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Analysis of Humanitarian Construction Logistics Practices Syrian Humanitarian Operations - Case Study

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A Dissertation

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Declaration

"I do hereby attest that I am the sole author of this dissertation and that its contents are only the result of the readings and research I have done". The dissertation titled "Analysis of Humanitarian Construction Logistics (HCL) Practices: Syrian Humanitarian Operations - Case Study," submitted for the Degree of Philosophy of Doctorate (Ph.D.) in Humanitarian Logistics at the University of Selinus, the Faculty of Business & Media; is my original work and the dissertation has not formed the basis for any award of any degree, associateship, fellowship or any other.

The research papers that were published as part of the research and conducted out of the course of the study are also based on the study and are not borrowed from other sources.

Student Signature

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Publications

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  https://www.facebook.com/OrganizacionLOGYCA/posts/10157679967579485
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- **Beneficiary Appointment Scheduling for Delivering Humanitarian Aid in Conflict Affected-Regions.**
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Abstract

The basic task of humanitarian logistics comprises acquiring and delivering requested supplies and services at the places and times where needed, whilst ensuring the best value for money. Supplies include vital survival items such as food, water, temporary shelter, and medicine amongst others, which are delivered on time and are cost-effective way across the supply chain from suppliers to the ultimate beneficiaries. (Fritz Institute, 2012, IFRC.org, 2018)

Construction logistics is a novel terminology in the USA and Europe, it aims to harness logistics functions involving profit and non-profit construction operations to reach effective achievements related to the execution period, cost, quality, transportation, reverse & waste management, sustainable development, and others. (Designing Buildings Wiki, 2020)

Herein, we can see similar aspects throughout both humanitarian logistics and construction logistics such as time management, cost-effectiveness, quality management, resources management, appropriate supplies, and offering distinct construction services to final beneficiaries.

This PhD dissertation aims to merge both humanitarian logistics and construction logistics under the novel title "Humanitarian Construction Logistics (HCL)". Explorative case study, quantitative, and qualitative methods were used to explore construction logistics practices that fits humanitarian operations. The new theory will enhance construction and logistics services for affected people before, upon, and after disaster apart from financial profits. The main research questions in this PhD dissertation are as follows:

1. What are the theoretical attributes of Humanitarian Construction Logistics (HCL)?
2. What are the proposed practices for Humanitarian Construction Logistics (HCL)?

The Syrian humanitarian operations have been including many non-profit humanitarian-construction projects since 2011 until now. It was selected as a case study in this PhD dissertation to explore the issue's background, the analysis concepts, and the recommended practices that are appropriate in the context of the Humanitarian Construction Logistics (HCL).

Keywords: Construction Logistics, Humanitarian Logistics, Humanitarian Supply Chains, Construction Supply Chains.

Table of Contents

List of Figures and Tables

List of Abbreviations

1. JIT: Just-in-Time
2. CCC: Construction Consolidation Centres
3. HCL: Humanitarian Construction Logistics
4. RIBA: The Royal Institute of British Architects
5. TPL: Third-Party Logistics
6. PEP: Project Execution Plan
7. BOQ: Bill of Quantities
8. SOW: Scope of Work
9. MLP: Material logistics planning
10. PPE: Personal Protective Equipment
11. IDPs: Internally Displaced Persons
12. WASH: Water, Sanitation and Hygiene
13. CLM: Construction Logistics Management
14. BIM: Building Information Modelling
15. GIS: Geographic Information Systems
16. HO: Humanitarian Organization

1. Introduction:

The underlying issues that motivate this doctoral dissertation are described in this chapter. The purpose of the dissertation is presented alongside the research questions in focus and the research scope. This doctoral dissertation focuses on modern construction logistics practices and their role in governing and coordinating non-profit/humanitarian constructions before, upon, and after disaster.

This dissertation seeks to highlight how a construction logistics for humanitarian purposes could ensure efficient activities carried out by the organizations in the context of building and re-building of temporary shelters, camps, public infrastructures, habitats, health centers, sanitation, schools, and others by reducing traditional disturbances within humanitarian-purposes constructions.

This chapter presents background information on humanitarian logistics, and construction logistics; moves to an overview about the Syrian humanitarian operations as a case study, its purpose, and scope; and ends with the dissertation's outline.

1.1 Background:

Disasters usually case a significant loss of life, damage to property, assets, and environmental resources, which in turn leads to the disruption of supply chains and markets. During 2008, roughly 354 natural disasters killed more than 235,000 people and affected another 214 million. Over the past decade, disasters have affected, on average, more than 250 million people a year. (Manuel Rodriguez-Lianes et al., 2009) The humanitarian response owns three phases: relief, recovery, and reconstruction. These phases are not rigidly defined but often merge into one another. Recovery and reconstruction start at the same time as the relief effort immediately following a disaster. (Cozzolino, 2012) The focus of the relief phase is to alleviate the suffering and prevent further loss of lives. Indeed, the recovery phase focuses on the reconstruction of critical infrastructure and enabling people to resume their normal lives by returning to work or school. The final reconstruction phase includes the building of permanent housing and infrastructure, and the development of sustainable livelihoods. (Wong et al., 2010)

In all three phases, engineers are considered as stakeholders who can influence the delivery and distribution of supplies after a crisis. Afflicted areas can remain in "crisis mode" for weeks or months after the disaster without the role of engineers, which includes defining rebuilding needs on both immediate and mid-term levels, coordinating communication, advocating, as well as, determining the key processes of recovery, rebuilding, and construction (Ohio university, 2020) Therefore, the role of engineers in disaster response is widely recognized when it comes to providing technical expertise in water, sanitation, shelter, logistics, communications, and the rebuilding of roads and bridges. (Wong et al., 2010) The mentioned engineers are necessary to integrated operations in terms of controlling and stockpiling supplies for the duration of rebuilding, route selection, facility location, and resources allocation which are considered as the core of the humanitarian logistics and the supply chain. (Ohio University, 2020)

There is a real-world example that presents the mutual affected relationship between humanitarian construction and humanitarian logistics, namely Djibouti port, which is the principal transit point for cargo in and out of Ethiopia and the key link in commercial transport routes to and from the greater Horn of Africa. The port is likewise critical for the efficient flow

of humanitarian goods; nearly four million metric tonnes of relief cargo have passed through Djibouti during 2009-2012. To enhance efficiencies in both humanitarian and commercial logistics, the Government of Djibouti and WFP built a humanitarian logistics base (HLB) in the port to enhance the efficiencies of supply chains in the Horn of Africa and augmented regional humanitarian re/constructions capabilities. As a result, the humanitarian agencies have been reducing steep storage costs and additional storage costs and increasing port storage capacity which was also most limited and expensive during peak periods (WFP, 2012)

Syrian wildfires emergency plan of action; issued by ICRC in October 2020; is another example of the importance of both construction and logistics in humanitarian operations. This action plan was a response to extreme damages involved 179 villages. This disaster was affecting more than 40,000 families through injuries, temporary displacement, loss of houses and assets, and a major loss of livelihoods (lands, crops, and livestock). Based on the ICRC initial assessments, preliminary information indicated that shelter sectors in many districts need to identify temporary shelters and supply them with basic materials (like water, hygiene kits or solar lamps) as well as to enhance the capacities and resources of logistics on the long-term to support the intervention and ensure the efficient and timely provision to affected people. The below Fig1, extracted from same action plan, shows that the relief items, construction, and supplies consumed around 72% of the total budget, which demonstrates how construction and logistics are priorities for any emergency plan.

Funding Requirements

all amounts in Swiss Francs (CHF)

International Federation of Red Cross and Red Crescent Societies

DREF OPERATION

MDRSY005 - SYRIA - WILD FIRE

10/22/2020

Budget by Resource

Budget Group	Budget
Cash Disbursement	369,484
Relief items, Construction, Supplies	**369,484**
International Staff	10,000
Volunteers	75,000
Personnel	**85,000**
Workshops & Training	20,000
Workshops & Training	**20,000**
Communications	5,000
General Expenditure	**5,000**
DIRECT COSTS	479,484
INDIRECT COSTS	31,166
TOTAL BUDGET	**510,650**

Fig 1: Emergency Plan of Action (EPoA) / Syria: Wildfires / MDRSY005 / 23/10/2020

Since the end of the 1980s, the construction industry has seen the launch of several supply chain management initiatives. (Getuli et al., 2016) as logistics processes prove to be crucial for the successful completion of the construction projects. (Sobotka et al., 2005) Humanitarian logistics have also seen the launch of construction logistics initiatives from the suppliers of raw material, manufacturers, distributors, to the end-users. This tendency is observed clearly in many cases like adopting temporary supply chains (TSCs) which has become a well-recognized logistics model within construction supply chains that is extensively used in

peacekeeping missions and in humanitarian operations. (Merminod et al., 2014) The importance of constructions within humanitarian logistics is exemplified by the values of the construction-materials stocks within The International Humanitarian City based in Dubai during 2020. The statistics issued by "Humanitarian Logistics Databank" for 2020 indicated that the classified stocks under logistics and constructions services (such as shelter, water, and sanitation) consist of around 56% out of total stocks' values. Please see Fig.2 below.

Fig 2: Humanitarian Logistics Databank (The International Humanitarian City /IHC)

This dissertation focused on the construction logistics cases throughout the Syrian humanitarian construction projects, as the Syrian Humanitarian Response Plan 2020, issued by OCHA, indicated that the costs of logistics and constructions services (such as shelter, water, and sanitation) consist of around 26% of the total current requirements (the data is shown via the link: https://fts.unocha.org/appeals/924/clusters)

1.2 Syrian Humanitarian Status:

During March 2020, the UNICEF Executive Director, Henrietta Fore, and the World Food Programme Executive Director, David Beasley, visited Syria and said the following about the Syrian situation: "Over the past nine years, schools and hospitals have been bombed, families have been torn apart, and young lives have been lost. Even in areas far away from the frontlines, families are struggling to feed their children and rebuild their lives. Some 180 schools are out of operation because they were either destroyed, damaged, or used as shelter for displaced families. Food prices have increased by 120 per cent since last year. Meanwhile, in the northeast, tens of thousands of children continue to languish in displacement camps, deprived of the most basic services, despite the significant efforts of humanitarian partners". (UNICEF, 2020)

The UNHCR Syria mentioned that after six years of conflict, the Syrian people remain vulnerable as they continue to face not just physical threats but the consequences of prolonged conflict. The conflict in Syria has been going on for over five years now. An estimated 13.1 million people in Syria require humanitarian assistance and protection. Around 4.2 million

people lack adequate shelter, of them, some 750,000 people live in last resort camps, informal settlements, transit centres and collective centres including schools, residential building, and warehouses. Over 1.75 million children and adolescents are out of school. 1 in 3 schools is either damaged, destroyed or occupied. Four out of five Syrians live in poverty. 1.2 million houses have been partially damaged, out of which 400,000 have been totally destroyed causing millions of people to flee to collective shelters, schools, public spaces, tower buildings, unfinished buildings, hospitals, basements, mosques and churches or to host families mostly from the local communities and other areas. (UNHCR, 2017)

In addition to these devastations, there are huge efforts from humanitarian organizations to rebuild the country. During 2018, about 108,790 internally displaced persons received emergency shelter assistance as well as in north-east Syria through the distribution and installation of 8,425 shelter kits, the provision of 6,085 tents, and the rehabilitation of 2,586 emergency rooms in collective shelters. In addition, 6,697 damaged houses were upgraded to support the returnee families through the installation of doors and windows. Support to public infrastructure in returnee areas included the implementation of the following activities:

- Removal of 231,527 m3 of debris and distribution of 276 solid waste bins targeting 5,525 persons.
- 5 Boreholes and 500 m pipeline were installed targeting 11,500 persons.
- Provision of 2,650 solar streetlights, and light maintenance for water and sewage networks.

As a result, the humanitarian constructions and logistics activities focus on many activities in Syrian humanitarian operations, some of them as follows:

- Provision of emergency shelter such as installation of tents with infrastructure, shelter kits, and winter kits.
- Rehabilitation of public buildings that are used as collective shelters such as schools.
- Upgrading unfinished private buildings.
- Durable shelter support such as the rehabilitation of partially damaged houses and public infrastructures. (UNHCR, 2018)

These humanitarian constructions were proceeded by many stockholders like international or national humanitarian organizations in Syria and these included, but are not limited to, the following: UNICEF,UNHCR,WFP, WHO, ACF, ADRA, Aoun, Al Birr, Al Ihsan, Al Taalouf, Child Care Society, DRC, GOPA, IOM, MEDAIR, MoLAE, MSJM, NRC, Oxfam, PUI, RSRP, Rescate, SARC, SIF, The Syria Trust, UN-Habitat, Dorcas Syria, and UNRWA, UNDP, Peace Wind Japan, TGH (Triangle Generation Humanitarian), ZOA Syria and others. (UNHCR, 2018)

1.3 Purpose and Scope:

The purpose of this dissertation is to explore how construction logistics practices can be used to support and develop humanitarian non-profit-constructions to reduce people's suffering during and after disasters. To fulfil this purpose, the following research questions will be addressed:

1. What are the theoretical attributes of Humanitarian Construction Logistics (HCL)?
2. What are the proposed practices for Humanitarian Construction Logistics (HCL)?

The dissertation is going to explore the elements of Humanitarian Construction Logistics (HCL) that have an impact on humanitarian operations. Herein, the research approach is divided into two parts; the first part investigates the theoretical perspectives by reviewing the literature of humanitarian logistics, relief operations, rehabilitations, humanitarian engineering, construction logistics, and others. The second part investigates the positive construction logistics practices which are used in the Syrian humanitarian operations during relief and recovery stages. Finally, this dissertation is going to recommend some of the modern construction logistics practices worldwide that could leverage humanitarian operations worldwide and allow for humanitarian organizations to best understand the Humanitarian Construction Logistics (HCL) practices.

1.4 Dissertation Outline:

The introductory chapter (chapter 1) describes the background of the study and introduces the purpose and research questions of this dissertation. Chapter 2 (Literature review / Theoretical framework) provides a thorough description of the important concepts to address the purpose and the research questions, chapter 2 starts with definitions of humanitarian logistics and construction logistics from different perspectives, as well as, reviewing extent literatures to best knowledge about role of humanitarian logistics in serving humanitarian-constructions with focusing on Syrian case. The methodology (chapter 3) presents used research methods and designs in context of collecting, classifying, and analyzing data. The dissertation's results are presented in chapter 4, these findings are structured into subsections describing the elements of Humanitarian Construction Logistics (HCL) that extracted from Syrian humanitarian operations. The discussion section (chapter 5) analyses the results jointly to provide answers for research questions as well as presenting how the modern construction logistics practices can address the needs of humanitarian-constructions throughout feasible applications. The conclusion section (chapter 6) summarizes the recommendations and identifies possibilities for future research.

2. Literature Review / Theoretical Framework:

2.1 Introduction to Construction Logistics:

Logistics has several definitions, the most known from the Greek word logistiki (λογιστική), meaning accounting and financial organization. It was initially used to describe the science of movement, supply, and maintenance of military forces on the ground. Later it was used to specify the management of material flow in an organization, from raw materials to finished products. Likewise, it is used as part of algebra and mathematical logic. In ancient Greece, the Roman Empire and Byzantine Empire, military officers with the title Logistikas were responsible for financial matters and supplies distribution. Logistics was the part of the military, as well as, instrumental in wars especially in the areas that take care of the planning of several important items related to storage, distribution, and maintenance of various types of materials such as weapons, clothing, food, health, transport…. etc. Currently, Logistics has known as essential part in business, becoming a department responsible for the management of any kind of materials. As logistics manages the financial and material resources, besides to, plan production, storage, transport, and distribution of these materials. (Sant'Anna, 2016)

Construction logistics can be defined as the process of mobilizing the various resources required for construction process and ensuring that the resources are productive i.e., they are in the right place at the right time at the minimum cost, as well as, creating enabling environment for construction activities i.e., ensuring safety, security, quality and efficiency. Construction logistics comprises planning, application, coordination, and supervision of resources flow; resources include materials, components, equipment, people, information, and technology; toward, within, and from construction sites as a self-contained management function. (Fadiya, 2012) These specifications were derived from general definition of logistics which is strategically managing of the procurement, movement, storage (materials, parts and finished inventory), and the related information flows through the organization and its marketing channels in such a way that current and future profitability are maximized through the cost-effective fulfilment of orders. (Tatham and Christopher, 2018, Janné, 2018)

The goal for any construction project is delivering the project on time, on cost and on stipulated quality. The construction industry is producing its end products from vast number of materials that must be delivered to the place of consumption. (Thunberg and Persson, 2013, Ekeskär and Rudberg, 2016, Janné, 2018) The construction industry is depending greatly on these materials arriving to site when needed. The process that manages of material flows is referred to as construction logistics. It can be defined likewise as dealing with supplying the right materials to the correct customer and construction site to meet customers' requirements. (Janné, 2018) In result, construction logistics for an optimal coordination of material flow to site, on site and from site. (Hasenclever et al., 2011) In the past, there have been initiatives to enhance logistics practices, for example, Johnson (1982) created a schedule for materials control; included the materials description and the proper way of handling, storing and protecting each type of material; which aimed to minimize loss or waste. (Labib, 2016) Currently in this decade, the construction logistics practices has been developing to deal with the planning operations, as well as control of materials, personnel, and information flows from the point of view of an optimized logistics service regarding schedule, cost and quality while taking into account health and safety as well as environmental aspects. (Tischer et al., 2013) In same context, the scope of construction logistics has been developing to involve disposal of materials, equipment and

personnel to and from the construction site, in addition to the efficient and effective planning and control of these resources at the construction site, to reduce waste substantially or eliminate it completely. (Janné et al., 2018) Currently, the stakeholders are responsible to ensure the safe delivery, storage, and protection of resources from theft and damage, which reduce waste of time by removing non-added-value activities or even adding added-value activities. (Fadiya, 2012) They must determine the best possible supply process for each resource, the material has to be provided in a timely manner, in the right quantity and quality. The same applies to waste disposal management, the returning storage equipment and the residual material, which are done in a timely manner within construction supply chains to maximize the quantity and quality of the materials that can be reused without obstructing the construction process. (Tischer et al., 2013)

Construction supply chains can be regarded as complex with many interactions between multiple actors during the construction process. The inability to manage this complexity is also one of the main reasons for why the construction industry is suffering generally from both low productivity and rising production costs. Ekeskär and Rudberg (2016) highlighted the complexity of construction logistics, which lies in the project-based process and carried out in temporary supply chains (Vrijhoef and Koskela, 2000). As much as 60-80 % of the gross work done in construction projects involves the buying-in of materials and services from suppliers and subcontractors, thereby, the supply chain actors heavily impact the performance of construction projects. (Vrijhoef and Koskela, 2000, Ekeskär and Rudberg, 2016) The literature review shows other current challenges that face the construction logistics sector, which could be summarized in the following:

1. Planning for the availability and efficient coordination of materials, tools, and equipment is a difficult task. Nevertheless, these resources need to be properly managed to ensure the success of any construction project (Almohsen and Ruwanpura, 2013) The Unclear division of responsibilities between site and supply chain leads to negative effects such as congestion around construction sites since vehicles are often unable to be unloaded and loaded immediately upon arrival. (Janné et al., 2018) As a consequence, insufficiently planned and non-coordinated logistics processes are the reasons for the high number of non-productive actions and, consequently, for the disturbed workflow on construction sites. (Voigtmann and Bargstadt, 2010).
2. Construction logistics can be defined as “the management of the flow of materials, tools, and equipment from the point of discharge to the point of use or installation” (The European Construction Institute,1994). In the same context, Vrijhoef and Koskela (2000) maintained that many of the problems have their origin in the supply chain’s upstream and their effects propagate to the construction site. (Ekeskär and Rudberg, 2016) That happens due to inefficiency in the construction supply chains, non- coordinated transports, and lack of data through supply chain planning. (Janné et al., 2018) Furthermore, contractors experience mostly the low delivery performance in the construction industry, Thunberg and Persson (2013) who indicated that less than 40 % of deliveries are delivered in full (right amount, right time, right location, damage free, and right documentation). (Ekeskär and Rudberg, 2016) That leads to a lack of materials and resources when needed and increase the number of transports to the construction site which hinders the progress of the project. (Janné et al., 2018)
3. Inefficient logistics on site leads to a lack of control at the construction site, inferior planning, material losses, extra costs, hazards for workers at site, and disorganized material storage, which causes extra time to search for material or rearranging storage areas. (Voigtmann and

Bargstadt, 2010) Consequently, unnecessary transports are generated to replace lost materials, in addition to, trucks with low fill rates due to small shipments. (Janné et al., 2018) Therefore, managing the flow of materials, assuring its quality, checking the quantity, allocating the storage areas, coordinating the overall process, triggering the orders, and updating the participants are major successful elements in construction logistics management. (Agapiou et al., 1998) Otherwise, ineffective logistics on site will ultimately cause project delays and cost overruns as the cost of materials and equipment, which represents a large proportion of the total project budget. (Almohsen and Ruwanpura, 2013)

4. The construction industry is project-based which means that the distinctiveness of a particular project depends on acquiring the necessary resources and developing suitable supply chains. Therefore, there is some complexity in terms of organization and timescale as multitude of suppliers who work in a range of different disciplines and technologies. Several studies on German construction sites pointed out that approximately one third of the total execution time is consumed by logistics processes. They also estimated that the well-planned and coordinated construction logistics could optimize of construction time up to 10 percent and building costs up to 4 percent. (Samuelsson and Ahmetasevic, 2014) A case study by Agapiou et al. (1998) shows that logistics management is relevant in the construction industry and that the total costs can be lowered 5 % if the logistics are managed efficiently. The cost savings based mainly on the reduction in materials wastage and in working days which provides opportunities for all stakeholders to achieve higher profits, lower costs, and better value for construction projects. (Labib, 2016, Ekeskär and Rudberg, 2016)

To summarize, the construction supply chain is fragmented and temporary, and the low levels of productivity indicate that there is a need for an effective management of construction logistics, which has become recently a significant and appropriate tool for planning of construction-operation activities (Ekeskär and Rudberg, 2016) Therefore, construction logistics must adapt with some distinctive characteristics as the following:

1. Each construction project demands a multitude of materials and resources that need to be delivered on-time, to the correct location on site according to the rules set by the site management. Therefore, each construction site requires a new logistics setup that will be conducted by temporary organizations within temporary supply chains (Ekeskär and Rudberg, 2016) since the location is unique and temporary (Janné et al., 2018)
2. Construction sites usually store accumulated materials and are supplied on an irregular basis depending on the construction phase. Besides that, activities should be performed in sequence and if one activity is delayed, all the following activities will also be delayed. Thereby, construction materials should be delivered to the construction site at the right time and in precisely coordinated numbers. (Janné et al., 2018)
3. Another distinctive character is the fragmented nature of the construction industry. There are many construction companies, suppliers and logistics service providers working in different temporary construction consortia. This leads to different ways of working and various ways of managing data. (Janné et al., 2018)
4. Suboptimal conditions of construction have a negative effect on productivity due to weather conditions, lack of space, and on-going activities that will inevitably damage materials; therefore, the construction site is the worse place to store materials (Labib, 2016)
5. Construction logistics are the industry-specific characteristics of logistics in construction business and appear more and more in academic research. Although, common definition of

construction logistics hasn't been established until today both in the scientific literature and in practice. (Tischer et al., 2013) Therefore, construction logistics and supply chains remain an area insufficiently reviewed and studied, as well as the academic approach is not being applied in practice despite the growing knowledge of the existing strategies, methods, and practices for an integrated management of construction logistics and material supply chains. Vidalakis et al (2013) highlighted a significant need for a variety of research to consider the structure and the nature of the construction industry supply chain and logistics. Similarly, the adoption of construction logistics necessitates examination of all logistical connections, cutting across organizational and constructional boundaries. (Vidalakis et al., 2013, Labib, 2016)

6. There is no research so far for examining and understanding implemented construction logistics in the context of humanitarian /non-profit purposes, albeit there are different construction logistics operations that deal with rehabilitation, non-profit construction projects, and severe consequences of any disaster on the affected population for a long period of time. (Cozzolino, 2012) This indicates the need for a 'big picture' view of construction logistics management as well as focusing on integrating the construction supply chains from the outset within different humanitarian construction operations, which leads to effective logistics and saving costs as much as possible during the reconstruction phase.

2.2 Introduction to Humanitarian Logistics:

Since the origin of humanitarianism and humanitarian aid, humanitarian organisations have adapted to an ever-changing environment, mostly through the field that we know today as humanitarian logistics. From simple food distribution during WWI and WWII, through massive operations during the 1990s and early 2000s, to cash-based interventions and refugee and IDP management, logistics have contributed to what humanitarian aid is today. It is a gigantic sector that is worth almost 30 billion Euros aiming to provide assistance to nearly 109 million people of the most vulnerable from a total of 168 million. (Vega et al., 2020)

Humanitarian logistics will help us understand the needs of a society, contribute to its resilience, and learn how to apply logistics and supply chain management to the humanitarian context by designing and managing supply chains on a strategic and operational level. (Hanken University, 2021) Humanitarian logistics are defined as "the processes and systems involved in mobilizing people, resources, skill and knowledge to help vulnerable people affected by disaster," (Van Wassenhove, 2006) which was being instrumental in humanitarian assistance, and it has a significant impact on the quality and speed of such assistance. (Sant'Anna, 2016) It involves activities such as procurement, transportation, warehousing, inventory management, tracking and tracing, bidding, and reverse bidding, reporting and accountability. (Vega et al., 2020)

One example of humanitarian logistics is presented in UNICEF emergency operations that used multipurpose tents for schools, health clinics, nutrition facilities, distribution points, and child-friendly spaces. According to UNICEF supply division, the logistical prerequisites, to install these tents worldwide, transporting around 1000 technical experts to fields, and transporting standard relief tents which are heavy (70-100 kg) and expensive in comparison with to other relief items. (OCHA, 2004, UNICEF Supply Division, 2020) These logistical prerequisites were changed at the time of dissertation writing, as a new generation of lightweight tents were in development for use in the first phase of emergency with weight around 18 kg - 50

kg, each one was equipping with solar power, electrical kits, and hard flooring. (UNICEF Supply Division, 2020)

Analysing the humanitarian logistics leads to determining the well-defined aspects for minimizing the suffering of those who are in a vulnerable state in an extremely compromised social structure. That leads to defining some challenges to the humanitarian logistics as follows:

- Humanitarian logistics must respond as quickly as possible to the needs of the affected population and assure of the effectiveness response. Albeit the environment in which relief operations are undertaken and the management of such operations can be quite challenging.
- The delivery of humanitarian aid can encounter unpredictable logistical and bureaucratic challenges at every step, and adaptations are needed simply to deliver assistance.
- Right after a disaster strikes or an emergency is declared, relief items and aid workers must be deployed as fast as possible with little or no clear information on needs, volumes or even the state of the infrastructure needed to deliver the goods to the beneficiaries. (Sant'Anna, 2016, Vega et al., 2020)

The humanitarian logistics is using during three phases: planning, emergency response, and reconstruction. In context of the planning phase, humanitarian logistics must deal with a large variability in supplies, suppliers, and large-scale activities. As well as it deals with irregular demands, unusual constraints, limited numbers of appropriate suppliers, and unsolicited donations. They also have to deal with high uncertainty in the accessibility to physical infrastructure, since airports, ports, roads or bridges may be damaged or simply non-existent. Access to information is limited as the telecommunication infrastructure might also be damaged or unreliable. Finally, in emergency situations, the lead times are severely reduced (close to zero), which leaves little or no time for organizations to accurately plan and coordinate the first deployments, but still organizations must design the transportation of first-aid material, food, equipment, and rescue personnel from supply points to a large number of destination nodes geographically scattered over the disaster region safely and very rapidly. The unpredictability of global emergencies and the stakes of adequately delivering the correct amount and number of people and resources highlight the uniqueness of humanitarian logistics. (Vega et al., 2020)

In context of emergency response, each type of disasters requires a specific emergency response which is presented in specific humanitarian logistics that needs to be known and implanted at once. An emergency response is more than just supplying shelter. It is more than just putting a new roof over people's heads and providing emergency shelter. It is about fit-for-purpose rebuilds that address the local culture, environment, and economy. It's about delivering the best rebuilds that incorporate future risk mitigation in the designing of humanitarian supply chains (Murray, 2015, Sant'Anna, 2016) The participation of humanitarian logistics through recovery (reconstruction) is the process by which communities and the nation are assisted in returning to their proper level of functioning following a disaster. The focus of the recovery phase is social and economic reconstruction, so humanitarian logistics support this approach by rebuilding infrastructures and the economy to support human needs, as well as, providing moral support, cash/voucher assistances and logistical consultations to the affected population. (Vega et al., 2020)

2.3 The Role of Humanitarian Logistics in Construction, Rehabilitation, and Recovery:

Encyclopedia Britannica defined humanitarian construction, rehabilitation, and recovery as the application of engineering to improving the well-being of affected people and communities upon and after any disaster. Humanitarian construction, rehabilitation, and recovery focus typically on programs that are affordable, sustainable, and based on local resources to perform projects and focus on finding simple solutions to basic needs such as close access to clean water, adequate heat, shelter, sanitation, and reliable pathways to markets. **(**Wikipedia contributors, 2020) To do that, humanitarian organisations, during over 40 years, have developed unique logistics expertise to support their own operations by developing specialized units to provide aid and relief logistics services. These units provide with high quality logistics services on a not-for-profit basis in areas such as procurement, warehousing and transportation management, which are providing and/or supporting context-specific services such as local procurement, food distribution, installation of water/sanitation infrastructures, reconstruction, maintenance and repair. (Vega et al., 2020) Thereby, logistics within humanitarian construction, rehabilitation, and recovery operations have a very important role in conducting the following functions such as:

- External procurement of products and resources needed for housing construction, transporting them to the warehouse/s then distributing them.
- Provision construction services and means for the restructuring the place of origin of affected population.
- Establishment of supply chains to ship products, items and construction materials that will be deployed and used in the last phase of the development relief cycle. (Sant'Anna, 2016)

In this case, supply chains are being very close to what a commercial supply chain looks like by trying to maintain a continuous flow of goods with a lower cost without having breakups and it is called recovery (reconstruction) supply chains, which are mostly based or billed as project-based supply chains. The reconstruction supply chains use more commercial techniques such as trying to reduce costs and improve performance, and it could last from six months to one year to five years and depending on the size of the crisis.

In some cases, response supply chains overlap with recovery (rehabilitation) supply chains, and recovery supply chains overlap with development. (Vega et al., 2020) De la Torre et al. (2012) pointed out the importance of construction logistics functions in humanitarian operations such as transportation and distribution which are key to install field hospitals as fast as possible and establishment a system of sanitation very quickly to meet local needs for minimizing the damage to health. (De la Torre et al., 2012) Thereby, humanitarian logistics should be prioritized to provide of basic services to this population such as implementation of sanitation actions, control of water quality for consumption, improvement measures of housing structure, and, disposal debris during refurbishment, conversion, and removal of buildings (Sant'Anna, 2016) That requires to apply of logistics aspects, which can help to increase productivity, apply the efficient supply of materials, and apply an optimal waste management according to the principles of a closed circle economy. (Hasenclever et al., 2011) However, planning of humanitarian logistics requires full attention to the type of housing /constructions that comprise these sites; otherwise, they will be improvised and often unstructured services without access to continuous or sustainable maintenance. (Sant'Anna, 2016) For instance,

"Crown Agents," the activated service providers in Syria, explains their logistical supports of the early recovery in Deir Ezzor governorate within Syria through a € 2.6 million project over 6 months during 2020 to remove debris, rubble, and solid waste from destroyed and partially damaged public spaces. The debris was recycled where possible and re-used for new development projects in the area. Below is some information about the scale of humanitarian logistics in rehabilitations within the aforementioned governorate.

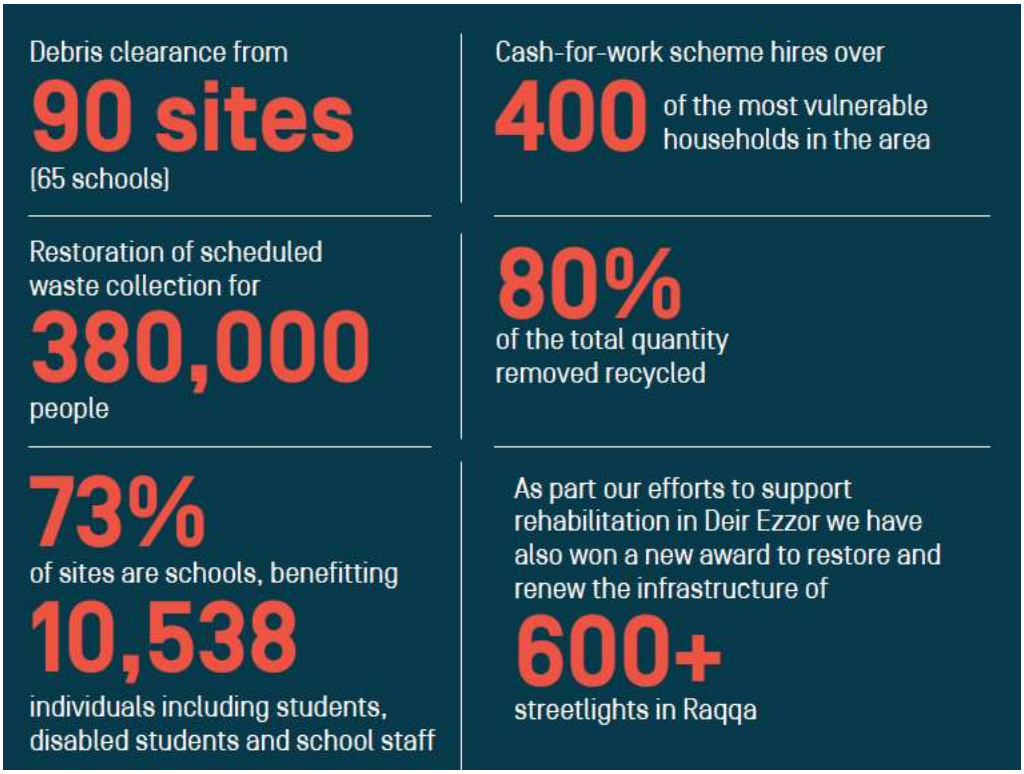

Fig 3: Crown Agents Operation Report 2020

As for the last updated instance in this context, the WFP rebuilds parts of the Beirut port after the blast, through the WFP initiative in Beirut port during September 2020, to ensure the flow of necessary supplies to Syria and Lebanon, thus, humanitarian logistics activities support humanitarian construction activities and vice versa.

2.4 The Role of Construction Logistics in Syrian Operations:

The humanitarian interventions in Syria aim at improving the difficult situation experienced by people in urgent need and who are no more autonomous with regards to fundamental needs such as food, water, shelter, safety, etc. (Kovács and Spens, 2007, Tatham and Christopher, 2018). Proper control of logistical flows can improve a humanitarian intervention's performance substantially. (Merminod et al., 2014) One of these interventions is building camps throughout Syria as temporary holding shelters until reconstruction phase is finalized and the displaced can go back to their homes. (Jahre et al., 2018) This traditional camp approach is setting up "a temporary space in which refugees may receive humanitarian relief and protection until a durable solution can be found to their situation." (Ramadan, 2013) Although, there are two approaches in Syria, namely, the emergency temporary construction phase and the

rehabilitation and reconstruction phase, which need the efforts of humanitarian construction logistics (HCL). These operations relate to building temporary shelter and permanent shelters accompanied by services like sanitation, water, and others. According to interviews with practitioners, the Humanitarian Construction Logistics (HCL) in Syria have a number of key aspects, which coincide with international aspects, namely:

- The building site of the temporary shelter is considered as a production system and a part of many supply chains where complex processes are executed within time, space, and budget constraints. (Sobotka et al., 2005)
- Supply chains deliver products from external sources to the building site, and that involves either the contractor is going to the supplier to pick up materials or materials are delivered to site. These deliveries occur on an ad-hoc basis to various locations in Syria accompanied by limited management skills and limited information exchange (Sobotka et al., 2005, Ying and Roberti, 2013)
- Co-ordination of material flows on the construction site (on-site logistics) differs significantly compared to other industries. The wide geographical and changeable positions of the construction sites in Syria create a demand on adapted solutions for unloading, inspection, and storage of incoming materials. (Sobotka et al., 2005, Ekeskär and Rudberg, 2016)
- The delivery and handling process of construction materials have to be coordinated with site resources, such as the subcontractors' machines and scaffolding. In this coordination, the return flows of waste and excess materials have to be considered as well. (Agapiou et al., 1998, Sobotka et al., 2005) According to the same interviews with practitioners, the Humanitarian Construction Logistics (HCL) in Syrian operations, like international construction projects, are considerably more difficult to manage and to optimize. This results from:
    - The diversification of projects (various materials, methods, location of each project), which means a new constellation of supply chain members each time.
    - The technical complexity of a project.
    - The number of participants in the project.
    - The domination of the bidding system for contractor/s acquisition that means random partnership within the chain.
    - The difficulty in adjusting the logistics routines of each member in line with the entire logistics system of the project.
    - Construction projects in Syrian humanitarian operations have strict operating routes and working hours. This means that construction logistics are forced to use specific routes during specific day's hours because there are dangers from severe conflicts.
    - Factors such as essential volumes of materials, limited on-site storage space and more frequent deliveries have considerable impact on construction for humanitarian operations. (Sobotka et al., 2005, Ying and Roberti, 2013)

Moreover, Syrian humanitarian constructions hadn't applied the advanced techniques that are applying internationally; in terms of construction logistics such as:

- Implementing strategic logistics planning across the full supply chain.
- Utilizing consolidation centers.
- Just-in-time delivery to the workplace.

- Adding a logistics specialist to construction project teams. (Ying and Roberti, 2013)

The review of articles and reports issued by humanitarian organizations, activated in Syria, demonstrated the severe usage of Humanitarian Construction Logistics (HCL) functions through Syrian humanitarian interventions as clarified below.

2.4.1 Syrian Shelter and Settlement Interventions:

Due to the massive destruction of homes, shelter needs are overwhelming the capacities of UN agencies, INGOs and local institutions which are inadequate to provide the required largescale response. The shelter and settlement sector led by UNHCR and other humanitarian organizations since 2015, due to their core humanitarian mission, is to guarantee access to adequate shelters. They have provided shelter support for internally displaced people who flee hostilities as well as returnees who go back to completely or partially damaged houses in their areas of origin. They have provided with durable shelter solutions, such as the emergency shelter assistance for lifesaving, the rehabilitation of public and private collective shelters, the provision of shelter kits, the establishment of camp-related infrastructure, and the distribution of tents in planned camps. (UNHCR Syria, 2019)

On the other hand, they have supported returnees and host communities with the long-term shelter assistance, such as infrastructure rehabilitation, debris removal, distribution of solid waste units, minor rehabilitation for water and sanitation in returnee areas, and rehabilitation of damaged houses. According to the UNHCR operational report for Syria during 2019, UNHCR and other humanitarian organizations used functions of Humanitarian Construction Logistics (HCL) to provide shelter assistance as follows:

- Distribution and installation of 1,360 shelter kits, 18,774 tents in the camps in North East of Syria alongside provision of technical assistance, establishment of new distribution centres, installation of big-size tents, and construction of communal kitchens and fences.
- Installation of 300 solar streetlights and provision of solar lights.
- Rehabilitation of 303 emergency rooms inside collective shelters in Al-Hasakeh and Lattakia governorates to support 3,849 individuals. As well as, creating welcoming learning spaces through rehabilitation of classrooms and provision of quality furniture.
- Distribution of 248 solid waste units to support 11,900 individuals.
- Rehabilitation of water systems has supported 27,150 individuals throughout Syria.
- Removal of 324,374 cubic meters of debris in different Syrian governorates to provide safe access to shelter for 42,500 individuals.
- Repairing damaged houses are ongoing across Syria as around 760,000 housing units in Syrian cities were damaged. A total of 1,290 damaged houses were rehabilitated in different Syrian governorates during 2019.
- Rehabilitation of public infrastructures as around 35% of urban schools are not operating due to damage or to occupation, and more than 50% of hospitals in cities are not operational. (UN-HABITAT Syria, 2020)

2.4.2 Syrian Water and Sanitation Interventions:

Water shortages are a major concern that the ICRC, Syrian Arab Red Crescent, and other humanitarian organizations are working to address. The hundreds of thousands of Syrian people may be affected as the main water infrastructures (water stations and dams) have been affected due to their locations near the conflict frontlines. Consequently, these infrastructures suffer from frequent breakdowns and demolishment. As a result, several emergency measures have been taken to provide/transfer clean water from alternative sources. (ICRC Syria, 2020) Oxfam Syria and other humanitarian organizations have been working since June 2013 to provide the immediate live-saving/sustainable water and sanitation needs for thousands of crisis-affected people by using functions of Humanitarian Construction Logistics (HCL). They have been providing support in 12 governorates across Syria by trucking water to those who have no access to safe clean water, rehabilitating water sources, drilling wells, equipping pumping stations, repairing the water network, and providing hygiene materials. They aim to mitigate the spread of diseases and to support the resilience of communities. (Oxfam Syria, 2020) To do that, the humanitarian logisticians have been contracting and implementation the many actions, for example:

- Maintenance of infrastructures and emergency repairs to supply clean water to over a million people in Syria by providing 15 water pumps and essential spare parts to water pumping stations.
- Provision of WASH facilities in collective shelters, public buildings, and schools to support adaptation of existing water systems and to serve to the emergency context. That will lead to improving sanitary conditions and will ensure clean water are accessible to 100,000 people in Syria. (ICRC Syria, 2020, Oxfam, 2020)

The above cases demonstrate that shelter, water, and sanitation interventions had needed to construction logistics functions within the Syrian humanitarian operations to complete these activities on time, ensuring an appropriate quality, and cost. The Humanitarian Construction Logistics (HCL) involves functions to support installation, rehabilitation, reparation, and building main infrastructures of WASH and shelters in humanitarian context. The Humanitarian Construction Logistics (HCL) already exists in a humanitarian field under the umbrella of logistics and supply sector, and this dissertation will explore in-depth the functions and elements of Humanitarian Construction Logistics (HCL).

3. Research Methodology and Data Analysis:

The following chapter describes the dissertation methodology and contains the following sections: research design, research strategies, data collection methods, data analysis, and ethical conduct. This chapter aims to explain how this dissertation was conducted and why the different methods were chosen by considering literature review, interviews, and empirical data collection. The chapter also strives to describe how validity was ensured and how bias was avoided during the process of the dissertation.

3.1 Research Design:

The subject of this dissertation emerged when observing the complexity of humanitarian construction projects in Syria associated with insufficient logistics applications. The observations demonstrated that the needs for efficient supply chain and well-planned logistics will become the key components for the up-coming humanitarian construction projects worldwide. The Syrian case study was chosen mainly because of good insight within the Syrian projects due to the fact that the author has been working in UN agencies between 2013 and 2021.The author was first encountered, during that employment period, by the complexity of construction logistics in a humanitarian context at Syrian projects organized by different humanitarian actors such UNICEF, UNHCR, UN-HABITAT and others. Consequently, the author outlined the scope and borders of research within the Syrian geographical borders. The main purpose of this dissertation is to launch a new approach of construction logistics associated with a humanitarian context that aims to simplify the process, reduce the risks, increase the quality of works, and apply different innovations in this sector.

Concerning the first research question and its propositions, “What are the theoretical attributes of Humanitarian Construction Logistics (HCL)?”, this dissertation investigated the information by reviewing the extant literature, researching reports and electronic documents on humanitarian constructions and supply chains. The literature review tries to understand the main challenges of construction logistics in a humanitarian context and to provide a broad perspective on the Humanitarian Construction Logistics (HCL) settings and performance. The review also broadly covers the definitions of construction logistics, humanitarian logistics, and Syrian humanitarian operations.

To address the second research question,” What are the proposed practices for Humanitarian Construction Logistics (HCL)?”. This question was answered through the following:

(1) The direct observation of site activities is a systematic data-collecting technique that involves watching individuals in their natural environment or in a naturally occurring situation. One of the main benefits of using observation is that the level of immersion and prolonged involvement with participants. That can lead to a good rapport with participants and encourage them to speak up freely. This helps to rich details of the collected data. (Silverman,1998) Time was spent initially to observe and monitor the current practices of humanitarian logistics related to areas inside and outside construction sites, which helped the author understand and assess the quality of current practices. The direct observation technique facilitated the conducting of the interviews and designing the questions because it provides the author with the merits and flaws in the existing Humanitarian Construction Logistics (HCL) system. The observations

focused on key processes within Humanitarian Construction Logistics (HCL) such as treatment materials (procurement, delivery, handling, and storage of materials), resources allocation, and integration among the parties of the humanitarian projects. Observations within ten site-visits were also an important data source to understand how materials and orders were handled, loaded, and unloaded by the different actors.

(2) The primary data has been sourced by a total of thirty semi-structured interviews during 2020 with members in UN agencies and NGOs on sites or inside offices. These interviews are informal, could take place at any time after and during the observation period, and could be considered as being comprised of brief chats as well. The interviews typically lasted between 1 and 1.5 hours, as well as the necessary clarifications and follow-up questions were asked by e-mail or by phone. The main objectives of the interviews were obtaining information about the current practices and understanding of the concerns and perceptions about Humanitarian Construction Logistics (HCL). Different people were targeted to participate in the interviews including project managers, project coordinators, superintendents, foremen, NGOs' engineers, logistics employees and even labourers. Many issues were discussed during the interviews such as the ordering process, humanitarian prerequisites, work methods, communications tools, and current logistical tools.

(3) Gathering of guidance materials, reports, statistics, and research papers that were issued officially by UN agencies and NGOs. They are presented in detail in the following sections in order to identify the essence of construction logistics practices for humanitarian purposes.

This dissertation aims to use this combination of methods which was considered to provide the best approach to the research, through making a literature review, direct observations and conducting informal interviews with people in UN agencies, INGOs, NGOs, and commercial companies, who have been working in context of humanitarian constructions and rehabilitation projects. That aimed to the best knowledge about key components of Humanitarian Construction Logistics (HCL) and assured that a construction project processes in the humanitarian context are highly similar to the commercial context in terms of designing the shelters/settlements, procuring, contracting, supplying system, and carrying out the actual construction. The mentioned varied combination of semi-structured interviews, meetings, observations, and document analysis aimed to construct a context-dependent understanding of Syrian humanitarian construction projects from 2013 to 2021.They also attempt to discuss proposals for merging the modern construction logistics methods through humanitarian logistics of humanitarian construction/rehabilitation projects, despite the fact that business models, funding methods and design models might be different.

The research is based on an exploratory case study approach for the "Humanitarian Construction Logistics (HCL) in Syrian cases" in order to provide examples extracted from studied phenomenon as in-depth studies are essential to understand its complexity. After that, the analysis of the collected data was used to construct a conceptual framework to improve Humanitarian Construction Logistics (HCL) management and to leverage a more efficient daily schedule and practices. The below diagram illustrates the sub-phases of methodology in this dissertation.

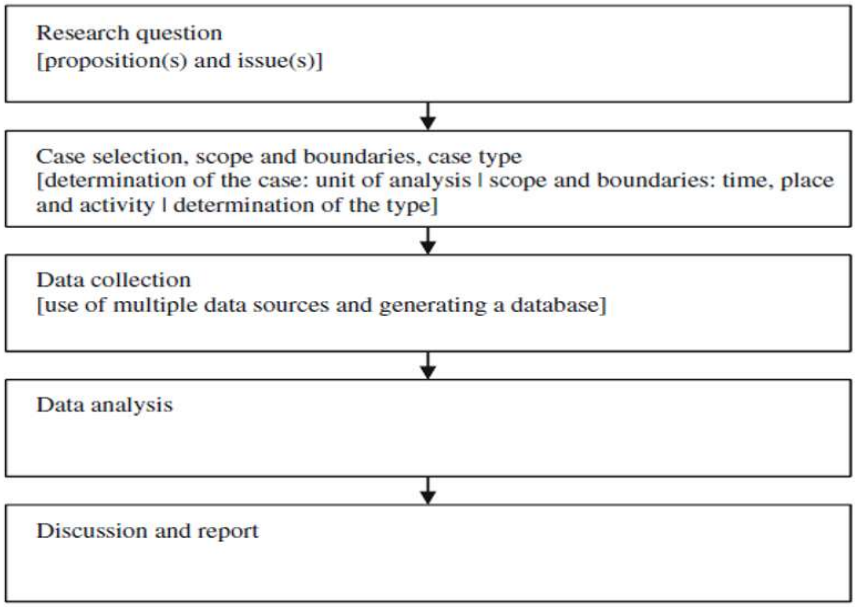

Fig 4: Approach of Exploratory Case Study Research

3.2 Research Strategies:

To formulate the deliverables, several research strategies have been selected. A desk research, grounded theory and a case study are selected as a research strategy. These strategies are explained below.

3.2.1 Desk Research:

This dissertation adopts a desk-top approach, with articles and sources from renowned scientific databases such as ScienceDirect, Google Scholar, and Emerald. A desk research is a non-empirical research strategy where the researcher uses material that is produced by others. (Whitlock et al., 2018) In many cases, the documents that are used in this strategy are written from another perspective. Therefore, the information is not directly usable for the purpose of this deliverable but can give information for a context. The goal of the desk research is to formulate a theoretical foundation for the deliverable (Saunders et al., 2009). The author harnessed many sources from Linköping university, Chalmers university, British universities, and others in terms of topics like humanitarian logistics, construction logistics, construction supply chains, and other topics to use this information to construct this dissertation's perspective.

3.2.2 Grounded Theory:

The grounded theory is a methodology that involves a systematic process of gathering a finite set of data to evolve a theory based upon the data and not from the speculation or preconceived ideas. (Knight and Ruddock, 2008)

In this strategy, data is collected without any theoretical framework; no theoretical framework exists prior to the data collection procedure (Partington, 2000). Theories are, therefore, derived from the collected data, after which conclusions are formed before being

tested. Application of grounded theory within humanitarian organizations is not easy due to the difficulty in gaining full access to data. Documents, observations, interviews, historical records, videotape, as well as any other suitable methods are used in grounded theory to fulfill the research gap (Bryman, 2008). Obviously, the application of this strategy requires lengthy periods of time and a specific work environment. These prerequisites were available constantly for the author who has worked in humanitarian organizations and Syrian humanitarian operations from 2013 to 2021. The author has been reading, watching, and discussing many public reports, videos, and data about construction and rehabilitation activities in Syrian humanitarian context that have attracted the attention of the author to the realistic links between humanitarian logistics and construction logistics. Eventually, that has led the author to suggest a new term, namely "Humanitarian Construction Logistics (HCL)".

3.2.3 Case Study:

A case-study research is excellent for theory building, for describing the ''best practices'' in details and for providing a greater understanding of the data gathered. It is one of the most commonly used research methods in operations management (Voss et al., 2002) probably because of the richness in data and the depth of understanding. Besides, it is used to explain and explore a complex phenomenon of interests and makes use of various quantitative and qualitative methods of data collection and it also explains how a phenomenon is influenced by the context within which it is situated. The methodology should be carefully planned in advance and should support the systematic gathering of data required to address the research questions of interest. A thorough literature review would exceed the extent of this paper in order to provide a deep investigation or validation of the research subject. Therefore, this method uses observations, interviews, documents, and records because of a case study is an empirical research strategy. (Yin, 2003, Saunders et al., 2009)

A case-study research has been used in the dissertation as one of three methods to fulfil the research objective. It has been used to understand of the logistical framework through Syrian construction projects and to explore the logistics challenges on-site and offsite, which can be translated into answers for research questions (Yin, 2009).

The dissertation author is admired for his ethics in case study research, which is demonstrated in the following definition of (Meredith,1998) who defines a case study as a method that ''… typically uses multiple methods and tools for data collection from a number of entities by a direct observer in a single, natural setting that considers temporal and contextual aspects of the contemporary phenomenon under study, but without experimental controls or manipulations ….''

A case study diary with notes about activities and problems was developed. These notes contained information about what activities were performed and why, together with the time and date, etc. This information was then classified into 'activities. In this manner, a conceptual map of what is done in a certain process could be drawn.

This dissertation used an explorative case-study approach that focused on Syrian humanitarian operations between 2013 and 2021 to identify the elements of construction logistics management and its efficiency in relation to humanitarian / non-profit construction projects. This dissertation relies on two case-study research approaches. The first one is a descriptive case study purely that described a specific environment, and it was performed with the intention of identifying and classifying the aspects or features of the subject which is herein construction

logistics within Syrian humanitarian environment. The second made use of exploratory case studies that contributed to theory building and were used when the number of previous studies was inadequate, or where hypotheses were found and could be tested to build a new knowledge. (Eisenhardt,1989) This dissertation aims to build a theory about the Humanitarian Construction Logistics (HCL) framework and practices to being base stone for next humanitarian operations and academic research in future.

Adopting mixed methods appears to be the best research choice in order to satisfactorily address the research gap and to fulfill the research aim and objectives. Thus, this dissertation used both qualitative and quantitative aspects, which opted for the most suitable choice. Accordingly, semi-structured interviews followed by content analysis (qualitative: non-numerical) served not only to enrich the research justification and evidence but also to provide further knowledge regarding Humanitarian Construction Logistics (HCL) within Syria and explore positive opportunities for Syrian humanitarian operations in the future.

3.3 Data Collection:

The research process is based on gathering preliminary information before collecting empirical data about construction logistics practices in context of the Syrian humanitarian operations from 2013 to 2021.

In the first phase, a comprehensive literature review was conducted, and the author gained insight into the logistical aspects of the construction industry. However, during this phase, the author also had to revisit literature in an explorative manner to allow for a deepening of the synthesis and analysis, resulting in an in-depth case study approach in dissertation. The investigation method in this dissertation was conducted by combining two research methods, a literature review, and interviews. The literature review was conducted through research on the internet and at library databases. This was mainly done to obtain a suitable overview of the subject area and its aspects. The literature review also worked as a knowledgebase for the upcoming semi-structured questions used during the informal interviews. The informal interviews were made throughout many Syrian humanitarian projects for construction, maintenance, and rehabilitation to acquire an understanding about construction logistics elements in context of humanitarian projects. The studied phenomenon was concerned with the current situation of construction supply chain functions within Syrian humanitarian operations. The questions included in the interviews, focused mainly on the current situation of construction logistics in context of Syrian humanitarian operations and possible improvements of the situation. Methods for data collection are clarified below.

3.3.1 Literature Search:

Parallel to the initial observations at the construction sites, the literature search was constructed with the purpose of creating a theoretical foundation for the dissertation. The literature search also functioned as a source of inspiration and knowledge for the author. The research strived to provide a relevant literature that meets the dissertation’s purpose from conference papers, scientific articles and books by searching at databases like Chalmers library, Linköping library, Designing Buildings Wiki, British resources, American resources, New Zealand resources and others. In addition, some websites were used such as Research Gate, Google Scholar, Journal of Humanitarian Logistics and Supply Chain, UN agencies, and others.

Some of the key words used in the search included “Construction Logistics”, “Construction Standardization”,” Humanitarian Rehabilitation”, “Syrian Humanitarian Operations”, “Just in Time”, “Logistics Planning”, “Construction Planning”, “Lean Construction”, “Supply Chain Management”, “Construction Procurement”, and others. Literature in English language was the main literature considered, and the research strived towards finding several sources considering the same subject to ensure validity. Furthermore, the publication date and the number of citations of the articles were also considered when choosing literature. The literature research was an iterative process which was complemented by the research questions that were also adapted to reflect what the dissertation examined. In total, approximately 80 scientific articles and resources were used in the process.

3.3.2 Literature Study:

A literature review is an important part of a research that aims to shape the scope of the research and find gaps in it. However, a literature review can also be used as a data gathering method. The first perspective is often called a traditional review such as the desk research, which is used by the author for literature study, collecting data and formulating analytical framework. Desk research is used to structure the literature study that is functioning as an analytical framework that links the theoretical questions to the empirical analysis. This dissertation will use a mix of quantitative and qualitative methods whereby many documents are being used to collect data. (Croom, 2009).

On the other hand, the latter review is called a structured systematic review, which tries to identify all relevant literature based on predefined search criteria. It is, therefore, not an ad hoc scoping method because it usually starts with identifying the scope and planning the review. The planning contains identifying the search keywords and sources to search within. It is important to develop well-defined research questions both concerning the planning and the scope, otherwise, there is a risk that the literature review becomes a ‘fishing trip’ without a clear purpose and research questions. Therefore, a traditional review can aid in shaping the research questions (Cronin et al., 2008, Croom, 2009, Jesson et al., 2011). The method was utilized in order to identify the feasibility of Humanitarian Construction Logistics (HCL) and understand their applications preliminary within Syrian humanitarian operations, which are selected as case study between 2013 and 2021.

3.3.3 Interviews:

Interviews are a tool mainly for the collection of qualitative data and are a popular data-collection tool because of their flexibility. They are conducted to provide the deliverable with empirical data to improve the reliability of the deliverable. By creating a dialogue, data can be corrected, and specific data can be obtained. By conducting semi-structured interviews, which are recorded and transcribed, topics are mentioned but enough space is given to deviate from the specific topics. The interviews were structured based on questions about construction logistics processes, stakeholders, approaches, activities, and resources in context of Syrian humanitarian operations. These interviews have an explorative function and do not have a specific structure, which in general are a useful method for both broadening and deepening the knowledge about a topic because the respondent might give new input because he or she can describe why certain things are the way they are. Therefore, this dissertation follows a semi-structured approach for

conducting an interview because there is a risk with structured interviews that the interviewer gets too dependent on the interview guide and forgets to listen to alternative ideas. Moreover, a problem-centered interview approach will follow as a useful method for building theory by probing a topic centered around a certain problem/topic. It is easier for respondents to come forward with input if the discussion is based on common problems/topics that they have experienced. (Silverman,1998, Flick, 2009, Yin, 2009, Bryman and Bell, 2015)

The interview series conducted in this dissertation was two-fold; both of interview series consisted of semi-structured problem-oriented interviews with stakeholders. The first series focused on identifying logistical issues on construction site and planning chains in context of Syrian humanitarian construction projects. The second ones focused on validating the problems to find solutions for the problems. Semi-structured problem-oriented interviews with stakeholders are a suitable method because of the wide experiential experiences of stakeholders who must have dealt with the problems which were already found through observations and the literature review.

3.3.4 Empirical Data Collection:

The case study involved the construction logistics for humanitarian projects through all Syria between 2013 and 2021 as all humanitarian projects faced challenges regarding construction logistics. Therefore, this dissertation required paying several field visits, despite of the large distances, in order to be able to conduct the study.

The empirical data collection consisted of site observations, official documents, and interviews with stakeholders within several projects and organizations that have been working during the time period between 2013 and 2021. The documents consisted of logistical plans, site dispositions, supplies' manifests, on-site & off-site stock reports, purchases, and others for many projects whether they are working currently or have already finished.

The interviews were conducted in a semi-structured manner with prepared questions. Nevertheless, the interviewees got the opportunity to elaborate in a broader context, allowing the author to gain new insights. Prior to the interviews, a question template was constructed regarding the initial observations and findings made in the literature research. Qualitative interviews fall under the term of semi-structured interviews, and this enabled the interviewer to deviate from the prepared questions and to use follow-up questions. Due to the number of planned interviews, the qualitative approach was suitable, therefore, chosen due to the fact that it focuses on specific answers and reflections rather than the number of interviews. In addition to the data collection through interviews, site visits were also used as a tool to generate a holistic impression of how the humanitarian construction projects and their sites were coping with their logistical challenges. These site visits could be a tool of what is called participant observations, which is also an explorative approach used in the qualitative research method. (Bryman and Bell, 2015)

3.4 Data Analysis:

There is no single accepted procedure for analyzing qualitative data. This dissertation used some processes that have been tested to be systematically effective, such as creating transcripts, sifting, and sorting these transcripts carefully, making comments and informal codes, coding the text, cutting up these transcripts under emergent categories, themes, and sub-themes,

and eventually building a theory through discourse analysis. (Silverman, 1998). The following points became evident as a result of this research:

- The investigation about Humanitarian Construction Logistics (HCL) management showed that 70% of the material orders took more than the necessary time by 50% because of the drawbacks.
- The deliveries were often late and short lead time because of the complexity of the Syrian crisis and the differences of the project's stakeholders, funders, implemented humanitarian organizations, implemented local NGOs, contractors, vendors, and others who are responsible for issuing material orders and following construction supply chains. In addition, there were numerous workers' replacements.
- Equipment scheduling was skipped and was not incorporated into the construction logistics management system.
- There was no coordination of the packages' arrivals between the purchase section and the other team members, or between subcontractors and suppliers.
- There was poor record keeping of the materials and tools, which resulted in poor storage management.

The results of the data analysis indicated that the above issues negatively affected humanitarian construction productivity and proved that the logistics management systems, used to date in the Syrian humanitarian construction, were highly inefficient. As it can be seen, there are several issues with respect to this process, which have a negative effect on the humanitarian construction process. Schedule disturbances, misinformed workers, poor logistics practices and time wasting are good examples. The major weaknesses in the current process are illustrated in the following points:

- There is no integration between storage management and schedule planning.
- The haphazard method shows an absence of accountability regarding the availability of materials, which in turn affects the logistics of a project. Also, this results in poor documentations.
- There are scheduling conflicts, project disturbances, and an absence of technology.

Subsequently, the results from the data analysis have to be prepared and questioned, in order to shape hypotheses about optimal Humanitarian Construction Logistics (HCL), and that has to be compared with conflicting and similar literature, as well as discussing the effectiveness of this hypotheses throughout practical Syrian humanitarian construction as a case study. Finally, the results from the case study must be critically discuss and demonstrate in a concise manner.

3.5 Ethical Conduct:

In order to ensure that this dissertation was constructed ethically, several actions were taken. Prior to all interviews, all interviewees were informed about the scope of this dissertation and their roles in the dissertation. Furthermore, all interviewees were clearly informed that they would have the possibility to review the answers given, and that no information associated with their position, organizations, projects, and names will be stated along within this dissertation, which is supposed to encourage the interviewees to speak freely and be open-minded as well as

feel more comfortable when answering the questions during the interview. This condition of anonymity resulted in obtaining more accurate and truly representative data.

- To identify the essence of construction logistics management in context of humanitarian operations.
- To explore the main elements of Humanitarian Construction Logistics (HCL).
- To prioritize the best practices of Humanitarian Construction Logistics (HCL) theory throughout Syria.
- To obtain data and examples related to construction logistics practices in context of Syrian humanitarian operations.

Furthermore, throughout the process, a close collaboration with all involved humanitarian organizations and commercial organizations has been managed.

4. Results:

This chapter of the dissertation will answer the first research question, "What are the theoretical attributes of Humanitarian Construction Logistics (HCL)?" by studying the cases of Syrian humanitarian construction-projects between 2013 and 2021. These results will draw the general specifications of Humanitarian Construction Logistics (HCL) by extracting the common logistics functions within Syrian projects that comprise the core of Humanitarian Construction Logistics (HCL).

4.1 Syrian Humanitarian Constructions Overview:

In context of responding to the Syrian crisis, shelter strategies have been developed at country levels in response to the very different contexts. The first version was launched in December 2012 and was later updated in July 2013 and December 2013. Until these dates, most refugees and IDPs are living in non-camp situations, which included both formal renting and informal settlements.

Thereby, shelter projects, during the years 2013-2014, deployed several logistical responses taken in different countries previously including:

- T-shelters in camps.
- Increasing housing supply outside of camps by support the completion of unfinished buildings.
- Vouchers for purchasing materials for shelter improvements.
- Shelter kit distributions. (Shelter Projects Working Group, 2014)

As the Syrian crisis has been intensifying since 2011, the constrcution logistics and shelter needs were increasing and a midterm solution was required for refugees, IDPs, and affected people in/out Syria, therefore, all humanitarian organizations continued to scale up their shelter, wash, and rehabilitation programmes.This scale up was being done by bringing other humanitarian partners as the international organizations, which did not have direct access to all the Syrian locations to monitor conmstruciton logistics issues. Good relations with the local partners and remote feedback mechanisms were essential to mitigate the impacts of these challenges. To support remote implementation, a mobile application was downloaded on staff's phones to collect data from the field digitally and allow the organization to access and analyse it throughout the implementation process. A WhatsApp feedback mechanism was established to supplement other systems (e.g. phone calls), based on a study of available communication options. Furthermore, third-party monitors conducted regular visits to all rehabilitated properties to assess progress and submitt narrative reports, which included verifiing bills of quantities, photographs and videos. Furthermore. post-implementation monitoring was carried out through household visits by a staff from a local partner immediately and three months after handover, as well as remotely, via WhatsApp and phone calls. (Shelter Projects Working Group, 2018)

These orgazations have been seeking to attract development funding which could allow for developing new modalities, such as training and involving affected people in rehabilitations. (NRC Syria, 2014). Therefore, families residing in mildly damaged homes were provided with shelter repair kits and received training from the organization's field staff on how to conduct repairs independently. On the other hand, a field staff directly repaired the homes that were identified as severely damaged. Repairs were carried out to ensure that families had adequate living conditions before winter. Customized repairs for each home were made in accordance with

the full-home assessment, on a case-by-case basis, with repairs such as the following: conversion of dirt floors to concrete, repairing plumbing/piping of homes in damaged bathrooms, installation of electrical wiring for solar panels and lighting purpose, latrine installation in homes without functional bathrooms, replacement of damaged doors and addition of locks, repairing damaged walls, replacement of destroyed walls, and repairing or replacement of ceilings according to the level of damage. (Shelter Projects Working Group, 2016)

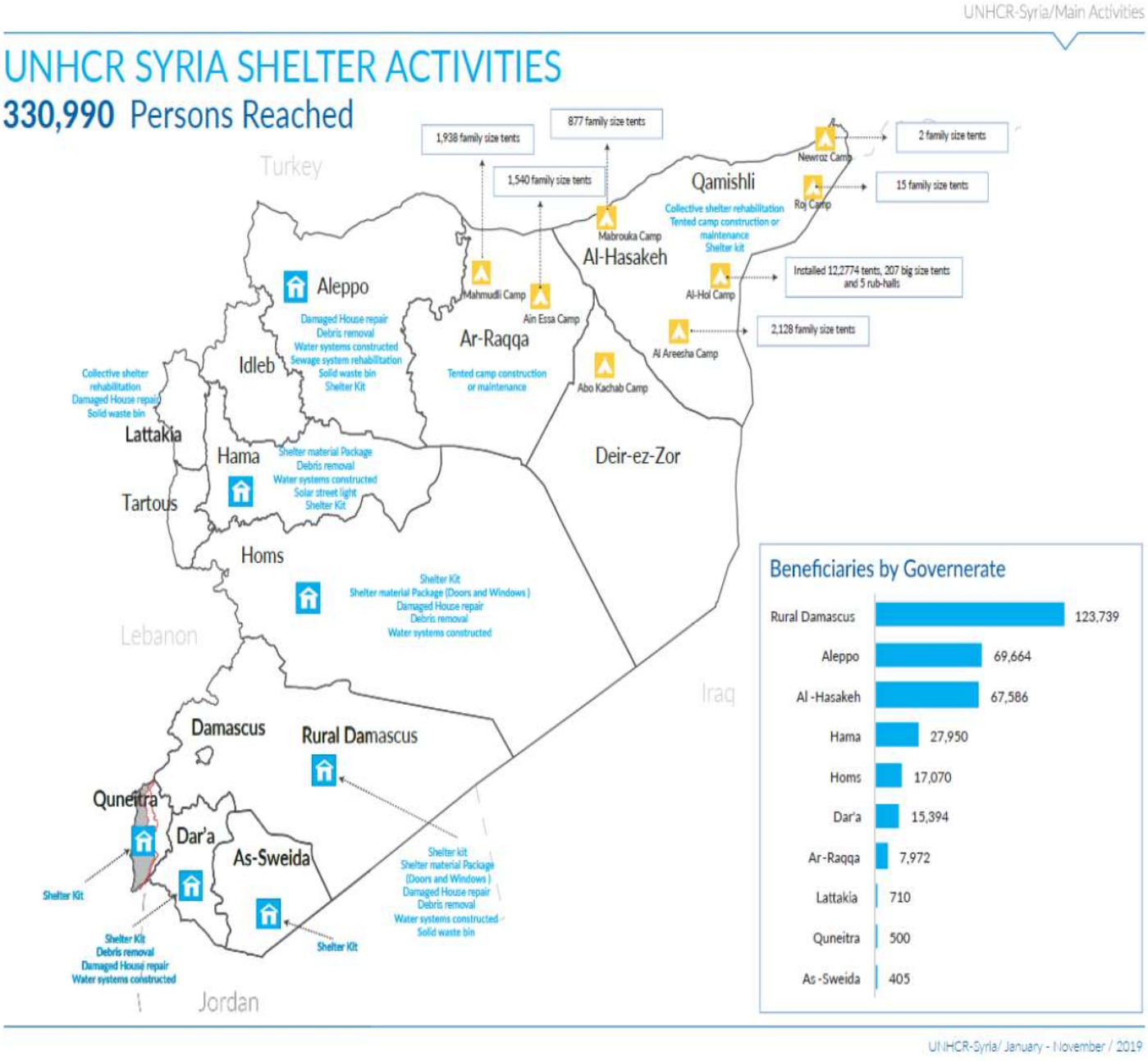

Fig 5: UNHCR Syrian Shelter Activities 2019

The above-menioned constrcution and logsitics activities are still ongoing in Syria. UNHCR mapped activities (Fig 5), which had covered most districts of Syria between 2011 and 2019. These activities are summarized below:

- Rehabilitation of emergency shelters.
- Distribution of shelter kits.
- Distribution and installation of shelter materials packages (Doors and Windows).
- Damaged house repairs.
- Debris removals.
- Water systems were constructed.
- Distribution of solid waste bins.
- Solar streetlight was installed.
- Collective shelter rehabilitation
- Sewage system rehabilitation.
- Tented camp construction or maintenance.

The informal interviews indicated that long, temporary, and complex humanitarian supply chains have been imposed on humanitarian organizations due to the different activities which spreaded across all Syria. The official reports issued by the OCHA for all humanitarian activities within Syria during 2017, 2018, 2019, and 2020 also indicated that there are fluctuations in the numbers of Syrian people that benefited from different programmes in terms of shelters and publich infastructure, wash, ER & L (early rehabilaition and life saving) as shown in the below statistics (Fig 6) extracted from OCHA Syria database between 2017 and 2020. (UNOCHA Syria Hub, 2020) Consequently, that confirms the information, mentiond in the interviews with logistics persons from different organizations, that planning of Humanitarian Construction Logistics (HCL) within Syria was complex because of extreme differences during the past squenced years in terms of activties, supplies, locations, components, procurements, reasources and even goals. For example, the number of beneficiaries from the shelter program during 2020 equals around half the beneficiaries of the previous years.

OCHA Syria / Year	Beneficiaries No. / Activity		
	Shelter	WASH	ER &L
2017	511,836	12,832,007	4,953,042
2018	518,529	10,463,713	2,984,368
2019	458,796	8,982,547	1,399,941
2020	225,929	5,021,725	1,589,022

Fig 6: UN-OCHA, Syrian Activities, 2017-2020 (www.ocha-sy.org/4wsresponse2020.html)

On the other hand, analyzing the timescales of the Syrian humanitarian construction projects shows that there is a prolonged timescale of supply chains, sometimes over years. Furthermore, planning, contracting, procurement, implementation, distribution of NFIs, installation water & sanitation supply-networks, installation electricity networks, and handover phase could be complex and changeable because of the unstable surrounding circumstances. The below diagram shows time-scale instances for five projects in Syria extracted from the Global Shelter Cluster (Syrian shelter projects reports) between 2015 and 2019. Most of them demonstrated periodic distances between the planning phase and the handover phase that reached to many years, therefore, the materials' costs, projects components, and original logistical plans could be changed according to the surrounding circumstances. (Shelter Cluster / Syria, 2021)

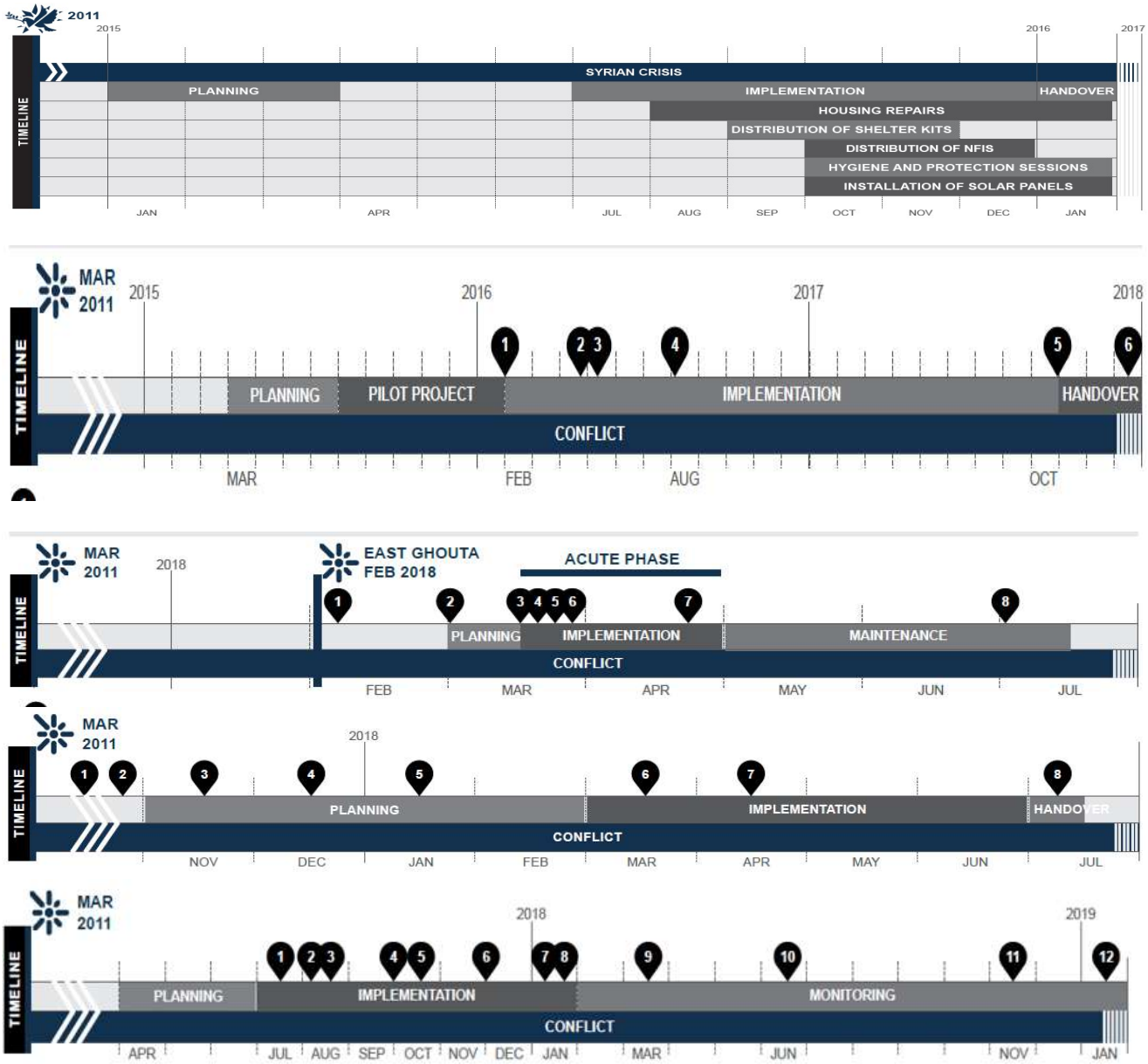

Fig 7: Syrian Shelter Projects Timelines, 2011-2019 (www.sheltercluster.org)

In the same context, UNHABITAT (United Nations Human Settlement Programme), as an appealing agency with coordination with other participants (UN agencies, INGOs, Syrian charities, and others), has been conducting many projects in Syria since 2017 until now in terms of shelter technical support, housing damage assessments, housing repairs for IDPs, improved solid waste management, and basic services through coordinating of interagency, integrated humanitarian responses in Syria.

According to the interviewees, whose duties include logistics, procurement, and operations in UNHABITAT Syria, there are differences in logistical prerequisites beginning from transportation experts and technical persons to workplaces, procurement materials for different projects, disposal debris, contracting with appropriate vendors, contracting on appropriate services, distributing solid waste tools, training IDPs, and eventually information flow between participants.

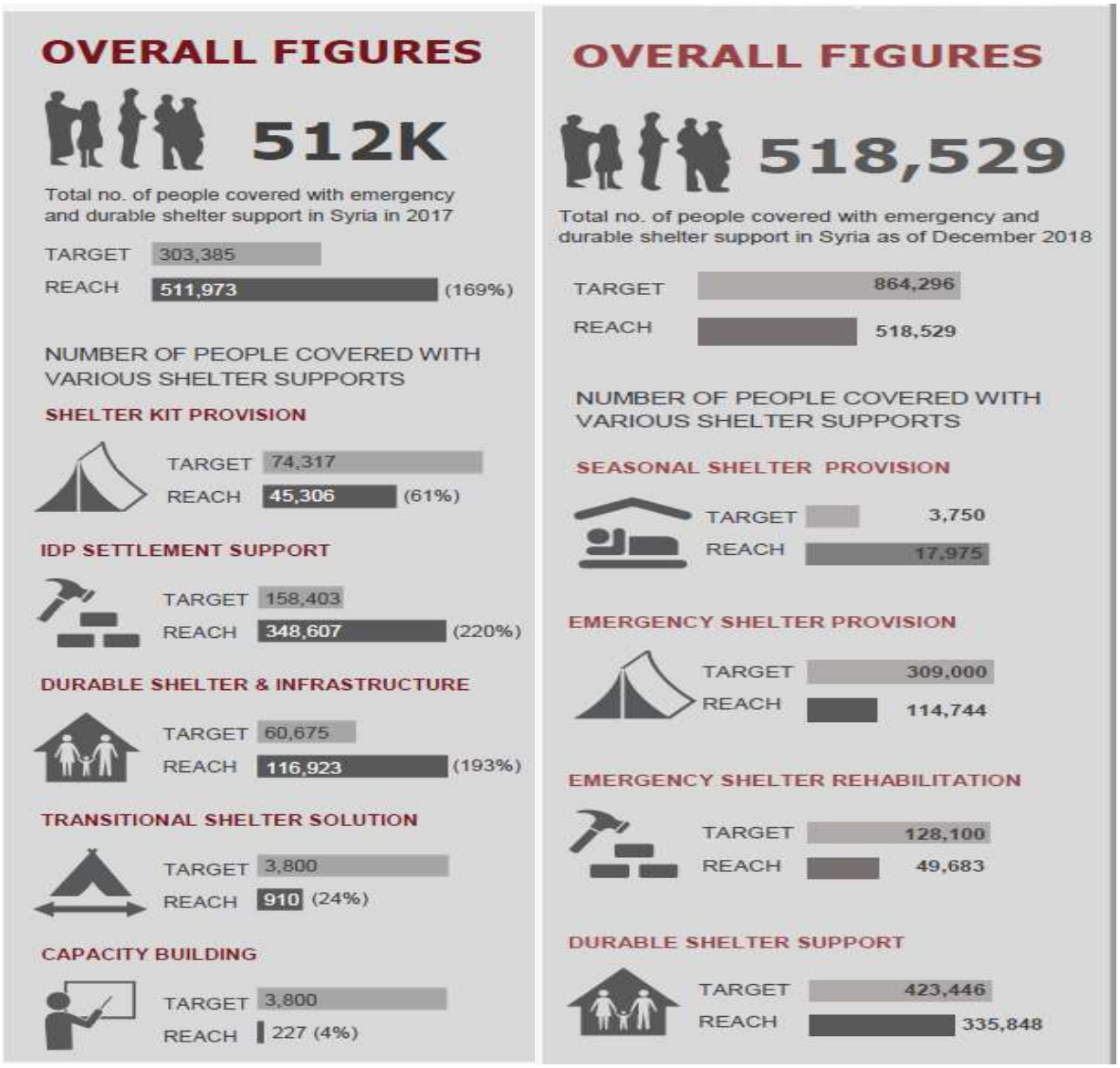

Fig 8: Shelter Sector, Syria Hub Activities, 2017-2018 (www.sheltercluster.org)

All these differences made planning, implementing, and controlling the Humanitarian Construction Logistics (HCL) for UNHABITAT Syria very complex (UN-Habitat Syria, 2020) The annual reports of the Global Shelter Cluster (Syria Hub) indicated another challenge facing the Humanitarian Construction Logistics (HCL) which is represented in planning and implementation. The above facts extracted from 2017 and 2018 reports (Fig 8) reflected the organizations' plans and what was achieved on the ground. That leads to determining the obstacles through the Humanitarian Construction Logistics (HCL), such as the inability to plan procurements, contracting, transportation, and other resources in the right way. For example, the emergency shelter provision in 2018 had intended to target 309,000 effected people, however, the organizations' performance covered only 114,744 effected people at the end of the year, which caused mis-planning throughout humanitarian construction supply chains. (Shelter Cluster / Syria, 2021)

4.2 Procurement & Logistics Functions in Syrian Humanitarian Constructions:

The reports of the Shelter Projects Working Group, with the numbers A30 (2016) and A29 (2018), indicated that all the contents of the distributed construction kits were procured from local markets as much as possible. Furthermore, most of the construction materials for rehabilitation were purchased nationally. In despite of that, there were delays associated with the transport of the procured items across the Syrian borders or internal cross-borders, which caused delays of shelter projects and NFI distributions as well as instability of domestic markets (affecting both availability and the quality of materials). Therefore, that led to an increase in the total project cost by 25 per cent and the bulk of activities were carried out during bad weather conditions in winter season.

All experts and laborers were sourced locally by the implementing partners, in despite of the limited local expertise. This was due to the migration of many professionals and the inability to advertise the project owing to security issues. Additionally, many armed groups, with no prior experience or permits to conduct construction works, tried to be involved in the projects, as they had several trucks and other machinery. These factors led to the direct engagement of the humanitarian organizations in technical planning and implementation. Moreover, the suppliers were selected by using a closed tender process (three quotations sought from different suppliers). The supplier was selected based on a combination of unit costs, quality, vetting, proximity to targeted communities and stock-levels. (Shelter Projects Working Group, 2016, Shelter Projects Working Group, 2018)

Below areas the key weaknesses, solutions, and lessons learning in terms of Syrian Humanitarian Construction Logistics (HCL) after reviewing the reports numbers: A30 (2016), A28 (2017), A29 (2018) and A31 (2018) which issued by Shelter Projects Working Group (Syrian Hub).

4.2.1 Weaknesses of the Syrian Humanitarian Construction Logistics (HCL):

While efforts were made to address the pressing shelter needs of the most vulnerable population, there are still challenges and gaps that remain to be addressed. Access and safety are the key challenges in many parts of the country. Likewise, limited partners' capacity, heavy processes, funding constraints, increased needs, diminishing coping capacities for both the IDPs and host communities, and the limited financial resources of the government to provide shelter compensation. That require from shelter-sector partners to scale up operational presence.

Shelter and infrastructure needs are huge, and the shelter-sector partners collectively do not have the capacity to meet all the needs. Besides, opportunities for systematic field-based data collection remain very limited due to access or authorization restrictions, which lead to incomplete needs analysis in some areas. (Dahia, 2018) The informal interviews with logisticians also indicated the negative impacts on the Syrian Humanitarian Construction Logistics (HCL) as summarized below:

- Security concerns impeding access or regular access to areas of need. Apart from remote management challenges, the project had to adapt to the highly dynamic and unpredictable environment. Logistical and operational plans were based on the most-likely scenarios and updated continuously based on the context analysis. The humanitarian organizations worked with the local partners to ensure access to high-risk areas and responded to the suddenness and unpredictability of displacements following tensions and conflict.
- The complexity of formal requirements and administrative procedures and the limited number of NGOs permitted to operate in Syria as well as their limited operational capacity.
- Some families decided to leave the house or the area, which resulted in about 19 per cent rehabilitated houses not being used (14.6% empty, 4.2% occupied by other families). This should have been identified in the selection process, to avoid wasting logistics capacity, by asking more detailed questions about the intention of the family to relocate, or the risk of eviction. That refers to hurdles in terms of verification of specific needs, vulnerabilities, and beneficiary groups.
- Improper market assessments have led to an increase in costs as some materials, such as timber, were not available in local markets and had to be imported. These logistics processes included delays in the procurement and transportation of materials across the Syrian borders.
- Limited assets and resources like the availability of sites and structures in certain areas for transitional solutions or upgrading for temporary use by IDPs.
- The short durations of the projects, which affected the quality and extent of the repairs. The projects were very small in scale compared to the needs in the country as well as in the target areas. That has led to losing logistics capacity without any clear results.
- The limited budget allocated for shelter rehabilitation activities, which resulted in many households being dropped from the beneficiary list.
- Dissatisfaction of most beneficiaries with the shelter repair kits, as the needs were very diverse for each house, and much greater than what could be solved by the materials provided. Also, some households felt that they did not have the skills to do the repairs, and this led the organization to change its modality and its supply chain nature.
- The majority of humanitarian projects were carried out through the winter because of the limited time. Although most elements were covered, the rain affected parts of the humanitarian constructions. That resulted in the suspension of work and the rebuilding of some parts. That had an impact on the overall budget.
- The organization did not properly identify and train contractors and local partners before implementation due to the lack of proper training and selection. This means that the organization often had to conduct activities directly with its own unexperienced staff, which led to a significant increase in the logistics costs.

- Low construction quality due to the fact that the project is managed remotely, which makes it difficult to conduct proper monitoring and inspection on the works' quality, carried out by the local partner. Seventeen per cent of surveyed households were not satisfied with the assistance, and 78 per cent stated that their properties needed further rehabilitation.
- Information flows between the shelter, WASH and other teams were challenging at the beginning, which caused confusion during the implementation. For most households the two teams at least conducted separate visits as part of the selection and due diligence processes. Instead, all assessments should have been undertaken at once, to save time, save logistics services, and avoid multiple visits to the same family.
- Due to extreme insecurity and difficulties in obtaining permission from the Syrian government, many international humanitarian organizations that are operational within Syria are reliant upon local partners to engage with beneficiaries and to carry out distributions of materials. That includes NFI distributions and providing sealing-off kits for unfinished or damaged buildings.

4.2.2 Solutions by Syrian Humanitarian Construction Logistics (HCL):

- Most of the shelter activities were conducted using over 1,500 standard shelter kits prefabricated by the organization and designed to be flexible enough to be used either as stand-alone or as components of partitions or walls.
- All works were implemented by contractors who started work before signing agreements and worked around the clock to deliver the works as quickly as possible. Multiple contractors were employed at the same time to speed up the delivery further. Some skilled IDPs were also hired during implementation. These processes strengthened the positive impacts of programmes, for example, one project, in the span of 45 days, availed shelter support for over 65,000 people across all the targeted sites.
- Due to the lack of direct access to many Syrian areas, many humanitarian construction projects were implemented by local partners and remotely managed from Jordan or the Syrian capital Damascus. The high quality of the interventions was ensured through independent monitors who were contracted to verify the implementation and conduct site visits throughout the duration of specific projects, which increased logistics and operational costs.
- Using local materials and labour to implement rehabilitation activities. Generally, the working team was composed of engineers, local workshops, and labourers who worked under the supervision of the local partner team. Approximately 3,500 job opportunities were created, and 450 toolkits were distributed to the most efficient workers. In addition, they were provided with vocational training to help them start their own businesses. Some of the beneficiaries were also contracted as either skilled or unskilled construction workers. As a result, using locally available labourers and materials helped support the local economy through providing new income opportunities and improving the status of local vendors.
- The Syrian construction-projects used the adobe construction-technique, which had several advantages compared to other options (such as concrete buildings or caravan units). These advantages included ease of building with manual tools, traditional technique allowing community buy-in, lower costs, and adobe does not need a lot of energy to be produced. Regarding soil sourcing, the process (extraction/transport/mixing/production) is manual and has a low environmental impact and embedded energy level. As a result, there was a low

environmental impact and the raw building materials (soil and straw) were locally available and sourced sustainably. Buildings were also easy to be disposed of compared to other shelter options.

- The humanitarian logisticians had been planning since initial stages to make the intended settlements as transitional so they could be dismantled or reused after the conflict. For instance, these settlements could be occupied by the local communities or converted to other uses, such as tourist resorts.
- The definition of a common standard for rehabilitation logistics works (BOQs and technical specification within the Shelter/NFI Working Group / Syrian Hub) helped harmonizing interventions and providing more equitable support to affected populations.
- The risk management plans were developed to mitigate many logistical and operational risks such as the lack of cooperation from local authorities, the limited availability of poor-quality supplies, and others. These risks could be mitigated by community engagement, close independent monitoring, preparedness, and an evacuation plan for aid workers in dangerous situations. Moreover, small quantities of raw material were procured and stored to reduce the effects of market fluctuations and border closures.

4.2.3 Learned Lessons of Syrian Humanitarian Construction Logistics (HCL):

- The necessity of conducting trainings for local laborers (on carpentry and construction) to enhance the quality of shelter interventions for future programmes.
- The need for more comprehensive projects that include multisectoral activities, such as shelter, WASH and protection.
- The number of kits (both repair and winterization) should be decreased in future projects, in order to increase the funding allocated to each household to cover more critical shelter needs.
- Developing a database between Shelter/WASH and humanitarian logistics assessment teams would have improved the communication flow and documentation during logistics operations.
- Remote management requires very clear information management systems and lines of communication. So, more resources should be made available to the monitoring and verification of activities.
- Contingency planning and preparedness procedures are essential for logistics operations. The organizations developed a contingency plan that built in risk assessments, stocks pre-positioning and high flexibility to adapt to constantly changing scenarios.
- The adoption of mobile technologies (i.e., online spreadsheets) made the reporting easier. However, the staff should have been trained on their use directly on their phones, as these are time effective, reduce the risk of mistakes and provide readily available data.
- Syrian Humanitarian Construction Logistics (HCL) aimed to provide a more durable alternative to camps, create job opportunities, build capacities and revitalize local markets. The humanitarian organizations chose to use a traditional building method (mud housing) to address the limited availability of construction materials inside Syria. Another reason for choosing adobe was to allow for an easy dismantlement of the buildings after the conflict, as the local authorities and public opinion would not permit the building of permanent settlements.

4.3 Framework of Construction Humanitarian Logistics (HCL):

Humanitarian Construction Logistics (HCL) management is the process of planning, implementing and controlling supply chain resources, generally from the point of origin, such as raw material accumulation, to the point of destination, i.e., delivering goods to the correct location on the construction site. (Designing Buildings Wiki, 2020) According to the above overview of Syrian humanitarian construction projects, the Humanitarian Construction Logistics (HCL) does not look like traditional construction logistics which are typically part of an engineer-to-order (ETO) industry, where most of the products are physically big and immobile, and consequently have to be produced on their future site of use. (Ekeskär et al., 2020) Humanitarian Construction Logistics (HCL) involve the integrating of many activities such as resources assessment, lead time assessment, supply planning, demand planning, procurement planning, production planning, scheduling, packaging, assembling, inventory management, order fulfilment, out/inbound transport management, warehousing, materials handling, on-site management, customer services, waste management, and other uncommon activities. (Chandes and Paché, 2010, Designing Buildings Wiki, 2020) Humanitarian Construction Logistics (HCL) are carried out in temporary and sudden activities, which leads to establishing temporary supply chains as much as 60–80% of the gross work done in humanitarian construction projects involving the buying-in/bringing of materials and services from suppliers, subcontractors, donors. That leads to considering the heavy impact of supply chain actors on the performance of construction projects. Hence, the humanitarian construction supply chains are regarded as complex with interactions between multiple actors during the humanitarian construction process. (Ekeskär et al., 2020)

For example, more than 18,000 people have arrived in the refugee camps in northern Iraq during a short period of time (between October and December 2019), according to the estimations of Pace Winds (INGO), which managed the refugees' camps in northern Iraq. It was mandatory to prepare shelter sites, install more than 3,000 temporary tent-shelters, and connect them to water and electricity by Peace Winds during a short period. As the temperature dropped, Peace Winds also provided kerosene for heating homes and addressed other needs as they arose. (Peace Winds, 2021) These activities were carried out by establishing effective Humanitarian Construction Logistics (HCL), which were important to enhance efficiency, productivity, and having a positive overall impact on cost, time, and quality of any humanitarian construction project. In despite of that, good Humanitarian Construction Logistics (HCL) ensured that the workforces were able to carry out the required activities without delays caused by materials being delivered to site. As a result, there are special specifications, challenges, and working environment that distinguish Humanitarian Construction Logistics (HCL) from other logistics sciences. This dissertation explored these differences in the following sections.

4.3.1 Bureaucracy & Non- Safety Impacts:

Help Logistics, as the research foundation involved in humanitarian logistics, have drawn attention in below image (Fig 9: modularity picture) to the possible risks related to humanitarian logistics, such as checkpoints set by conflicted parties, limited access via broken bridges, camps based away from urban areas, losing aids on the way to beneficiaries, and others.

Fig 9: Humanitarian Operations Risks, HELP Logistics (https://www.help-logistics.org)

Syrian interviewees discussed many challenges in terms of safety and bureaucracy. Below are some of the key points they highlighted:

- Humanitarian Construction Logistics (HCL) have been impacted by issues like corruption, bureaucracy, cost overrun, political issues, projects' delays, and low productivity.
- There are many bureaucracy challenges, such as no clear national framework regarding the demolition of damaged and unsafe housing units, in addition to the removal of rubble. Humanitarian assistance for affected families to repair damaged homes, to restore their livelihoods could be hindered due to bureaucracy.
- There are the challenges related to donors because it is easy for aid workers to get the funds to do things across border. However, it is hard inside Syria which used to be a communist country that counts mostly on its public services. Education, the health system, the electricity services, the water services, and the main services are all part of public services. There are a lot of challenges related to convincing donors that aid workers need to build and rehabilitate the schools because they are important for children. On the other hand, these schools are part of the public education system. Thus, aid workers were accused that they were supporting the government.
- There were insufficient funds to build more solid shelters on a large scale within Syria, which led to neglecting logistics functions, such as low-quality materials' procurement and temporary non-practical solutions represented in tents, plastic sheeting and traditional shelters that are not fireproof.

As a result, understanding the current state of unpredictable logistical and bureaucratic challenges is needed simply to deliver assistance. Humanitarian Construction Logistics (HCL) are crucial to learning how to deal with them and knowing the roles of the different stakeholders is even more important. (Vega et al., 2020)

4.3.2 Budget Overruns:

Towey (2013) describes the cost management of a construction project as the key element that helps drive the success of the project. It manages the costs of logistics functions, procurement, contract administration and different costs. The cost management of a construction project provides a guide for cost managers and quantity surveyors to help them in dealing with any day-to-day issues they might face. (Towey, 2013, Arewa, 2020) There are many initial costs and sub-budgets that could compile in one document namely, " Pricing Document," which depends on the form of contract and the chosen procurement route. For a traditional project, a full bill of quantitates is a common pricing document. (Mzyece, 2020)

In the context of humanitarian construction-projects, there are many logistics factors that could cause budget overrun/s. For example, the WFP project "Construction and Management of the WFP Humanitarian Logistics Base at Djibouti Port 2011-2017" had witnessed many revisions in budget periodically due to logistical reasons, such as increased staffing costs and purchased resources' costs required to carry out this project, as well as differences between actual construction expenditures and procurements versus planned budget. (WFP, 2012)

The poor-quality of Humanitarian Construction Logistics (HCL) costs the vast sums, which has a negative impact on beneficiaries and costing humanitarian organizations many financial burdens to address the poor quality. (McCabe, 2020) For instance, Peace Winds (INGO) has sought, since September 2018 until now, to provide more durable shelters for refugee households through improving the homes of a total of 1,493 families, who had been forced to live in tents and insufficient structures within the Syrian refugee camps in northern Iraq over eight-years period. On the other hand, this NGO had to use the allocated construction logistics capacity to build durable shelters when refugees were received in the first year instead of waiting around eight years to upgrade these shelters because using the durable materials leads to avoiding the repeated distributions and the wastage of low-grade products. (Wynveen, 2021)

The supply chains of reconstruction materials increasingly became a problem as the humanitarian projects continued, because of largescale purchasing by organizations and local purchasing by the affected communities. This led to an increase in local prices for all purchases which took place through same local suppliers. (Ashmore et al., 2009)

The experts within the Syrian humanitarian construction projects revealed that the cost of construction materials on the Syrian local market quickly rose when housing reconstruction during the recovery phase. Steel, cement, bricks, wood, sand, and stone all became scarce and expensive. UN agencies, INGOs and NGOs, which involved in the rehabilitation and reconstruction, paid all efforts to reduce the construction costs as possible. For example, they mobilized all logistics capacity to ship construction materials from elsewhere to reduce prices and used local merchants for economic benefits (restock their supplies). On the other hand, local suppliers participated by letting the organizations keep purchased materials in their warehouses until needed by projects. In despite of that, there are high costs associated with large-scale humanitarian construction projects, which place high demands on logistics, such as supplying and completely disposing of numerous raw materials, prefabricated components, large elements, construction machinery and volumes of excavated materials. Therefore, price stability plays a role here, which is just as important as the timely securing of transportation and inexpensive logistics functions.

The experts mentioned many negative practices in the Syrian Humanitarian Construction Logistics (HCL) like Carillion's negative practices (Carillion was the UK's second-largest

private construction firm which liquidated in January 2018) that led to interruptions and unsatisfactory results. The practices employed by the humanitarian organizations themselves, such as poor practices of auditing, accounting, reporting, initiating of pricing document and filling bill of quantities, which led to collapses and interruptions within humanitarian construction supply chains accordingly. Furthermore, employing a lot of unnecessary employees and associated volunteers in/out of humanitarian organizations with high salaries in the context of their work. (Arewa, 2020)

As a result, the successful Syrian Humanitarian Construction Logistics (HCL) helped to control the projects' budgets through quick implementation, monitoring costs, realistic pricing of documents associated with realistic bill of quantities, use of local resources (materials and labourers), assessing the availability of local resources, following international standards (like providing appropriate shelter models that were accepted rapidly by local authorities and beneficiaries), providing professional logistics services, matching construction materials supplies with demands, prioritizing the purchased decisions (which will impact the local economy as well as the local prices), and monitoring transportation networks during the rehabilitation/ re-construction interventions. (Ashmore et al., 2009, InterAction et al., 2020)

4.3.3 Third-Party Logistics (TPL):

Construction projects are temporary organizations that demand a multitude of materials and resources being delivered on-time to the correct site and according to rules set by site management. The construction industry is characterized by one-off projects, tendering, procuring, contractors, sub-contractors, and suppliers with every new project. (Janné et al., 2020) To handle with these characterizes, TPL providers have started, in the last decade, to offer specialized and dedicated logistics setups to the construction industry by taking over the logistics of the construction sites and establish structured interfaces between supply chains and construction sites. These types of outsourced logistics setups are often mandatory to use by involved actors in large construction projects and urban development projects (Ekeskär and Rudberg 2016, Janné et al., 2018, Ekeskär et al., 2020) to mitigate a high total acquisition cost of purchased materials based on the lowest price, which usually leads to very high handling and logistics costs, varying between 40 and 250% of the materials purchase price. (Agapiou et al. 1998, Vrijhoef and Koskela 2000, Ekeskär et al., 2020) They are also mandatory to optimize the delivery performance of the suppliers of the construction industry, who are described as rather poor in supply chain planning of the construction projects. (Thunberg and Persson 2013, Ekeskär et al., 2016, Ekeskär et al., 2020) The suppliers must be flexible to cope with last minute orders due to the lack of inventory control and poor storage capacity on the construction sites, a service appreciated by the contractors, but involves negative consequences for the suppliers in terms of planning their business and operations (Vidalakis et al., 2013). The interviews and literature review demonstrated that there are similar setups within Syrian Humanitarian Construction Logistics (HCL) defined as the way that the logistics system (including elements, components, information systems, etc.) are designed and arranged to handle logistics in humanitarian construction projects. These setups were offered by the TPL providers dedicated to managing sequence deliveries of materials to site and logistics on construction sites, these tasks were traditionally performed by the contractors. This led to a situation where the humanitarian construction projects were managed locally by TPL to become disconnected from the organization level. (Janné et al., 2020)

TPL providers could be construction companies located in disaster-affected areas and have assets that can be invaluable to humanitarian relief organizations. These can be tangible and intangible assets such as shelter materials (for examples, tarpaulins, timber, scaffolding, and others), equipment for moving debris, vehicles to assist in distribution materials to affected areas, generators, fuel to provide power, office space to enable coordination, storage space for materials at construction sites. Furthermore, they provide experts to coordinate activities such as damage assessment, engineering services, cost estimating, schedule control, contracting management, and commodity procurement.

TPL providers can also offer a number of intangible assets that can be extremely useful to humanitarian organizations such as networks with local government, construction companies, manufacturers and communities as well as access to existing supply chains for the procurement of additional materials, which are all invaluable to humanitarian organizations frequently operating in an unfamiliar environment. (Wong et al., 2010, Ekeskär et al., 2020) The TPL on-site team means moving logistics and materials handlings activities from craftsmen to the TPL provider, which means the craftsmen can focus on their trades and thus increase the added-value time in the project. Consequently, the material handling efficiency will be increased because TPL is using skilled material handlings personnel with proper equipment who do their work at times when the craftsmen are not around. (Janné et al., 2020)

The interviews, which were conducted with humanitarian logisticians and Syrian TPL companies during 2020, discovered that the humanitarian organizations relied on TPL providers during the Syrian crisis (since 2013 until now) to carry out the humanitarian construction projects on a short, medium, or long-term. TPL providers have been using skilled personnel to ensure the durability and quality of humanitarian construction projects, infrastructures, suppliers' capability, regulatory requirements, supply routes and logistical capacity. Besides, TPL providers have been managing extensive supply chains within Syria to manage deliverables with minimum lead-time, to deliver in remote and challenging environments, and to mobilize local labour and suppliers to support the local community. In the context of the Syrian humanitarian constructions, the TPL providers have been submitting many positive logistics services as follows:

1. TPL providers have specialists to support the humanitarian operations in post-conflict reconstruction, building camps, rehabilitation infrastructures, and other humanitarian constructions in some of the harshest and most remote environments. TPL providers work collaboratively with local construction companies already operating in an area affected by a disaster and are ideally positioned to contribute labour, materials and equipment that can save lives and reduce suffering. TPL providers are likely to have the advantage of pre-established local supply chains, relationships with local government, and a unique understanding of regulatory frameworks that may be lacking in the humanitarian agencies arriving on the scene.
2. At the start of a project, aid workers may need a temporary base for their operations. TPL can provide a start-up camp that is easy to expand as numbers grow. TPL providers have sourced and assembled tents or prefab shelters that helped humanitarian organizations to get into Syria fast and contributed into stabilizing their reconstruction efforts.TPL providers are usually providing the needed basic infrastructures while humanitarian organizations see to the needs of the local people.

3. TPL providers always have a clear strategy for dismantling the temporary humanitarian constructions such as refugees' camps. They take into consideration the end-of-life of the temporary humanitarian constructions from the earliest stages of planning. Eventually, they aim to reuse, recycle, or safely dispose of materials in order to leave each location in good shape, if not better than when they arrived.

4.3.4 Procurement & Contracting in Humanitarian Construction Logistics (HCL):

4.3.4.1 Procurement in Humanitarian Construction Logistics (HCL):

Procurement is generally seen as the process of obtaining goods and services for a stated task in return for money. The purpose of procurement, in the construction industry, is designing and constructing the proposed project as well as acquiring relevant expertise from professional construction consultants, main contractors, sub-contractors, manufacturers and suppliers. (Mzyece, 2020, Shibani, 2021) In the context of humanitarian constructions, procurement acquires the logistical requirements of humanitarian reconstructions upon and after disasters, and these are represented in water supplies, shelter materials, tools, equipment, vehicles, power, labor, communications, space, networks, technical expertise, safety management, project management, supply chain management, site supervision, and infrastructure design (shelters, roads, power, facilities...etc.). (Wong et al., 2010) The literature review explored how the procurement process is usually crystallized into formal contractual arrangements in order to successfully deliver the humanitarian construction projects, which is defined as a procurement strategy, it outlines the key means by which the objectives of the project are to be achieved. A procurement strategy must be developed, chosen, and implemented to ensure appropriate procurement in light of the project execution plan (PEP) and the specific project details.

A procurement strategy is more than just a high-level plan, it recommends delivery model and procurement method, which are to be deployed for project delivery. It also provides clear justification for their use on a value-for-money basis, how project or program outcomes can be optimized, and how it will facilitate aspects of risk management. The effective procurement strategy needs to:

- Fully understand the project (including key drivers, constraints, and risks).
- Assess market capabilities and capacity.
- Evaluate potential delivery models and procurement methods for suitability.
- Involve key stakeholders and experts as early as possible in the planning and development process.
- Challenge assumptions in order to better achieve desired outcomes.
- Use practical analytical techniques in the decision-making process. (Mzyece, 2020, Shibani, 2021)

One of the Syrian aid workers discussed the complexity of the procurement function within Syrian Humanitarian Construction Logistics (HCL), as follows: "Because we have technical and financial specifications. Therefore, we announce a bid, then we choose the best submitted offers concerning technical and financial specifications. Technical specifications are set by engineers with hands on experience of the market, they are already aware of the materials

available in the market. We try to balance between some good quality and staying within the budget limits. Also, we have like a checking team, when the material comes, we check every box. For each quality, we check the barcodes in case there were any. And if contractor did not comply with the signed contract, there is a penalty condition in the contract. We suffered a little in finding the products we wanted, especially, if the products are too technical because the construction team or the water-board team need specific materials like PVC pipes."

As a result, the traditional procurement route in Humanitarian Construction Logistics (HCL) commences with the humanitarian organization employment of architect or team of consultants (comprising an architect, quantity surveyor, and so on) to prepare the tender documents, which include a full design (comprising of specifications and drawings), a pricing document (typically a bill of quantities prepared by the quantity surveyor) and a standard form of contract, which allows for the selection of an appropriate contractor to carry out the on-site construction works. (Mzyece, 2020, Shibani, 2021) There are many challenges in selecting the appropriate procurement strategy within the Humanitarian Construction Logistics (HCL). For example, the timber was used previously in many building projects (tents or emergency shelters) worldwide, but supply challenges and major sustainability issues have led to revised designs for 2007 onwards that will use steel instead of timber. During 2007 and 2008, the rising costs of steel led to an increase in prices, $900 to more than $1500 per shelter. This caused serious budget shortages, consequently, the materials used needed to be reassessed. (Ashmore et al., 2009) Besides, reviewing the documents of humanitarian construction projects in Syria demonstrated that records keeping for procurement, supplies and distribution was not very good. This was the result of the complex and very rapid procurement of multiple items. In addition, the multiple local partners and organizations had different working practices not to mention the lack of management staff who have experience in construction projects, which led to an unexpectedly large amount of management time being required for procurement.

4.3.4.2 Contracting in Humanitarian Construction Logistics (HCL):

In the context of Humanitarian Construction Logistics (HCL), the contract establishes the conditions under which the work is undertaken. Its main purpose is to support an accountable, timely and efficient use of resources and ensure the completion of work to time, cost and standard, as outlined in the objectives of the construction project, (Mzyece, 2020) whilst guaranteeing the rights of the beneficiaries to safety, protection, sheltering, and other things that meet the humanitarian needs of beneficiaries. (Reigber, 2018) The contract/agreement is with a contractor or individuals who will undertake the work, or both owner and beneficiary in case of self-help. (Good, 2010, Klenk, 2010, Reigber, 2018)

The review of documents that are related to the Syrian humanitarian constructions and rehabilitations reached the conclusion that there are three different types of contract/agreement. Some of them fits effected communities such as "cash for work" and "self-help," which give funds directly to the beneficiaries/owners to do the work themselves, with the help of the relatives and friends or by hiring a contractor or workers themselves. (Reigber, 2018, Crown Agents, 2021) The involved humanitarian organization should select the contracting method that suits the scale of humanitarian construction projects and the capacity of the targeted community, and contractors /laborers who own experiences and knowledges of building, local standards, and construction practices. There are general clauses included generally in different contracts such as scope of work, required works and materials (quantity and quality) based on the specific Bill of

Quantities (BOQ), proposed timetable for work plan, preferred deadline for finishing the work (completion period included preliminary handover and final handover), legal responsibilities of all involved parties, cost estimation for specific material and labor, schedule of payments, details on implementation, and the capacity of the required contractor. (Mzyece, 2020) Besides, all contracts should include the quantities that will be allocated to each beneficiary as seen in the Bill of Quantities (BOQ). The below diagram (Fig 11) and the following sections explain the specifications of each contracting modality. (Reigber, 2018)

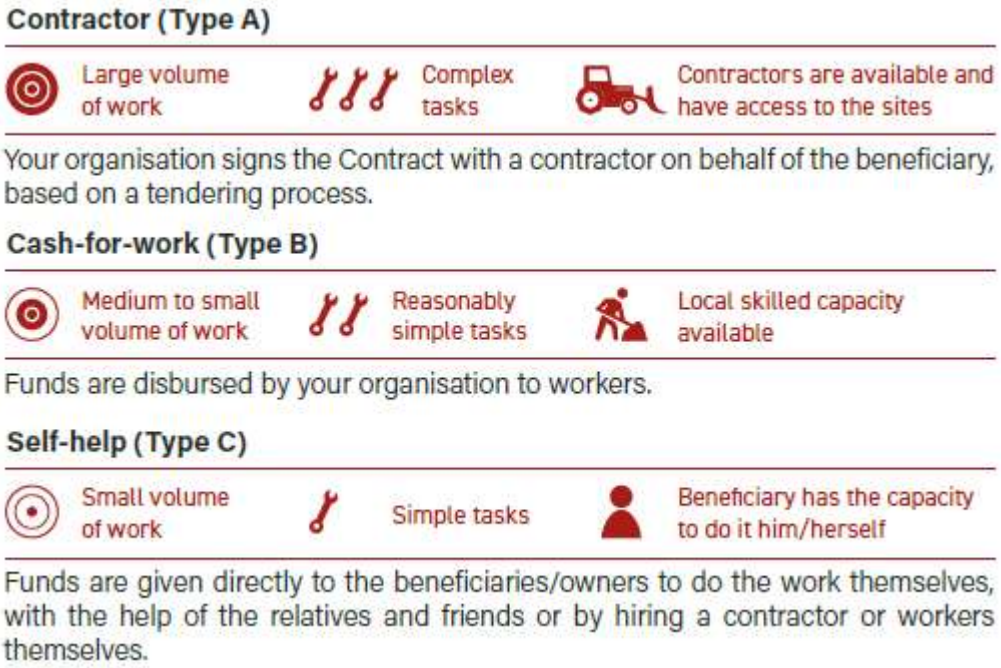

Fig 11: Contract / Agreement Modalities in Syrian Humanitarian Construction

Contractor / Type (A)

In this type of contracting, the cost may be reduced due to the economy of scale, as the contractor has more technical capacity, the risk of future problems is reduced. A framework agreement format is recommended in order to start with implementation while still identify beneficiaries without the need to wait for a final BOQ of all the selected humanitarian constructions. The standards and prices of the materials must have been pre-agreed during the tendering process. (Reigber, 2018, Mzyece, 2020) This type of the contract offers professional logistics functions because a contractor is responsible for the procurement and transportation of materials, the coordination of works (including hiring staff, health, and safety practices) as well as the commitment that the work is completed on time. The contractor can hire subcontractors at their own discretion to assist with the work, however, they should be monitored and coordinated by the contractor to ensure the work is done correctly, efficiently and to the required standards. This type of contracting includes clauses such as legal responsibilities of all parties involved, the working plan (including the completion period), the schedule of payments, and how to manage variation orders, incentive, and penalty. (Good, 2010, Klenk, 2010, Reigber, 2018)

The process adopted to choose the contractor must be transparent, accountable, and fair. The selecting process usually takes place before assessing the BOQs for the humanitarian

construction projects. This type does not require agreement on a specific amount, but that the envisioned works be specified, and a ceiling of costs is set based on the expected amount of works. In this way, the humanitarian constructions' works can start immediately after the BOQ assessment. This kind of contract is generally employed for large-scale projects and has to be carried out according to the legislation of the country where the agency is working. (Reigber, 2018)

Cash-For-Work / Type (B)

In the cash-for-work modality, work does not require complex technical expertise. Workers are hired by a humanitarian organization in which their expertise match the required functions. In the context of cash-for-work modality, the implementing humanitarian organization is responsible for logistics functions such as coordination of works (including hiring of staff), ensuring that the work is completed on time, procurement (materials, equipment, water networks, personal protective equipment PPE, and emergency first aid supplies), and transportation of material to site (including responsibility for losses in transit and storage). (Crown Agents, 2021) In a scenario when a high volume of material is to be procured, the implementing organization should organize the storage and manage the delivery of material to the beneficiaries and contractors according to their needs. The security of the storage building should be taken in consideration, in this case, and the quality assurance of materials and tools.

In the cash-for-work modality, daily or seasonal workers must be selected based on the necessary skills and must be provided with a contract that includes a working plan (including a completion period, a preliminary handover and a final handover), a code of conduct, legal responsibilities of all parties involved, and a schedule of payments. As a result, the implementing humanitarian organization must do follow ups of the works with the staff and provide guidance daily. (Reigber, 2018)

For example, the Syrian Red Crescent (SARC) made similar contracts in some projects like Homs, Alhamedia area, where they did a rehabilitation of the old city. It was a kind of cash-for-work contract because the area was full of local craftsmen who had participated and rehabilitated their own houses. SARC teams and the affected families worked hand in hand to rehabilitate their houses.

Self-Help / Type (C)

Beneficiaries with simple repair requirements and enough skill to do the work themselves, can be approached to be engaged in self-help contracting. In self-help modality, the funds necessary for the work can go directly to the beneficiary who procures the necessary materials. In this case, possible changes in market values should be considered. The humanitarian organization must have the time and resources to support the beneficiary. (Good, 2010, Klenk, 2010, Reigber, 2018) The support may come in the form of technical advice, according to the Scope of Work (SOW) and Bill of Quantities (BOQ). The payments provided for the purpose of self-help rehabilitation are for exclusive use to conduct the necessary works. The humanitarian organization should carefully consider the recipient of the cash to prevent misuse or diversion of funds. In this case, there is no contract but a rehabilitation/ repairing agreement that includes information from the BOQ and the SOW. The agreement should lay out the specific standards to repair and rehabilitate of the beneficiary's shelter. The specifications

and quantities of materials cannot be changed without the consent of both the beneficiary and humanitarian organization. (Reigber, 2018)

For instance, regarding self-help agreement, Syrian Red Crescent (SARC) have ready-to-use kits for the rehabilitation team (which is a collection or a package of materials like nails, hammers, and other materials required to complete a specific task) that does not need any professional experience. So, they gave these kits to several areas within several stages. They provided the beneficiaries with the first kit, and when they finished the first stage, they gave the beneficiaries the second kit. By this way, the beneficiaries are involved in the process of rehabilitation, which makes them more responsible. These projects ended very well because the beneficiaries were doing their own houses well. SARC have a database of the contractors and workers after a project is finished and they started to recruit these beneficiaries as the parts of other rehabilitation projects. (WRAP, 2007, Good, 2010, Klenk, 2010)

4.3.5 Humanitarian Construction Logistics (HCL) for Site Layout:

The layout of a construction-site is a crucial part of Humanitarian Construction Logistics (HCL) management and is prepared by logisticians as part of their mobilisation, as sites can be very complex places involving the co-ordination, movement, protect and control of large quantities of materials, high-value products, plant, equipment, components, and people, that are to be kept on a proper construction site during the construction process. (Navaratne et al., 2010)

Laying out a site effectively and accurately can help ensure that the logistics works are undertaken efficiently and safely since the careful sizing and positioning of temporary assets can help reduce travel time, congestion, waiting time, and ensures an effective workplace with better worker morale. (Sobotka et al., 2005, Navaratne et al., 2010, Ekeskär and Rudberg, 2016, Designing Buildings Wiki, 2020)

For instance, the site layout for tent camps is a major consideration for humanitarian logisticians; tents must be carefully sited because badly chosen site can create major problems in terms of internal distributions and supply chains.

Logistics specialists should be involved in the site layout planning to reduce potential risks such as crowd, fire, loosed resources, and other risks. Moreover, it is much harder to move people and their tents once they are settled. For example, people prefer to pitch tents in clusters instead of long rows like the villages where people used to live. By this way, they streamline aid distributions, smooth access to water and sanitation facilities, and establish ecological infrastructures such as drainage, electrical, and others. (OCHA, 2004)

The literature review demonstrated that there are several factors to be considered when planning the layout of a construction-site especially in context of humanitarian rehabilitations and reconstructions:

- Humanitarian Construction Logistics (HCL) pay attention to physical properties in terms of the size, shape, weight, and mode of delivery. They also pay attention to organisation issues such as whether unloading space is available, storage space has been allocated, and zones have been installed and allocated for activities like site offices, welfare facilities, off-loading, temporary storage, and laydown areas.
- Humanitarian Construction Logistics (HCL) must establish control, protection, and security processes to check the quality and quantity of materials on delivery, monitoring stock holdings, and putting in place the necessary protection for materials and components from damage such as employment for guarding against theft and vandalism.

- Humanitarian Construction Logistics (HCL) must pay attention to costs associated with handling, transporting, stacking requirements, required workforce, heating, lighting, and/or facilities to be provided for subcontractors, and other services like establishing emergency/ temporary routes and managing the waste/recycling process.
- Humanitarian Construction Logistics (HCL) must establish a programme and a process that offer answers to logistics concerns such as what needs to be done to materials before they can be used? Is there packaging that needs to be removed or returned? When are items required? What is the risk to the project of them not being available? How long in advance are they ordered and how long will they be on site? (Sobotka et al., 2005, Ekeskär and Rudberg, 2016, Designing Buildings Wiki, 2020)

The interviews within Syrian humanitarian projects have reached the conclusion that a construction project manager/ infield engineer will be responsible for the logistics and supply chain functions instead of recruiting specialized logistics manager, who undertakes the coordination of workforce, goods, and equipment at the construction site. A construction project manager engages usually with the project planning, commercial management, and other tasks to ensure that all logistics activities are properly coordinated across the project and to keep the construction programme on-schedule. The same interviews unveiled the problems caused by poor site layout such as inappropriate storage (which can damage products and materials), poor siting of assets, inadequate spaces, unsatisfactory security and safety issues, demoralised workers, delays, increased costs. In addition, an inadequate planning for storage space, location and size can result in congestion or having more materials on site than the storage space allows for. As a result, the logistical advantages of good construction-site layout include:

- ✓ Cost savings and waste reduction as productivity is enhanced.
- ✓ Logistical planning on site enables materials to be stored correctly which improves efficiency and reduces the potential for damage.
- ✓ Sites can be kept safe, clean, and easy to move around.
- ✓ Deliveries can be received and handled promptly. (Designing Buildings Wiki, 2020, Mzyece, 2020)

4.3.6 Humanitarian Construction Logistics (HCL) & Prefabricated Modular:

4.3.6.1 Prefabricated Modular & Humanitarian Construction Logistics (HCL):

The prefabricated modular construction systems consist of standard modules that can be designed and produced independent from one another. The modules are made in a factory, transported to the construction site, and then assembled into a building. That allows for these types of buildings to be set up at remote locations that are distinguished with hard to access and less space within the construction-site. So, the combination can be dismantled later, and the parts reused again at other locations. (Good, 2010, Hillegersberg et al., 2020, Designing Buildings Wiki, 2020, House Matic, 2021) Furthermore, building with standard material dimensions wherever possible reduces both the waste stream and material costs, as the need for cutting, altering, or fabricating materials by construction crews will be much reduced. (Klenk, 2010, Good, 2010) Prefabrication techniques have been progressively adopted in the construction industry in various countries. The demand was at its peak in the early 1970s in Eastern and Western Europe for the construction of new towns. Recently, the use of prefabrication is further

encouraged to increase productivity and build ability. In Syria, the first residential project was in Damascus, Syria (the establishment of 2400 housing units during 1977-1980). However, the rate of construction pre-cast in Syria still does not exceed 2% of building of reinforced concrete. (Ahmed, 2016) Modular construction systems are becoming more common in context of humanitarian construction projects and building with standard material dimensions has its roots in the humanitarian construction planning/design (Klenk, 2010) because it can be applied for variety of humanitarian organizations' requirements such as field hospitals, refugees camp, modular shelters, and settlements. (Hillegersberg et al., 2020, House Matic, 2021)

Moreover, modular construction systems can optimize material strength with lower quantities of materials while still meeting the standard building codes and safety considerations, and the size of the structures can meet the minimum standards but does not exceed the building size necessary to meet the need. (Good, 2010) For example, Peace Winds organization established 100 prefabricated shelters (within camps in north Iraq) to participate in improving life for Syrian refugees. (Peace Winds, 2021) In despite of that, experience shows that modular construction does not generally directly lead to lower construction costs. In addition, there were more workloads in a remote factory instead of infield construction sites. (Hillegersberg et al., 2020, House Matic, 2021).

4.3.6.2 Prefabricated Modular & Syrian Humanitarian Construction Logistics (HCL):

The contractors within humanitarian constructions have begun globally to adopt the concept of design for manufacture and assembly (DFMA) for the off-site prefabrication of humanitarian construction components. (WRAP, 2007) It is a design approach that focuses on the ease of manufacture, the efficiency of assembly, and simplifying the design of products like prefabrication units, upgrade tents (Fig 12), modified containers and others. It is possible to manufacture and assemble them efficiently in the minimum time available and at a lower cost. Therefore, humanitarian organizations attempt to trade-off between two methodologies within the DFMA approach. The first approach is Design for Manufacture (DFM), which involves designing for the ease of manufacture of a product's parts, and it is concerned with selecting the most cost-effective materials and processes to be used in production and minimising the complexity of the manufacturing operations. The second approach is Design for Assembly (DFA), which involves design for a product's ease of assembly, and it is concerned with reducing the product assembly cost and minimising the number of assembly operations. (Designing Buildings Wiki, 2020, House Matic, 2021)

The interviews have reached the conclusion that technical experts and logisticians attempted to implement the DFMA approach in the Syrian humanitarian operations, even on-site or offsite, to gain the logistical advantages shown below.

- Minimise the number of components to reduce of assembly costs, ordering costs, work-in-process, amount of labour required, and simplify automation. That leads to increasing reliability as low number of parts decrease the chance of failure. Besides, it increases safety by removing dangerous construction activities from the site and placing them in a controlled factory environment.
- Design for ease of parts-fabrication by the geometry of parts is simplified, and unnecessary features are avoided. Components should be designed so they can only be assembled one way.

- Reduce a programme on-site through the use of prefabricated elements and setting up local 'factories' to prefabricate components, that leads to reducing logistics and supply challenges and the ensuing costs. Besides, this increases the ability to adapt the suggestions made for improvements.
- Higher quality, sustainability, and less waste generation in the construction phase. Greater efficiency in site-logistics and a reduction in vehicle movements transporting materials to site.

The literature review and interviews demonstrated some hurdles related to the prefabrication modular, such as the humanitarian community, which spends millions of dollars each year on upgraded tents and prefabrication modular, which have general specifications such as a high unit cost, a long production, a long transportation time, a high transportation cost, and that can be inflexible (bulky, complex, more costly to procure), and have a limited lifetime. Moreover, logistics requirements and storage were increased since fabricated material components took up more space than non-value-added raw materials. In context of Syrian humanitarian constructions, these prefabricated modules suffered from poor quality, inadequate specifications, poorly informed usage, scarce of supporting materials (e.g., Poles for structures), and skills or capacity to construct were limited.

These negative points were explored in IDPs/refugees' camps within Syria and Lebanon when natural disasters of floods and storms ripped off their tents and heavy rains flooded their shelters. In despite of that, tents and prefabricated structures created cover rapidly for the Syrian refugees/ IDPs. Furthermore, they may be used to cover various infrastructure needs, such as emergency operating theatres or accommodation for organizations. Besides, the costs of their components were reduced by directly employing people on site to fabricate them. Everything was fabricated as needed on site and according to specification. This approach also provided a 'just-in-time' inventory system but required the hiring of additional skilled staff by the contractor. (Ashmore et al., 2009, OXFAM, 2020, Designing Buildings Wiki, 2020, House Matic, 2021, IFRC, 2021)

Fig 12: Upgrade Tent by UNICEF Supply Division 2020

4.3.7 Humanitarian Construction Logistics (HCL) for Shelters & Other Functions:

Humanitarian logistics priority is an adequate supply of water and food in their optimal amount and time required. They also plan and organize safe havens within sturdy construction projects regardless of the construction materials employed. (Sant'Anna, 2016) Humanitarian

Construction Logistics (HCL) are required to install shelters, settlements, and infrastructures in a good state with good lighting, ventilation, electrical-supply, water-supply, and sanitation systems. (Sant'Anna, 2016, Vega et al., 2020) These interventions are live-saving and foundational for survival and recovery because they are often among the first priorities of people affected by humanitarian crises. Logisticians are involved in the delivery of tangible actions, either through international or local procurement, such as provision of emergency shelters, technical assistances, and others. (Wynveen, 2021) This section explores the necessary capabilities required by Humanitarian Construction Logistics (HCL) to address these requirements.

4.7.3.1 Humanitarian Construction Logistics (HCL) for Shelters:

The shelter sector, among all sectors, could bring and use the largest number of materials in a response. The Logistics Cluster reports referred that around 80% of their supply chain relates to shelter items. (Wynveen, 2021) Humanitarian Construction Logistics (HCL) attempts to bridge the gaps to reach to permanent housing. (InterAction et al., 2020, UNDP Syria, 2021) It participates mainly in planning, designing, procuring, delivery, installation, expanding and upgrading the different kinds of settlements and shelters to being as permanent housing. (Vega et al., 2020, Vad et al., 2020, Hillegersberg et al., 2020) According to the Syria Shelter Cluster Meeting in April 2021, there are 3.63 M targeted people out of 5.88 M Syrian people who need shelters. One of the main constraints to accessing adequate shelter relate to insufficient logistics capability like resources to buy tools and material to repair shelters. (OCHA, 2020) This leads to focusing on developing of Humanitarian Construction Logistics (HCL) in order to meet these high-scale needs.

The decisions of the Humanitarian Construction Logistics (HCL), which are taken in the shelter sector, can have an enormous influence in terms of cost and response during the short and long term. (Wynveen, 2021) For example, project/logistics managers consider all possible ways to effectively meet the humanitarian sheltering needs with fewer materials like designing structures with standard material sizes that can also help to prevent waste of materials during the construction phase. (Good, 2010) The literature review and interviews demonstrated together that the Syrian Humanitarian Construction Logistics (HCL) have been addressing the different logistical requisites for the four different kinds of shelters described as the following:

- **Humanitarian Logistics for Emergency Shelters**:

Emergency shelters focus on waterproofed first-tier shelters which secure lifesaving needs, such as health and safety (survival). (InterAction et al., 2020) According to Professor Diego Vega, Humanitarian Construction Logistics (HCL) create these shelters by procurement, delivery, and installation of many solutions for water storage, site drainage, food distribution areas, markets, storage places for individual households. (Vega et al., 2020)

Experts in logistics always face many complex situations as quick emergency sheltering solutions, such as tents, could have been deployed smoothly, but they could not have been upgraded for permanent use. (Ashmore et al., 2009) On the other hand, non-tent-based emergency sheltering solutions need high-logistical efforts, but they are rapid, cost-effective, and can be acceptable by populations and humanitarian organizations in both the short term and over a longer period of recovery. Moreover, logisticians could adopt a shelter kit which is a useful

option, from a logistics perspective, because of its flexibility, adaptability, and reuse-ability. (InterAction et al., 2020)

The interviews and literature review demonstrated that Syrian Humanitarian Construction Logistics (HCL) have been submitting the different emergency sheltering solutions which need different costs and logistics efforts, such as distributing repair kits, plastic sheeting, shelter kits, tents, building materials, tools, self-built shelters, and proceeding training courses. (InterAction et al., 2020, Vega et al., 2020, Peace Winds, 2021)

- **Humanitarian Logistics for Immediate Shelters:**

The immediate shelters may potentially become durable rather than transient in nature like emergency shelters. The humanitarian logisticians, in these cases, must consider long-term sheltering issues and logistical requisites, such as materials (plastic sheeting, tarpaulins, fixings and others), self-help tools, and others which must be available for affected people even within local markets and settlements. (Ashmore et al., 2009)

The interviews and literature review demonstrated that the Humanitarian Construction Logistics (HCL), in context of immediate shelters, exert efforts beyond emergency shelters to find solutions that are rapid, cost effective, and acceptable to the affected populations with less logistical requisites, less construction materials, and more durability. For example, Syrian Humanitarian Construction Logistics (HCL) have been submitting many activities to immediate shelters like in-kind sheltering delivery, cash for work scheme, cash grants, vouchers, technical support, and proceeding training courses that can enable affected people to obtain materials, perform construction, pay for labour, and achieve reconstruction for public infrastructure within local settlements. (Ashmore et al., 2009, UN-Habitat Syria, 2020, InterAction et al., 2020, Crown Agents, 2021)

- **Humanitarian Logistics for Transitional Shelters:**

Transitional shelters are developed to bridge the emergency and permanent shelter phases, (Ashmore et al., 2009) which are aimed at the second-tier shelter needs such as comfort, security, protection, social and cultural appropriateness. (InterAction et al., 2020) Humanitarian Construction Logistics (HCL) have been implementing these shelters when emergency sheltering was deteriorating. Moreover, permanent reconstruction and housing programmes can take many years to complete, especially when they are implemented on a large scale. (Ashmore et al., 2009, InterAction et al., 2020, Peace Winds, 2021)

The logistical requisites for transitional shelters are capital, time, labour, and know-how to construct, which are more than the requisites of emergency shelters. In addition, provision material packages and /or tool kits are needed to repair damaged houses or build transitional shelters. (UNHCR, 2019, InterAction et al., 2020) For example, transitional shelters cost, in some projects, just USD 55 more than a standard relief tent did and took longer to deploy but provided a steppingstone to permanent reconstruction. (Ashmore et al., 2009) The interviews and literature review demonstrated that Syrian Humanitarian Construction Logistics (HCL) have been submitting to the community many supports like contractors, cash grants, materials, tools, and training courses. (Ashmore et al., 2009, InterAction et al., 2020, Crown Agents, 2021, Rebuild Syria Reconstruction Programme, 2021) They facilitated also longer-term reconstruction

by ease of maintenance, re-using and dismantling of transitional shelters, enabling households to improve their homes overtime as resources and opportunities permit. (InterAction et al., 2020)

- **Humanitarian Logistics for Reconstruction/ Permanent Shelters:**

The permanent shelters are more than four walls and a roof, more than plastic sheeting, tents, and even houses. Therefore, framing better buildings and using better materials are also important in the humanitarian response. (InterAction et al., 2020) Humanitarian Construction Logistics (HCL) have been re/constructing permanent shelters via many modalities like repairs, retrofit, cash grants for recovery, upgrading transitional shelters to permanence, in cases the length of time required building permanent shelters, and building new permanent shelters entirely (Ashmore et al., 2009, UNDP Syria, 2021)

Humanitarian Construction Logistics (HCL), in context of permanent sheltering, are doing many modern practices like disassembling a number of unused temporary housing units after disaster and reusing or recycling many of the materials to construct longer-term "redesigned" houses. (Good, 2010) That resulted in significant materials and energy savings without compromising structural integrity and helped speed up the recovery process for the affected populations, in despite of extreme logistical requisites like capital, time, labor, and know-how to construct which are deployed to build sustainable shelters (Good, 2010, Klenk, 2010, UNDP Syria, 2021)

4.7.3.2 Humanitarian Construction Logistics (HCL) for WASH (Water, Sanitation and Hygiene):

WASH is an acronym that stands for "water, sanitation and hygiene". Universal, affordable, and sustainable access to WASH which is a key public health issue within international development, and it is the subject of the first two targets of Sustainable Development Goal 6. (UNICEF, 2021) Recently, SPHERE project has been stipulating practices of Humanitarian Construction Logistics (HCL) to reach the goals like designing appropriate ways to supply water and other services for affected people. (UNICEF, 2020, Disaster Ready, 2021, UNICEF, 2021) These practices could be summarized as follows:

1. Sphere standard 2.1 (Access and Water Quantity) specifies that "people have equitable and affordable access to a sufficient quantity of safe water to meet their drinking and domestic needs," (Navaratne et al., 2010) which leads logisticians to procure services and materials to supply right water quantities to the right places especially to disaster affected areas. (The Save the Children, 2020, Disaster Ready, 2021, UNICEF, 2021)
2. Sphere Standard 1 (Access and Water Quantity) specifies that "water sources and systems are maintained such that appropriate quantities of water are available consistently or on a regular basis," (Navaratne et al., 2010) which leads logisticians to supply water sustainability by procuring appropriate maintenance services and sustainable solutions like solar-powered water pump (The Save the Children, 2020, Disaster Ready, 2021, UNICEF, 2021)
3. Sphere Standard 2 (Water Quality) specifies that "people drink water from a protected or treated source in preference to other readily available water sources." (Navaratne et al., 2010) These workloads are performed by humanitarian logisticians who procure services like water-transportation by tank-trucks, withdrawing water from secured sources, installing

durable networks, and others. (The Save the Children, 2020, Disaster Ready, 2021, UNICEF, 2021)

Now the above activities are becoming the main functions of the Humanitarian Construction Logistics (HCL) to provide water supply in sufficient quantity and quality for different uses, such as drinking, personal hygiene, bathing, cooking, laundry, medical activities, cleaning, and disinfection. (The Save the Children, 2020)

The Syrian Humanitarian Construction Logistics (HCL) have been supporting the WASH activities since late 2014 by WASH cluster (UNICEF, the Swiss State Secretariat for Migration, UN-Habitat, and other). These humanitarian organizations have been expanding their cooperation in terms of WASH sector to provide logistics support for water, sanitation, and solid waste management to Syrian cities. This support focuses on logistics functions such as collecting more detailed information on the status of WASH assets and contracting to rehabilitate them throughout phases. (UN-Habitat Syria, 2016)

For example, the local procurements and contracts of UNICEF Syria throughout 2020 helped to protect populations, in conflict-affected areas, from the negative effects of the destruction and the lack of maintenance done to the national water and sanitation infrastructure. (UNICEF, 2020) Besides, Syrian Humanitarian Construction Logistics (HCL) properly managed wastewater and stormwater by installing appropriate drainage networks. The logisticians repeated these functions twice because they had built two types of WASH infrastructures during the Syrian humanitarian response. Initially, a temporary WASH infrastructure and facilities were procured, delivered, and installed quickly to use by Syrian beneficiaries temporarily, while the logistics teams and technical experts were performing collaboratively the repairing, rehabilitation, and installation of permanent WASH facilities in affected areas. (UN-Habitat Syria, 2016, UNICEF, 2021)

For instance, double works were performed to address the necessitates for wash facilities in Syrian schools that children could access. Given that the reconstruction of school infrastructure would take time, logisticians and WASH experts were procuring and contracting collaboratively to construct something temporary that could last until the durable reconstruction activities were completed. (UN-Habitat Syria, 2016, UNHCR, 2018, UNICEF, 2021)

The interviews demonstrated that there are serious challenges facing the Syrian Humanitarian Construction Logistics (HCL) in terms of WASH activities. These can be summarized as follows:

- Whenever a humanitarian response gives household a water tap, and no water gets to their house, then the intervention is zero. There isn't only shortage in water within Syrian, but there is the issue of water infrastructure that is ruined due to warfare. It has been renovated in some places, but the water networks in general are old and overused. That requires more efforts from the logistics team.
- The goal of humanitarian organizations is improving water-use efficiency, through upgrades of Syrian water and sanitation facilities or even drawing water from boreholes. That requires more efforts from the logistics team.
- Syria is an agricultural country, but it has water shortages. The Syrian people used to use drinking-water for irrigation, which is like a huge crime to water. Logistical and technical teams have been performing many projects to use water that cannot be used as drinking water, but it could be used for irrigation. This irrigation water draws from many sources like

rivers, rains-water pools, and others. In this way, humanitarian construction logisticians aim to fill a gap in the drinking water and restore agriculture lands.

4.7.3.3 Humanitarian Construction Logistics (HCL) for Public Infrastructures:

It is common that planning decisions, in the aftermath of a disaster, is based purely on building "something" to accommodate the affected populations, but the poorly designed or constructed infrastructure which can lead to a costly waste of building materials and unintended impacts that harm communities over both the short and long terms. (Klenk, 2010)

Typically, humanitarian organizations face a problem in the fact that the local infrastructure is destroyed completely/partially by disasters, which creates many hurdles, such as hindering the access of resources with the difficulty to guarantee the quality of donated resources and hindering the human resources to participate in humanitarian operations, as usual, there is an excess of volunteers without the ability to transfer them to the affected area (Wong et al., 2010, Sant'Anna, 2016)

A common consequence of disaster is the need for different logistical functions to repair a large number of damaged pre-existing infrastructure; like recruiting contractors to maintain public roads, seaports, and airports; with paying attention to structural safety, ease, and cost. (Klenk, 2010)

Humanitarian Construction Logistics (HCL) focus on the status and availability of public infrastructure as the main part within quick humanitarian responses because the loss of a minute might mean the loss of a life. (Wong et al., 2010, Sant'Anna, 2016) It follows a strategy to conserve resources and reduce the demand on natural resources to repair existing infrastructure, where practical, instead of rebuilding with all new materials. (Klenk, 2010)

The humanitarian operations following the tsunami 2004 demonstrated that robust relation between Humanitarian Construction Logistics (HCL) and public infrastructures. The roads were severely damaged in three of the five targeted areas, as well as the bridges, roads and drainage had to be built in some villages before work started on the houses. Accordingly, the easier access to materials in the two areas (with good roads) resulted in that the community-built housing programme was quicker and more successful. Furthermore, there was also the need for Humanitarian Construction Logistics (HCL) to restore the public infrastructure to provide basic services, such as water and electricity, which were slow and somehow chaotic. (Ashmore et al., 2009)

Other instances about Humanitarian Construction Logistics (HCL), and its significant impact on rehabilitation of Syrian public infrastructure, was presented by Crown Agents logisticians. They, together with the implementing partners in Syria, have procured the services and materials to restore street-lighting infrastructure in Raqqa city to provide safer streets for 44,000 people who use them daily. (Crown Agents, 2021) In addition, logisticians of WeWorld organization have been procuring services and materials to increase access to drinking water and water resources, which are often insufficient in terms of quantitative and qualitative terms, through rehabilitating the water management infrastructures and equipping water supply points in areas which have been damaged in Syria. (WeWorld, 2021)

4.3.8 Local Materials & Humanitarian Construction Logistics (HCL):

Worldwide supply chains and global logistics have become the norm. Some 70% to 80% of all the things we daily use are not fabricated or grown in our home region or country but elsewhere, not seldom even at other continents, because massive specialization provides economies of scale. (Hillegersberg et al., 2020) However, there is a movement to procure and buy local materials recently. For instance, the Global Shelter Cluster (GSC) and Global Logistics Cluster (GLC) have been promoting the use of sustainable local solutions and materials that can help avoid international procurement, promote an informed use of cash, and increase the participation of affected populations, as well as finding options for reducing, repurposing, reusing, and recycling these solutions and materials. (Hillegersberg et al., 2020, Wynveen, 2021) This potentially reduces logistics costs and the environmental burden and vitalizes local and small-scale production. It can also enhance trust and bounding of consumers with the products they buy. (Hillegersberg et al., 2020)

According to the book "Humanitarian Architecture – 15 stories of architects working after disaster", the approach to working with a damaged community by procuring locally available building materials, construction techniques, local contractors, and the labour of the displaced themselves is relatively new and helping to provide not just shelter over people's heads but community resilience and benefitting the local economy. (Murray, 2015)

The production of local materials, throughout Humanitarian Construction Logistics (HCL), is one of the most common shelter-related livelihood activities, such as local brickmaking and pre-fabrication of doors and windows. Apart from the revitalization of humanitarian construction, this also has the added benefits of providing communities with additional skills that they may not previously have had. This type of support also offers great opportunities for the integration of disaster risk reduction components. (InterAction et al., 2020)

The literatures review and interviews demonstrated the importance of supply chains localization within Syrian humanitarian construction projects, which had significant positive impacts on the design of shelters, reconstruction, rehabilitation, and the timescale for implementation. The scale of some procurements was huge, and many projects attempted to source materials locally where possible. That could encourage setting up local factories and developing a design based on materials salvaged from houses.

Meanwhile, there was an effort to ensure that the local procurement process would support the national economy. Therefore, the humanitarian organizations made logistical joint agreement to share supplier lists and agree on the materials to be provided. That leads to prevent scarcity and inflationary pressures on the materials needed for permanent reconstruction, and reduce inter-agency competition and local price inflation (Ashmore et al., 2009)

For instance, Crown Agents logistics specialists in Syria depended on the Syrian local market that had met their projects' requirements, although some items were procured from other areas and transferred to projects' sites. Therefore, they did not need an international supply chain because the local markets were developed enough within Syria to avoid a situation where importing things takes three, or more, months. (Crown Agents, 2021) In addition, local procurement of materials /labourers can be a more environmentally sound strategy than the procurement of distant materials because it saves transportation costs and packaging. (Good, 2010)

4.3.9 Scheduling & Humanitarian Construction Logistics (HCL):

Scheduling is a key part of Humanitarian Construction Logistics (HCL) management due to the complexity of the process and the interaction of many supply streams, and it is needed to analyse, visualise, and optimise logistics. Therefore, the humanitarian construction projects draw a programme which describes the sequence in which tasks (included logistics tasks) must be carried out so that a project (or part of a project) can be completed on time. (Shibani, 2021) Programmes will often identify:

- ✓ Dates and durations allocated to tasks.
- ✓ A critical path (the sequence of critical tasks upon which the overall duration of the programme is dependent). Any modification in their duration results in an alteration to the critical path and, as a result in the project's duration.
- ✓ Tasks which can only be carried out after other tasks have been completed.
- ✓ Tasks which can be carried out simultaneously.
- ✓ The need for specific resources such as plant, services or materials and their lead time. (Designing Buildings Wiki, 2020, CIOB, 2021)

The scheduling gives great flexibility and possibility for humanitarian construction logisticians to deal with the unexpected logistical changes (e.g., purchases' cost, individual duration of each logistics activity, production speed, and others). Using schedules offers a lot of flexibility through the distribution of logistics works on the overall duration of the project to get the financial resources that are needed daily and to draw the cash flow. Scheduling creates ability to periodically monitor the progress of logistical activities through calculating the extent of achievement of each activity and adjusting the delays to preserve the final period of the project. (Ahmed, 2016)

The interviewees in the field have stressed that resource limitations result in conflicts which can be addressed by using scheduling practices, such as allocation and monitoring methods without delaying the timeframe.

Allocation ensures that the required resources do not exceed those available, but on the condition that any resulting delay is kept to a minimum. The priority in allocating resources will be greater for activities with less flexibility and that have a timeline of project stages and a full inventory of required materials and tools. As a result, preparing a scheduling programme, for complex humanitarian construction projects, should not be a paper exercise that simply records what has already happened or what is likely to happen. To be effective, it must be used as a tool to help plan activities, monitor progress, and identify where additional resources may be required. (Designing Buildings Wiki, 2020)

Monitoring progress against the schedule involves reviewing each element, especially the logistics functions, in Gantt chart to ensure work is on track and amending Gantt chart, in some cases, for humanitarian construction project/s to reflect the reality of the situation.

These tasks relate directly with the project manager and the logistics specialist, who must track logistical activities in line with the project timeframe and budget to meet the project deadline. (Disaster Ready, 2021) They must use a clear and a real-time load diagrams, (as appeared in Fig 10) which is a graphic representation for needed resources over time. That helps get an assessment of trends and reach an optimized usage of logistics functions to prevent any excess in needed resources and durations of the logistics activities. That help them to produce an

appropriate balance as durations of logistics activities can be reduced by adding additional resources, but this will also increase its cost.

In result, the logistics specialists must analyse all scenarios relation to humanitarian construction projects scheduling according to the surrounding circumstances, even where infinite resources are available, to adjust the duration of implementation properly, therefore, the time-logistics capacity relationship must be known for each activity. (CIOB, 2021)

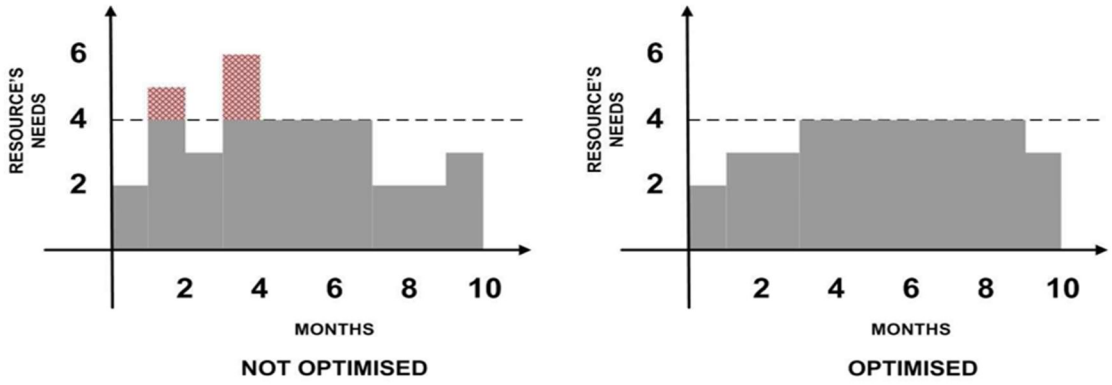

Fig 10: Construction Activities Load Diagrams, CIOB (The Chartered Institute of Building).

4.3.10 Debris Clearance and Waste Management in Humanitarian Construction Logistics (HCL):

One of the most common issues after a disaster is the build-up of debris and solid waste that come from a variety of sources such as destroyed/ damaged infrastructures, downed vegetation, and other sources. (Navaratne et al., 2010, Rebuild Syria Reconstruction Programme, 2021, Crown Agents, 2021) The construction of temporary, transitional, permanent housing and other infrastructures, during the recovery and reconstruction phases, leads to generating the large amounts of construction wastes such as the products of deconstruction/demolition, (Designing Buildings Wiki, 2020) which must be managed properly with consideration given to reusing, recycling and disposal. (Navaratne et al., 2010, Good, 2010, Klenk, 2010)

Humanitarian organizations became involved with fast disposal of large amounts of unused, wrong, and waste materials to reduce the need for space on the construction sites. (Hillegersberg et al., 2020, Rebuild Syria Reconstruction Programme, 2021) Increasingly, they are following the available options in terms of reusing, recycling, and reducing the number of wastes throughout humanitarian construction projects. (Good, 2010, Klenk, 2010)

Syrian Humanitarian Construction Logistics (HCL) have been conducting many activities involving waste management and debris clearance which can be described as follows:

- **Waste Management Plan** must be prepared before humanitarian construction begins. It describes how materials will be managed efficiently and be disposed legally during the constructions. (Designing Buildings Wiki, 2020) It explains how to maximise re-using and recycling materials to reduce the burden of large volumes of material on local landfills and to avoid disposal costs through a resale of materials. (Klenk, 2010)

Interviewees explained that they have been implementing some modern construction logistics practices within the Syrian humanitarian constructions, such as a site waste management plan (SWMP), which is implemented relatively throughout the below practices:

- Confirmation of the correct quantities for ordered materials to reduce the normal wastage factors accompanied with surplus in stocks.
- Confirmation of the shortages before ordering additional materials to avoid storing too much of the same materials.
- Checking the construction drawings and quantity surveying because a shortfall of a material may be due to drawing errors or to a wrong surveying caused by quick implementing of humanitarian construction projects. It is important to check constantly on the available materials and acting when there may be insufficient amounts.
- It may be possible to eliminate a certain amount of construction waste through the mobilization of local community, reuse and recycle practices. (WRAP, 2007) Brick masonry from damaged and destroyed structures was used extensively to cast-in-place concrete to build permanent replacement housing (recycled materials). In doing this, construction costs were significantly reduced, and a masonry rubble was removed extensively. (UNDP Syria, 2021) Another example was presented by the Rebuild Syria initiative for the management of solid waste through community mobilization. This aimed to collect garbage and to clean the environment from solid waste in Mayadeen, Deir Ezzor governorate (Rebuild Syria Reconstruction Programme, 2021)
- Checking the opportunities to re-use materials and products, which are in a suitable condition (e.g., doors, windows, roof tiles and so on), or exchange them for other materials with a different construction site.
- There were many logistics practices to build resilience in Syria through the delivery of waste to controlling and safe disposal. For example, the logistics practices of Crown Agents have been participating in the removal of the piles of waste from irrigation sites and the surrounding area, which helped recover and use the land for agricultural production. (Crown Agents, 2021)

- **Debris Clearance** is considered as a key activity within the Humanitarian Construction Logistics (HCL) since the removal of debris is a precursor to implementing recovery activities. (Good, 2010) The activities of Humanitarian Construction Logistics (HCL) need to remove debris from roads, homes and public facilities before those reconstructions can commence. The Guidance from the Emergency Shelter Cluster stresses that clearance activities must be undertaken with caution, because if the debris is disposed of improperly, it can cause the affected population future hardships. (Ashmore et al., 2009)
  The Shelter Cluster noted to the value of such debris as a source of building and reconstruction materials, and it is considered as an environmentally sustainable option for humanitarian construction projects as long as this debris meets applicable specifications for strength and safety. (Ashmore et al., 2009, Good, 2010) The debris should not just be disposed of but collected, sorted and where possible, reused and recycled. (Ashmore et al., 2009) These logistics activities could be used to mitigate the need to buy new materials and prevent the costs for moving debris to landfill areas. The steel, bricks, timber, and tiles can

often be used to provide transitional shelter to affected families as long as costs for transportation and processing are appropriate. (Good, 2010)
For example, Crown Agents has been doing the logistics practices for debris removal in Syria by identifying the nature of the debris, analysing possible uses for the debris, developing a programme to collect and process the debris, and implementing the programme in phases. (Crown Agents, 2021) In the same context, Crown Agents, UNDP, OCHA, Rebuild Syria Reconstruction Program, and other humanitarian organizations in Syria have been following feasible logistics practices and cash-for-work modality to retrieve of building materials for reuse. (Good, 2010) Therefore, the debris quantities across Syrian cities, which can be significant and difficult to measure, have been reused and recycled at a local level. (Crown Agents, 2021) For example, Crown Agents' team have been supporting public roads and infrastructures to recover through working together with the local implementing partners to clear 44,000 m3 of debris from 128 public buildings including 102 schools in Deir Ezzor province. Later, 78% of the debris was recycled to rebuild roads and bridges. These debris clearances were an important and visible step in restoring services in the recently effected areas. All these activities were supported by local logistics functions such as local transporters, local labour (cash for work), and others (Crown Agents, 2021, UNDP Syria, 2021, Rebuild Syria Reconstruction Programme, 2021)

As a result, the debris and waste logistics planning must be established immediately as part of the Humanitarian Construction Logistics (HCL) to ensure that safety measures and the needed equipment are in place to achieve debris and waste management effectively. (InterAction et al., 2020) Effective debris and waste logistics can support an early recovery for the post-disaster phase, because of recycled debris (often cheaper than raw materials when transport is considered) usually use to overcome the significantly increasing costs of raw materials following disaster, which is caused by the reconstruction demands that outstrip their local supply. (Crown Agents, 2021, UNDP Syria, 2021, Rebuild Syria Reconstruction Programme, 2021) By reusing and recycling the debris and waste close to their sources, transport costs can be significantly reduced. That in turn reduces the overall cost of Humanitarian Construction Logistics (HCL) as transportation of the debris and waste from their sources to their disposal or treatment site was considered as one of the biggest costs within debris and waste management in Syria. (Crown Agents, 2021) Furthermore, wise debris and waste logistics leads to effectiveness in terms of pick up, transportation, disposal, timeliness of other intervention, safety, environmental impacts, reuse, recycling, repurposing benefits, and culturally sensitive impacts. (InterAction et al., 2020)

4.3.11 Material Logistics Plan (MLP):

According to the author of The Ecology of Building Materials, the building industry is after food production, the largest consumer of raw materials in the world today. Logisticians involved in humanitarian constructions require a wide range of building materials to complete the tasks, such as constructing a temporary shelter to house displaced people, rebuilding a health centre or a school, and installing sanitation systems. (Klenk, 2010, Good, 2010)

Material Logistics Planning (MLP) is a tool to assist the proactive management of material types and quantities to be used during construction to ensure the right materials are in the right place at the right time in the right quantity. (WRAP, 2007) The MLP covers the management of materials from design to construction including supply routes, handling, storage,

security, usage, reuse, recycling, disposal, and through project demobilisation and completion. (WRAP, 2007, Klenk, 2010, Good, 2010) It will enable organizations to produce quantifiable achievements and undertake benchmarking activities against similar projects. (WRAP, 2007) The MLP aims to ensure that the right materials and equipment are delivered to the site at the right time to reduce the idle resources and space requirement on site. It can reduce unnecessary transportation and material handling, and it will decrease the chances of late delivery or the delivery of incorrect material, which is still common on construction sites nowadays. (Designing Buildings Wiki, 2020, Disaster Ready, 2021) This is achieved through rigorous attention to design, materials specification, estimations, and orders, as well as, preventing lost, surplus, and damaged materials resulting from poor storage or from multiple handling of materials. (WRAP, 2007) The material logistics plan guidance, which was endorsed by the Chartered Institute of Waste Management (CIWM), distinguishes many stages in MLP throughout the construction-projects that could apply throughout humanitarian construction-projects as following.

Stage 1- Once the design of the project has been agreed on, the MLP is designed to identify the project's material requirements i.e., the types and quantities of materials to be used throughout the project and how and when these will be delivered to the site including any constraints. The KPIs should be set to procure of all key materials and understand how materials will be procured, delivered, stored, and handled onsite and incorporate these procedures into the MLP, so that they can be communicated to all relevant parties.

Stage 2 – Identify the requirements for the receipt and storage of materials, which will include the identification of the locations for receiving and storing materials as well their handling procedures. Any requirements which may restrict or limit the receipt or storage of materials should be identified and mitigation measures should be put in place.

Stage 3 - Site practices should be monitored for their conformance to the MLP. The plan should also be reviewed on a regular basis and updated as improvements or design changes are identified. During the review of the MLP, the data on the quantities and types of waste generated from the project will assist in the evaluation of material types and ordered quantities and how they were managed. Besides, identifying the main causes of material wastage during the construction phase could be described briefly as follows:

- Inaccurate or excessive ordering of materials.
- Damage to materials through inappropriate handling and inadequate storage.
- Rework due to errors, poor workmanship, or defective site processes.
- Inefficient use of materials such as uses of temporary materials.

Stage 4 – A planned approach to project demobilization and completion should be implemented to ensure that materials, equipment, plant, personnel and waste are removed from site in a managed and timely manner. An effective demobilization plan will minimize costs through hindering equipment, plant, and materials orders when it is no longer required onsite. (WRAP, 2007)

The Syrian interviewees declared that they used the material logistics plan (MLP) as a tool to formalise and implement the logistics planning process that satisfies the donors' auditing processes and as a complementary approach, which is becoming more popular in humanitarian

construction-project, not just on large complex schemes, but also in the planning and delivery of small restored-houses and fit-out small-size contracts. The MLP has been implemented during the mobilisation of humanitarian construction-projects, although it is a live document that changes to assist humanitarian construction-projects in proceeding smoothly, because as projects get larger, supply chains increase in complexity and planning controls get tougher. Consequently, the MLP becomes progressively more important especially for rehabilitation/reconstruction projects in severely affected areas. The MLPs for Syrian humanitarian constructions have been designed by experts in logistics to analyse the different logistical options of supply chain such as availability of materials locally, internal transportation, and free-damaged roads. They aim to address challenges like materials running out, the inability for the needed materials to be quickly obtained from nearby areas, works' interruptions, workers standing idle (or must be reorganised to do other works) while new materials are procured. Eventually, MLPs for humanitarian constructions must focus on the local appropriateness of the material, legality, cost, transport distance, and impact on the environment, because the intensive demand for raw materials in reconstruction ultimately leads to impacts on the environment and the people who depend on it. (Klenk, 2010, Good, 2010)

4.3.12 BOQ & Quantity Surveyor:

One of the most important elements in Humanitarian Construction Logistics (HCL) is the bill of quantities (BOQ) which can be defined as the list of all the necessary materials for the construction works, as well as, the quantities, the units of measurement (related with the technical drawings), and the price per unit, according to the standard price at the local market for each element within the BOQ. (MSF, 2011, Reigber, 2018)

These tasks are conducted by the quantity surveyors (sometimes referred to as cost consultants or commercial managers) who provide expertise about construction costs, assuring that the proposed projects are affordable, assuring available good value for money, helping the client and the design team to assess different options, tracking variations, and keeping costs under control as the project progresses. (Mzyece, 2020)

In perspective of logistics, the quantity surveyors who are conducting the tasks will vary depending on the nature of the project, but they might include the following: estimating quantity take-off, estimating costs, preparing bills of quantities, and tendering documentation, as well as, advising on procurement, packaging, monthly valuations, contractual claims, and final accounts. (MSF, 2011, Reigber, 2018, Designing Buildings Wiki, 2020, Mzyece, 2020)

The BOQs help in determining the logistics requirements like the number of the designated technicians involved in the construction project, the issues related to workmanship of construction logistics (for instance the transport and storage of material), the acts related to the workers, and the issues related to the pricing of the materials. (MSF, 2011) It is important to realize that the initial BOQ is not a complete and final version; it is a condensed version that includes the structured tables, the different elements, and some examples about the way of calculating / representing the quantities of materials, their measurement units, their rates, and their values. The actual contents and values of the tables will depend definitely on the context and the specifics of the project. (MSF, 2011, Mzyece, 2020)

In context of the Syrian humanitarian projects, the interviews and literature review demonstrated that the humanitarian organizations have been recruiting the trained and qualified technical members since 2013, to conduct the rehabilitation technical assessment (which consists

of BOQ and Scope of Works), to quantify the required materials and to estimate materials' costs for the overall intervention. The BOQ should be created for all humanitarian projects regardless what type of contract/agreement is used for the repair and rehabilitation process (contractor, cash-for-work, or self-help) to fulfil the logistics requirements within the cost parameters of the projects. There are many restrictions in terms of preparing BOQ (bill of quantities), for example, it must be signed by beneficiaries and it must be very clear about the supplies. Moreover, each beneficiary must sign upon delivery to prove the reception of the specific bill of quantity for his/her house. Therefore, humanitarian organizations need to assure that the determined quantities are measured precisely from the beginning. (Reigber, 2018, Mzyece, 2020) For instance, the Syrian Red Crescent usually assigns two volunteers to go into each house; one counts and the other double-checks. As this is donors' money, BOQ must be precise and fit the beneficiary's best interest.

5. Discussion:

This chapter aims to discuss the above-mentioned results to reach to best frameworks for Humanitarian Construction Logistics (HCL). Based on that, this chapter aims to answer the second research question, namely, "What are the proposed practices for Humanitarian Construction Logistics (HCL)?" by discussing the best logistical practices, technologies, and sustainable solutions for Humanitarian Construction Logistics (HCL).

5.1 Humanitarian Construction Logistics (HCL) Strategy:

The objective of the Humanitarian Construction Logistics (HCL) strategy is to implement a holistic and system-optimal approach for the construction logistics within a humanitarian context, based on collected real-time data and stakeholder consultation. It will arrange to address the challenges of coordinating workers, delivering of material timely, optimizing efficiency and assessing the impacts regarding sustainability criteria. (Vega et al., 2020)

Humanitarian Construction Logistics (HCL) need to be considered early in humanitarian, rehabilitation, and development projects to minimise the disruptions in the surrounding environment and optimise efficiency. Key stakeholders must work to optimize Humanitarian Construction Logistics (HCL) based on real time data and smart technologies that enable the effective use of efficient logistics and make participatory decisions in terms of urban, humanitarian, rehabilitation, and development projects. (CIVIC, 2018)

Humanitarian Construction Logistics (HCL) need to adopt the agility principles to perform in a constantly changing and unpredictable environment and be effective. On the other hand, it needs to adopt the lean principles to help humanitarian organizations to achieve efficiency. Moving these two strategies to Humanitarian Construction Logistics (HCL) helps in achieving an effective response against unforeseen events while using resources efficiently, resources that in most cases are scarce. Besides, the challenges, that the Humanitarian Construction Logistics (HCL) face, are significantly broader and deeper than those related to issues like movement of material, storage, last mile distribution and information management. Humanitarian Construction Logistics (HCL) are shaped for preparedness and response against to changeable and continuable disasters. (Vega et al., 2020) For example, heavy rainfall and widespread flooding increased the needs of communities in Northwest Syria in early 2021. At least, 418 IDP sites were affected by the flooding, and that increased the needs by Humanitarian Construction Logistics (HCL) for tent replacements, NFIs, plastic sheets, multi-purpose cash assistance, ground levelling, winterization, and infrastructure improvement services. (Shelter Cluster / Syria, 2021)

5.2 Smart Humanitarian Construction Logistics (HCL):

More than 15% of construction costs have to do with transport to and from construction sites. The costs of failure of inefficient construction logistics are high. In recent years, the construction sector has experimented with new concepts including setting up a construction hub on the edge of town, using construction containers, and setting up smart construction logistics in advance. Smart construction logistics will prevent most of the disruptions, and lead to results like nearly 70% fewer transport movements to construction sites, nearly 70% fewer CO2 emissions, up to 40% higher productivity at the site, and 3 to 5% lower construction costs were achieved at

the end. Smart construction logistics not only benefit society, but they also ensure more efficiency within the construction chain. That means investments will eventually pay for themselves. (CIVIC, 2017)

The concept of smart Humanitarian Construction Logistics (HCL) aims to proceed projects more quickly, cause less disruptions, require fewer people, reduce construction costs, and use humanitarian construction sites efficiently, whereby as little storage as possible takes place on the construction site. It is an innovation extracted from smart construction logistics concepts, which clearly deserves a prominent place on the agendas of humanitarian construction projects (CIVIC, 2017, Hillegersberg et al., 2020) It aims to address productivity through on-site like delays and disruptions which are significant problems in the humanitarian constructions caused by workforce, materials, and equipment clashes. (Magill et al., 2020) A robust and well-thought-out smart Humanitarian Construction Logistics (HCL) approach is critical to securing optimum construction site's efficiency and safety and decreasing waste. (Whitlock et al., 2018) The costs of failure of Humanitarian Construction Logistics (HCL) are high, thereby, setting up smart construction logistics in advance will prevent most of the disruption that will not only save money and benefits society and humanitarian organizations, but it also ensures more efficiency within the construction supply chains. (CIVIC, 2017)

In order to implement smart humanitarian construction, all parties within humanitarian construction sector need to work together and need to use different technologies like RFID technology (Hillegersberg et al., 2020). Below are the modern technologies that could be incorporated within Humanitarian Construction Logistics (HCL).

5.2.1 RFID:

Radio frequency identification (RFID) technology enables automated tracking of building materials in construction supply chains. RFID makes information related to building materials readily available to the persons handling these materials and supports in this way a further optimization of construction logistics. (Hillegersberg et al., 2020)

Tracking the materials means that you can quickly identify if there is a need to order more details or change delivery plans. (Disaster Ready, 2021) As a result, there will be visibility in the supply chain and all materials and deliveries can be coordinated more effectively, which in turn reduces costs for tracking and tracing and offers the possibility to plan operations more proactively. (Janné et al., 2020) It is the best practice within humanitarian organizations to ensure accountability for the materials until they have been used and to avoid incorrect stocks that can lead to cost and time over-runs. (Disaster Ready, 2021)

RFID implementation requires the usage of a cloud-based system, standardises the planning of material deliveries, introduces stipulated planning time fences, allocates resources to deliveries, and offers easy access for all project participants. (Janné et al., 2020, Disaster Ready, 2021)

5.2.2 Building Information Modelling (BIM):

BIM is defined as "a digital representation of physical and functional characteristics of a facility. As such, it serves as a shared knowledge resource for information about a facility, forming a reliable basis for decisions during its life cycle from inception onward. Currently, BIM is mainly used in the design phase of a building project. (Oosterwijk, 2017)

Both BIM and Construction Logistics Management (CLM) disciplines revolve around the timely delivery of resources, whether information or construction materials. Construction Logistics involve the coordination of deliveries to the site, the layout of the site itself, and the distribution of material resources from point of delivery to workface. (Agapiou et al., 1998)

The BIM software can integrate logistic information with computational models, and it supports humanitarian organizations in managing their construction supply chains. (Oosterwijk, 2017) It aims to improve construction logistic efficiencies for materials and equipment from manufacture to the point of use by the workforce. (Magill et al., 2020) Another important purpose of BIM is to deploy accurate data to all the different partners within entire the supply chain. This is needed to steer Humanitarian Construction Logistics (HCL) to achieve just-in-time deliveries, comparing the plan against the actual achievement and steering accurately on humanitarian construction-sites. (Hillegersberg et al., 2020)

The aim of recent UK studies done by universities like Oxford and Yaounde is to investigate how BIM can be applied to construction logistics management, (Whitlock et al., 2018) which can also be applied to Humanitarian Construction Logistics (HCL). The literature recommends the use of building information modelling (BIM) to facilitate the sharing of information, supporting decision-making, applying of lean production concepts, simulating some operations, supporting production planning, and controlling assembly process to support logistics management. (Bataglin et al., 2018) The literature suggests integrating BIM with GIS (geographic information systems) to manage the logistics of a humanitarian constructions (Oosterwijk, 2017) because BIM has a number of applications to both the logistical management of materials delivery and distribution, and it has a dynamic site layout planning. (Whitlock et al., 2018) That use could potentially add value with a trusted supply chain and disciplined planning by using a multiple stream logistics model. (Magill et al., 2020)

According to Whitlock et al. (2018), there are benefits to the application of BIM systems to Humanitarian Construction Logistics (HCL). These benefits are outlined below.

-Improved understanding of logistics information as presentation of logistics information through a three-dimensional platform, that brings the benefits of improving the comprehension of site layout data and allowing complex logistics processes to be more easily interpreted by individuals who have no background on construction or logistics.

- Increasing the ease at which proposed logistics plans can be interpreted, that reduces the effort associated with identifying both issues and opportunities associated with the logistics proposals.

-Site operatives can be quickly briefed with well-defined and easily understood information. This reduces the occurrence of elements of the logistics plan that are open to interpretation, and reducing the hazards associated with inaccurate construal. The use of BIM for logistics planning offers improved clarity in the comprehension of proposed logistical processes that helps spotting health and safety risks quickly.

- Improved effectiveness of layout planning to avoid time/space clashes. The 4D BIM model facilitates control over the proposed schedule of construction works and interactions between logistics and construction operations. The 4D BIM-based logistics allow planners to quickly identify potential issues where a scheduled order of works conflicts with proposed logistical arrangements. Spotting these conflicts prior to discovering them on site leads to improved site efficiency and reduced cost.

-Improved efficiency of logistics planning. Clash detection tools that accompany BIM software packages aid this process by quickly identifying conflicts. A three-dimensional

simulation results in easier to identify solutions, reducing the time associated with reviewing and revising logistics proposals. (Whitlock et al., 2018)

On the other hand, challenges of adopting BIM in Humanitarian Construction Logistics (HCL) are represented in the following issues.

- The 4D BIM logistics models produced at the outset of the project are infrequently utilised to coordinate logistics processes following commencement of the scheduled works, instead of reverting back to managing construction logistics via 2D information. (Whitlock et al., 2018)
- The use of BIM for logistics management need to invest in training of site staff and perceived costs of IT (Whitlock et al., 2018, Hillegersberg et al., 2020, Magill et al., 2020)
- The 4D BIM based logistics plans are rarely distributed to these contractors in a format that allows detailed scrutiny. Early participation of contractors would provide a greater clarity for the management of Humanitarian Construction Logistics (HCL). (Whitlock et al., 2018)
- A basic premise of BIM-based logistics is collaboration by different stakeholders at different phases of humanitarian constructions to insert, extract, update or modify information in the BIM to support and reflect the roles of that stakeholders (Oosterwijk, 2017)

At the end, The BIM model must include a detailed overview about the layout, the use of the construction site, the way to manage the materials, and the way to manage the inventory.

Information of Humanitarian Construction Logistics (HCL) and BIM must be connected by the main contractor or humanitarian organization/s who coordinate the received procurement from the sub-contractors /suppliers, and who add time to the BIM-model for a successful management of Humanitarian Construction Logistics (HCL). (Oosterwijk, 2017)

5.2.3 GIS (Geographic Information Systems):

Geographic Information Systems is a technology which combines geography, computer science and space science. Its main functions include spatial analysis, processing map data and some aspects of attribute data. GIS gathers, processes, stores, manages, and analyzes geographical spatial data and attributes information conveniently. GIS is a tool that helps comprehend geography and make intelligent decision. It organizes geographic data in such a way that anyone using digital map can select data necessary for a specific task. (Fadiya, 2012)

In context of humanitarian constructions, GIS is concerned with using mapping to improve the data we have and help the humanitarian operations. Practical applications of GIS in Humanitarian Construction Logistics (HCL) aim to collect spatial data that is important for construction logistics management, like locating the populations with the most urgent and immediate needs. That keep planners and decision makers, who are not active on the ground, informed about the evolution of the situation to make their interventions more effective to address shortcomings. (Heyns, 2021)

For example, the locations of subcontractors and suppliers are not frequently weighted in procurement's decisions. Therefore, it is understandable that this leads to unnecessary construction logistics flows. Consequently, the geographic positions have to be weighted in future throughout the decisions made by procurement to embrace construction logistics solutions. (CIVIC, 2017, CIVIC, 2018)

The produced maps can provide context and scale within a single picture frame and compare maps over different time frames, providing insight into the progress of humanitarian constructions' activities, like the growth of the camps that receive hundreds and thousands of refugees on a daily basis. Thereby, the picture is constantly changing, and this keeps updating the needs regularly, to demonstrate locations of actors (UNHCR, WFP, Red Cross, etc.), their interventions, needs, stocks, humanitarian construction activities and the rapidly changes within Humanitarian Construction Logistics (HCL) activities. (Heyns, 2021)

For example, Humanitarian Construction Logistics (HCL) map the significant damages and long-lasting failures in infrastructure networks (such as gas, power, and water) upon disasters. They also map maintenance needs, contractors to repair each site and the logistics activities for each team in order to minimize the sum of the recovery time.

In the end, there are countless available information, communications, and GIS technologies that can contain the entire set of data which support the construction process, transport planning, materials management, and other logistics functions (CIVIC, 2017, CIVIC, 2018). Nevertheless, there are some challenges regarding the smart functioning of Humanitarian Construction Logistics (HCL), such as the sub-contractors and suppliers which are not used to work in these systems and the different parties that do not adhere to standardized processes. Furthermore, extra administrative costs and initial investment costs are prerequisites to set up the above-mentioned technologies for stipulated construction logistics. (Janné et al., 2020)

5.2.4 Blockchain:

Blockchain is a type of decentralized database that records transactions shared across a network of multiple participants. The blockchain maintains a continually growing list of data records, with all participants within a network having their own identical copy of the ledger. Any changes to the ledger are reflected in all copies close to real time. The security and accuracy of the assets stored in the ledger are maintained cryptographically through the use of digital signatures. (Ko, 2016) This technology will help simplify gaining access to any needed information. The technology will help in site organization by providing decisionmakers with access to all the necessary information to make any decisions with respect to the logistics process. (Almohsen and Ruwanpura, 2013)

Ko (2016) and Baharmand et al. (2021) studied the application of blockchain to humanitarian logistics to gain a better understanding of added values and challenges. They revealed that the application of blockchain could increase transparency and development among humanitarian operations by providing data that help inform more effective and accurate decisions, enable evidence-based interventions and management, expose issues for effective remedy and increase accountability. The application of blockchain could be an added value that helps to improve visibility, traceability, transparency, commitment, and swift trust within humanitarian supply chains. (Ko, 2016, Baharmand et al., 2021) The blockchain can ensure a real-time record of all activities within humanitarian construction projects rather than waiting for reports to be created after the disaster. This ensures stronger collaboration, less duplication of resources, more accountability and more efficient use of time. In addition, the blockchain could integrate with programmable smart contracts which are automated, self-executing, and that no one controls on smart contracts. These contracts could be used to tie funding or transactions among Humanitarian Construction Logistics (HCL) based on agreed rules to ensure all parties are held accountable. For example, person A and person B agree that the ownership of asset is

transferred only if a certain amount of money is sent from A to B. If person A pays in time, a smart contract transfers that ownership automatically, otherwise, it will decline the transference of ownership (Ko, 2016)

In context of blockchain implementation among Humanitarian Construction Logistics (HCL), there are major challenges that are the result of engagement issues, lack of technical skills, lack of training, lack of resources, privacy concerns, and regulatory problems. In addition, Humanitarian Construction Logistics (HCL) are extremely dynamic, as result, its visibility and data tracing can often be poor. (Ko, 2016, Baharmand et al., 2021) Affected areas with inadequate infrastructure or capacity would not be appropriate to use for blockchains that require access to the internet. The technology is new, intricate, and difficult to understand, so more appropriate and user-friendly applications still need to be developed for blockchain. (Ko, 2016)

At the end, the combined use of the above presented technologies and the mobile applications will facilitate the communication process between participants of Humanitarian Construction Logistics (HCL). That will ultimately reduce most causes of poor logistics management, such as material unavailability, double handling, and overlapping of activities. It also enables all participants to make their real-time contributions by allowing all parties to put in their requests and necessities among Humanitarian Construction Logistics (HCL). (Almohsen and Ruwanpura, 2013)

5.3 Construction Logistics Solutions:

The key purpose of Humanitarian Construction Logistics (HCL) is to provide solutions that align with the humanitarian-construction programme. This starts at the design stage to scope the work into packages. Early evaluation based on feedback from the Humanitarian Construction Logistics (HCL) can produce enormous cost benefits and value. (Designing Buildings Wiki, 2020) The Humanitarian Construction Logistics (HCL) stipulate incorporating construction solutions within humanitarian logistics, which will present a different configuration and will face different challenges, while maintaining the same goal, i.e., responding to effected population's needs effectively and alleviating the suffering of vulnerable people. (Vega et al., 2020) Therefore, Humanitarian Construction Logistics (HCL) have adopted many solutions, and they are as follows:

5.3.1 Prefabricated Products in Humanitarian Construction Logistics (HCL):

Prefabricated Products provide a solution to meet the needs of all kinds of shelters and settlements upon and after disaster. Humanitarian Construction Logistics (HCL) are involved in bringing all kinds of products related to high-resistance textile architecture for camps and humanitarian aid uses in emergency situations. These products are ideal for emergency situations in remote locations, refugee resettlement, natural disasters, and armed conflicts. (Whitlock et al., 2018, House Matic, 2021) Moreover, the building site, in disaster areas, is not much bigger than a building that is going to be built there. This means that a temporary storage of building materials at a construction site itself is not possible. Therefore, construction elements have to be manufactured elsewhere, in factories located outside the construction sites. (Whitlock et al., 2018, Hillegersberg et al., 2020)

A number of benefits can be realized in these factories like increasing precision and quality, reducing overall manufacture/assembly time, increasing safe and clean working

conditions, reducing multi-trade interfacing, decreasing on-site workforce numbers, and reducing the need for material transport and on-site storage. An example of a prefabricated construction part is a wall, complete with doors, insulation, and windows which reduces the demand for storage space and assembly time at construction site, because it is prefabricating in controlled environments in factories and using of standardized construction elements. (Whitlock et al., 2018, Hillegersberg et al., 2020, House Matic, 2021)

The humanitarian agencies, such as UNFPA, UNHCR, UNICEF, UNOPS, UNDP, IFRC, and others, adopt and set up prefabricated modules worldwide in 140 countries throughout the world where they have a presence. The best specifications for these products tailor the needs of each humanitarian organization, as well as express assembly, and easy international shipping. (House Matic, 2021) Furthermore, the materials that arrive at the construction site are assembled immediately, because of the limited space at the building site and time restriction. (Whitlock et al., 2018, Hillegersberg et al., 2020)

In a commercial context, prefabricated products are becoming more advanced. For example, a Chinese company had constructed a 10-storey residential tower, named the Living Building, in just 28 hours and 45 minutes by using prefabricated modular units (معجزة صينية.. بناء مبنى مكون من 10 طوابق خلال 28 ساعة فقط - RT Arabic). These techniques were adopted in a humanitarian context to develop a prefabricated approach within the Humanitarian Construction Logistics (HCL). For example, the humanitarian logisticians commence to modify and adapt shipping containers. They convert them for end uses at hospitals, mobile clinics, and kitchens, among other uses. (House Matic, 2021)

Eventually, the management of prefabricated building systems within Humanitarian Construction Logistics (HCL) demands an intense exchange of information between the plant and the construction site, in order to synchronize the production of components, logistics operations and site assembly, especially in humanitarian operations where the degree of uncertainty tends to be high. (Bataglin et al., 2018)

5.3.2 Innovative Emergency Shelters:

There are many innovations that could be adopted by Humanitarian Construction Logistics (HCL) to deliver inexpensive and sustainable shelters for the affected people. This dissertation presents two instances.

The first instance is the Japanese architect Shigeru Ban who invented practical design solutions for emergency relief housing in disaster areas through his Voluntary Architects Network (VAN). To construct his disaster relief shelters, Ban often employs recyclable cardboard paper tubes to act as columns, walls, and beams, as they are locally available anywhere in the world. The tubing is inexpensive, is easy to transport, mount and dismantle, and can be water-proofed, fire-proofed, and recycled. (Murray, 2015)

The second instance is the Jordanian Canadian engineer, Abeer Seikaly, who designed smart tents (livable solar-powered tents for refugees) to use in the wake of natural disasters and world wars. The affected people usually don't find a place to resort to except traditional tents that do not provide them with their most important daily needs and requirements, such as water and electricity. However, these tents are designed to provide and store heat, water, and electricity. These tents are also characterized by their light weight, which makes them easy to carry and transport from one place to another due to the structural fabric from which they are made. (Nolen, 2015)

As a result, these solutions must be adopted early in the stages of humanitarian logistics, so their components can be simply managed alongside the remaining materials and building components within Humanitarian Construction Logistics (HCL) strategy. (Whitlock et al., 2018)

Fig 13: Prototypes of Self-Structuring Tent for Eng. Abeer Seikaly

5.3.3 Solar Solutions in Humanitarian Construction Logistics (HCL):

There are many humanitarian constructions that have benefited recently from modern solar solutions to alleviate the suffering of affected people. For example, Kubum Solar Water Project provides an instance where modern solutions were adopted. It was initiated by the growing need for sustainable sources of water for IDPs in Darfur. The logisticians in Caritas-International implemented innovative solar-powered water pumps to increase water supply. Despite the fact that solar power is frequently criticized for its expense, it is a long-term solution that has exponential benefits for communities. (Navaratne et al., 2010)

Eventually, the above-mentioned solutions provided by humanitarian organizations could have vast consequences on Humanitarian Construction Logistics (HCL) in terms of the network of actors involved and the designed logistical processes. Therefore, logistics experts must pay attention to the consequences on humanitarian construction projects and learn lessons for the future. (Vega et al., 2020) In addition, information about orders and schedules must be transferred and shared in a short time. (Young et al., 2004)

5.4 The Team of Humanitarian Construction Logistics (HCL):

Humanitarian Construction Logistics (HCL) employ many professionals from multiple disciplines like construction technical employees (like architects and engineers), contracting managers, construction-site managers, commercial managers, planners, quantity surveyors, and estimators involved in designing and logistical execution of humanitarian construction projects. (Arewa, 2020) Humanitarian Construction Logistics (HCL) focus on employing local people to provide skills and development opportunities in affected locations where unemployment rates are often high. Furthermore, humanitarian organizations believe that the best people to involve in the reconstruction are the affected local people themselves. (Murray, 2015)

For example, Crown agents have been recruiting many local employees in Syria, within a cash-for-work scheme. These are well-educated people like logistics assistants, engineers, and

technicians. This results in high economic dependency ratios because the salaries of the employees make a significant contribution to the local economies and the communities, with the scheme being the sole source of income generation. (Crown Agents, 2021)

The Humanitarian Construction Logistics (HCL) focuses also on off-site/on-site teams who are dedicated to receiving deliveries and distributing materials, equipment, and others. (WRAP, 2007) For example, an on-site materials-handling team is prepared to handle the deliveries upon arrival, and they relieve work from the craftsmen. That leads to more efficient on-site operations and less costs for materials handling. (WRAP, 2007, Janné et al., 2020)

Humanitarian organizations have developed a tendency recently to integrate logistics teams who complete supply chain functions involved in the delivery of massive-scale humanitarian construction projects worldwide. This may include the main contractor, designers, sub-contractors, suppliers, facility managers, and so on. The integrated logistics team differs from the integrated project team as it relates only to the main contractor/s and their supply chains (designers, sub-contractors, suppliers, etc.), whereas the integrated project team includes the client, and a project manager if there is one. (Designing Buildings Wiki, 2020, UNICEF, 2020)

For example, the UNICEF Supply Division has established new units (construction) in its main supply hub (Copenhagen, Denmark) and in its offices worldwide, even in Syria, which included engineering and logistics experts who manage construction logistics related to humanitarian projects to scale up relief and recovery efforts. (UNICEF Supply Division, 2020)

After reviewing the website Job.sy, which is the most dependable employment website in Syria between 2013 and 2021, it appears that construction logistics approach has been rooted gradually in the Syrian humanitarian operations by UN agencies, INGOs and NGOs. They have been interested in hiring professional logisticians to do main functions as shown in the following:

- Growing the excellent knowledge about the prerequisites for logistics for each stage of the construction-project.
- Managing day-to-day implementation, coordinating of logistics activities, providing regular progress reports on the assigned projects, maintaining project up-to-date documentation, and following up the time schedule agreed on with the contractor/s.
- Conducting surveys, assessments and collecting the needed information from the field by filling the assessment forms and the bill of quantities (B.O.Q) based on the minimum standards and feasible estimates. That leads to consolidating properly the different assessment outputs to verify all the logistics orders according to relevant technical studies like the BOQ, assessments, etc.
- Ensuring high-quality implementation by following up the quality of the executed works, the equipment delivered to the project site, and reporting on any discrepancies between the quality of the delivered items and the ones agreed on in the initial specifications. Logisticians receive the works from the contractors /suppliers, calculate the quantity of delivered goods/equipment to the work locations according to the prepared bills of quantities, test the quality, measure quantities, and sign the certificate of reception.

As a result, the humanitarian organizations, activated in Syria, proved of the importance of Humanitarian Construction Logistics (HCL) teams in order to organize resources and achieve contracts on deadlines by deploying an appropriate logistical team for each project. (Ashmore et al., 2009)

For example, Crown Agents have been recruiting the logistical teams of their implementation partners who collect the data and the monitoring criteria on a monthly basis and send feedbacks to Crown Agents staff on a monthly basis. This includes the quantities of materials that were procured, and the number of infrastructures that have been repaired as well as general data like the number of beneficiaries (Crown Agent, 2021).

Pace Winds have presented a real example during upgrades of several shelters since 2018. The sites were bustling with logistics activities like laborers, trucks delivering building materials; nevertheless, Peace Winds staff performed efficiently and ensured the delivery of materials, construction, and paying laborers on schedule. (Peace Winds, 2021) Their role encompasses several different areas of responsibility, including:

- Planning and programming that includes planning the set-up of the site so that the workforce, plant, and materials can move around efficiently and safely, planning the use of key assets to adhere to the programme, organising routes through the site, planning off-loading points, and so on.
- Supply chain management that includes liaising with contractors and subcontractors in accordance with the programme, ensuring materials are brought to site as and when required, ensuring waste is kept to a minimum and that disposal procedures are implemented.
- Delivery management that includes liaising with project suppliers, managing all movements to and from the site, maintaining an organisational delivery management system, and maximising the use of delivery vehicles. (Peace Winds, 2021)

One of the major challenges in terms of Humanitarian Construction Logistics (HCL) teams is that the sub-contractors and suppliers are not used to adhering to structured logistics arrangements. This increases mistakes in labelling of goods, mistakes in the planning documents, extra work at site with unclear work instructions, missing materials, mistakes in material handling, early deliveries with return flows, delivery errors, etc. All these issues lead to extra costs, which makes it hard to exploit the benefits and to offset the extra costs that come with the logistics arrangement. (Janné et al., 2020)

Other challenges are related to safety. The first condition for rehabilitation is minimum safe for the team. The team works also need to be approved by the different parties and should be accepted by the affected people because they cannot force up to someone. A safe intervention needs also safe for the contractor/s, for example, the building would not go down with them inside. Moreover, logistics team need to be in a safe flow, so they cannot do any intervention in any area where there are no good roads in order to transport the materials and human forces. (Shelter Cluster / Syria, 2021)

5.5 The Quality in Humanitarian Construction Logistics (HCL):

Supervision is viewed by many as the key in order to meet the quality standards of the Humanitarian Construction Logistics (HCL). Due to this, pressures on quality through humanitarian construction projects keep rising to keep pace with the changes in Humanitarian Construction Logistics (HCL), especially throughout implementation to maintain standards. (McCabe, 2020) This means the supervising teams in the field ensure that the work follows the right specifications, and that the quality of the construction is acceptable and is compliant with contracts and relevant regulations. (Disaster Ready, 2021) For example, material quality is paid

proper attention within the process of Humanitarian Construction Logistics (HCL) to maintain attention to the right quality, accurate time, accurate place, accurate quantity, and cost. (Lundesjö, 2015, Labib, 2016) Quality in Humanitarian Construction Logistics (HCL) is presented in four categories:

- The logistics quality means using different transportation concepts during the different phases of the humanitarian construction projects like using volume and cost data to support different logistics operations and linked shipments to local traffic control plans.
- The logistics quality means availability of operational, tactical, and logistics plans which include, for example, indicators to select partners like wholesalers, suppliers, and third-party service providers.
- The logistics quality means applying logistics data synchronisation, data quality, and key performance indicators for data.
- The logistics quality means knowledge and communication management between the partners in the humanitarian construction supply chains, as well as procedures for lessons learned (Arewa, 2020, Disaster Ready, 2021)

Lundesjö (2015) said that the challenges could occur due to the nature of the humanitarian constructions like disruptions throughout the construction process along with increasing the material waiting time, which results in considerable damage and defects. (Lundesjö, 2015, Labib, 2016) This can be a cause for concern in quality management implemented by field teams who work in bad circumstances during crisis. Moreover, quality management now requires expertise in a wide range of areas and one person cannot assure the quality of everything on site. Therefore, humanitarian construction projects are far too complex for one logistician alone to hold all the expertise and assure the quality of construction logistics. (McCabe, 2020)

At the end, quality is considered one of the main pillars of the humanitarian constructions and the Humanitarian Construction Logistics (HCL) process. (Lundesjö, 2015, Labib, 2016) Quality within Humanitarian Construction Logistics (HCL) provides the basis for improved forecasting of activities, scheduling, and risk management. It can contribute to certainty in humanitarian construction programme specially in relation to project timing and the ability of personnel to keep working to plan. The main contractors and sub-contractors should regularly review the implementation of logistics quality standards that are monitored during periodic project reviews. They must review any achievement against KPIs to enable the identification of opportunities for improvement or areas of concern, e.g., material quantities used against estimated quantities as identified by sub-contractors during a tender. (Lundesjö, 2015, Labib, 2016, Arewa, 2020) Moreover, as materials move throughout several points from a certain supplier to the construction site, there is a high possibility that the required quality of materials is decreased. Consequently, there is a substantial need to urge construction stakeholders to consider all the previous information when planning the construction logistics process. (Lundesjö, 2015, Labib, 2016)

5.6 The Handling in Humanitarian Construction Logistics (HCL):

In the construction industry, the term 'material handling' refers to the delivery, movement, storage and control of materials and other products. This forms part of the logistics management

within the humanitarian construction project. The material handling system should be well-coordinated and organized from receipt and inspection of materials, through to storage, assembly, and use, taking into consideration the safety of materials. (WRAP, 2007, Designing Buildings Wiki, 2020) For instance, limiting the number of materials stored at site and delivering materials after hours to the designated materials zones will result in a more structured, clean, and tidy production environment. It will also make materials available for production when needed. This increases productivity, reduces accidents, and subsequently reduces the total cost of operations as well. (Janné et al., 2020)

During the design stage, issues like material laydown and storage areas should be identified, demarcated clearly, and managed to prevent the areas from becoming overfilled and to ensure that they are suitable for the materials. Receipt and storage can be devised based on the information supplied by all parties about the material types and quantities that will be required during the project phases/dates. This also requires the availability of suitable plant and equipment to unload and handle the materials at the identified storage or point-of-use area. (WRAP, 2007) According to the literature review, this dissertation presents the handling techniques that could fit Humanitarian Construction Logistics (HCL) as the following:

5.6.1 CLP (Construction Logistics Plan):

Construction Logistics Plan (CLP) is a document to plan and streamline the logistical processes (Lundesjö, 2015, Whitlock et al., 2018). The CLP aims to provide a holistic view of the logistical work in the project and stretches from initiation of the project to commissioning and everything in-between. The CLP is designed to benefit a more structured and controlled way of working with construction logistics. The CLP clarifies the constraints of the project regarding logistics and should be produced by the main contractor as a coordinator. The document should provide a holistic view of the relevant logistics in the project and be a communicative tool for the management regarding receiving, storing, distributing materials, and managing waste along the entire supply chain. (Lundesjö, 2015, Andersson et al., 2018, Whitlock et al., 2018)

The CLP will function as a logistics playbook which will contain the specifications of materials (regarding deliveries, packaging, announcing) and the logistical project management which can differ based on whether the contractor is using a digital delivery system or a Construction Consolidation Center (CCC)…etc. Since the logistical prerequisites are seldom specified in the contracts, the CLP will fill that gap to minimise communication issues and the operator's errors, and to ensure a desired logistical outcome. These points are considered the most critical since they reflect the problem otherwise occurring on site where the logistics plan is not used. (Sobotka et al., 2005)

The CLP is one solution to ensure efficient Humanitarian Construction Logistics (HCL). It is a tool used to coordinate construction logistics to overcome the obstacles of congestion on humanitarian construction-sites, especially in times of disaster, by addressing how to use, for example, just-in-time delivery, construction consolidation centres, dedicated planning systems, and a standardised execution process which simplifies the transition between humanitarian projects. (Andersson et al., 2018) A well written CLP benefits both Humanitarian Construction Logistics (HCL) and the local environment as it saves costs by encouraging efficient working practices and reduces deliveries. It is progressively developed to describe the primary products required for the humanitarian construction projects, method of transportation, expected wastes, methods of removal, and local access routes to be taken by local distributors. (Whitlock et al., 2018, Disaster Ready, 2021)

The challenges of using the CLP are rare, for example, it is often confined only to the site while overlooking the complete construction supply chains. (Andersson et al., 2018)

In addition, the CLP as a logistics plan itself may come in different versions depending on the complexity of the project. (Sobotka et al., 2005)

At the end, the CLP presents a key tool for the Logisticians/ humanitarian organizations to co-ordinate the movement and guide Humanitarian Construction Logistics (HCL). (Whitlock et al., 2018)

5.6.2 Humanitarian Construction Logistics (HCL) Guideline:

Humanitarian Construction Logistics (HCL) have a unique nature as a project-based industry. (McCabe, 2020) They are defined as temporary, however, they require a very sound structure for the time they last. (Merminod et al., 2014) They deal with the planning, operation, and controlling of materials, personnel, and information flows from the point of view of an optimized logistics service regarding schedule, cost and quality while taking into account health and safety as well as environmental aspects. (Tischer et al., 2013) That will result in some challenges, such as varied locations, shifting work volume, supply chain management, labor intensive work, changing weather, transient workforce, and competing visions between stakeholders. (McCabe, 2020)

All these challenges impose the need for a proposed charter for Humanitarian Construction Logistics (HCL), which address both requirements of humanitarian organizations and beneficiaries. In order to achieve that, the guideline is a vital part of the logistics management process, and it has two key purposes; namely, making sure that the requirements of the humanitarian constructions are met, and identifying what has to be done, by who, and when. Moreover, the guideline sets the statement of scope, objectives, and people who are participating in a project and their roles and responsibilities. (Shibani, 2021) Considering the complex and hostile environment, a proper logistics guideline contributes to ensuring that competency deployment and knowledge diffusion will be an integral part of the effective and sustainable coordination among action plans by the various stakeholders within the Humanitarian Construction Logistics (HCL).

WRAP (2007), Merminod et al. (2014), and other authors in Designing Buildings Wiki (2020) clarified the best practices that must be stated within the logistics guideline when designing a material handling system for a humanitarian construction project, namely:

- The proposed system of material handling should be defined in terms of needs, objectives, and functional specification.
- Methods and processes should be standardised to avoid confusion, and unnecessary handling or movement should be reduced or eliminated.
- Working conditions and methods should have worker safety as the primary objective, and good site security should be ensured to minimize materials lost due to theft or vandalism.
- Storage areas should be kept organised and cleaned, maximising density as much as possible and eliminating damage to materials. Moreover, deliveries should be received and handled promptly by automated material handling technologies where practicable.
- Site waste management plans should be created and maintained. (WRAP, 2007, Designing Buildings Wiki, 2020)

On the other hand, a construction site resembles a temporary factory with at least three different kinds of temporary supply chains in term of delivery, site, and disposal. (Tischer et al., 2013)

The Humanitarian Construction Logistics (HCL) guideline must focus on coordinating the fragmented operations to control the material procurement, the transportation of material to and on site, the provision of materials as well as the recovery and disposal of residual materials on site and from site. (Tischer et al., 2013, Ekeskär et al., 2020)

Vrijhoef and Koskela (2000) proposed four roles that the guideline can play to improve coordination and enhance construction operations:

- Focus on the interface between the supply chain and site activities,
- Focus on improving the supply chain,
- Manage the site and the supply chain as an integrated domain,
- Transfer site activities from the site to the supply chain.

Ekeskär and Rudberg (2016) proposed that a fifth role played by the guideline, which is focusing on full integration between both the construction supply chain and the site. (Ekeskär et al., 2020) The five roles that the construction logistics can play for humanitarian constructions are demonstrated in the below Fig 14, according to Vrijhoef et al., 2000, Tischer et al., 2013, Ekeskär et al., 2016, Janné et al., 2020, and Ekeskär et al., 2020.

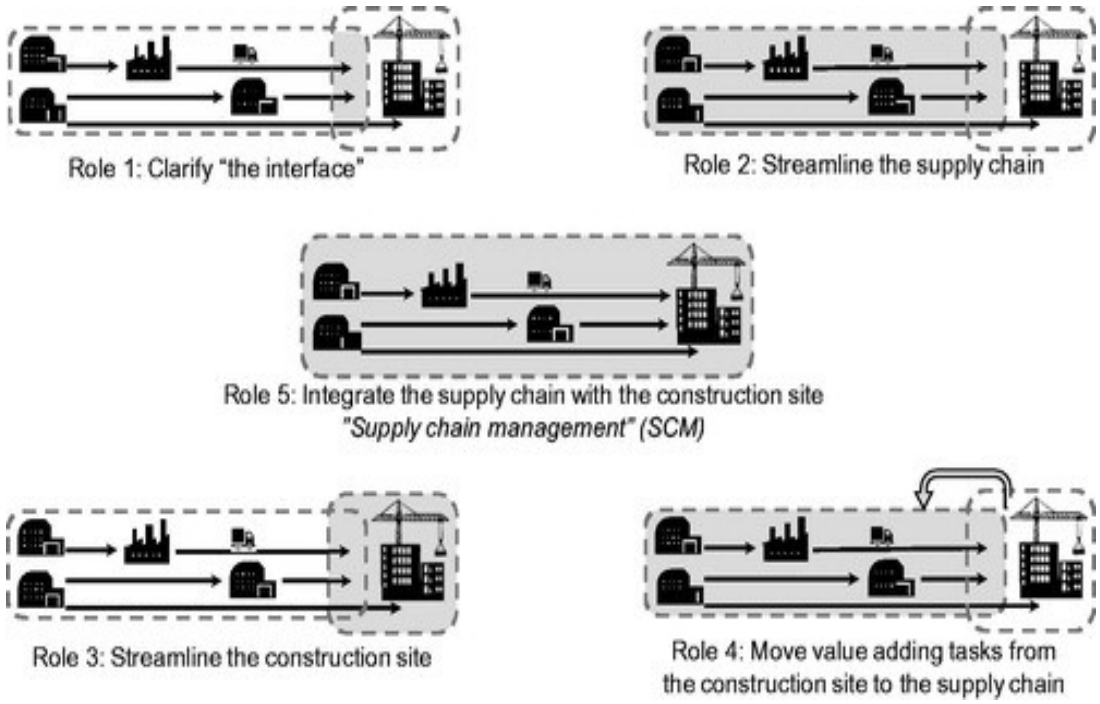

Fig 14: Five Roles of Construction Logistics in Humanitarian Constructions

Finally, the Humanitarian Construction Logistics (HCL) guideline ensures that pre-start inspections are applied, load limits are not be exceeded, material movements are directed around the site by the appropriate banksmen, similar materials are stored together to prevent wasting partly utilized items, and the appropriate practices are applied by the contractors to confirm

receipt of the materials by using either a manual paper-based system or an electronic system. (WRAP, 2007, Designing Buildings Wiki, 2020)

5.6.3 Construction Consolidation Centre (CCC):

A construction consolidation centre (CCC) is a distribution facility that can be used in the process of managing construction project logistics and channelling material deliveries to a large single construction site or a number of different sites. It facilitates the efficient flow of materials through the supply chain and reduces waste and other issues such as congestion. The construction materials are delivered from suppliers to the CCC where they are stored until call-off from the site, at this point, the CCC operator makes up and delivers a consolidated load on a 'just-in-time' basis. This has the advantage of keeping the site clear of obstacles. It also cuts down on the required storage space and ensures that the logistics manager is aware that the materials are available close-at-hand. (Young et al., 2004, Lundesjö, 2015, Andersson et al., 2018, Designing Buildings Wiki, 2020, Designing Buildings Wiki, 2021)

In context of humanitarian constructions, relief items and aid workers must be deployed upon emergency as fast as possible with little or no clear information on needs, volumes or even the state of the infrastructure needed to deliver the goods to the beneficiaries. Nevertheless, the unpredictability of the demand hinders the capacity of humanitarian organizations to respond to a real demand. (Vega et al., 2020) For this reason, setting up such construction consolidation centers (CCC) enables reliable planning of the (grouped) transport of construction materials. The humanitarian organizations/ logisticians/ contractors will be more likely to stock up with extra raw materials that are critical for the continuation of the humanitarian construction projects. (Hillegersberg et al., 2020) The shared construction consolidation centers can set up jointly for several humanitarian construction projects that make it possible to keep total stocks and costs low. Containers filled with the correct material produced on a certain day and materials can be transported daily to the construction site. (Hillegersberg et al., 2020, Janné et al., 2020) Sometimes a construction consolidation center is situated in the middle of several different sites. However, it can be more sensible to have two smaller construction consolidation centers, each of which are closer to the respective sites, than one large construction consolidation center. (Janné et al., 2020)

There are many advantages from the implementation of the CCC approach in Humanitarian Construction Logistics (HCL). The usage of the CCC has led to fewer deliveries to site, and the temporary storage of materials has shifted from the site to the CCC. It can be used as a buffer to cover for unplanned changes in the production schedule and to make it possible to call-off JIT-deliveries when needed. It can also be a lever to excel in productivity at site. Fewer deliveries lead to reduced transportation costs, less disturbance, increased labour productivity and a reduction in material wastes. (Lundesjö, 2011, Whitlock et al., 2018, Janné et al., 2020) Furthermore, a CCC is a place for the unused materials to be returned: excess packaging can be removed rather than create clutter on site, manufacturer errors or damage can be detected there rather than when delivered to site, and the delivery of materials can be sequenced (Young et al., 2004, Designing Buildings Wiki, 2021)

From a storage point of view, The CCC can reduce the cost of the supply chain by reducing the on-site inventory and the possibility of ordering larger quantities to a lower price when not being limited to the available space on the construction site. Larger orders can also be separated in the CCC and then shipped out to the construction site, which would also be cost-

efficient. Since a humanitarian organization can use the CCC in several humanitarian projects, the overall safety stock can be reduced as all the projects can share the safety stock, which lowers the total stock. (Lundesjö, 2015)

The CCC is a buffer storage that is supposed to store material for a limited period before it is transported to the construction site. (Lundesjö, 2015, Andersson et al., 2018) Nevertheless, the CCC is used less than expected based on their benefits of precise deliveries, storage possibilities, productivity gains and environmental benefits. The main cause for this is the highly competitive procurement process, resulting in the fact that few are willing to trust that the savings of using a CCC would be fulfilled. (Lundesjö, 2015, Andersson et al., 2018) As the CCC is an extra node in the supply chain, the extra warehousing, handling, and personnel leads to extra costs, in despite of fewer and more efficient logistics operations on site. The poor layout of the CCC could impact efficiency, and this would reflect negatively on costs. In addition, the suppliers and sub-contractors are not used to working with a logistics arrangement and a consolidation centre, so that will create confusion on how to label, pack and deliver the materials. (Janné et al., 2020)

In the end, Construction Consolidation Centre (CCC) in Humanitarian Construction Logistics (HCL) is defined as an appropriately located distribution facility, where multiple bulk material deliveries are stored then transported to humanitarian-construction sites. A CCC presents a solution for humanitarian constructions as it is a single point of storage and administration for all the deliveries arriving to different sites that store them safely and securely. The daily needs of each site are then fed through consolidated loads, which results in a significant reduction in the volume of daily site deliveries. (Lundesjö, 2015) The Construction Consolidation Centre (CCC) brings the logistics professionals into the humanitarian construction team who impose discipline on how the materials are supplied to the workplace and take onsite distribution out of the hands of trade contractors, thus contractors can focus on construction process for better products and higher productivity. (Young et al., 2004)

5.7 Delivery Management in Humanitarian Construction Logistics (HCL):

Internationally, 30 percent of the overall costs of a construction project is directly or indirectly influenced by logistical factors; delivery alone accounts for an average of six percent of construction output. In context of Humanitarian Construction Logistics (HCL), delivery is the flow of resources used to satisfy the demand of humanitarian organization/s, such as materials, laborers, information, skills, and so on. It can also refer to competencies or a combination of resources. (Designing Buildings Wiki, 2020) For example, contractors must follow a variety of delivery methods within the humanitarian construction operations. They aim to follow international standards of delivery like reducing vehicle movements and material consumption and ensuring supplies are delivered just-in-time. These standards include agreements with suppliers to make comprehensive improvements in how materials and assemblies are designed, packaged, fabricated, in addition to planning and scheduling techniques to deliver efficiently to the workplace. (Young et al., 2004)

Effective delivery means, for example, better contracts, optimized routes, better utilization of transport systems, bundling transport legs and volumes, which can result in decreased costs for the suppliers and reduced total acquisition cost of materials, as well as higher levels of reliability, resource, and environmental protection. (Vidalakis et al., 2013)

In context of humanitarian constructions, key challenge is balancing between the humanitarian responsiveness and the efficiency of the delivery. The HOs attempt to reduce transportation costs by consolidating deliveries, loading full trucks, and maximizing the loading of trucks, which results in large quantities of materials, unnecessary moving and handling of materials sometimes, and increasing the risk of the materials being forgotten or stolen. (Vidalakis et al., 2013, Ekeskär et al., 2020) Nevertheless, the humanitarian organizations tend to focus more on quality than price in delivery. (Designing Buildings Wiki, 2020)

The oversupply in the humanitarian operations, or sudden bottlenecks in supplying the construction products and transporting resources require from Humanitarian Construction Logistics (HCL) to have the knowledge and practices, as clarified blow, to react appropriately and rapidly.

5.7.1 Smooth Delivery:

Smooth delivery activities involve a chronological distribution of tasks over the available timeframe and determining the resources, durations, and procedures necessary to ensure the works are completed in a way that optimises cost, timeframe, and quality. The resulting delivery plan should be clearly understandable, especially to those involved in carrying out the construction works. (CIOB, 2021) Smooth delivery is a means of looking at the humanitarian construction activities in the entire value chain and identifying how the activities can be balanced or 'smoothed' to reduce the amount of transport resources, materials and labour needed to carry out the task or activity. Delivery smoothing can be done at any level in the supply chain by humanitarian logisticians and /or contractors to even out the peaks and troughs in the demands during the humanitarian construction project. (WRAP, 2007)

Delivery management within the Humanitarian Construction Logistics (HCL) is a means by which the humanitarian organizations and suppliers can keep track of received materials, workforce, equipment, and plant. This is particularly important when a humanitarian organization has multiple projects to manage as efficient delivery can become very complicated. A well-managed delivery can be critical to profitability as delayed, misplaced, or lost items can incur avoidable delays and unnecessary costs. (Designing Buildings Wiki, 2020)

Smooth delivery constitutes a technique in Humanitarian Construction Logistics (HCL) that could be made available to site coordinators, representing an opportunity to both reduce freight requirements and improve labour output, especially within effected areas, by minimising the frequency of delivery through a comparison of expected material and labour demands against the forecast project activities. This is achieved by reviewing project activities in the entire chain and identifying whether the performance can be smoothed to decrease transport resources, materials and labour that is needed to carry out the activities. (Lundesjö, 2015)

For example, the smooth delivery for each resource can be attained by moving uncritical humanitarian construction activities to the next non-peak periods within projects. (Whitlock et al., 2018) The main challenge facing a smooth delivery within Humanitarian Construction Logistics (HCL) is the lack of standardization, structure, efficient communication, and digital support. That can hinder the contractor from planning deliveries and being notified when they arrive. (Lundesjö, 2015). Moreover, that could lead to a longer waiting time for the trucks and the un-deployment of available space for the delivered material. (Andersson et al., 2018)

5.7.2 JIT

In 2012, the Royal Institute of British Architects (RIBA) defined just-in-time (JIT) delivery, or just-in-time logistics as “receiving raw materials, products, and parts in the factory and then on site as they are needed, rather than days or even weeks before. This allows businesses to significantly cut inventory costs by having fewer unnecessary supplies on hand and means they have far less material to store and handle”. (Designing Buildings Wiki, 2021)

JIT delivery is a service of frequent deliveries in work packs or task loads, that are pulled just in time when there is a need to perform constructions without incurring any delays. (WRAP, 2007) The effectiveness and efficiency of JIT deliveries can be further improved by introducing a Construction Consolidation Centre for material and equipment deliveries. (WRAP, 2007, Lundesjö, 2015, Whitlock et al., 2018)

JIT in construction has also been referred to as ‘lean construction logistics’ as it has been estimated that effective logistics and JIT can reduce waste in construction by up to 35% because it adapts to lean production. (Designing Buildings Wiki, 2021) The handling costs of construction materials can be reduced by JIT practices as construction workers spend close to 15% of their working time moving materials and equipment from storage areas to the assembly area. (Sobotka et al., 2005, Ekeskär et al., 2020) Moreover, JIT deliveries reduce or even eliminate the need for on-site storage of materials, which improves the site logistics and reduces the risk of damage or loss of materials stored on-site. It also lowers congestion and the associated risks such as safety incidents. (WRAP, 2007, Designing Buildings Wiki, 2021)

In context of humanitarian, Just-In-Time (JIT) deliveries are well-known and commonly used especially in affected areas. JIT delivers materials and/or equipment as close as possible when needs arises. This enables the tasks to be executed without delay while substantially decreasing the requirement for on-site material storage. (Lundesjö, 2015, Whitlock et al., 2018) JIT in Humanitarian Construction Logistics (HCL) exemplifies that suppliers with their competence may be a source of value-adding services on the construction site, including packaging materials in order of installation, sequence deliveries, and scheduling JIT deliveries according to the installation process to avoid storage of materials on the construction site. A supplier might even go further and install a component, instead of having a subcontractor on the construction site for that task. (Ekeskär et al., 2020, Designing Buildings Wiki, 2021)

On the other hand, wrong JIT planning or sudden changes in humanitarian constructions could lead to serious delays. Therefore, the full collaboration between the parties of the humanitarian constructions and the suppliers is the most substantial foundation to apply JIT because late deliveries are considered a primary cause for a non-application of JIT. (Labib, 2016, Ekeskär et al., 2020, Designing Buildings Wiki, 2021) In addition, the humanitarian logisticians, in affected countries, have a huge tendency to buy, receive, and save materials at an early time to avoid any kind of inflation, delays or shortages of materials. (Labib, 2016)

In the end, JIT is one of the main practices that help reduce inventory level in Humanitarian Construction Logistics (HCL), which leads to effectiveness and efficiency in time, cost, and quality through bringing materials when needed (Vidalakis et al., 2013, Lundesjö, 2015, Labib, 2016, Whitlock et al., 2018)

5.8 Sustainable Humanitarian Construction Logistics (HCL):

The primary responsibility of Humanitarian Construction Logistics (HCL) is to deliver the appropriate supplies, in good condition and in the quantities required, to the right places and the people who need them, on time and cost effectively. In addition to this fundamental job description, there is a new trend to add the description of "appropriate supplies," meaning that they meet the criteria of minimizing pollution, embodied energy, and the negative impact on the environment. Procurement should not be based only on cost, timeliness, and availability, but also on verifying that the source of material is legal and sustainable, while simultaneously seeking to minimize the energy used for the transportation. (Good, 2010) These aspects and descriptions are added to Humanitarian Construction Logistics (HCL) by humanitarian organizations because of the massive rebuilding efforts after disasters which requires a huge number of these building materials as part of the global demand for raw materials. The fact that communities need to rebuild the infrastructure, that took decades or even centuries to build, and must do so within a much shorter recovery timeframe, that means there will be a rapid and intense demand for raw materials. The extraction of minerals, sand, or clay is likely to increase to an unsustainable rate in the years immediately following a disaster, particularly if the goal is to rebuild to the same level of infrastructure that had previously existed. The urgent demand for raw materials in the reconstruction ultimately impacts the environment and the people who depend on it.

In order to ensure that recovery following a disaster does not make communities more vulnerable, the staff involved in designing buildings and procuring materials should ensure that their material choices take advantage of available opportunities to maximize environmental performance. (Good, 2010, Klenk, 2010). Therefore, there are many initiatives like the one by Global Shelter Cluster (GSC) and Global Logistics Cluster (GLC), who are working closely on environmental protection in humanitarian logistics and focusing on reducing the impact of waste and transport linked to humanitarian operations. Moreover, IFRC is one of several large humanitarian agencies that will be a partner in this project with the GLC. IFRC collaborates in activities related to the green procurement, green disposal, and green reverse logistics of construction materials and shelter items, as well as the application of circular economy concepts to reduce building materials waste. (Wynveen, 2021) As a result, sustainable Humanitarian Construction Logistics (HCL) mean that the principles of sustainable development are applied to the comprehensive construction cycle, from the extraction and processing of raw materials through to planning, design, and construction of buildings and infrastructure. It is also concerned with the final deconstruction of any building and the management of the resultant waste. (Klenk, 2010) The final aim is to address the needs of the humanitarian community, which seek increasingly to evaluate and refine procurement and supply chain processes, looking to achieve of increased speed, transparency, reliability, reduced cost, and enhanced environmental sustainability. (USAID, 2020) Therefore, many approaches like green, eco-design, localization, and recycling are recommended to implement within the Humanitarian Construction Logistics (HCL), as explained in the following sections:

5.8.1 Green in Humanitarian Construction Logistics (HCL):

The term 'Green supply chain management' (GSCM) refers to the concept of integrating sustainable environmental processes into the traditional supply chain. This can include processes

such as product design, material sourcing and selection, manufacturing and production, operation, and end-of-life management. (Designing Buildings Wiki, 2020)

The same approach could be applied to humanitarian supply chains, that is the management of goods and information among all actors involved in supporting the people in need, that are often designed with an emphasis on responding quickly. That usually implies that little thought is given to environmental impacts of humanitarian operations. (Vad et al., 2020) This environmental impact, in context of humanitarian constructions, is significant when we account for the manufacturing, transportation, use and end-of-life steps of the different products used in an emergency response, such as shelter materials, tents, prefabricated units, and others. (Gårdestedt, 2019) Therefore, the green Humanitarian Construction Logistics (HCL) approach seeks to ensure a minimized adverse impact on the environment resulting from the emergency response systems applied. Applying green Humanitarian Construction Logistics (HCL) as a mainstreamed approach will facilitate a swifter recovery and build in the communities with a further opportunity of enabling more innovations and environmentally sustainable solutions to be promoted and established. (IFRC, 2021)

The best practices of this approach, in a humanitarian context, is establishing green procurement criteria, revising items' specifications, introducing new materials and other resources for procurement, and redesigning the supply chain strategy. For example, IFRC follow these practices like using shorter distances, optimizing product supply approach, prepositioning, and others. (Vad et al., 2020) Therefore, the procurement process is an excelling time to assess and commit to green Humanitarian Construction Logistics (HCL). Green procurement considers the environmental, social, and economic consequences of design, materials used, manufacturing methods, logistics and disposal. (Gårdestedt, 2019)

In addition, green practices in humanitarian construction supply chain involves driving value creation throughout the supply chain organisations to reduce the total environmental impact. The tangible benefits of this approach include greater efficiency of assets, less waste production, greater innovation, reduction of production costs, reuse of raw materials, increased profitability, perception of added value to the client base, and so on. (Designing Buildings Wiki, 2020)

The main challenge of green Humanitarian Construction Logistics (HCL) approach is related to upstream and downstream partners. A much greater degree of collaboration, transparency and integration of supply chain processes and systems is required for the initiative to be effective. (Designing Buildings Wiki, 2020)

In the end, the aim of green Humanitarian Construction Logistics (HCL) is integrating environmental and social considerations alongside the typical price and quality considerations into the humanitarian organizations which handle humanitarian-purposed constructions.

5.8.2 Eco-Design in Humanitarian Construction Logistics (HCL):

Saving lives and reducing the suffering should always remain at the heart of an emergency response operation. Eco-design logistics are very much a change of mind-set prior to and during the response phase, where traditional disaster response operations are supplemented with consideration for the environment and ecosystems. (IFRC, 2021) The Humanitarian Construction Logistics (HCL) support actions that minimize environmental impact, resource extraction, the use of energy, water, materials, and land, and prefer renewable resources to nonrenewable ones. The eco-design Humanitarian Construction Logistics (HCL) also minimize the use of potentially harmful materials and other nonreusable and/or nondegradable materials

that can have negative effects on the environment following a disaster. (Klenk, 2010) Therefore, the humanitarian construction projects that use this approach in logistics will reduce:

- The tonnage of waste sent to landfills or for treatment.
- The raw material requirements and the need to manage re-use and recycle excess materials.
- The carbon footprint from CO2 emissions associated with extracting, processing/ manufacturing, and transporting material. (WRAP,2007)

The Humanitarian Construction Logistics (HCL) could implement a green eco-design approach by following many strategies like the following:

1. Selection of low-impact materials such as clean materials, renewable materials, low energy-content materials, recycled materials, and eco-friendly materials.
2. Reduction of material usage such as reduction in weight, reduction in transport/ volume, reduction in energy consumption, reduction in generated waste, removal of products that do not meet the required quality norms.
3. Optimization of production techniques such as alternative production techniques, fewer production steps, low/clean energy consumption, less production waste, few/clean production consumables.
4. Optimization of the distribution system such as less/clean/reusable packaging, energy-efficient transport mode, energy-efficient logistics. (Remmerswaal et al., 2002)

There are many practical examples of the implementation of these strategies in humanitarian logistics. The first example is tent pegs, that are widely used for shelter. They were originally made of aluminum, but at some point, the aluminum was replaced by carbon fiber to make them lighter and reduce their environmental impact. ICRC ultimately decided to go back to aluminum. The problem was that people living in the camps were able to repair tent pegs made of aluminum on their own, but they could not fix the ones made of carbon fiber. For that reason, aluminum turned out to be the choice. (Vad et al., 2020, IFRC, 2021)

The second example of eco-design logistics is tarpaulins, which are large sheets of strong, flexible, water-resistant material that are used to make tents. ICRC usually makes these tarpaulins with metal eyelets to put up tents quickly and efficiently. The problem was that the use of eyelets lowered the quality of the tarpaulins. ICRC found ultimately that pre-punched holes are a better solution. (Vad et al., 2020)

The main challenge of eco-design Humanitarian Construction Logistics (HCL) is the degree of the clients' and contractors' commitment to reduce their impact on the environment. (WRAP, 2007)

In the end, eco-design Humanitarian Construction Logistics (HCL) encourage the use of alternative / complementary supply chains, multiple sources, the reuse of salvaged materials, alternative materials, and eco-production processes to reduce any long-term adverse impact on the local environment. (Klenk, 2010).

5.8.3 Localization in Humanitarian Construction Logistics (HCL):

This is a model that is being increasingly adopted in the humanitarian organizations worldwide as they seek to increase socio-economic responsibility when delivering humanitarian constructions. They seek to involve the local suppliers and contractors in the design

process. (Designing Buildings Wiki, 2020) A trend that was reinforced by different humanitarian organizations set to purchase all materials locally (trucks, labors, materials…etc.) to address the logistical challenges of emergency sheltering programs like mass distribution, even if they have to buy local materials at high prices. They pay attention to the principle of sustainable management of local resources as the usage of alternative materials was not pursued due to transportation issues and the potential for further delays. On the other hand, the shortage of local materials could delay the implementation of the project. (Ashmore et al., 2009)

There are many examples of localization practices which are inserted within Humanitarian Construction Logistics (HCL). For example, OCHA considers forming a team managed by community members to erect some sample tents with drainage ditches and supplying them with tools for putting up tents. This will ensure that tents are correctly erected, and communities participate in putting them up. In this way, teams of people may put all of the tents ready for families in any refugee camp. (OCHA, 2004) Peace Winds conducted a cash-for-work (CFW) program that provides short-term employment opportunities for the Syrian refugees in camps as workers for the project. Peace Winds also provided building materials to communities for self-organizing construction. That has led to a quick installation of safe shelters for the refugees themselves. (Peace Winds, 2021) The IFRC demonstrates that there are opportunities for local procurement, whilst ensuring that the quality, sustainability, and environmental impact of that procurement process is considered. It also ensures the capacity to provide high volume if required. The IFRC shows that local pre-position stocks lead to less freight emissions, more efficiency and cost- effectiveness within Humanitarian Construction Logistics (HCL), such as the local pre-position of water-purification units instead of water-bottles. (IFRC, 2021)

5.8.4 Recycling in Humanitarian Construction Logistics (HCL):

The demands of humanitarian assistance continue to rise in parallel with an increasingly urgent and underfunded waste management crisis. This waste management crisis disproportionately affects countries that commonly receive humanitarian assistance, which comes as a result of the lack in sufficient infrastructure or management systems to handle regularly produced waste, let alone the waste generated by assistance efforts. (USAID, 2020) The literature review found that the implementation of a waste management plan can reduce the environmental impact by focusing on the reuse and recycling processes. (Tischer et al., 2013) Therefore, the logistics managers in the humanitarian organizations started paying more attention to using building materials that have recyclable content where practical to reduce demand on natural resources and to lower the project's human and environmental impact. For example, the reuse of debris is common e.g., damaged wood boats can be used for timber building material, and broken cement blocks can be used for filling. (Klenk, 2010) In addition, they started paying more attention to the issue of packaging waste, since packaging serves an essential function in commodity delivery and protection within Humanitarian Construction Logistics (HCL); which also often becomes an unintended waste stream in the most fragile and strained operational humanitarian contexts. (USAID, 2020)

Furthermore, humanitarian construction logisticians started selecting building materials as well as project designers who can support, by their designs, the future recycling of the building's materials once the need for the building has ended. That leads to recycling the component of humanitarian-purposes buildings partially or entirely which can be easily reused.

As a result, buildings are often constructed with an inherent capacity to be dismantled and their components reused. Building deconstruction practices may offer a source of high-quality materials to assist in improving the recovery process. (Klenk, 2010)

The logisticians are also involved in the disposal of waste streams, which can be sorted on site and returned to the material cycle directly from site despite challenges related to large-scaled humanitarian constructions. (Tischer et al., 2013) Their works focus on designing and implementing the impactful solutions to Humanitarian Construction Logistics (HCL) like minimizing packages, which in turn reduces the damage caused to people and the environment while respecting the lifesaving imperative of humanitarian assistance. (USAID, 2020)

There are many challenges that are related to recycling, such as higher costs incurred by the collection and separation of waste on site and the associated monitoring and coordination of the logistical processes. (Tischer et al., 2013) In addition, the limitation of time, resources, and environmental infrastructure frequently lead to poor waste management in Humanitarian Construction Logistics (HCL). (USAID, 2020) Furthermore, special care should be taken to ensure that the reused materials are high quality enough to be used for safe and long-lasting construction, and that the quantity of available debris, transportation and any processing costs should be taken into account in logistics budgeting. (Klenk, 2010)

In the end, the effective Humanitarian Construction Logistics (HCL) can reduce the costs of disposal by recycling waste and implementing waste management. (Tischer et al., 2013) By supporting the reuse of materials in building construction, logistics managers can also provide economic opportunities for disaster-affected people through creating a market dedicated for the deconstruction of existing structures and the reuse of materials. (Klenk, 2010)

6. Conclusion:

Humanitarian Construction Logistics (HCL) comprises the planning, the coordination, and the supervision of material flow to, within, and from construction-sites. The Humanitarian Construction Logistics (HCL) approach aims to promote the benefits of good logistics and supply chain management for humanitarian-purposes construction, recovery, and rehabilitation projects which save time and construction costs. This dissertation explored a new approach within humanitarian logistics towards to humanitarian-purposes constructions, recovery, and rehabilitations by investigating the case study systematically, visiting sites for informal interviews, as well as, studying the involved materials and academic sources. That leads to establishing facts, reaching new conclusions, and recommending solutions.

The critical exploration for re/building activities, which have been conducted by humanitarian organizations based in Syria and their local partners, was able to set a feasible approach to optimize the theory for Humanitarian Construction Logistics (HCL).

The definitions, framework, components of Humanitarian Construction Logistics (HCL), explored by the dissertation through the research processes and procedures, combined humanitarian affairs and construction logistics approaches. This aids in understanding the importance of Humanitarian Construction Logistics (HCL) through the stages of planning, designing, and implementation of constructions by analyzing their relationship with multidisciplinary sectors like shelter, WASH, rehabilitation, cash, voucher, prefabrications, sustainability …etc.

It remains for future research to verify if the results of the Syrian case study can be generalized. For this, further case studies of real-world examples are necessary. At the same time, it would be interesting to know the main factors to leverage of Humanitarian Construction Logistics (HCL) and how to measure Humanitarian Construction Logistics (HCL) influences on the multidisciplinary humanitarian sectors and how to decrease the costs of Humanitarian Construction Logistics (HCL).

Many existing and new practices were proposed by suppliers, academia, stakeholders, and private sectors to identify a range of effective logistics solutions, new materials, and technical options. For example, analyzing the Syrian case highlighted the positive role of the localization approach, where local labor and materials were key factors in the effectiveness of the Humanitarian Construction Logistics (HCL). The localization approach had significant economic impacts on disaster-affected local communities as they worked to contribute to their own recovery.

Promotion of appropriate local materials and logistical techniques had assisted to reduce the suffering of affected people and ensured that the delivery of humanitarian construction projects was effective, efficient, and swift. For example, promoting concepts within Humanitarian Construction Logistics (HCL), like material logistics planning (MLP), BIM, blockchain, GIS, RFID, eco-design, and others, promote tidy construction sites and efficient project delivery.

Furthermore, most humanitarian organizations have policies related to the environment, but these policies are often not consistently implemented, monitored, or evaluated throughout Humanitarian Construction Logistics (HCL). Therefore, there is a tremendous approach to incorporate sustainable environmental practices within Humanitarian Construction Logistics (HCL) as a route to improve the potentials of people, communities, and economies worldwide.

This dissertation's ambition is to encourage all humanitarian organizations and aid workers to include logistics and supply chain management skills as part of humanitarian-construction projects. That will later help implement positive logistics initiatives and benchmarking within Humanitarian Construction Logistics (HCL) that serve non-profit/ humanitarian construction projects. Consequently, stakeholders will be pushed to find a way to integrate the logistics management into the everyday process of humanitarian constructions. Accomplishing that requires a structured and systematic work-procedures for transportation and logistics since the planning stage of the humanitarian construction projects. Besides, the humanitarian logisticians must integrate concepts like a joint distribution mechanism and a joint procurement to manage cost-effective supply chains, reduce the logistics overheads, and allow humanitarian aid workers to concentrate on giving direct assistance to beneficiaries.

In the end, this dissertation highlights the importance of investment in research on logistics development, that is done by the humanitarian organizations and other stakeholders to reach an optimal systematic structure of Humanitarian Construction Logistics (HCL). Upon achieving this structure, humanitarian agencies will be able to use overall emergency funds effectively due to economies of scale and less logistics overheads. As a result, further research is necessary to define the robust frameworks of efficient Humanitarian Construction Logistics (HCL) management as well as to integrate sustainable and technological solutions to the overall processes.

References

Agapiou, Andrew et al. "The role of logistics in the materials flow control process." *Construction Management & Economics*, vol.16, no.2,1998, pp.131-137. https://doi.org/10.1080/014461998372420

Ahmed, Sonia. "Modeling System for The Rapid Construction in Syria." *Business & IT*, vol. VI, no. 1, 2016, pp. 7–13. https://doi.org/10.14311/bit.2016.01.02

Almohsen, Abdulmohsen and Ruwanpura, Janaka." Logistics Management in The Construction Industry." Proceedings, *Annual Conference - Canadian Society for Civil Engineering*, vol.4, 2013. https://www.researchgate.net/publication/265942527

Andersson, Oskar, and Andreas, Nilsson. "Planning for Construction Logistics an Evaluation and Development of a Construction Logistics Plan at Serneke." *Chalmers Open Digital Repository*, 2018. https://odr.chalmers.se/handle/20.500.12380/255901

Arewa, Andrew Oyen. "Research for Construction Management." *Future Learn*, *Coventry University*, 2020. www.futurelearn.com/courses/research-construction-management

Arewa, Andrew Oyen. "An Introduction to Financial Management in Construction." *Future Learn, Coventry University*, 2020. https://www.futurelearn.com/courses/introduction-to-financial-management-in-construction-and-basic-accounting-conventions

Ashmore, Joseph, et al. "Shelter Projects 2008, IASC Emergency Shelter Cluster." *Relief Web*, IFRC, UN-HABITAT, UNHCR, 18 June 2009. https://reliefweb.int/report/world/shelter-projects-2008-iasc-emergency-shelter-cluster

Baharmand, Hossein, et al. "Exploring the Application of Blockchain to Humanitarian Supply Chains: Insights from Humanitarian Supply Blockchain Pilot Project." *International Journal of*

Operations & Production Management, vol. ahead-of, no. ahead-of-print, 2021. https://doi.org/10.1108/IJOPM-12-2020-0884

Bataglin, Fernanda Saidelles, et al. "4D BIM Applied to Logistics Management: Implementation in the Assembly of Engineer-to-Order Prefabricated Concrete Systems." *Ambiente Construído*, vol. 18, no. 1, 2018, pp. 173–92. https://doi.org/10.1590/s1678-86212018000100215

Bryman, Alan. "Social Research Methods.3rd edition." *Oxford University Press*, 11 May 2008. ISBN-13: 978-0199202959

Bryman, Alan and Bell, Emma. "Business Research Methods." *Oxford University Press*, 2015, Oxford, UK. ISBN: 9780199668649

Chandes, Jérôme and Paché, Gilles. "Investigating humanitarian logistics issues: from operations management to strategic action." *Journal of Manufacturing Technology Management*, vol. 21, no. 3, 2010, pp. 320-340. https://doi.org/10.1108/17410381011024313

CIOB (The Chartered Institute of Building). "Scheduling Construction Activities." *Designing Buildings Wiki,* 21 Jan. 2021. www.designingbuildings.co.uk/wiki/Scheduling_construction_activities

CIVIC (Construction in Vicinities: Innovative Co-creation). "Smart Construction Logistics Keeps Cities Livable: Chaos is a Choice." *CIVIC*, 7 Apr. 2017. www.civic-project.eu/en/news/smart-construction-logistics-keeps-cities-livable-chaos-choice

CIVIC (Construction in Vicinities: Innovative Co-creation). "CIVIC at Transport forum." *CIVIC*, 16 January. 2018. https://www.civic-project.eu/en/news/civic-transportforum

Cozzolino, Alessandra. "Chapter 2. Humanitarian Logistics and Supply Chain Management." *Humanitarian Logistics - Cross-Sector Cooperation in Disaster Relief Management*, New York-United States, United States, Springer Publishing, 2012, pp. 5–16.

Cronin, Patricia, et al. "Undertaking a Literature Review - a Step by-Step Approach." *British Journal of Nursing*, vol.17, no.1, 2008, pp.38-43. https://doi.org/10.12968/bjon.2008.17.1.28059

Croom, Simon. "Introduction to Research Methodology in Operations Management." Karlsson, Christer (Ed.) *Researching Operations Management, Routledge*, 2009. http://202.62.95.70:8080/jspui/bitstream/123456789/4027/1/Researching%20Operations%20Management.pdf

Crown Agents. "Conflict Pollution: Crown Agents' Approach to Rehabilitating Post-War Urban Landscapes." *Crown Agents*, 22 Jan. 2021. www.crownagents.com/blog-post/conflict-pollution-crown-agents-approach-to-rehabilitating-post-war-urban-landscapes/#_ftn1.

Crown Agents. "Syria Rehabilitation." *Crown Agents*, 2021. www.crownagents.com/project/syria-rehabilitation

Dahia, Jaafar. "Shelter Sector End Year Report – 2018." *UNHCR*, 2018. www.unhcr.org/sy/wp-content/uploads/sites/3/2019/04/2018-Shelter-Year-End-Report.pdf.

De la Torre, Luis E., et al. "Disaster relief routing: Integrating research and practice." *Socio-Economic Planning Sciences*, vol.46, no.1, 2012, pp. 88–97. https://doi.org/10.1016/j.seps.2011.06.001

Designing Buildings Wiki. "Green Supply Chain Management." *Designing Buildings Wiki*, 16 Oct. 2020. www.designingbuildings.co.uk/wiki/Green_supply_chain_management

Designing Buildings Wiki. "Logistics Management in Construction." *Designing Buildings Wiki*, 18 Sept. 2020. www.designingbuildings.co.uk/wiki/Logistics_management_in_construction

Designing Buildings Wiki. "Material handling in construction." *Designing Buildings Wiki*, 18 Sept. 2020. https://www.designingbuildings.co.uk/wiki/Material_handling_in_construction

Designing Buildings Wiki. "Construction inventory management." *Designing Buildings Wiki*, 09 Oct. 2020. https://www.designingbuildings.co.uk/wiki/Construction_inventory_management

Designing Buildings Wiki. "Site layout plan for construction." *Designing Buildings Wiki*, 27 Aug. 2020. https://www.designingbuildings.co.uk/wiki/Site_layout_plan_for_construction

Designing Buildings Wiki. "Construction waste." *Designing Buildings Wiki*, 16 Nov. 2020. https://www.designingbuildings.co.uk/wiki/Construction_waste

Designing Buildings Wiki. "Supply in construction." *Designing Buildings Wiki*, 06 Nov. 2020. https://www.designingbuildings.co.uk/wiki/Supply_in_construction

Designing Buildings Wiki. "Design for Manufacture and Assembly (DfMA)." *Designing Buildings Wiki*, 2 Sept. 2020. www.designingbuildings.co.uk/wiki/Design_for_Manufacture_and_Assembly_(DfMA).

Designing Buildings Wiki. "Site Storage." *Designing Buildings Wiki*, 16 Nov. 2020. www.designingbuildings.co.uk/wiki/Site_storage

Designing Buildings Wiki. "Programme for Building Design and Construction." *Designing Buildings Wiki*, 28 Aug. 2020. www.designingbuildings.co.uk/wiki/Programme_for_building_design_and_construction

Designing Buildings Wiki. "Quantity Surveyor." *Designing Buildings Wiki*, 1 Sept. 2020. www.designingbuildings.co.uk/wiki/Quantity_surveyor

Designing Buildings Wiki. "Material shortage on construction projects." *Designing Buildings Wiki*, 05 Jan. 2021. https://www.designingbuildings.co.uk/wiki/Material_shortage_on_construction_projects

Designing Buildings Wiki. "Construction Consolidation Centre (CCC)." *Designing Buildings Wiki*, 15 Apr. 2021. www.designingbuildings.co.uk/wiki/Construction_consolidation_centre_(CCC).

Designing Buildings Wiki. "Just in Time." *Designing Buildings Wiki*, 8 Apr. 2021. www.designingbuildings.co.uk/wiki/Just_in_time

Disaster Ready. "Technical Project Management (TPM) in WASH Emergencies - Online Course." *DisasterReady.Org*, 2021. https://get.disasterready.org/wash/

Eisenhardt, Kathleen. "Building theories from case study research." *The Academy of Management Review*, vol.14, no.4, Oct 1989, pp.532–550.

Ekeskär, Andreas and Rudberg, Martin "Third-party logistics in construction: the case of a large hospital project." *Construction Management and Economics*, vol. 34, no.3, 2016, pp.174-191. https://doi.org/10.1080/01446193.2016.1186809

Ekeskär, Andreas and Rudberg, Martin. "Third-Party Logistics in Construction: Perspectives from Suppliers and Transport Service Providers." *Production Planning & Control*, 2020, pp. 1–16. https://doi.org/10.1080/09537287.2020.1837932

European Construction Institute. "Total Productivity Management: Guidelines for the Construction phase." *European Construction Institute*, June 1994. http://www.eci-online.org/wp-content/uploads/2015/11/ECI-ARC11-Total-Productivity-Management-Guidelines-for-the-Construction-Phase.pdf

Fadiya, Olusanjo "Development of An Integrated Decision Analysis Framework for Selecting ICT-Based Logistics Systems in The Construction Industry." *University of Wolverhampton*, 2012. https://wlv.openrepository.com/handle/2436/250494

Flick, Uwe. "An Introduction to Qualitative Research." *SAGE Publications Ltd*, Fourth edition, 5 March 2009, London, UK. ISBN-13: 978-1847873248.

Gårdestedt, Caroline. "Green Response." *Presentation, Swedish Red Cross, ICRC, IFRC*, 2 Dec. 2019.

Getuli, Vito, et al. "A BIM-Based Construction Supply Chain Framework for Monitoring Progress and Coordination of Site Activities." *Procedia Engineering*, vol. 164, 2016, pp. 542–549, https://doi.org/10.1016/j.proeng.2016.11.656

Good, James. "Module 5: Green Guide to Materials and the Supply Chain." *World Wildlife Fund (WWF) Environment and Disaster Management (EDM) Program*, InterWorks LLC, 2010. https://envirodm.org/training/eng/green-guide-to-materials-and-the-supply-chain

Hanken University. "Humanitarian Logistics." *Hanken University*, 2021. www.hanken.fi/en/apply/masters-degree-programme-english/business-and-management/track-humanitarian-logistics

Hasenclever, Tobias, et al. "Logistics Management in the construction industry." Gunther W., Borrmann A. (eds), *Digital construction site-innovative planning, more efficient execution*, 1st edition. Springer, Berlin, 2011, pp. 205–287. https://doi.org/10.1007/978-3-642-16486-6_5

Heyns, Andries. "Field Experience as a GIS Specialist for Doctors Without Borders in Sudan – Tigray Refugee Crisis." *Humlog Blogs*, 30 Apr. 2021. blogs.hanken.fi/humlog/2021/04/30/field-experience-as-a-gis-specialist-for-doctors-without-borders-in-sudan-tigray-refugee-crisis

Hillegersberg, Jos-Van and Voordijk, Hans. "Supply Chain Innovation." *Future Learn, University of Twente*, 2020, www.futurelearn.com/courses/supply-chain-innovation

House Matic. "Prefabricated Modular Buildings and Houses - Integral Solutions for Emergency Situations Worldwide." *House Matic*, 2021, www.house-matic.com/en

ICRC Syria." Water and sanitation." *The International Committee of the Red Cross*, 2020. https://www.icrc.org/en/what-we-do/water-habitat

IFRC. "Suppliers - IFRC." *IFRC.org*, 2021. https://www.ifrc.org/suppliers

InterAction and USAID/OFDA. "Humanitarian Shelter and Settlements- Online Training." *Disaster Ready*, InterAction, USAID/OFDA, 2020, www.disasterready.org/humanitarian-shelters-settlements

Jahre, Marianne, et al. "Approaches to the design of refugee camps: An empirical study in Kenya, Ethiopia, Greece, and Turkey." *Journal of Humanitarian Logistics and Supply Chain Management*, vol. 8 no. 3, 2018, pp. 323-345. https://doi.org/10.1108/JHLSCM-07-2017-0034

Janné, Mats.” Construction Logistics Solutions in Urban Areas.” *Linköping Studies in Science and Technology, Licentiate Thesis*, No. 1806, 2018, http://liu.diva-portal.org/smash/record.jsf?pid=diva2%3A1200736&dswid=-8131

Janné, Mats, et al. “Smart Construction Logistics.” *Construction in Vicinities: Innovative Co-creation (CIVIC)*, June 2018, https://www.civic-project.eu/sites/default/files/content/bilder/civic-handbook_digital-2.pdf

Janné, Mats, and Rudberg, Martin. “Effects of Employing Third-Party Logistics Arrangements in Construction Projects.” *Production Planning & Control*, 2020, pp. 1–13. https://doi.org/10.1080/09537287.2020.1821925

Jesson, Jill, et al. “Doing Your Literature Review - Traditional and Systematic Techniques.” *SAGE Publications Ltd*, March 2011, London, UK.

Klenk, Jeffrey. “Green Guide to Construction.” *World Wildlife Fund (WWF) Environment and Disaster Management (EDM) Program*, InterWorks LLC, 2010. https://envirodm.org/training/eng/green-guide-to-construction

Knight, Andrew, and Ruddock, Les. “Advanced Research Methods in the Built Environment.” *Wiley-Blackwell*, 2008. https://www.wiley.com/en-us/Advanced+Research+Methods+in+the+Built+Environment-p-9781444309515

Kovács, Gyöngyi, and Spens, Karen. “Humanitarian Logistics in Disaster Relief Operations.” *International Journal of Physical Distribution & Logistics Management*, vol. 37, no. 2, 20 Mar. 2007, pp. 99–114. https://doi.org/10.1108/09600030710734820

Ko, Vanessa, and Verity, Andrej. "Blockchain For the Humanitarian Sector: Future Opportunities." *Academia*, OCHA, 9 Dec. 2016. www.academia.edu/30287787/Blockchain_For_The_Humanitarian_Sector_Future_Opportunities.

Labib, Yaser. "Lean Framework for Assessing Construction Logistics in Jordan." *The University of Salford*, UK, 2016. http://usir.salford.ac.uk/id/eprint/41280/

Lundesjö, Gregor. "Supply Chain Management and Logistics in Construction: Delivering Tomorrow's Built Environment." *Kogan Page*, 2015. https://www.koganpage.com/product/supply-chain-management-and-logistics-in-construction-9780749472429

Magill, Leslie J., et al. "4D BIM Integrated Construction Supply Chain Logistics to Optimise On-Site Production." *International Journal of Construction Management*, 2020, pp. 1–10. https://doi.org/10.1080/15623599.2020.1786623

Manuel Rodriguez-Lianes, Jose, et al. "Annual Disaster Statistical Review 2008 - The Numbers and Trends." *Centre for Research on the Epidemiology of Disasters (CRED)*, Brussels, 1 June 2009, www.researchgate.net/publication/266390026_Annual_Disaster_Statistical_Review_2008_-_The_Numbers_and_Trends.

McCabe, Martin and Montague, Adrian. "Construction Quality Management." *Future Learn, Chartered Institute of Building Academy*, 2020, www.futurelearn.com/courses/construction-quality

Médicos Sin Fronteras (MSF). "MSF Small Constructions Manual." *Humanitarian Library*, 2011. www.humanitarianlibrary.org/resource/msf-small-constructions-manual-2

Meredith, Jack. "Building Operations Management Theory Through Case and Field Research." *Journal of Operations Management (JOM)*, vol.16, issue.14, 25 Nov 1998, pp.441–454. https://doi.org/10.1016/S0272-6963(98)00023-0

Merminod, Nathalie, et al. "Streamlining humanitarian and peacekeeping supply chains: Anticipation capability for higher responsiveness." *Society and Business Review*, vol. 9, no. 1, 2014, pp. 4-22. https://doi.org/10.1108/SBR-06-2013-0048

Murray, Louise. "Disaster Relief: Humanitarian Architecture for Post-Disaster Shelter." *The Institution of Engineering and Technology*, 19 Jan. 2015. https://eandt.theiet.org/content/articles/2015/01/disaster-relief-humanitarian-architecture-for-post-disaster-shelter/

Mzyece, Dingayo. "Pre-Contract Management for Construction Projects: The Basics." *Future Learn, Coventry University*, 2020. www.futurelearn.com/courses/introduction-pre-contract-management-practices

Navaratne, Achala, et al. "Green Guide to Water and Sanitation." *World Wildlife Fund (WWF) Environment and Disaster Management (EDM) Program*, World Wildlife Fund, 2010. https://envirodm.org/training/eng/green-guide-to-water-and-sanitation

Nolen, Stephanie. "How This Innovative Temporary Tent Design Could Change the Way Refugees Live." *The Globe and Mail*, 18 Nov. 2015. www.theglobeandmail.com/life/home-and-garden/design/how-this-innovative-temporary-tent-design-could-change-the-way-refugeeslive/article27316668

NRC Syria. "NRC Syria Regional Paper June 2014.", *NRC Syria*,1 June 2014. https://www.nrc.no/countries/middle-east/syria/

OCHA. "A Guide to the Use and Logistics of Family Tents in Humanitarian Relief." ref nr. OCHA/ESB/2004/19. *Office for the Coordination of Humanitarian Affairs Emergency Services Branch/Logistics Support Unit*, 2004.

www.sheltercluster.org/sites/default/files/docs/Guide%20to%20the%20Use%20and%20Logistics%20of%20Family%20Tents.pdf.

Ohio University. "Engineering Management in Humanitarian Logistics." *Ohio University*, 7 Feb. 2020. https://onlinemasters.ohio.edu/blog/engineering-management-in-humanitarian-logistics/

Oosterwijk, Lisa. "Supply Chain Management with BIM: Towards Better Control of Construction Logistics." *Delft University of Technology*, 26 June 2017. https://repository.tudelft.nl/islandora/object/uuid%3Afdf72132-946e-4b72-9b27-d3a807e79937

Oxfam Syria. "Oxfam in Syria (What we do)." *OXFAM International*, 2020. https://www.oxfam.org/en/what-we-do/countries/syria

Oxfam Syria. "Oxfam in Syria aims to support the resilience of communities." *Oxfam International*, 2020. https://www.oxfam.org/en/what-we-do/countries/syria

Partington, David. "Building Grounded Theories of Management Action." *British Journal of Management*, vol.11, issue.2, June 2000, pp.91-102. https://doi.org/10.1111/1467-8551.00153

Peace Winds. "Middle East Programs." *Peace Winds*, 2021. http://peacewindsamerica.org/relief_recovery/middle-east-projects/

Ramadan, Adam. "Spatialising the refugee camp." *Transactions of the Institute of British Geographers*, vol. 38, no.1, 2013, pp. 65-77. https://doi.org/10.1111/j.1475-5661.2012.00509.x

Rebuild Syria Reconstruction Programme. "Ongoing Projects – Rebuild and Relief International (RRI)." *Rebuild and Relief International (RRI)*, 2021. https://rirp.org/category/ongoing-projects

Reigber, Alex. "Shelter Repair and Rehabilitation Guidelines 2018." *Shelter Cluster*, 29 Nov. 2018, www.sheltercluster.org/x-border-operation-turkey-hub/documents/shelter-repair-and-rehabilitation-guidelines-2018

Remmerswaal, Han, et al. “Environmentally Oriented Product Development.” 2nd edition, *Schoonhoven by Academic Service*, 2002. https://lib.ugent.be/catalog/rug01:001928338

Samuelsson, Stefan and Ahmetasevic, Mia. “Management of Construction Logistics in Stockholm: Identifying Ways of Improvement for Construction Logistics within the Inner City of Stockholm.” *The Faculty for Technology, Construction engineering*, *Uppsala University*, 2014. http://uu.diva-portal.org/smash/get/diva2:733476/FULLTEXT01.pdf

Sant'Anna, Douglas. “Humanitarian Logistics in Refugee Camp.” *LinkedIn*, 2016. https://www.linkedin.com/pulse/humanitarian-logistics-refugee-camp-douglas-sant-anna/

Sant'Anna, Douglas. “Humanitarian Logistics.” *LinkedIn*, 2016. https://www.linkedin.com/pulse/humanitarian-logistics-douglas-sant-anna/

Saunders, Mark, et al. “Research Methods for Business Students.” *Prentice Hall*, 2009. ISBN-13: 978-0273716860

Shelter Cluster / Syria. “Whole of Syria – Factsheets.” *Global Shelter Cluster*, 2021. https://www.sheltercluster.org/whole-syria/factsheets/2021-05

Shelter Projects Working Group. “A.8 Syria Conflict – 2011 Onwards - Overview.” *Global Shelter Cluster, shelterprojects.org*, 2014. www.shelterprojects.org/shelterprojects2013-2014/SP13-14_A08-Overview-Syria.pdf

Shelter Projects Working Group. “A.30 Syrian Arab Rep. 2015-2016 / Conflict”, *Global Shelter Cluster, shelterprojects.org*, 2016. https://shelterprojects.org/shelterprojects2015-2016/SP15-16_A30-Syria-2015-2016.pdf

Shelter Projects Working Group. “A.28 Syrian Arab Rep. 2015–2017 / Conflict.” *Global Shelter Cluster, shelterprojects.org*, 2017. https://shelterprojects.org/shelterprojects2017-2018/SP17-18_A28-Syria-2015-2017.pdf

Shelter Projects Working Group. "A.29 Syrian Arab Rep. 2017–2018 / Conflict." *Global Shelter Cluster, shelterprojects.org*, 2018. https://shelterprojects.org/shelterprojects2017-2018/SP17-18_A29-Syria-2017-2018.pdf

Shelter Projects Working Group. "A.31 Syrian Arab Rep. 2018 / Conflict." *Global Shelter Cluster, shelterprojects.org*, 2018. https://shelterprojects.org/shelterprojects2017-2018/SP17-18_A31-Syria-2018.pdf

Shibani, Abdussalam. "Construction Project Management: An Introduction - Online Course." *Future Learn, Coventry University*, 17 May 2021. www.futurelearn.com/courses/construction-project-management

Silverman, David. "Qualitative Research, Theory, Method and Practice." Fourth Edition, *ResearchGate*, January 1998. www.researchgate.net/publication/232481491_Qualitative_Research_Theory_Method_and_Practice

Sobotka, Anna, et al. "Logistics of Construction Projects." *Foundations of Civil and Environmental Engineering*, vol.1, no.6, 2005, pp. 203-216. http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.124.6468&rep=rep1&type=pdf

Tatham, Peter, and Martin Christopher. "Humanitarian Logistics: Meeting the Challenge of Preparing for and Responding to Disasters." 3rd edition, *Kogan Page*, 2018. ISBN-13: 978-0749481445

The Save the Children. "Introduction to Water, Sanitation, and Hygiene (WASH) in Emergencies." *Kaya*, 2020. Summary of Introduction to Water, Sanitation, and Hygiene (WASH) in Emergencies (kayaconnect.org)

Thunberg, Micael and Persson, Fredrik. “Using the SCOR model’s performance measurements to improve construction logistics.” *Production Planning & Control*, vol.25, issue.13-14, 04 May 2013, pp.1065-1078. https://doi.org/10.1080/09537287.2013.808836

Tischer, André, et al. “Efficient waste management in construction logistics: a refurbishment case study.” *Logistics Research*, vol.6, 2013, pp.159–171 https://doi.org/10.1007/s12159-013-0105-5

Towey, Donald. “Cost Management of Construction Projects.” *Wiley-Blackwell*, 2013. https://www.wiley.com/en-sy/Cost+Management+of+Construction+Projects-p-9781118473801

UNDP Syria. “UNDP in Syria.” *UNDP*, 2021. www.sy.undp.org/content/syria/en/home.html

UN-Habitat Syria. “Country Profile: Syria.” *Urban Humanitarian Response, United Nations Human Settlements Programme (UN-Habitat)*, 2016. www.urban-response.org/system/files/content/resource/files/main/Country%20Profile-Syria%20Eng%20Final.pdf

UN-HABITAT Syria. “Syria urban statistics.”, *UN-Habitat*, 2020. https://unhabitat.org/syria-urban-statistics

UN-Habitat Syria. “UN-Habitat Projects in Syria.” *UN-Habitat*,14 December 2020. https://mirror.unhabitat.org/categories.asp?catid=822

UNHCR. "Shelter and Non-Food Items (NFI) Sectors’ Publications." *UNHCR*, 2017. www.unhcr.org/sy/shelter-and-non-food-items-nfi-sectors-publications.

UNHCR. "Shelter." *UNHCR,* 2018. www.unhcr.org/sy/shelter.

UNHCR Syria. “Syria: UNHCR Operational Update.” *reliefweb*, December 2019. https://reliefweb.int/sites/reliefweb.int/files/resources/UNHCR%20Syria%27s%20Operational%20Update%20December%202019.pdf

UNICEF. "UNICEF, WFP Chiefs Wrap Up Two-day Visit to Syria, See Impact of Conflict on Children and Families." *UNICEF*, 2020. www.unicef.org/mena/press-releases/unicef-wfp-chiefs-wrap-two-day-visit-syria-see-impact-conflict-children-and-families.

UNICEF Supply Division. "High Performance Tents." *UNICEF*, January 2020. www.unicef.org/innovation/media/12701/file

UNICEF. "Water, Sanitation and Hygiene (WASH)." *UNICEF*, 2021. www.unicef.org/wash.

UNOCHA Syria Hub. "UNOCHA Syria Hub / 4 Ws Response." *UNOCHA Syria Hub*, 14 December. 2020. www.ocha-sy.org/4wsresponse2020.html.

USAID. "Joint Initiative for Sustainable Humanitarian Packaging Waste Management." *USAID*, Aug. 2020. www.usaid.gov/sites/default/files/documents/Fact-sheet-Joint-Initiative-On-Sustainable-Humanitarian-Packaging-Waste-Management.pdf.

Vad, Kathrine and Liwak, Anna Maria. "Sustainability in Humanitarian Action." *Future Learn*, *International Federation of Red Cross and Red Crescent Societies (IFRC), International Committee of the Red Cross (ICRC), Homuork*, 2020. www.futurelearn.com/courses/sustainable-development-humanitarian-action

Van Wassenhove, Luk." Humanitarian aid logistics: supply chain management in high gear." *Journal of the Operational Research Society*, vol.57, no.5, 2006, pp. 475–489. https://doi.org/10.1057/palgrave.jors.2602125

Vega, Diego, et al. "Introduction to Humanitarian Logistics Course - Online Course." *Future Learn, Hanken School of Economics*, 2020. www.futurelearn.com/courses/humanitarian-logistics.

Vidalakis, Christos and Sommerville, James. "Transportation responsiveness and efficiency within the building supply chain." *Building Research and Information*, vol.41, issue.4, 2013, pp.469-481. https://doi.org/10.1080/09613218.2012.715824

Voigtmann, Julia and Bargstadt, Hans-Joachim. “Construction logistics planning by simulation.” *Proceedings of the 2010 Winter Simulation Conference*, 2010, pp. 3201 - 3211. DOI: 10.1109/WSC.2010.5679012

Voss, Chris, et al. "Case Research in Operations Management." *International Journal of Operations & Production Management*, vol.22, issue.2, 2002, pp.195-219. https://doi.org/10.1108/01443570210414329

Vrijhoef, Ruben and Koskela, Lauri “The four roles of supply chain management in construction.” *European Journal of Purchasing & Supply Management*, vol.6, no.3-4, Dec 2000, pp.169-178. https://doi.org/10.1016/S0969-7012(00)00013-7

WeWorld. “WeWorld in Syria.” 11 Feb. 2021, www.weworld.it/en/what-we-do/global-projects/siria

WFP. “Construction and Management of the WFP Humanitarian Logistics Base at Djibouti Port.” *World Food Programme*, 2012, www.wfp.org/operations/200358-construction-and-management-wfp-humanitarian-logistics-base-djibouti-port.

Whitlock, Kane, et al. “BIM for Construction Site Logistics Management.” *Journal of Engineering, Project, and Production Management*, vol. 8, no. 1, 2018, pp. 47–55. http://doi.org/10.32738/JEPPM.201801.0006

Wikipedia contributors. “Humanitarian Engineering.” *Wikipedia*, 11 May 2020. https://en.wikipedia.org/wiki/Humanitarian_engineering

Wong, Alex, Eapen, Arun, Gutknecht, Tania. “Engineering & Construction Disaster Resource Partnership A New Private-Public Partnership Model for Disaster Response.” *World Economic Forum*, vol. REF: 241110, November 2010. https://www.humanitarianlibrary.org/sites/default/files/2014/02/22.03.2012_-_wef_en_disasterresourcepartnership_report_2010.pdf.

WRAP (Waste & Resources Action Programme).” Material Logistics Plan Good Practice Guide.” *Project code: WAS041-001*, Dec 2007. ISBN: 1-84405-370-9, https://cupdf.com/document/mlp-guidance-document.html

Wynveen, Reneé. “GSC ECHO Grant 2021–23: Mobilising Collective Efforts towards a Greener and Climate Smart Humanitarian Shelter and Settlements Response | Shelter Cluster.” *Single Form for Humanitarian Aid Actions [United Nations High Commissioner for Refugees / Switzerland]*, 28 May 2021. www.sheltercluster.org/global/documents/gsc-echo-grant-2021-23-mobilising-collective-efforts-towards-greener-and-climate

Yin, Robert. “Case Study Research: Design and Methods.” 3rd edition, *Thousand Oaks, Sage Publications*, vol.5, 2003, London, UK.

Yin, Robert. “Case Study Research: Design and Methods.” 4th edition, *SAGE Publications Ltd, Thousand Oaks,* 2009, London, UK. pp.240. https://www.jstor.org/stable/23279888

Ying, Fei and Roberti, Hans. “Improving Construction Logistics.” *Build 134: Canterbury tales: Vital lessons emerge from the rubble, BRANZ*, 1 Feb 2013. https://www.buildmagazine.org.nz/articles/show/improving-construction-logistics

Young, Adrian and James, Wilson. “Construction Logistics: Models for Consolidation.” *Constructing Excellence*, 2004. https://constructingexcellence.org.uk/wp-content/uploads/2015/04/construction_logistics_models.pdf