant noted that "we are funded by our donors, so we have to show to them that on the specific disaster we did the most work in comparison to the other NGOs. And I bet the other NGOs also need to show this to their donors. So, whether we want it or not, all the active NGOs have a competitive attitude to give the best performance in the context of the relief operation. This competitive attitude sometimes makes us not wanting to communicate with other agencies" (ICS Practitioner 5). This attitude can affect the performance of LMRD operations as collaboration and sharing of information and resources are key to the success of relief operations.

Trust:
Trust is defined as "an expectancy held by an individual that the advice offered by another individual or organisation can be relied upon"(45, p 2). In relief operations, trust is essential among organisations providing relief and between these and the affected populations so that LMRD operations can run smoothly. This was highlighted by a participant, who commented that "it is essential to have a clear trust among active agencies in disaster response operations. If one organisation has already done some need assessment to identify the number of casualties and understand specific demand, sharing the data with other agencies is important to continue response operations. However, it is essential that agencies are reliable and aware of each other expertise and capabilities" (GCS Practitioner 8).

Coordination:
Coordination in the context of relief operations represents "the relationships and interactions among different actors operating within the relief environment" (44, p 23). During LMRD operations, all active agencies have the same overall purpose to help the affected population and provide them with the relief items they need. The diversity of relief providing organisations can create some challenges in the management of operations. These can be caused by language barriers, different operational processes, and diverse organisational cultures, increasing the need for better coordination. This was confirmed by one participant, who stated that "if organisations do joint decision making and share

information and knowledge then it will be easy to fulfil the demand of all the affected communities and there will be no over-supply or under-supply" (ICS-Practitioner15).

However, coordination has always been a weakness during LMRD operations prompting suggestions of solutions such as the use of information technology tools, resource sharing, and joint decision making (44, p 25). According to one participant's perspective

"coordination among the involved agencies is lacking for various reasons (for example communication gap, limited resource sharing, limited information and many others) which is a major factor causing uncertainty during relief distribution operation" (ICS-Practitioner10).

The relationship between the objectives of LMRD and the factors driving its performance is presented in Table 3.

Table 3: Relationship between LMRD objectives and factors driving its performance

Objectives of LMRD	Factors related to the objectives	Recommended Implementation
Minimise the response time to deliver relief	-Correct needs assessment - Competing attitudes of relief organisations -Trust -Coordination	Coordinate relief delivery, avoid competition, and develop inter-agency trust. Use of tools to acquire correct knowledge (information technologies, information from local areas) to minimise time delay and satisfy the demand of the affected community within a minimum time frame.
Coverage of all the affected areas	-Correct needs assessment - Involvement of local community members - Accurate information about the disaster area -Coordination	Use of need assessment review meetings and coordination of actions accordingly. Response plan needs to be discussed with the involvement of local community members to help correct identification of those in need and maximise the coverage level.
Reduce the distance to deliver relief	- Involvement of local community members -Accurate information about the disaster area - Knowledge and competence of staff providing relief -Coordination.	Knowledge of the state of the local area post disaster will provide information regarding non-damaged routes, which can be used for relief transportation. Cross knowledge of fleet capacity of different organisations can help these coordinate transportation activities in the most efficient way.
Satisfaction of demand for relief items	-Correct needs assessment - Involvement of local community members - Cultural considerations -Coordination -Trust	Use of need assessment review meetings to have an accurate view of what relief is needed. Development of trust among agencies and with the affected community to facilitate distribution of relief. Understand the culture of the affected community through active involvement of its members. Coordination of activities to ensure all the affected areas are covered by relief operations and provided with what they need.
Correct allocation of relief items and resources	-Correct needs assessment - Involvement of local community members - Accurate information about the disaster area -Competing attitudes of relief organisations	Involvement of local community member and knowledge of the local area will provide information about the most affected areas. Reduction of competition between organisations should enable these to coordinate activities and avoid duplication of relief distribution activities in same areas.
Reduction of relief distribution operations cost	-Correct needs assessment - Cultural considerations - Knowledge and competence of staff providing relief -Coordination	Use of needs assessment review meetings to reduce waste. Competence of staff in logistics and transportation to improve operations efficiency. Coordination of activities and sharing of resources to eliminate unnecessary and costly duplication of relief operations. Understanding of culture so that correct relief items are distributed.
Prioritisation of service	- Involvement of local community members - Accurate information about the disaster area -Trust -Coordination	Design of a clear communication plan with the local community to enable a fast and reliable transfer of information about what is required at different stages of relief operations. Coordination between organisations to assess priorities and respond adequately.
Securing relief items supplies	- Involvement of local community members -Cultural considerations - Accurate information about the disaster area -Trust -Coordination	-Coordinate with authorities to ensure safety of relief items and storage facilities. Understand local culture and involve local communities in activities to minimise theft and other unlawful activities. Develop trust with local populations.

DISCUSSION:

This paper focuses on the factors driving the performance of LMRD operations as this is an important and overlooked aspect of disaster management and emergency logistics. As LMRD is the phase of emergency logistics where relief delivery organisations interact with the populations needing relief and the geographical context of the disaster, it is the most complex and difficult phase of relief operations. Against this background, it is surprising that LMRD research so far has been narrow focusing mainly on transportation and to a less extent on agility and adaptability to sudden changes in the disaster area, and the cost effectiveness of relief delivery operations. To enable a broader perspective of LMRD, this research investigates the objectives of and factors affecting LMRD operations. This should provide a better understanding of the areas, which require attention from researchers and practitioners to improve relief operations management and performance.

Many of the LMRD objectives identified by participants in this research have been highlighted in previous research. This include minimisation of time to deliver relief (46, 47), satisfaction of demand for relief items (48, 49), minimisation of distance to deliver relief (50, 51), correct allocation of relief items to places where these are needed (52, 53), and reducing the cost of LMRD operations (54). However, these objectives were included as par of transportation optimisation models, which did not include many of the factors affecting LMRD performance identified in this research. In addition, some of the objectives such as prioritisation of service and securing relief items are not covered by past research.

The findings of this research indicate that LMRD operations performance is affected and driven by a large set of factors. The different organisations, roles, and expertise of participants yielded rich information covering several aspects of LMRD and identifying a wide range of drivers that can affect it. This provides evidence that LMRD operations are complex and cover several areas, which need to be managed effectively. Reducing the scope of LMRD operations to mostly transportation related problems does not give justice to the size and complexity of these operations.

Cultural and behavioural factors have been highlighted by many participants as important aspects of LMRD operations. These factors include those related to the organisations themselves such inter-organisational trust and competition attitudes and those related to the cultural trails of the populations in the disaster area such as eating and clothing habits (42). Participants' statements suggested that these cultural factors can have a significant impact on LMRD operations performance,

yet an overview of the LMRD academic literature provides little evidence that these have been investigated. This is clearly a weakness of research in this area, which warrants further attention from academics and practitioners.

Some of the factors affecting LMRD operations are internal to the organisations and can be addressed through internal policies and processes. Examples include knowledge and competence of staff, which can be improved through training programs, and coordination, which can be enhanced through the use of modern information technology tools (43). However, many factors are outside the control of organisation such as the involvement of local community members in, for example, early rescue operations and provision of information about local needs just after the disaster. As local community competencies to support LMRD operations are important, they can be developed and nurtured through tailored training and disaster simulation programs supported by governments, local, and international NGOs (55-57) (58). However, this critical issue has not been adequately covered by research so far.

The current model of financing NGOs is problematic as it creates a competitive attitude between these organisations and this can have an adverse effect on LMRD operations performance (59). It is important that funders become more aware of the complexities and difficulties of disaster relief operations and that a coordinated and mutually supportive approach between organisations is the best way to achieve the desired outcomes to the affected populations (60). Funders need to move from a micro-level focusing on the individual NGOs they finance to a macro-level looking at the whole disaster management operations focusing on integration and complementarity between the organisations involved in relief. Further research is required on NGOs funding mechanisms and financial and operational performance evaluation for the benefit of LMRD operations.

The knowledge and competence of staff involved in different activities of LMRD operations has been highlighted as important drivers of their success (61). Therefore, it is important that training programs are designed and delivered to staff. These can be organised with the involvement of government departments and agencies, local NGOs, and international organisations and NGOs. These programs will be of significant benefits to the staff and will provide a forum for exchange of ideas and experiences from different parts of the world given the high frequency of natural disasters affecting every corner of the globe.

Many factors affecting LMRD operations can be improved by advances in information technology (IT) and artificial technology (AI) (62). Assessment of

disaster affected population needs, coordination between organisations, correct estimation of demand for relief items, determination of the areas where the affected populations are located, evaluation of the state of the landscape and infrastructure in the disaster area, and involvement of local communities can tremendously benefit from new IT and AI tools and applications. There is a need for developing customized tools for disaster management and LMRD operations and deploying them in organisations and local communities so that performance is improved. Research regarding design, implementation, acceptance, adoption, deployment, and impact of the tools on LMRD operations management and performance will be very valuable in enabling organisations and communities to benefit from their vast potential.

CONCLUSION:
Natural disasters cannot be avoided, but a lot can be done to deal with their consequences and reduce their impact on populations and communities. LMRD is at the heart of disaster management operations and emergency logistics and its success is critical to alleviate the suffering of those affected by disasters. However, LMRD operations have a multitude of objectives to achieve and their performance is driven by several factors. They are very complex and require involvement of and coordination between a significant number of national and international stakeholders.

This study involved a wide range of participants from different organisations and roles with a significant experience in disaster management to capture the complexity of LMRD operations and what drive their performance. The study yielded valuable insights regarding these and, therefore, constitutes a good initial platform to identify and inform research gaps and agenda in this area beyond the narrow perspective taken so far regarding LMRD research.

Research in LMRD is still limited in scope and it needs to be widened to cover many untapped aspects of this most complex phase of emergency logistics. This study is an initial step towards a more comprehensive and holistic approach to LMRD management. It is hoped that its findings offer academics and practitioners valuable insights into the areas to be explored further for the benefit of disaster affected populations and the organisations providing them with relief

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