SELINUS UNIVERSITY
OF SCIENCES AND LITERATURE

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

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A Dissertation

Submitted to Faculty of Business & Media
in Partial Fulfilment of the Requirements
for the degree of Doctor of Philosphy
in Humanitarian Logistics

2021

Declaration

"I do hereby attest that I am the sole author of this thesis and that its contents are only the result of the readings and research I have done". The dissertation titled " Analysis Humanitarian Construction Logistics Practices: Syrian Humanitarian Operations - Case Study" submitted for the Degree of Philosophy of Doctorate (Ph.D) in Humanitarian Logistics at University of Selinus, 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 published based on the research conducted out of the course of the study are also based on the study and not borrowed from other sources.

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ACKNOWLEDGEMENTS

I would like to especially thank my wife Raneem, my mother, my father and my children: Joseph and Jad who believed in me and without whose guidance, support and inspiration I would not be able to do this PhD degree.

Publications

Published:

- **Experiences and Challenges of Aid Distribution in Syria**
  publication date Nov 25, 2019 within "II Symposium on Humanitarian Logistics & Disruptive Supply Chains", University of La Sabana, Bogota, Colombia.
  https://www.facebook.com/OrganizacionLOGYCA/posts/10157679967579485
- **Beneficiary Appointment Scheduling for Delivering Humanitarian Aid in Conflict Affected-Regions.**
  publication date Oct 21, 2019 within INFORMS Annual Meeting 2019, Seattle, USA.
  http://meetings2.informs.org/wordpress/seattle2019/

- **Beneficiary Appointment Scheduling for Delivering Humanitarian Aid in Conflict Affected-Regions.**
  publication date Sep 5, 2019 within Euro Hope Mini Conference 2019, Kristiansand, Norway.
  https://www.uia.no/en/conferences-and-seminars/euro-hope-mini-conference-2019
- **Logistics Data Analytics alongside Voucher Programme Phases**
  publication date Jul 18, 2019 within Journal of Humanitarian Logistics and Supply Chain Management.
  https://doi.org/10.1108/JHLSCM-06-2018-0050
- **Barriers of Inventory Management in Humanitarian Logistics: Syrian Supply Chains Study**
  publication date Sep 6, 2018 within LOGISTICS RESEARCH NETWORK ANNUAL CONFERENCE 2018 5-7 September 2018

  https://ciltuk.org.uk/LinkClick.aspx?fileticket=j6SEQXXTx4o%3d&portalid=0

- **Sharing Key Coordination Challenges from Humanitarian Practitioners in the Middle East**

  publication date Jul 19, 2018 within HHL2018 - 10th Annual Conference on Health & Humanitarian Logistics July 18-19, 2018, Dubai, UNITED ARAB EMIRATES

  https://chhs.gatech.edu/conference/2018/sites/default/files/cfp-file/547_AminMaghsoudi.pdf

Abstract

The basic task of humanitarian logistics comprises acquiring and delivering requested supplies and services at the places and times where needed, whilst ensuring best value for money. Supplies include vital items for survival such as food, water, temporary shelter and medicine amongst others, which deliver on time and cost-effective way across the supply chain from suppliers to ultimate beneficiaries. (Fritz Institute, 2012, IFRC.org, 2018) Construction logistics is novel terminology in USA and Europe that aims to harness logistics functions involved profit and non-profit construction operations to reach effective achievements related to 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 cost-effective, time management, effective logistics functions, quality management, resources management, effective supplies, quality services, and offering distinct construction services to final beneficiaries in humanitarian cases. This PhD dissertation aims to merge both humanitarian logistics and construction logistics under novel title "humanitarian construction logistics". Explorative case study, quantitative, and qualitative methods had used to explore construction logistics practices that fits humanitarian operations. The new theory will enhance construction services for effected people before, upon, and after disaster apart from financial profits.

The main research questions in this PhD research as following.

1. What are the theoretical attributes of humanitarian construction logistics?
2. What are the proposed practices for humanitarian construction logistics?

The Syrian humanitarian operations; which have been conducting many non-profit construction projects since 2011 until now; had selected as case study in this PhD dissertation to explore issue's background, analyzed concepts and aspects, then, recommended appropriate practices in context of Syrian humanitarian constructions logistics.

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

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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

1. Introduction

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

This thesis seeks to highlight how a construction logistics for humanitarian purposes could ensure efficient organizations' activities in context of building and re-building of temporary shelters, camps, public infrastructures, habitats, health centers, sanitation, schools and others. Furthermore, reduce disturbances within construction logistics for humanitarian purposes.

This chapter presents the background information related to humanitarian logistics, construction logistics, overview Syrian humanitarian operations as case study, purpose, scope, and ended with thesis outline.

Background:

Disasters result in significant loss of life, damage to property, assets and environmental resources, therefore, 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 on average affected 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 alleviation of suffering and the prevention of further loss of life. 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 phases, the engineer is one of many 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 engineer's role in which includes defining rebuilding needs on both immediate and mid-term levels, coordinating communication, advocating, and determining the key process of recovery, rebuild, and construction (Ohio niversity,2020) Thereby, a 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 engineering works need to integrated operation in terms of controlling and stockpiling supplies for the duration of rebuilding, route selection, facility location, and resources allocation which are combined into a cohesive systemic element of the humanitarian logistics and supply chain. (Ohio University,2020)

There is a key example presenting mutual affected relationship between humanitarian construction and humanitarian logistics, Djibouti port is the principal transit point for cargo in and out of Ethiopia and a 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 in just the past three years. To enhance efficiencies in both humanitarian and commercial logistics, the Government of Djibouti and WFP had built a humanitarian logistics base (HLB) in the port to enhanced efficiencies of supply chains in the Horn of Africa and augmented regional humanitarian response capabilities. Furthermore, increased port storage capacity which was also most limited and expensive during peak periods. In result, humanitarian agencies have been reducing steep storage costs and additional storage costs which were incurred while waiting for customs clearance. (WFP,2012)
Syrian wildfires emergency plan of action issued by ICRC in October 2020 considered as another example about the important of construction and logistics together in humanitarian operations. This action plan was responding 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 majorly loss of livelihoods (lands, crops, and livestock). Based on the ICRC initial assessments preliminary information indicates that there is a need from shelter sector in many districts to identify temporary shelters and provide the affected people. Assessments also indicated that there was a need to provide first responders with basic and logistical materials (like water, hygiene kits or solar lamps) as well as to enhance logistics capacities and resources 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 relief items, construction, and supplies were consisting around 72% of total budget, thereby, construction and logistics are priorities for any emergency plan.

Funding Requirements

International Federation of Red Cross and Red Crescent Societies

all amounts in Swiss Francs (CHF)

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

From the end of the 1980s, the construction industry has seen the launch of a number of supply chain management initiatives (Getuli, Vito, et al,2016) ,there are attempts to integrate construction logistics into humanitarian logistics from the suppliers of raw material, manufacturers, distributors, to the end-users. Logistics processes being crucial for successful completion of the humanitarian (non-profit) projects and this tendency is also to be observed in humanitarian construction. (Sobotka et al., 2005) Thus, temporary supply chains (TSCs) have become; during the last decade; a well-recognized logistics model, particularly in construction supply chains which are extensively used in peacekeeping missions and humanitarian operations. (Merminod et al.,2014)

The importance of construction supply chains demonstrated by values of available stocks within The International Humanitarian City based in Dubai during 2020. Their 2020 statistics issued by "Humanitarian Logistics Databank" indicated that the classified values under logistics and constructions services such as shelter, water, sanitation, and logistics services are consisting around 56% out of total stocks' values. Please see below the Fig.1

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

The dissertation focused on several aspects of construction logistics and its positive contributions throughout Syrian humanitarian construction projects. According to Syria Humanitarian Response Plan 2020 issued by OCHA (real-time reports), the values of logistics and constructions services; such as shelter, water, sanitation, and logistics services; are consisting around 26% of total current requirements (the real time data shows via link: **https://fts.unocha.org/appeals/924/summary)**

1.1 Syrian Humanitarian Status:

During March 2020, UNICEF Executive Director Henrietta Fore and World Food Programme Executive Director David Beasley had visited Syria and they had declared about Syria situations as following. 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)

UNHCR Syria mentioned that after six years of conflict, Syrian people remain vulnerable as they continue to face not just physical threats but the effects 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)

During 2018, 108,790 internally displaced persons were reached with 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 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.

  In result, the humanitarian constructions and logistics activities focus on many activities in Syrian humanitarian operations, some of them as following.
- Provision of emergency shelter (installation of tents with infrastructure / shelter kits / winter kits).
- Rehabilitation of public buildings that are used as collective shelters such as schools.
- Upgrading of unfinished private buildings.
- Durable shelter support such as rehabilitation of partially damaged houses and public infrastructures.

There are many stockholders and activated humanitarian organizations in Syria even as international or national NGOs such as ; but not limited; 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)

1.2 Purpose and scope:

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

1. What is the conceptual framework for proposed humanitarian construction logistics?
2. What are the appropriate construction logistics practices for Syrian humanitarian operations?

The thesis explores an elements of non-profit/humanitarian construction logistics throughout humanitarian operations. Herein research approach divides into two parts; the first part investigates about proposed theory aspects by reviewing literatures of humanitarian logistics, relief operations, rehabilitations, humanitarian engineering, construction logistics, and others. The second part investigates among current construction logistics practices under Syrian humanitarian operations during relief and recovery stages. Finally, modern practices of construction logistics will be recommended to leverage Syrian humanitarian operations and understand best construction logistics practices for humanitarian organizations.

1.4. Thesis outline

This introductory chapter (chapter 1) describes the background of the study and introduces the purpose and research questions of the project. 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, then review extent literatures to best knowledge about main purpose. The methodology (chapter 3) presents used research methods and designs in context of collecting, classifying and analyzing data. The thesis results are presented in chapter 4. Research findings is structured by subsection describing how each aspects effect on humanitarian construction logistics in Syrian operations. The discussion section (chapter 5) analyses them jointly to provide answers to the research questions of the thesis as well as fulfilling the thesis purpose which is presenting how the modern construction logistics practices can address the needs of humanitarian-constructions and what are the potential feasible applications. The conclusion (chapter 6) summarizes the dissertation recommendations and identifies possibilities for future research.

Literature review / Theoretical framework:

1.3 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. Then being part of the art of the military and were 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. Logistics manages likewise the financial and material resources, 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, ensuring that the resources are productive i.e. they are in the right place at the right time at the minimum cost and 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 to deliver the project on time, on cost and on stipulated quality. The construction industry is producing its end products from vast amount of materials that have to be delivered to the place of consumption. (Ekeskär and Rudberg, 2016; Thunberg and Persson, 2013; Janné,2018) Thus, the construction industry is greatly dependent on these materials arriving to site when needed and the managing process of these 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 which included the materials description and the proper way of handling, storing and protecting each type of material, aiming to minimize loss or waste. (Labib,2016) Currently in this decade, the construction logistics practices has been developing to deal with the planning, operation, and 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)

The scope of construction logistics involves 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. (Janné et al.,2018) to reduce waste substantially or eliminate it completely. The stakeholders must 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)

In same context, as the goal of material management in construction logistics is determining the best possible supply process for each resource, so that the material is in a timely manner, in the right quantity and quality available for every contractor on site. The same applies to waste disposal management, the returning storage equipment and the residual material in 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)

Ekeskär and Rudberg,(2016) highlighted on complexity of construction logistics which is project-based process and carried out in temporary organizations, also requiring the

establishment of 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, these supply chain actors heavily impact on the performance of construction projects. 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, in general, is suffering from both low productivity and rising production costs. (Vrijhoef and Koskela, 2000, Ekeskär and Rudberg, 2016) The literature review shows other current challenges face construction logistics sector which could be summarize as 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. Instead, they should wait for further instructions before being directed to the right location on site. (Janné et al.,2018) In consequence, insufficiently planned and non-coordinated logistic processes are the consequence and reasons for the high amount of non-productive actions and consequently 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 (and any related object) from the point of discharge to the point of use or installation (The European Construction,1994). In same context, Vrijhoef and Koskela (2000) described that many of the problems have their origin in the supply chain's upstream, but their effects propagate to the construction site. (Ekeskär and Rudberg, 2016) That happens due to inefficient in construction supply chains which is presenting in non- coordinated incoming transports due to a lack of data and supply chain planning, as well as, an unnecessary high number of transport movements are sent to the site. (Janné et

al.,2018) Furthermore, contractors experience mostly the low delivery performance that was highlighted by Thunberg and Persson (2013) who indicated to the poor delivery service in the construction industry, indicating 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 lack of materials and resources when needed, which hinders the progress of the project and generates express transports, thus further increasing the number of transports close to the construction site. (Janné et al.,2018)

3. Inefficient logistics on site leads to lack of control at the construction site, inferior planning, material losses and extra costs, as well as hazards for workers at site. As well as, disorganized material storage causes extra time for the search of material or to rearrange storage areas. (Voigtmann and Bargstadt, 2010). Furthermore, even more transports are generated to replace the lost materials, as well 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 obstacles in construction logistics management (Agapiou et al. 1998) Thereby, ineffective management will result in conflicts between these aspects. These conflicts will ultimately cause project delays and cost overruns because of the cost of materials and equipment 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. The assembled materials and components are often designed and produced by a multitude of suppliers who are working in a range of different disciplines and technologies. Thereby, there are complexity in terms of organization and timescale. Several studies on German construction sites pointed out that approximately one third of the total execution time is consumed by logistics processes and they estimated that the deducible optimization potential by well-planned and coordinated construction logistics up to 10 percent of

construction time or 4 percent of building costs in outfitting processes. (Samuelsson, and Ahmetasevic, 2014)

5. A case study by Agapiou *et al.* (1998) shows that logistics management is relevant in the construction industry and that total costs can be lowered if logistics is managed efficiently. The cost savings reported in Agapiou *et al.* (1998) constitutes 5 % of the total costs, mainly based on 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 effective management of construction logistics that has become recently a significant and appropriate tool for planning and construction-operation activities (Ekeskär and Rudberg, 2016) Thereby, construction work has some distinctive characteristics that influence on the logistics:

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 as set by site management. Therefore, each construction site requires a new logistics setup will conduct 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 are material intensive and are supplied on an irregular basis depending on the construction phase (first concrete, last furniture).
3. Activities should be performed in sequence and if one activity is delayed, all the following activities also be delayed. Therefore, construction materials should be delivered to the contractors at a construction site at the right time and in precisely coordinated numbers.
4. 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)

5. Suboptimal conditions of construction affect negatively on productivity, i.e. 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)
6. Construction logistics is the industry-specific characteristics of logistics in construction business and appears more and more often in academic research. However, the academic approach is not being applied in practice despite growing knowledge of existing strategies, methods and practices for an integrated management of construction logistics and material supply chains,
7. No common definition of construction logistics has been established until today both in the scientific literature and in practice (Tischer et al.,2013) Thereby, construction logistics and supply chains remain an area insufficiently reviewed and studied. Many points have not been adequately covered. Furthermore, Vidalakis et al (2011) highlighted on 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 logistics necessitates examination of all logistical connections, cutting across organizational and constructional boundaries. (Vidalakis et al., 2013, Labib,2016)
8. To the best of our knowledge, there is no research so far for examining and understanding an implemented construction logistics in context of humanitarian /non-profit purposes, albeit there are different construction logistics operations ;underlie behind rehabilitation and other non-profit construction projects; to address severe consequences of any disaster on the affected population for a long period of time. (Cozzolino,2012) This indicates to 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 possible during the reconstruction phase.

1.4 **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 has 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 to 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. (HUMLOG Institute,2020) Humanitarian logistics is defined else 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 about humanitarian logistics presents in UNICEF emergency operations which 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; have transportation around 1000 technical experts to operational fields, transportation of standard relief tents which are heavy (70-100 kg) in comparison with to other relief items. This make them expensive to transport. (OCHA, 2004) At the time of writing, a new generation of lightweight tents is in development for use in the first phase of emergency with weight around 18 kg - 50 kg, and equipping each tent with solar, electrical kits, and hard flooring. (UNICEF Supply Division,2020)

Analysing the humanitarian logistics leads to determine the well-defined aspects and peculiarities, mainly aim at minimizing the suffering of people who are in a vulnerable state in an extremely compromised social structure. That leads to define some challenges of the humanitarian logistics as following:

- The environment in which relief operations are undertaken and the management of such operations can be quite challenging, therefore, humanitarian logistics must respond as quickly as possible to the needs of the affected population, managing and ensuring the effectiveness of the response.
- In despite the lack of need information about the real situation; with the largest suppliers, individuals and corporations who donate funds without prior information and shipping resource specification such as quantity, packaging, conservation status, expiration date, among others; 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.

  (Vega et al.,2020, Sant'Anna, 2016)

Deployment of humanitarian logistics consists of three phases: planning, emergency response and reconstruction. In context of planning phase, humanitarian supply chains must deal with large variability in supplies and suppliers, large-scale activities, irregular demand, and unusual constraints in large-scale emergencies. Sometimes supplier choice is limited and in the worst cases, humanitarian organizations must deal with 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 highlights the uniqueness of humanitarian logistics. (Vega et al.,2020)

The type of event generated by disasters requires a specific emergency response which is presenting in supply chains need to be known and implanted at once. emergency response is more than just supplying shelter. It's about involving communities in places of uncertainty and rapid change, delivering the best rebuilds that incorporate future risk mitigation in the design such as safe and dignified shelter is a basic human right, and in a post-disaster scenario provision 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. (Sant'Anna, 2016, Murray,2015)

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. This process usually takes years and the point of transition from emergency response phase to recovery phase is mostly blurry. The focus of the recovery phase is social and economic reconstruction. While economic reconstruction includes the "hard" aspects of the recovery such as rebuilding infrastructures and the economy to support human needs, the social reconstruction deals with the "heart" aspects of recovery, providing moral support and counselling to the affected population. (Vega et al.,2020)

1.5 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 typically focus on programs that are affordable, sustainable, and based on local resources to perform projects ;are typically community-driven and cross-disciplinary; and focus on finding simple solutions to basic needs (such as close access to clean water; adequate heat, shelter, and sanitation; and reliable pathways to markets). **(**Wikipedia contributors,2020)

To do that, humanitarian organisations ;during over 40 years, have developed an unique logistics expertise to support their own operations by developing specialized units to provide aid and relief logistics services and creating other specialized units that are able to provide high quality logistics services on a not-for-profit basis in areas such as procurement, warehousing and transportation management to provide and/or support context-specific services such as local procurement, food distribution, installation of water and sanitation infrastructures, reconstruction, maintenance and repair. (Vega et al.,2020) The logistics within humanitarian construction, rehabilitation, and recovery operations has a very important role in conducting the following functions such as external procurement of products and resources needed for housing construction, transportation them to the warehouse, storage and distribution them. Beside to provide construction services and means for the restructuring of the place of origin of this affected population, (Sant'Anna, 2016) especially during the rehabilitation and recovery phases, because of supply chains begin to ship products and items and maybe construction material that will be deployed and used in the last phase of the development relief cycle. Herein 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 chain which respond to specific projects; either in rehabilitation or simply development construction. Reconstruction supply chains use more commercial type of techniques such as trying to reduce costs and improve performance. The entire phase of recovery and rehabilitation could last from six months

to one year to five years, depending on the size of the crisis and when each one of these projects come to end, these supply chain begin to shut down. In some cases, response supply chains are overlapping with recovery (rehabilitation) supply chains and recovery supply chains are overlapping with development. (Vega et al.,2020)

However, when planning the non-profit-humanitarian logistics, we must consider the type of housing /constructions that comprise these sites, otherwise it will be improvised and often unstructured services without access to acquisition of continuous or sustainable maintenance. Humanitarian logistics should be prioritized to conduct the process of storage, improvement measures of housing structure, provision of basic services to this population, enabling implementation of sanitation actions and control of water quality for consumption. For example, non-profit-humanitarian construction logistics is usually serving very quickly to establish a system of sanitation able to meet local needs, to ensure drainage of waste from latrines and to minimize the damage to health. (Sant'Anna, 2016) In same context, De la Torre et al., (2012) pointed out to important of construction logistics functions in humanitarian operations such as transportation and distribution which are key to install field hospitals as fast as possible.

Furthermore, humanitarian logistics participates else in disposal debris; during refurbishment, conversion and removal of buildings; by effective and efficient implementation and operation of material and waste flow on sites during construction upon and after disaster. The implementation of logistic aspects can help to increase productivity in phase of humanitarian construction, rehabilitation, and recovery by efficient supply of materials as well as to ensure an optimal and efficient waste management according to the principles of a closed circle economy. (Hasenclever et al, 2011) For instance, “Crown agents” ;activated logistics service providers in Syria; explains about their supporting early recovery in Deir Ezzor governorate within Syria in the immediate aftermath of ISIS withdrawal, through a €2.6 million project over 6 months to remove debris, rubble and solid waste from destroyed and partially damaged public spaces. This includes sites with hazardous explosive remnants of war, to ensure greater safety and usage of public spaces for local populations. This debris is recycled where possible and re-used for new development projects in the area. Herein below some

information about scale of humanitarian logistics in rehabilitations within namely governorate.

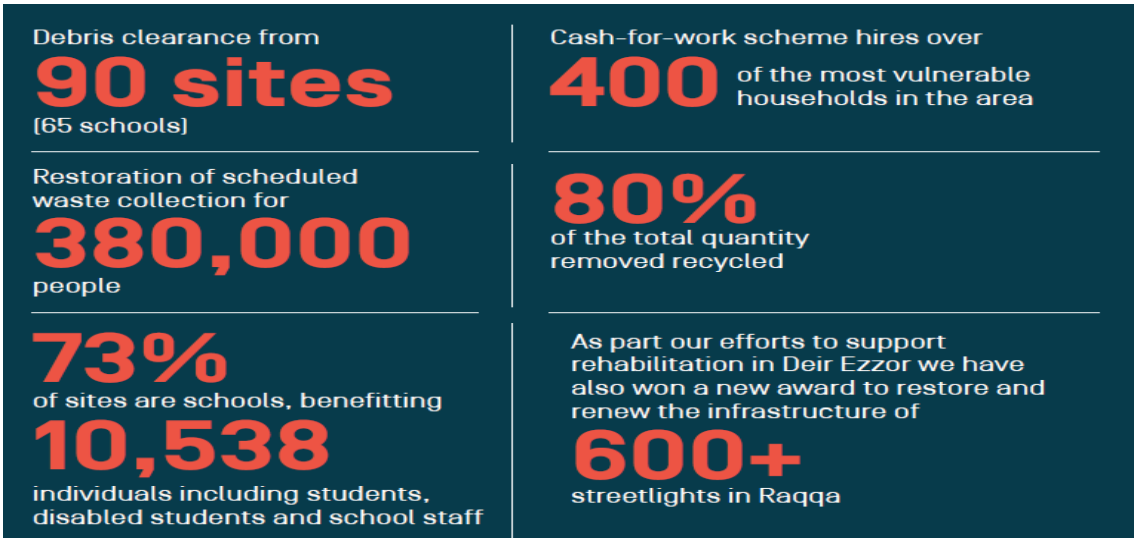


Fig 3: CROWN AGENTS operation report 2020

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

1.6 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 substantially a humanitarian intervention's performance. (Merminod et al.,2014) Once of these interventions is building camps in whole of Syria as temporary holding shelters until reconstruction phase is finalized and the displaced can go back to their homes. (Jahre et al. 2018) The traditional camp design approach is to set 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)

Herein, there are two approaches in Syria; which are emergency temporary construction phase and rehabilitation & reconstruction phase; that need to efforts of non-profit/ humanitarian construction logistics. These operations relate to build temporary shelter and permanent shelters accompany with services like sanitation, water, and others. These non-profit construction logistics in Syrian humanitarian operations own number of key aspects; according to interviews with practitioners; which coincide the international aspects as following:

- The building site of temporary shelter consider as a production system and a member of many supply chains where complex processes are executed within time, space and budget constraints (Sobotka et al., 2005)
- Supply chains are delivering products from external sources to the building site that involves either the contractor 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 locally and nationally in Syria accompany with limited management skills and information exchange are commonly employed. (Sobotka et al., 2005, Ying and Roberti, 2013)

- Co-ordination of material flows on the construction site (on-site logistics) is differed significantly compared to other industries. The geographical positions of the construction sites in Syria and the changing site layout put demand on adapted solutions for unloading, inspection of incoming materials and storage (Ekeskär and Rudberg, 2016, Sobotka et al., 2005)

- Participants of the construction project as separate entities participating in other projects at the same time. Thereby, delivery and handling of construction materials have to be coordinated with site resources such as 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 same interviews with practitioners, humanitarian construction logistics in Syrian operations are considerably more difficult to manage and to optimize. This results from:

- Diversification of projects (various materials, methods, location of each project means a new constellation of supply chain members each time.
- Technical complexity of a project,
- Number of participants in the project,
- Domination of the bidding system of contractor acquisition (random partnership within the chain),
- Difficulty in adjusting each member's logistic routines to the 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' hours because there are dangerous according 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)

Beside that there is lack with advance techniques for improving humanitarian 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 for articles and reports of humanitarian organizations activated in Syria demonstrated the severe usage of humanitarian construction logistics functions in terms of extremely Syrian humanitarian interventions as below.

1.6.1 Syrian shelter and settlement interventions:

Due to massive destruction of homes, shelter needs are overwhelming the capacities of UN agencies, NGOs 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 because of their core humanitarian mission is to guarantee access to adequate shelter. Therefore, they provide shelter support for internally displaced people who fled hostilities as well as returnees who were back to completely or partially damaged houses in their areas of origin. They have provided a sound basis for increasing traditional emergency services ;while developing more durable shelter solutions; such as emergency shelter assistance involves the provision of immediate lifesaving assistance as the rehabilitation of public and private collective shelters, the provision of shelter kits, and establishment of camp-related infrastructure, as well as, the distribution of tents in planned camp which are established by an accountable humanitarian actor and to the extent possible, the meet the minimum SPHERE standards. (UNHCR Syria,2019)

On the other hand, long-term shelter assistance focused on the provision of support to those returning to their places of origin. Infrastructure rehabilitation for returnees and host communities includes debris removal, solid waste units' distribution, minor rehabilitation for water and sanitation in returnee areas, in association with the rehabilitation of damaged houses. According to UNHCR operational report for Syria during 2019, UNHCR and other humanitarian organizations provided shelter assistance as following:

- 330,990 individuals /66,198 families in different Syrian governorates benefited from the shelter assistance such as the distribution and installation of 1,360 shelter kits as well as the distribution of 18,774 tents in the camps in North East of Syria along with the provision of technical assistance , construction of communal kitchens, installation of 300 solar streetlights, provision of solar lights, land preparation, installation of big-size tents, fence construction and establishment of new distribution centers and reception areas.

- 303 emergency rooms inside collective shelters were rehabilitated in Al-Hasakeh and Lattakia governorates supporting 3,849 individuals.
- 248 units of solid waste had distributed to support 11,900 individuals /2,380 families and water systems maintenance had conducted to benefit 2,000 individuals throughout Syria, as well as, rehabilitation of water systems had supported 27,150 individuals/5,430 families.
- To provide safe access to shelter, humanitarian organizations completed the removal of 324,374 cubic meters of debris in different Syrian governorates to support 42,500 individuals.
- Projects of repairing damaged houses are ongoing across Syria, the total of 1,290 damaged houses were rehabilitated in different Syrian governorates during 2019.
- Create welcoming learning spaces through rehabilitation of classrooms and provision of quality furniture, beside to, rehabilitate damaged and sub-standard private housing and other facilities ; around 35% of urban schools are not operating due to damage or to occupation , more than 50% of hospitals in cities are not operational, and around 760,000 housing units in Syrian cities were damaged, in addition to historic and traditional urban centers were massively destroyed in different Syrian governorates. (UN-HABITAT Syria,2020)

1.6.2 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. There are concerns that hundreds of thousands of people in Syria may affected as the main water infrastructure (water stations and dams serving the different areas) has been affected because they are located near the conflict frontlines, thus, these infrastructures suffer from breakdowns and demolishment frequently. Therefore, several emergency measures have been taken to provide clean water from alternative sources. (ICRC Syria,2020)

On the other hand, Oxfam Syria and other humanitarian organizations have been working since June 2013 to address the immediate live-saving and sustainable water and sanitation needs of thousands of crisis-affected women, men, girls and boys. They

provided support in 12 governorates across Syria by trucking water to those who have no access to safe clean water, rehabilitating water sources, equipping wells and pumping stations, repairing the water network, providing hygiene materials, and conducting public health awareness campaigns to help prevent the spread of diseases. They aim to support the resilience of communities by provision of sustainable access to clean water through the rehabilitation and restoration of water supply and water distribution systems. (Oxfam Syria,2020) These aims are conducted by following steps:

- Maintenance infrastructure, emergency repairs, and supplying clean water to over a million people in Syria by provision 15 water pumps and essential spare parts to water pumping stations to improve clean water provision.
- Provision of emergency water trucking services, materials, equipment and repair.
- Provision of WASH facilities and hygiene promotion in collective shelters, public buildings and schools to support adaptation of existing water systems and services to the emergency context. That leads to improve sanitary conditions; ensure clean water and proper sanitation; for 100,000 people in Syria. (ICRC Syria, 2020, Oxfam,2020)

These above presentations demonstrate that shelter, water, and sanitation interventions have requested construction logistics functions in non-profit-humanitarian context throughout Syria to complete these activities on appropriate time, quality and cost. This humanitarian construction logistics entails functions to support installation, rehabilitation, reparation, and build main infrastructures of wash, shelters, and settlements in non-profit humanitarian context, it is already exist in humanitarian field under umbrella of logistics and supply sector and this dissertation will explore in-depth the functions and elements of humanitarian construction logistics.

2. Research Methodology and Data Analysis:

The following chapter describes the thesis methodology and contains the following sections: Research design, methods, data collection methods, data

analysis, and Ethical conduct. The chapter aims to explain how the thesis was conducted and why the different methods were chosen, considering the literature search, literature study, 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 thesis.

3.1 Research Design:

The subject of the thesis emerged when observing the complexity of humanitarian construction projects in Syria associated with insufficient logistics applications. The need for an efficient supply chain and well-planned logistics could be key components for the up-coming humanitarian construction projects worldwide. The Syrian case study were chosen mainly because of good insight within Syrian projects due to the author has been working in UN agencies since 2013 until 2021. construction logistics in humanitarian context was first encountered by the author at Syrian projects organized by different humanitarian actors such UNICEF, UNHCR, UN-HABITAT and others. The main purpose of thesis is launching new approach of construction logistics associated with humanitarian context that aims to simplify the process, reduce the risks while increasing the quality of works and applying different innovations in this this sector.

Concerning the first research question and its propositions "What is the conceptual framework for proposed humanitarian construction logistics?". this thesis investigated about information on the research topics that was collected by reviewing the extant literature, researching about reports and electronic documents on humanitarian constructions and supply chains. The literature review tries to understand the main challenges of construction logistics in humanitarian context and provide a broad perspective about humanitarian construction logistics 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 best practices for Syrian humanitarian construction logistics?". We outline the scope and boundaries of research within Syrian geographical boarders. This question was answered by

(1) 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 that the level of immersion and prolonged involvement with participants can lead to a good rapport, thereby encouraging participants to speak up freely. This is helps with the rich details of the collected data. (Silverman,1998). Time was spent initially to observe and monitor the current practices of humanitarian logistics related inside and outside construction sites which helped the author to understand and assess the quality of current practices. Direct observation technique facilitated the conducting of the interviews and design of the questions because it provided the author with the merits and flaws in the existing humanitarian construction logistics system. The observations have focused on several processes within humanitarian construction logistics management such as treatment materials (procurement, delivery, handling, and storage of materials), resources allocation, and integration among humanitarian projects' parties. Observations within ten site-visits were also an important data source in order to understand how materials and orders were handled, loaded and unloaded by the different upstream actors.

(2) The primary data have been sourced by total of thirty semi-structured interviews during 2020 with members in UN agencies and NGOs even on sites or inside offices in order to find answers to propositions. The semi-structured interviews in this thesis are informal that 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 h, and when necessary clarifications and follow-up questions were asked by e-mail or by phone. The main objectives of the interviews were to obtain information

about the current practices and gain an understanding of the concerns and perceptions about humanitarian construction logistics management. Different people were targeted to participate in the interviews including project management members, project coordinators, superintendents, foremen, NGOs' engineers, logistics employees and even labours. 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 ,information, and experts' views issued officially by UN agencies and NGOs combination with interviewing stakeholders during field visits to Syrian humanitarian construction projects which have been included and analysed together, they are presented in detail in the following sections in order to identify essence of construction logistics practices for humanitarian purposes.

The two thesis questions aim to use of this combination of methods 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 to best knowledge about key components of humanitarian construction logistics management which will evaluated and identified. Besides that, all initial indicators assure that the project execution processes in the humanitarian context are highly similar with commercial context, including designing the shelters/settlements, procuring, contracting and supplying system and carrying out the actual construction.

Thereby, the mentioned varied combination of semi-structured interviews, meeting observations and document analysis aim to construct a context-dependent understanding in terms of Syrian humanitarian construction projects from 2013 until 2021 and to discuss proposals for merging the modern construction logistics methods through projects and

organizations that are working in context of Syrian-humanitarian constructions even that business models, funding methods and design models might be different,

The research is based on exploratory case study approach for “Syrian humanitarian construction logistics “in order to provide examples extracted from studied phenomenon as in-depth studies are essential to understand this complex phenomenon. After that, the analysis of the collected data was used to construct a conceptual framework to improve humanitarian construction logistics management and to leverage a more efficient daily schedule and practices. The below diagram illustrates the sub-phases of methodology in this thesis.

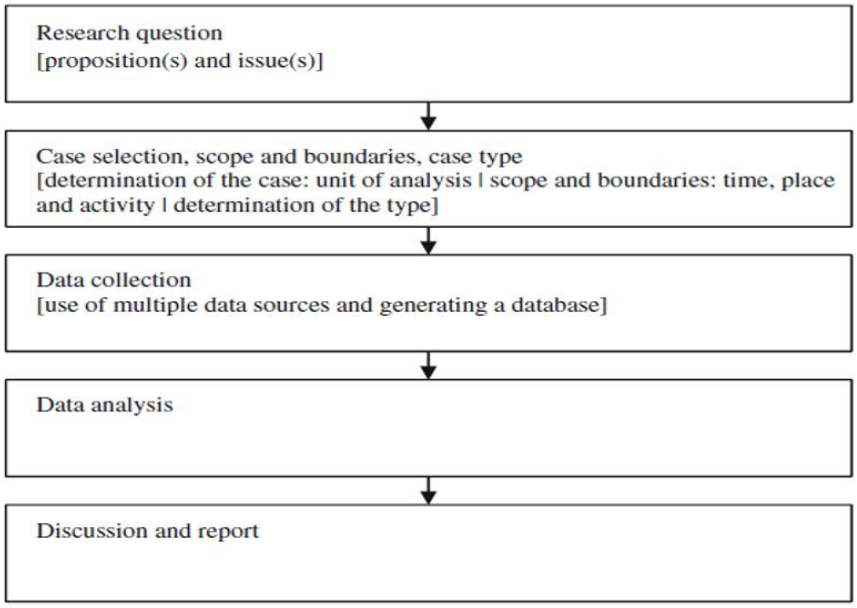


Fig 4: Approach of exploratory case study research

3.2 Research strategies

To formulate the deliverables, several research strategies have been selected. A desk research, grounded theory and 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 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 thesis' 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 difficulty in gaining full access to data. Documents, observations, interviews, historical records, videotape, as well as any suitable method are used in grounded theory to fulfill the research gap (Bryman, 2008). Obviously, application of this strategy requires lengthy periods of time and a specific work environment, these prerequisites were available constantly for author who has worked in humanitarian organizations and Syrian humanitarian operations since 2013 until 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 been paid attention of the author about realistic linkages between humanitarian logistics and construction logistics. Eventually, that leaded author to suggest new term called "humanitarian construction logistics".

3.2.3 Case Study

Case study research is excellent for theory building, for describing ''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 beside that 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 else explain how a phenomenon is influenced by the context within which it is situated. The methodology should be carefully planned in advance and should support 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. Thereby, this method uses observations, interviews, documents, and records because of a case study is an empirical research strategy. (Saunders et al, 2009, (Yin, 2003)

Case study research has been used in the thesis as one of three methods to fulfil research objective. Getting an understanding about construction projects logistical framework and measuring the logistics performance on-site and offsite can be translated into what questions. These are questions that suit a case study approach (Yin 2009).

The thesis author admire with ethics of case study research , which demonstrates in 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 are done in a certain process could be drawn.

This thesis used an explorative case study approach for Syrian humanitarian operations between 2013 and 2021 to identify the elements of construction logistics management and its efficiency related to humanitarian / non-profit construction projects. This thesis depended on two of case study research approaches which is descriptive case studies purely describe a specific environment in which performed with the intention of identifying and classifying the aspects or features of the subject which is herein construction logistics within Syrian humanitarian environment and exploratory case studies contribute to theory building that used when the number of previous studies is inadequate, where hypotheses are found and can be tested to build a new knowledge (Eisenhardt,1989). This thesis aims to build theory about humanitarian construction logistics 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 thesis used both qualitative and quantitative aspects, which deemed 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 so providing further knowledge regarding humanitarian construction logistics within Syria and explore positive opportunities for Syrian humanitarian operations in future.

3.3 Data collect

The research process is based on gathering initial knowledge before collecting empirical data about construction logistics practices in context of Syrian humanitarian operations since 2013 until 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-depth case study approach in paper. The investigation method in this thesis was conducted by combining two research methods, a literature review and interviews. The literature review was conducted by 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 phenomenon studied concerned 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 as 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 thesis. The literature search also functioned as a source of inspiration and knowledge for the authors. The research strived to provide relevant literature meet

the thesis' 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 other, as well as, 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", "Logistic Planning", "Construction Planning", "Lean Construction", "Supply Chain Management", "Construction procurement", and others. English literature was mainly considered, and the research strived towards finding several sources considering the same subject to ensure validity. Furthermore, publication date and the number of citations of the articles were also considered when choosing literature. The literature research was an iterative process which were complemented by the research questions were also adapted to reflect what the thesis 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 in research in order to shape the scope of the research and find gaps. However, the 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 author for literature study, collecting data and formulating analytical framework. The desk research is used to structure the literature study that is functioning as an analytical framework links the theoretical questions to the empirical analysis. This thesis will use a mix of quantitative and a qualitative method where many documents are being used to collect data. (Croom 2009).

While 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. Thereby, a traditional review can aid in shaping the research questions (Croom 2009, Cronin et al. 2008, Jesson et al. 2011). The method was utilized in order to identify feasibility of humanitarian construction logistics and understand their applications preliminary within Syrian humanitarian operations is selected as case study since 2013 until 2021.

3.3.3 Interviews

Interview are a tool mainly for the collection of qualitative data and are popular data-collection tool because of their flexibility. Interviews are conducted to provide the deliverable with empirical data to improve the reliability of the deliverable because of literature study’s data will be reviewed. 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 structured 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 and deepening because he or she can describe why certain things are the way they are. Therefore, this thesis follows a semi-structured approach for conducting an interview because a risk with structured interviews is that the interviewer gets too dependent on the interview guide and forgets to listen to alternative ideas. As well as follows problem-centered interview approach 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 experience. (Bryman and Bell 2015, Flick 2009, Yin,2009, Silverman,1998)

The interview series conducted in this thesis was two-fold, both of interview series consisted of semi-structured problem-oriented interviews with stakeholders. While the first series focused on identifying logistical issues on construction site and planning chains in context of Syrian humanitarian construction projects. The second one focused on validating the problems and trying to find solutions for the problems. Semi structured problem-oriented interviews with stakeholders are a suitable method because of wide experiential experiences of stakeholders that must deal 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 since 2013 until 2021 as all humanitarian projects faced challenges regarding construction logistics. Thereby, this thesis required involved several field visits; in despite of 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 time scale from 2013 until 2021. The documents consisted of logistical plans, site dispositions, supplies' manifests, on-site & off-site stock reports, purchases, and others for many projects even they are working currently or already done.

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 authors 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 which enables the

interviewer to deviate from the prepared questions and to follow-up questions (Bryman & Bell, 2015). Due to the number of planned interviews, the qualitative approach was suitable and chosen since it emphasizes more on specific answers and reflection 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 calls participant observations which also is an explorative approach used in the qualitative research method. (Bryman & Bell, 2015)

3.4 Data Analysis

There is no single accepted procedure for analyzing qualitative data. This thesis 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 building a theory by discourse analysis eventually. (Silverman,1998).

The following points became evident as a result of this research:

- The investigation about humanitarian construction logistics management showed that 70% of the material orders took double the necessary time because of the drawbacks.
- The deliveries were often late and short lead time, because of complexity of Syrian crisis and differences of project's stakeholders; funders, implemented humanitarian organizations, implemented local NGOs, contractors, vendors, and others whom 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 on 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 negatively effect on 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 to poor documentations.
- There are scheduling conflicts, project disturbances, and absence of technology.

Subsequently, the results from data analysis have to be prepared and questioned, in order to shape hypotheses about optimal humanitarian construction logistics and that have to be compared with conflicting and similar literature as well as discuss 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 thesis was constructed ethically, several actions were taken. Prior to all interviews, all interviewees were informed about the scope of this thesis and their roles in the thesis. 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 thesis in which supposed to encourage the interviewees to speak freely and be open-minded as well as felt 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.
- To prioritize the best practices of humanitarian construction logistics 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 have been managed.

3. Results

1. This chapter of dissertation will answer on first research question “What are the theoretical attributes of humanitarian construction logistics?” by studying the cases of Syrian humanitarian construction-projects since 2013 until 2021. These results will draw the general specifications of humanitarian construction logistics throughout extracting the common logistics functions within Syrian projects that are comprising the core of humanitarian construction logistics.

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 launched in December 2012 and later updated in July 2013 and December 2013. Until these dates, most refugees and IDPs are living in non-camp situations, which include both formal renting and informal settlements.

Thereby, shelter projects; during 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, report no.A.8, 2014)

As long as Syrian crisis have been increasing since 2011, the constrcution logistics and shelter needs are increased and midterm solution are required for refugees, IDPs, and affected people in/out Syria, thereby, all humanitarian organizations continue to scale up their shelter, wash, and rehabilitation programmes.This scale up was being done by bring other humanitarian partners as the international organizations whom did not have direct access to the all 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 local partner staff immediately and three months after handover, as well as remotely, via WhatsApp and phone calls. (Shelter Projects Working Group, report no.A.29, 2018)

These orgazations have been seeking to attract development funding which could allow for developing new modalities such training and participating effetded people in rehabilitations. (NRC Syria,2014). Thereby, 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, field staff directly repaired homes identified as severely damaged. Repairs were carried out to ensure that families had adequate living conditions in advance of the winter. Specific 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; repair of 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; repair of damaged walls; replacement of destroyed walls; and repair or replacement of ceilings according to the level of damage. (Shelter Projects Working Group, report no. A30,2016)

These menioned constrcution and logsitics activties are still onpgoing in Syria as UNHCR activities mapping in 2019 which was developed, differentiated, and covered most districts of Syria since 2011 until now. These activties suammrized as below.

- Rehabilitation of emergency shelters
- Distribution shelter kits
- Distribution and installation shelter materials packages (Doors and Windows)
- Damaged house repairs
- Debris removals

- Water systems constructed
- Distribution solid waste bins
- Solar streetlight installed
- Collective shelter rehabilitation
- Sewage system rehabilitation Tented camp construction or maintenance.

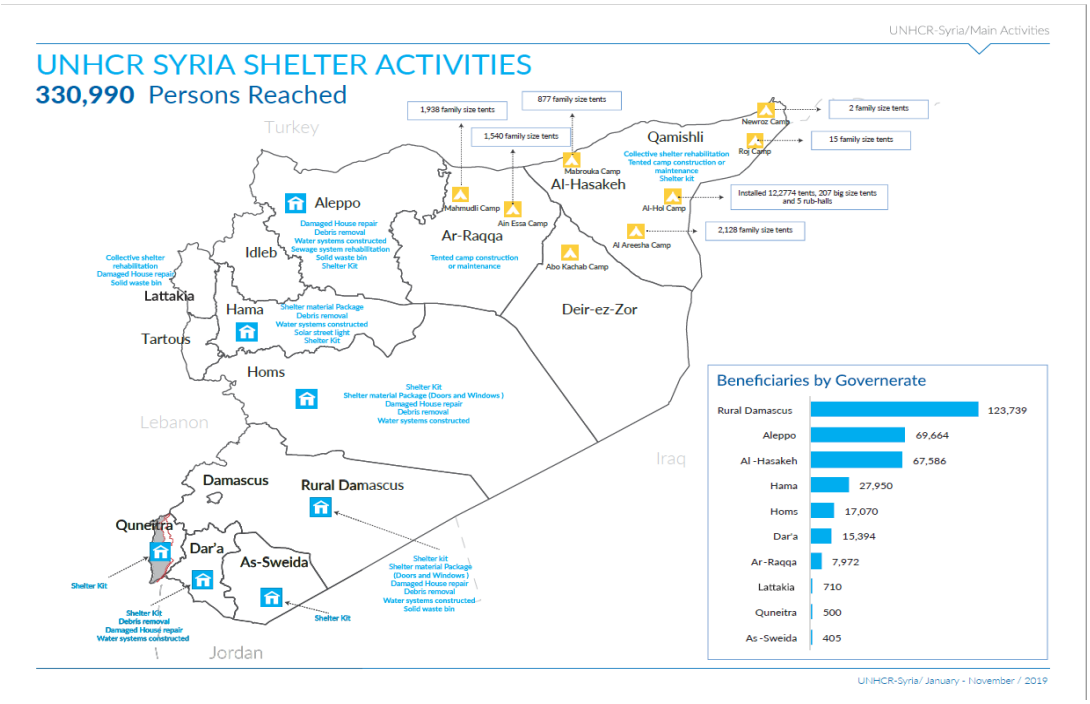


Fig 5: UNHCR Syrian shelter activities 2019

The informal interviews indicated that long, temporary, and complex humanitarian supply chains have been imposed on humanitarian organizations due to different activities which spreaded across all Syria. The official reports issued by OCHA for all humanitarian acitvities within Syria during 2017 , 2018, 2019, and 2020. They indicated else that there are fluctuations in numbers of Syrian people that were benefited from different programmes in terms of shelters & publich infastructure, wash, ER & L (early rehabilaition and life saving) accoridng to the below diagram extracted from OCHA Syria database since 2017 until 2020. Consequently, that confirm the information; mentiond in interviews with logistics persons from different organizations; that planning of humanitarian construction logistics within Syria was complex because of there are extreme differences duirng past squenced years in terms of activties, supplies, locations, components, procurements, reasources and even goals. For example, number of beneficriares from shelter program duirng 2020 equals around half of beneficries within previous years.

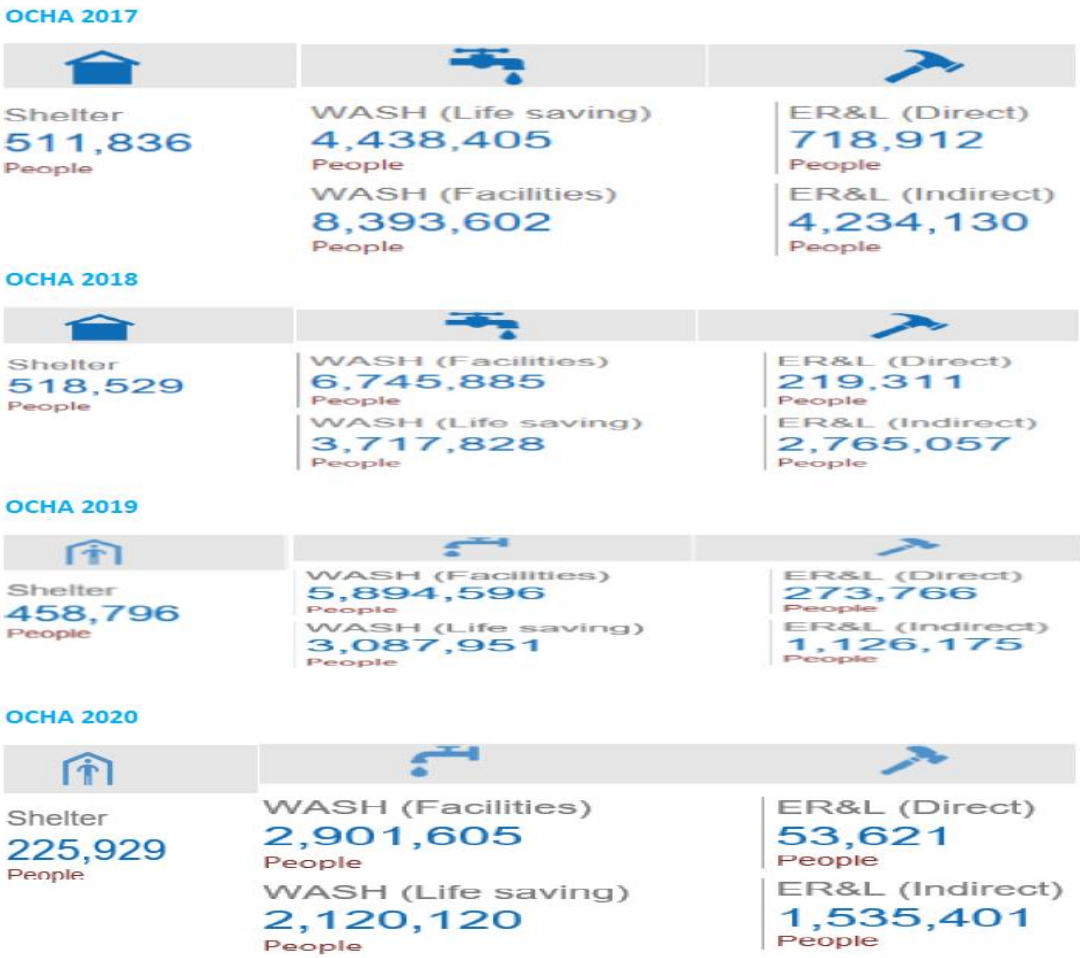
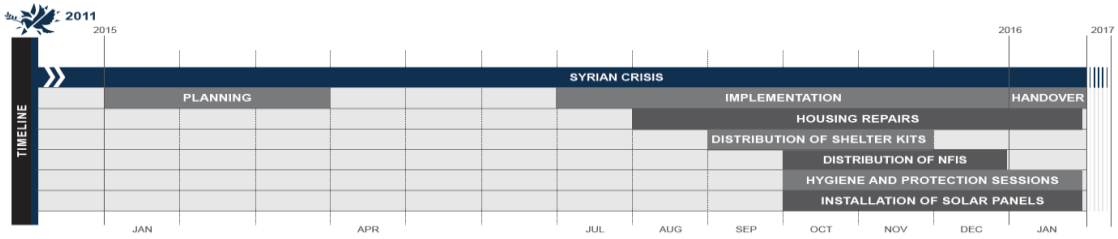
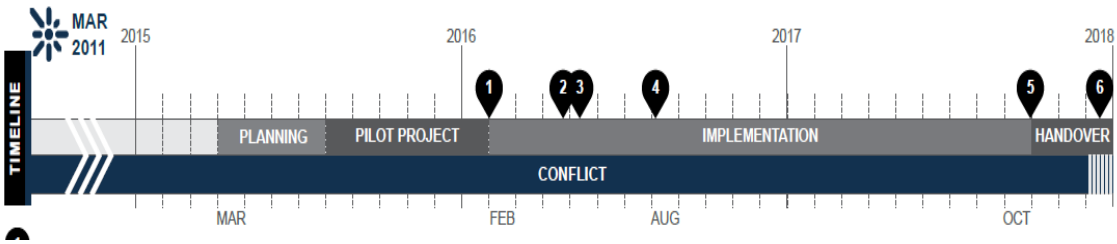
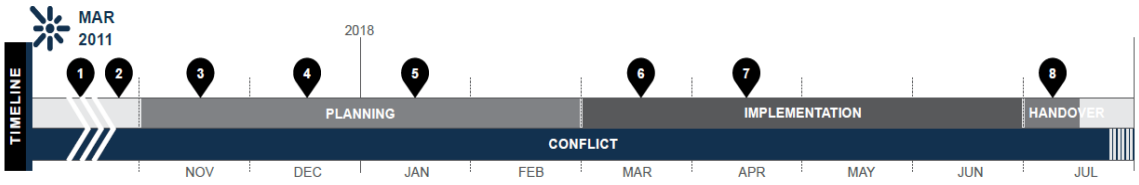


Fig 6: UN-OCHA, Syrian Activities , 2017-2020 ([www.ocha-sy.org/4wsresponse2020.html)](www.ocha-sy.org/4wsresponse2020.html)

On the other hand, analyzing timescales of Syrian humanitarian construction projects shows that there is 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 unstable surrounding circumstances. The below diagram shows time-scale instances for five projects in Syria extracted from Global Shelter Cluster (Syrian shelter projects reports) from 2015 until 2019. Most of them demonstrated periodic distances between planning phase and handover phase were reached to many years, therefore, the materials' costs, projects components, and original logistical plans could be changed according to surround circumstances. (Shelter Cluster / Syria, 2021)







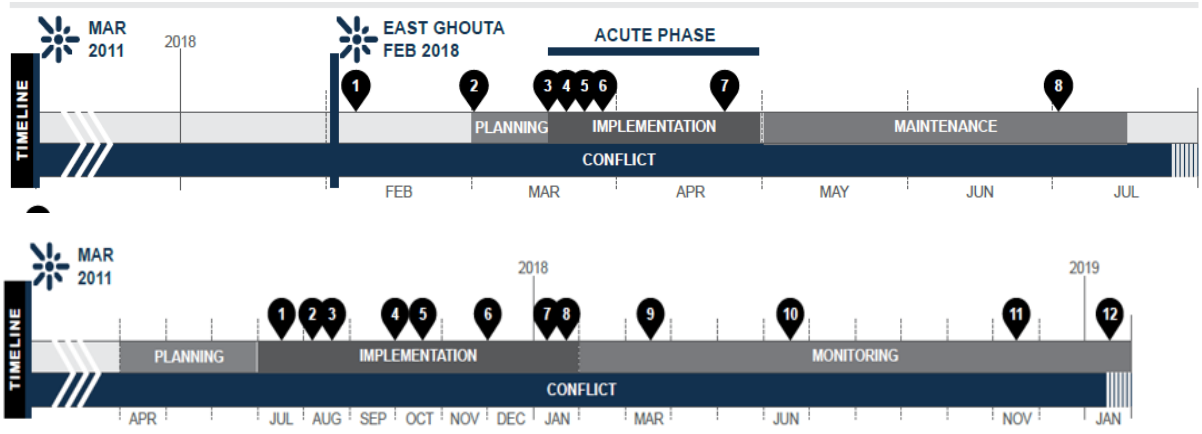


Fig 7: Syrian shelter projects timelines, 2011-2019 (www.sheltercluster.org)

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

According to interviewees with duties of 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 of solid waste tools, training IDPs, and eventually information flow between participates.

OVERALL FIGURES

512K

Total no. of people covered with emergency and durable shelter support in Syria in 2017

TARGET	303,385	
REACH	511,973	(169%)

NUMBER OF PEOPLE COVERED WITH VARIOUS SHELTER SUPPORTS

SHELTER KIT PROVISION

TARGET	74,317	
REACH	45,306	(61%)

IDP SETTLEMENT SUPPORT

TARGET	158,403	
REACH	348,607	(220%)

DURABLE SHELTER & INFRASTRUCTURE

TARGET	60,675	
REACH	116,923	(193%)

TRANSITIONAL SHELTER SOLUTION

TARGET	3,800	
REACH	910	(24%)

CAPACITY BUILDING

TARGET	3,800	
REACH	227	(4%)

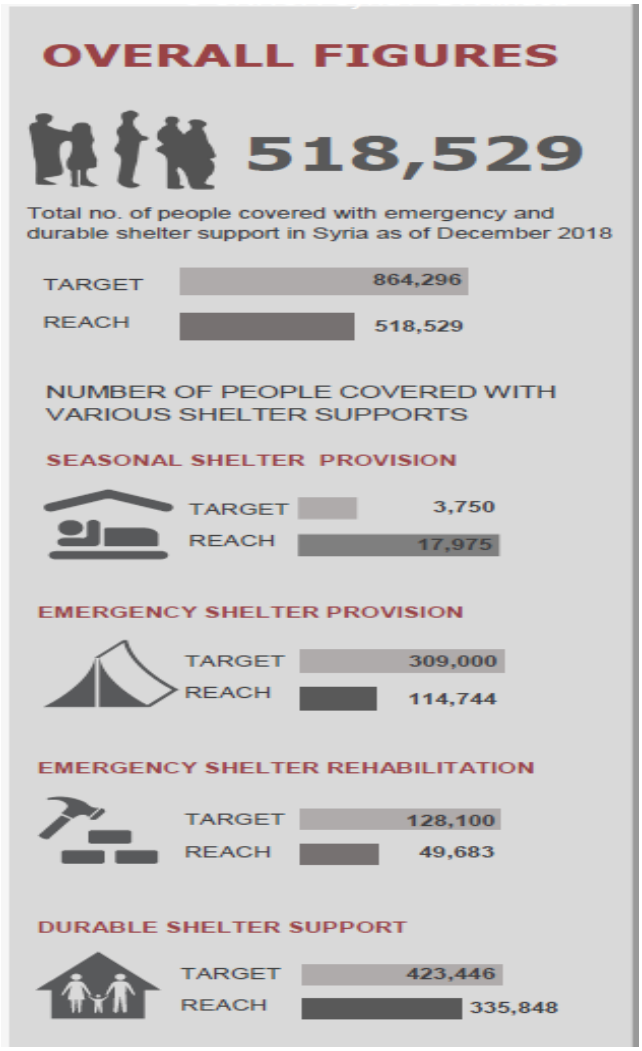


Fig 8: Shelter Sector, Syria Hub activities, 2017-2018 (www.sheltercluster.org)

All these differences made planning, implementing, and controlling the humanitarian construction logistics for UNHABITAT Syria is so complex (UN-Habitat Syria,2020) Reviewing annual reports of Global Shelter Cluster (Syria hub) indicated to another challenge in front of humanitarian construction logistics presenting in planning and implementation. The above facts extracted from 2017 and 2018 reports reflected what were the organizations' plans and what were achieved on ground. That leads to determine the obstacles through humanitarian construction logistics such as inability to planning procurements, contracting, transportation, and other resources in right way. For example, the emergency shelter provision in 2018 intended to target 309,000 effected people while the organizations' performance cover only 114,744 effected people at the end of year

which cause mis-planning throughout humanitarian construction supply chains. (Shelter Cluster / Syria, 2021)

4.2 Procurement & Logistics Functions in Syrian Humanitarian Constructions:

The reports of Shelter Projects Working Group with numbers A30(2016) and A.29 (2018) indicated that all contents of the distributed construction kits 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 transport of 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 quality of materials). Thereby, that led to increase the total project cost by 25 per cent and carried out the bulk of activities during bad weather within winter season.

All experts and labors were sourced locally by the implementing partners, in despite of the limited local expertise in the selected techniques (Adobe). 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. As well as, 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, report no. A30 (2016), report no. A29 (2018)) Here in below the key weaknesses, solutions, and lessons learning in terms of Syrian humanitarian construction logistics according to reviewing the reports numbers: A30 (2016), A28 (2017), A.29 (2018) and A31(2018) issued by Shelter Projects Working Group (Syrian Hub)

4.2.1 Weaknesses of Syrian Humanitarian Constructions:

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, partner capacity and heavy processes along with funding constraints such increasing needs, diminishing coping capacities; for both the IDPs and host communities; and limited financial resources of the government to provide shelter compensation require 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 that, opportunities for systematic field-based data collection remain very limited due to access or authorization restrictions which leads to incomplete needs analysis in some areas. (Dahia,2018**)** The informal interviews with logisticians indicating else to negative impacts on Syrian humanitarian construction logistics as summarized below.

- Security concerns impeding access or regular access to areas of need. Apart from remote management challenges, the project had to adapt with highly dynamic and unpredictable environment. Logistical and operational plans were based on most-likely scenarios and updated continuously based on context analysis. The humanitarian organizations worked with the local partners to ensure access thorough high-risk areas and responded to suddenness and unpredictability of displacements following tensions and conflict.
- Complexity of formal requirements and administrative procedures beside to 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 is indicating to hurdles in terms of verification of specific needs, vulnerabilities, and beneficiary groups.

- Improper market assessments leaded to increase in costs as some materials, such as timber, were not available in local markets and had to be imported. These logistics process included delays in the procurement and transportation of materials across the Syrian borders.
- Limited assets and resources like availability of sites and structures in certain areas for transitional solutions or upgrading for temporary use by IDPs.
- 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 leads to loss logistics capacity without clear results.
- 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 most of humanitarian projects were carried out through the winter because of limited time. Although most elements were covered, the rain affected on parts of the humanitarian constructions. That was resulting in the suspension of work and rebuilding 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 a lack of proper training and selection. This meant that the organization often had to conduct activities directly with its own unexperienced staff who leaded to increased transport costs significantly.
- Low construction quality because of managing the project remotely. That leads to difficult to conduct proper monitoring and inspection on the works' quality which were 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 are operational within Syria 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 Constructions Logistics:

- 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 lack of direct access to many Syrian areas, many humanitarian construction projects were implemented by local partners and remotely managed from Jordan or Syrian capital (Damascus). High quality of the interventions was ensured through the selection of independent monitors were contracted to verify the implementation and conducted site visits throughout the duration of specific projects. That leaded to increase logistics and operational costs.
- Using local materials and labour for implementing rehabilitation activities. Generally, the working team was composed of engineers, local workshops, and labours under supervision of the local partner team. Approximately 3,500 job opportunities were created, 450 toolkits were distributed to the most efficient workers, as well as, provided them with vocational training to help them start their

own businesses. Some of the beneficiaries also contracted as either skilled or unskilled construction workers. In result, using locally available labour 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 in which had several advantages compared to other options (such as concrete buildings or caravan units). These 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 to soil sourcing, the process (extraction/transport/mixing/production) is manual and has a low environmental impact and embedded energy level. In result, there was a low environmental impact, the raw building materials (soil and straw) were locally available and sourced sustainably; buildings were also easy to dispose compared to other shelter options.
- The humanitarian logisticians had been thinking since initial stages to make the intended settlements as transitional and 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 lack of cooperation from local authorities, limited availability of poor-quality supplies, and others. these could be mitigated by community engagement, close independent monitoring, preparedness evacuation plan for aid workers in the dangerous situations, as well as, small quantities of raw material were procured and stored to reduce the effects of market fluctuations and border closures.

4.2.3 Learnings of Syrian Humanitarian Construction Logistics:

- Necessity of conducting trainings for local labors (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 amount 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 HLP 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, 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 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

Humanitarian construction logistics 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 above overview of Syrian humanitarian construction projects , the humanitarian construction logistics isn't look like as traditional construction logistics which is typically 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 involves the integrating of many activities such as resources assessment, lead time assessment, supply planning, demand planning, procurement planning, production planning, scheduling, packaging, assembly, inventory management, order fulfilment, out/inbound transport management, warehousing, materials handling, on-site management, customer services, waste management, and other uncommon activities . (Chandes, 2010, Designing Buildings Wiki, 2020) Humanitarian construction logistics is 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 involves the buying-in/bring of materials and services from suppliers, subcontractors, donors. That leads to consider supply chain actors heavily impact 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 to refugee camps in northern Iraq during short time (between October and December 2019) according to estimations of Pace Winds (INGO) that managed refugees camps in northern Iraq. It was mandatory to prepare shelter sites, installed more than 3,000 temporary tent-shelters, and connected them to water and electricity by Peace Winds during short period. As the temperature drops, Peace Winds was also providing kerosene for heating homes and addressing other needs as they arise. (Peace Winds, 2021)

These activities were done by establishing effective humanitarian construction logistics, which was 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 ensured that the workforces were able to carry out required activities without delays caused by materials being delivered to site. In result, there are special specifications, challenges, and working environment that distinguish humanitarian construction logistics more than other logistics sciences. This thesis explored them in following below sections.

4.3.1 Bureaucracy & Non- Safety Impacts:

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

Help Logistics ;as research foundation involved in humanitarian logistics; have paid attention in above image (Fig 9: modularity picture) about possible risks related to humanitarian logistics such checkpoints by conflicted parties, limited access via broken bridges, camps based away from urban areas, lose aids on way to beneficiaries, and others. Syrian interviewees discussed many challenges in terms of safety and bureaucracy. Herein below key points.

- Humanitarian construction logistics have been impacting by the 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, as well as, for the removal of rubble. Humanitarian assistance for affected families to repair damaged homes, to restore their livelihoods could hinder 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. While it is hard inside Syria in which used to be the communist country that is mostly counting on its public services. The education, the health system, the electricity services, the water services, and the main services are all public. There are a lot of challenges to convince donors that aid workers need to build and rehabilitate the schools because it is important for children. While, these schools are part of the public education system. Thus, aid workers were accused that they are supporting the government
- There were insufficient funds to build more solid shelters on large scale within Syria. That leaded to neglected logistics functions such as low-quality materials' procurement and temporary non-practical solutions represented in tents, plastic sheeting and traditional shelters in which are not fireproof.

In result, understanding the current state of unpredictable logistical and bureaucratic challenges are needed simply to deliver assistance. Humanitarian construction logistics is crucial to learn how to deal with them, and what the roles of the different stakeholders is even more important. (Vega et al.,2020)

4.3.2. Budget overruns

Towey (2013) describes construction project cost management as the key element that helps drive the success of a construction project, it manages costs of logistics

functions, procurement, contract administration and different costs. Construction project cost management 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 chosen procurement route. For traditional project, full bill of quantitates is a common pricing document. (Mzyece, 2020) In context of humanitarian construction-projects, there are many logistics factors could cause budget overrun/s. For example, 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 is costing the vast sums. That is impacting negatively on beneficiaries and holding humanitarian organizations many financial burdens to address poor quality. (McCabe,2020) For instance, Peace Winds (INGO) has sought ;since September 2018 until now; to provide more durable shelters for refugee households by improving the homes of a total of 1,493 families; who had been forced to live in tents and insufficient structures within Syrian refugee camps in northern Iraq over eight-years period. While, this NGO had to use the allocated construction logistics capacity to build durable shelters when refugees had been received in first year instead of waiting around eight years to upgrade these shelters, because of using the durable materials leads to avoid repeat distributions and 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 affected communities. This led to local prices' increases for all purchases which took place through same local suppliers. (Ashmore et al., 2009) The experts within Syrian humanitarian construction projects revealed that the cost of construction materials on the Syrian local market quickly rose when housing reconstruction during recovery phase. Steel, cement, bricks, wood, sand,

and stone all became scarce, and expensive. UN agencies, INGOs and NGOs involved in rehabilitation and reconstruction by mobilizing all logistics capacity to ship construction materials from elsewhere to reduce prices and using local merchants for economic benefits (restock their supplies). Local suppliers participated by letting the organizations keep purchased materials in their warehouses until needed by projects. The NGOs paid all efforts to reduce the construction costs as possible. In despite of that, there are high costs associated large-scale humanitarian construction projects in which place high demands on logistics such as supplying and disposing perfectly of numerous raw materials, prefabricated components, large elements, construction machinery and volumes of excavated materials. Thereby, 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 Syrian humanitarian construction logistics that leaded to interruptions and unsatisfactory results as similar as Carillion's practices (Carillion was the UK's second-largest private construction firm went into liquidation in January 2018). These factors were resulting from the practices employed by the humanitarian organizations themselves such as poor practices of auditing, accounting, reporting, initiating of pricing document and full bill of quantities in which led to collapses and interruptions within humanitarian construction supply chains accordingly. As well as, employment a lot of unnecessary employees and associated volunteers in/out humanitarian organizations with high salaries against their works. (Arewa, 2020)

In result, the successful Syrian humanitarian construction logistics helped to control projects' budgets by quick implementation, monitoring costs, realistic pricing documents associated with realistic bill of quantities, use of local resources (material and labours), assessing the availability of local resources, following international standards (like provision appropriate shelter models were accepted rapidly by local authorities and beneficiaries), provision professional logistics services, matching construction materials supplies with demands, prioritizing the purchased decisions (which will impact on the local economy as well as the local prices), and monitoring transportation networks during the

rehabilitation/ re-construction interventions. (InterAction et al., 2020, Ashmore et al., 2009)

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 lowest price ;which usually lead 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) As well as, to optimize the delivery performance of construction industry' suppliers, who are described as rather poor in supply chain planning of construction projects. (Thunberg and Persson 2013, Thunberg et al. 2013, Ekeskär et al.,2016,Ekeskär et al.,2020) The suppliers have to be flexible to cope with last minute orders due to 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 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 traditionally performed by the contractors. This leads 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. As well as, 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 all are 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 ,that is meaning the craftsmen can focus on their trades and thus increase the added-value time in the project. That leads to increase the material handling efficiency because of TPL is using skilled material handlings personnel with proper equipment who do their works at times when the craftsmen are not around. (Janné et al.,2020)

The interviews; with humanitarian logisticians and Syrian TPL companies during 2020; discovered that humanitarian organizations relied on TPL providers during Syrian crisis since 2013 until now to carry out humanitarian construction projects for short, medium or long-term. TPL providers have been using skilled personnel to ensure durability and quality of humanitarian construction projects, infrastructures, suppliers' capability, regulatory requirements, supply routes and logistical capacity in current operational areas as well as potential areas. Besides

that, TPL providers have been managing extensive supply chain 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 context of Syrian humanitarian constructions, the TPL providers have been submitting many positive logistics services as following:

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 works collaboratively with local construction companies already operating in an area affected by a disaster is ideally positioned to contribute labour, materials and equipment that can save lives and reduce suffering. TPL providers is 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's easy to expand as numbers grow. TPL providers sourced and assembled tents or prefab shelters, that helped humanitarian organizations to get into a 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 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 at least as good, if not better shape than when we arrived.

4.3.4 Procurement & Contracting in Humanitarian Construction Logistics:

4.3.4.1 Procurement in Humanitarian Construction Logistics:

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 of relevant expertise from professional construction consultants, main contractors, sub-contractors, manufacturers and suppliers. (Shibani,2021, Mzyece,2020) In context of humanitarian construction, procurement is acquiring the logistical requirements of humanitarian reconstructions upon and after disasters which are representing 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 (shelter, roads, power, facilities...etc.) (Wong et al. 2010) The literature review explored that procurement process is usually crystallized into formal contractual arrangements in order to successfully deliver a humanitarian construction projects which is defined as 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 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. (Shibani,2021, Mzyece,2020)

One of Syrian aid workers discussed the complexity of procurement function within Syrian humanitarian construction logistics as said "Because we have technical and financial specifications. Thereby, we announce a bid and we choose the best offers of submitted contractors 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. we have like a checking team, when the material come, 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 do a project proposal and project sheet, for example, in case of a water intervention, we have like piping specifications which included mainly in project sheet for engineers and for the technical issues. We suffered a little for finding the products we wanted, especially, if it is very technical products. Because of the construction team or the water-board team need specific material like PVC pipes maybe thickness above needs to be horizontal, not submersible, that kind of stuff."

In result, traditional procurement route in humanitarian construction logistics 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), pricing document (typically a bill of quantities prepared by the quantity surveyor) and standard form of contract, which allows to select an appropriate contractor to carry out the on-site construction works. (Mzyece,2020, Shibani,2021) There are many challenges to select of appropriate procurement strategy within humanitarian construction logistics, 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 in place of timber. During 2007 and 2008, rising costs of steel led to cost escalations from US$ 900 per shelter to more than US$ 1500 per shelter. This caused serious budget shortages and the materials used consequently needed to be reassessed. (Ashmore et al., 2009) Beside that, 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 as well as lack of management staff available with experience of construction projects led to an unexpectedly large amount of management time being required for procurement.

4.3.4.2 Contracting in Humanitarian Construction Logistics:

In context of humanitarian construction logistics, the contract establishes the conditions under which work is undertaken. Its main purpose is to support an accountable, timely and efficient use of resources and ensure completion of works to time, cost and standard, as outlined in the construction project's objectives, (Mzyece,2020) whilst guaranteeing the rights of the beneficiaries to safety, protection, sheltering, and others that meets 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; related to Syrian humanitarian constructions and rehabilitations; explored 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 & materials (quantity and quality) based on specific 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 & labor, schedule of payments, details on implementation,

and required contractor's capacity. (Mzyece,2020) Besides that, all contracts should include the quantities which will allocated to each beneficiary as seen in the Bill of Quantities (BOQ). The below diagram (Fig 11) and following sections explain specifications of each contracting modality. (Reigber, 2018)

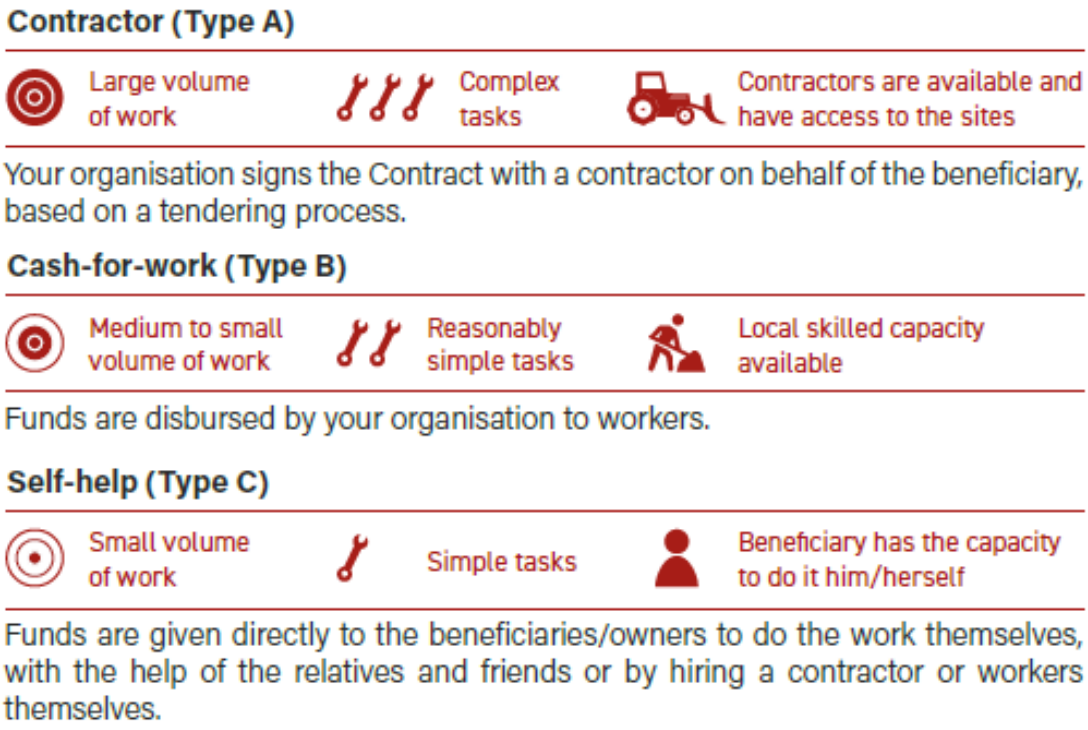


Fig 11: Contract / Agreement Modalities in Syrian Humanitarian Construction

Contractor / Type (A)

In this type of contracting, the cost may be reduced due to economy of scale, the contractor has more technical capacity, and so the risk of future problems is reduced. A framework agreement format is recommended in order to implement while still identifying beneficiaries and without the need to wait for a final BOQ of all selected humanitarian constructions. Materials' standards and prices must have been pre-agreed during the tendering process. (Reigber, 2018,Mzyece,2020) This type of the contract submit professional logistics functions because of a contractor is responsible for procurement and transportation of materials, coordination of works (including hiring of staff, health and safety practices) as well as a 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, working plan (including completion period), and schedule of payments and how to manage variation orders, incentive and penalty. (Good.,2010, Klenk 2010, Reigber, 2018)

The process to choose the contractor must be transparent, accountable and fair. The selecting process usually take place before assessing the BOQs (Bill of quantities) for humanitarian construction projects. This type does not require to agree on a specific amount, but to specify the envisioned works and put a ceiling of costs based on the expected amount of works. In this way, 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 humanitarian organization in which their expertise are matching with the required functions. In context of cash for work modality, the implemented humanitarian organization is responsible for logistics functions such as coordination of works (including hiring of staff), assurance the work is completed on time, as well as 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, implemented 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, beside to, quality assurance of materials and tools. For some of the materials, sub-contractors can be hired (such as aluminum works, carpentry, etc..). In cash for work modality , daily or seasonal workers must be selected based on the necessary skills and must be provided with a contracts that include a working plan (including completion period preliminary handover and final handover), a code of conduct, legal responsibilities of all parties involved, and a schedule of payments. In

result, implementing humanitarian organization must do follow up of the works with the staff and provide guidance daily. (Reigber, 2018)

For example, Syrian Red Crescent (SARC) made similar contracts in some projects like Homs, Alhamedia area, where they did the rehabilitation of old city. It was kind of cash for work contracts because it was an area 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 material. 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. Humanitarian organization should take careful consideration on who is 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 standards as to which the beneficiary's shelter is repaired and rehabilitated according to specific standards. The specifications and quantities of materials cannot be changed without the consent of both the beneficiary and humanitarian organization. (Reigber, 2018) For instance about self-help agreement, Syrian Red Crescent (SARC) have ready- to- use kits for rehabilitation team (which is a collection or package of materials like nails, hammers, and others 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 provide the beneficiaries with the first kit, 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 of beneficiaries were doing their own houses well. SARC have a database for

contractors and workers after project 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 for Site Layout

Construction-site layout is a crucial part of humanitarian construction logistics management and is prepared by logisticians as part of their mobilisation as sites can be very complex places involving the co-ordination and movement of large quantities of materials, high-value products, plant, and people. Likewise, the logisticians must protect and control of materials, components and equipment that are to be kept on a proper construction site during the construction process. (Navaratne et al.,2010) Effectively and accurately laying out a site can help ensure that the logistics works are undertaken efficiently and safely, because of careful sizing and positioning of temporary assets can help reduce travel times, congestion, waiting times, and making the 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 major consideration for humanitarian logisticians , tents must be carefully sited because of badly chosen site can create major problems in terms of internal distributions and supply chains. Logistics specialists should involve with site layout planning to reduce potential risks such as crowd, fire, loosed resources, and others, as well as, it is much harder to move people and their tents once they are settled. For example, they 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 establishing ecological infrastructures such as drainage, electrical, and others (OCHA,2004)

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

- Humanitarian construction logistics pay attention to physical properties in terms of the size, shape, weight and mode of delivery. It pays attention else to organisation issues like 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 must establish control, protection, and security processes for checking 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 must pay attention to costs associated with handling, transporting, stacking requirements, required workforce, heating and/or lighting , facilities to be provided for subcontractors, and other services like establishment emergency/ temporary routes and management waste/recycling process.
- Humanitarian construction logistics must establish programme and processing that enable to answer on 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 they will be on site. (Designing Buildings Wiki,2020, Ekeskär and Rudberg, 2016, Sobotka et al., 2005)

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

4.3.6.1 Prefabricated Modular & Humanitarian Construction Logistics:

The prefabricated modular construction systems are consisting 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 distinguish with hard to access, less space within the construction-site, 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) As well as, 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). Although, the rate of construction pre-cast in Syria is still 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. (House Matic, 2021, Hillegersberg et al., 2020). As well as, modular construction systems can optimize material strength with lower quantities of materials while still meeting 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, as well as, more workloads in remote factory instead of infield construction sites. (Hillegersberg et al., 2020, House Matic, 2021).

4.3.6.2 Prefabricated Modular & Syrian Humanitarian Construction Logistics

The contractors within humanitarian constructions have begun globally to adopt 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 ease of manufacture, 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 and at a lower cost. Thereby, humanitarian organizations attempt to trade-off between two methodologies within DFMA. The first approach is Design for Manufacture (DFM) that involves designing for the ease of manufacture of a product's parts which 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) that involves design for a product's ease of assembly which is concerned with reducing the product assembly cost and minimising the number of assembly operations. (Designing Buildings Wiki,2020, House Matic, 2021)

The interviews explored that technical experts and logisticians attempted to implement DFMA approach in Syrian humanitarian operations, even on-site or offsite; to gain logistical advantages of as 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 increase reliability as low number of parts decreasing the chance of failure. Beside to increase safety by removing dangerous construction activities from the site and placing them in a controlled factory environment.

- Design for ease of part-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 reduce logistics and supply challenges and the ensuing costs. Besides that, increase 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 prefabrication modular such as the humanitarian community spends millions of dollars each year on upgraded tents and prefabrication modular, which have specifications generally such as a high unit cost, a long production, a long transportation time, a high transportation cost, can be inflexible (bulky, complex, more costly to procure), have a limited lifetime, and 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 are limited. These negative points were explored in IDPs/refugees' camps within Syria and Lebanon when natural disasters of floods and storms have ripped off their tents and heavy rains flooded their shelters. In despite of that, tents and prefabricated structures created cover rapidly for Syrian refugees/ IDPs, as well as, they may be used to cover various infrastructure needs, such as emergency operating theatres or accommodation for organizations. Besides that, 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. (Designing Buildings Wiki,2020, House Matic, 2021, Ashmore et al., 2009, IFRC, 2021, IFRC,2020, OXFAM, 2020)

Fig 12: Upgrade Tent by UNICEF Supply Division 2020

4.3.7 Humanitarian Construction Logistics for Shelters & Other Functions:

Humanitarian logistics priority is an adequate supply of water and food in their optimal amount and time required, as well as, plan and organize safe havens within sturdy construction projects regardless of the construction materials employed. (Sant'Anna, 2016) Humanitarian construction logistics is 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 involve the delivery of tangible actions; either through international or local procurement; such provision of emergency shelters, technical assistances, and others. (Wynveen,2021) This section explores the necessary capabilities required by humanitarian construction logistics to address these requirements.

4.7.3.1 Humanitarian Construction Logistics for Shelters:

The shelter sector; among the all sectors; could bring and use the largest amount 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 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 Syria Shelter Cluster Meeting in April 2021, there are 3.63 M targeted people out of 5.88 M Syrian people who need for 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) that leads to focus on developing of humanitarian construction logistics to meet these high-scale needs.

The decisions of humanitarian construction logistics; that 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 ways to effectively meet the humanitarian sheltering needs with fewer materials like designing structures with standard material sizes can also help to prevent waste of materials during the construction phase. (Good.,2010) The literature review and interviews demonstrated together that Syrian humanitarian construction logistics have been addressing the different logistical requisites for the four different kinds of shelters described as following:

- **Humanitarian logistics for emergency shelters**:

Emergency shelters focuses on waterproofed first-tier shelters which are securing lifesaving needs such as health and safety (survival) (InterAction et al., 2020) According to Professor Diego Vega, humanitarian construction logistics are achieved these shelters by procurement, delivery, and installation many solutions for water storage, site drainage, food distribution areas, markets, storage places for individual households. (Vega et al.,2020) Logistics experts always face many complex situations, although quick emergency shelter solutions, such as tents, could have been deployed smoothly, but they could not have been upgraded for permanent use. (Ashmore et al., 2009) While, non-tent-based emergency sheltering solutions; that are rapid and cost effective; can also be acceptable by populations and humanitarian organizations in both the short term and over a longer period of recovery, but they could need for high-logistical efforts. For example, shelter kit is a useful option; from 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 have been submitting the emergency sheltering solutions 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, as well as, logistical requisites such as materials (plastic sheeting, tarpaulins, fixings and others), self-help tools, and others which must be available for effected people even within local markets and settlement. (Ashmore et al., 2009) The interviews and literature review demonstrated that Syrian humanitarian construction logistics 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 which can enable effected people to obtain of materials, perform construction, pay for labour, and achieve reconstruction for public infrastructure within local settlements. (UN-Habitat Syria, 2020, InterAction et al., 2020, Crown Agents) In context of immediate shelters, the humanitarian construction logistics efforts beyond emergency shelters to find solutions that are rapid, cost effective, and acceptable to the effected populations with less logistical requisites, less construction materials, and more durability. (Ashmore et al., 2009)

- **Humanitarian logistics for transitional shelters:**

Transitional shelters are developed to bridge the emergency and permanent shelter phases, (Ashmore et al., 2009) which aimed at the second-tier shelter needs such as comfort, security, protection, and social and cultural appropriateness. (InterAction et al., 2020) Humanitarian construction logistics has been implementing them when emergency sheltering is deteriorating, as well as, permanent reconstruction and housing programmes

can take many years to complete, especially when 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 emergency shelters' requisites. As well as, provision material packages and /or tool kits to repair damaged houses or build transitional shelters. (UNHCR,2019, InterAction et al., 2020) For example, transitional shelters cost; in some projects; just US$ 55 more than a standard relief tent 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 have been submitting to 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 facilitate longer term reconstruction, e.g. 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, thereby, framing better buildings and using better materials are being also important in humanitarian response. (InterAction et al., 2020) Humanitarian construction logistics have been re/constructing permanent shelters via many modalities like repairs, retrofit, cash grants for recovery, upgrading transitional shelters to permanence ;in cases of the length of time required to build permanent shelters, and building new permanent shelters entirely (Ashmore et al., 2009, UNDP Syria, 2021) Humanitarian construction logistics; in context of permanent sheltering; is doing many modern practices like disassembling a number of unused temporary housing units after disaster and reuse or recycle 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 speed up the recovery process for 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 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 to reach the goals like designing appropriate ways to supply water and other services for effected people. (Disaster Ready,202, UNICEF,202, Disaster Ready,2021) These practices could summarize as following:

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) that leads logistician to procure services and materials to supply right water quantities to right places especially to disaster effected 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) that 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)

The above activities are becoming now as main functions of humanitarian construction logistics 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)

Syrian humanitarian construction logistics has 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 examples, the local procurements and contracts of UNICEF Syria throughout 2020 helped to avoid populations; in conflict-affected areas; from negative effects of the destruction and lack of maintenance in which done to the national water and sanitation infrastructure. (UNICEF,2020) Beside that, Syrian humanitarian construction logistics was managed properly 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, whilst the logistics teams and technical experts were performing collaboratively the repairing, rehabilitation, and installation of permanent WASH facilities in effected areas. (UN-Habitat Syria, 2016, UNICEF,2021) For instance, double works were performed to address the necessitates for constructing temporary wash facilities in Syrian schools that children could access. Given that the reconstruction of school infrastructure would take time, so 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 main challenges in front of Syrian humanitarian construction logistics in terms of WASH activities as following.

- Any humanitarian response gives household a water tap without water gets to their house then the intervention is zero. There isn't only shortage in water within Syrian, but there are the issues 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 it is overused. That requires more efforts from 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 logistics team.
- Syria is very agricultural country which has water shortages. Syrian people were using drinking-water for irrigation, which is like a huge crime to water. Logistical and technical teams have been performing many projects to use irrigation water that is cannot be used as drinking water, but it could be used for irrigation. This irrigation water withdraws 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.

4.7.3.2 Humanitarian Construction Logistics for Public Infrastructures:

It is common that planning decisions; in the aftermath of a disaster; are based purely on building "something" to accommodate affected populations, as well as, 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 the problem of local infrastructure which are destroyed completely/partially by disasters. That cause many hurdles such as hindering the access of resources with difficult to guarantee the quality of donated resources and hindering the human resources to participate in humanitarian

operations ,as most of the times, there is an excess of volunteers without ability to transfer them to affected area (Sant'Anna, 2016 a, Sant'Anna, 2016 b, Wong et al.,2010)

A common consequence of disaster is needing 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 about structural safety, ease, and cost. (Klenk.,2010) Humanitarian construction logistics focus on status and available of public infrastructure as main part within quick humanitarian responses because of any loosed minute might mean the loss of a life. (Sant'Anna, 2016 a, Sant'Anna, 2016 b, Wong et al.,2010) It follows a strategy to conserve resources and reduce 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 and public infrastructures. The roads were severely damaged in three of the five targeted areas. 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 the community-built housing programme was being quicker and more successful. Furthermore, there was also the need for humanitarian construction logistics to restore the public infrastructure to provide of basic services such as water and electricity were slow and somehow chaotic. (Ashmore et al., 2009) Other instances about humanitarian construction logistics and its significantly impact on rehabilitation of Syrian public infrastructure was presented by Crown Agents logisticians. They; together with 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) As well, logisticians of WeWorld organization have been procured services and materials to increase access to drinking water and water resources ;which are often insufficient in terms of quantitative and qualitative terms; through the rehabilitating of the water management infrastructures and equipping of water supply points in which have been damaged in Syria (WeWorld,2021)

4.3.8 Local Materials & Humanitarian Construction Logistics:

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 of massive specialization provides economies of scale. (Hillegersberg et al., 2020) However, recently there is a movement to procure and buy local, 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 increased participation of affected population. As well as, finding options for reducing, repurposing, reusing, and recycling these solutions. (Hillegersberg et al., 2020, Wynveen,2021) This potentially reduces logistics costs and environmental burden and vitalize 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 also benefitting the local economy. (Murray ,2015) local materials production; throughout humanitarian construction logistics; is one of the most common shelter-related livelihood activities like local brickmaking, compressed earth block, as well as, pre-fabrication of doors and windows. Apart from revitalization humanitarian construction, this also has the added benefits of providing communities with additional skills 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 important of logistics and supply localization; within Syrian humanitarian constructions projects; which had significant impacts on both the design of shelters, reconstruction, rehabilitation, and the timescale for implementation. The scale of some procurements was huge, many projects attempted to source materials locally where possible. Sometimes, the humanitarian organizations made logistical joint agreement to share supplier lists and agree on the materials to be

provided reduced inter-agency competition and local price inflation. That could lead to encourage setting up local factories and developing a design based on materials salvaged from houses. In parallel, there was an effort to ensure that the procurement process would support the national economy, while trying to avoid creating scarcity or putting inflationary pressures on the materials needed for permanent reconstruction. (Ashmore et al., 2009) For instance, Crown Agents logistics specialists in Syria depended on Syrian local market that had met their projects' requirements, although, there were procured some items from other areas and transferred them to projects' sites. Thereby, they did not need an international supply chain because of local markets were developed enough within Syria to avoid a situation where import something takes three months or more. (Crown Agents,2021) As well as, Local procurement of materials /labors can be a more environmentally sound strategy than the
procurement of distant materials because of the savings in transportation costs
and packaging. (Good.,2010)

4.3.9 Scheduling & Humanitarian Construction Logistics

The Scheduling is a key part of humanitarian construction logistics management; due to the complexity of the process and the interaction of many supply streams; which is needed to analyse, visualise and optimise logistics. Thereby, humanitarian construction projects draw 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 for humanitarian construction logisticians in terms of the unexpected changes and possibility to deal with the logistical changes (in terms of purchases' cost, duration of individual activity, production speed, and others). Using schedules offers a lot of flexibility through distribution of logistics works on the overall duration of the project size to get the financial resources that are needed daily and drawing the cash flow. The scheduling gives the possibility of periodic monitoring on the progress of logistical activities, through calculating could know the extent of achievement of each activity and adjust the delay to preserve the final period of the project. (Ahmed,2016) The interviewees in field assure that resource limitations result in conflicts which can be addressed by using levelling and allocation methods without delaying the timeframe. Allocation ensures that the resources required 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 with having a timeline of project stages planned in advance and a full inventory of materials and tools required. In result, preparing a 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 plan involves reviewing each element especially 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 project manager and logistics specialist who must track logistical activities in line with project timeframe and budget to achieve the project deadline. (Disaster Ready,2021) They must use a clear and real-time load diagrams (as appeared in Fig 10) which is a graphic representation ;for constructional and logistical resources over time; allowing assessment of trends and reaching to optimized usage of logistics functions, that don't exceed the needed resources. In despite that, duration of an activity can be reduced by adding additional resources, but this will also increase its cost. The two scenarios must analyse within humanitarian construction projects' plans according to surrounding circumstances; even where infinite resources are available; to adjust duration properly, therefore, the time-cost relationship must be known for each activity. (CIOB,2021)

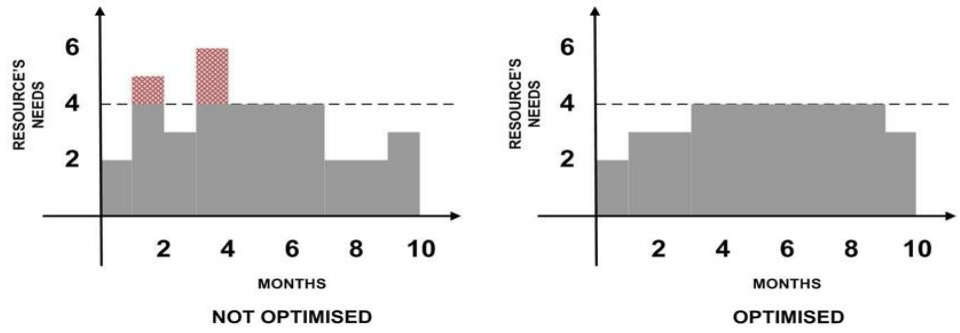


Fig 10: Construction Activities Load Diagrams, CIOB (The Chartered Institute of Building).

4.3.10 Debris Clearance and Waste Management within Humanitarian Construction Logistics:

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 generate 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 reuse, 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 available options in terms of reusing, recycling and reducing the amount of wastes throughout humanitarian construction projects. (Good.,2010, Klenk.,2010) Syrian humanitarian construction logistics has been conducting many activities involved waste management and debris clearance which can described as following.

- **Waste Management** must be prepared its plan 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 of materials to reduce the burden of large volumes of material on local landfills and to avoid disposal costs through resale of materials. (Klenk.,2010)

  Interviewees explained that they have been implementing some of modern construction logistics practices within Syrian humanitarian constructions such as site waste management plan (SWMP) which implement relatively throughout below practices.

  - Confirmation the correct quantities for ordered materials to reduce the normal wastage factors accompany with surplus in stocks.
  - Confirmation the shortages before ordering additional materials to avoid storage too much from same materials.
  - Checking the construction drawings and quantity surveying because a shortfall of a material may be due to drawing errors or wrong surveying caused by quick implementing of humanitarian construction projects. Importantly, checking constantly on the available materials and act when it appears that there may be insufficient amounts.
  - It may be possible to eliminate a certain amount of construction waste through local community mobilization, 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 Rebuild Syria initiative for solid waste management through community mobilization. Which 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 removal the piles of waste from irrigation sites and the surrounding area that allowed to recover and use the land for agricultural production. (Crown Agents,2021)

➢ **Debris Clearance** considered as key activity within humanitarian construction logistics since the removal of debris is a precursor to recovery activities being implemented. (Good.,2010) The activities of humanitarian construction logistics 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, as if disposed of improperly it can cause future hardships for the affected population. (Ashmore et al., 2009) The Shelter Cluster noted to the value of such debris for humanitarian logisticians as a source of building and reconstruction materials; which consider as environmentally sustainable options; for humanitarian construction projects as long as this debris meets applicable specifications for strength and safety. (Ashmore et al., 2009, Good.,2010) Then debris should not just be disposed of but collected, sorted and where possible, reused and recycled. (Ashmore et al., 2009) These logistics activities could use 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 debris logistics practices 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 context of Syrian humanitarian constructions, 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) Thereby, the debris quantities across Syrian cities; which can be significant and difficult to measure; have been reusing and recycling at a local level. (Crown Agents,2021) For example, Crown Agents' team have been supporting public roads and infrastructures to recovery through working together with local implementing partners to clear 44,000m3 of debris from 128 public buildings including 102 schools in Deir Ezzor province, then 78% of the debris has been 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 local transporters, local labour (cash for work), and others (Crown Agents,2021, UNDP Syria, 2021, Rebuild Syria Reconstruction Programme, 2021)

In result, the debris logistics planning must establish immediately as part of humanitarian construction logistics and ensure that safety measures and needed equipment are in place to achieve debris management effectively. (InterAction et al., 2020) Effective debris logistics can support early recovery for the post-conflict phase, because of using recycled debris (often cheaper than raw materials when transport is considered) to overcome on significantly increasing of raw materials' costs following conflicts, that is caused by reconstruction demands outstrips their local supply. (Crown Agents,2021, UNDP Syria, 2021, Rebuild Syria Reconstruction Programme, 2021) By reusing and recycling the debris close to the debris source, transport costs can be significantly reduced which in turn reduces the overall cost of humanitarian construction logistics. As transportation of the debris from the source to its disposal or treatment site was considering as one of the biggest costs within debris management in Syria (Crown Agents, 2021) Furthermore, wise debris 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 construction 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 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 and disposal, through to 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) MLP aims to ensure that the right materials and equipment are delivered to site at the right time to reduce the idle resources and space requirement on site. It can reduce unnecessary transportation and material handling, as well as, reducing delivery of late or incorrect material which are 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 construction-projects that could apply throughout humanitarian construction-projects as following.

Stage 1- Once the design of the project has been agreed, 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. KPIs should be set for procurement

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, such as planning conditions, should be identified and mitigating measures 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 wastes generated from the project will assist in the evaluation of material types and quantities ordered and how they were managed. Besides that, identifying main causes of material wastage during the construction phase which could describe briefly as following:

- ❖ Inaccurate or surplus ordering of materials.
- ❖ Damage to materials through inappropriate handling, 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 wastes are removed from site in a managed and timely manner. An effective demobilization plan will minimize costs through off hiring equipment and plant when it is no longer required onsite as well as planning for excess materials management. (WRAP,2007)

The Syrian interviewees declared that they used of material logistics plan (MLP) as tool to formalise and implement the logistics planning process that satisfy the donors' auditing processes and as a complementary approach is becoming more popular in humanitarian construction-projects ; not just on large complex schemes; but also in the planning and delivery of small restored houses and fit-

out small-size contracts. MLP have been implementing during 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. So that MLP becomes progressively more important especially for rehabilitation/reconstruction projects in severely affected areas. MLPs for Syrian humanitarian constructions have been designing by logistics experts to analyse the different logistical options of supply chain such as availability of materials locally, internal transportation, and free-damaged roads. It aimed to address challenges like materials run out, needed materials can't be quickly obtained from a nearby areas, works' interruptions, workers stand idle (or must be reorganised to do other works) while new materials are procured. Eventually, logisticians ;through MLPs for humanitarian constructions; focus on the local appropriateness of the material, legality, cost, transport distance, and impact on the environment, because of 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 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 normal local market price; for each element within the BOQ. It should be divided into different sections and following the components that are parts of the project (Reigber, 2018, MSF,2011) These tasks are conducted by quantity surveyors (sometimes referred to as cost consultants or commercial managers) who are providing expertise about construction costs, assuring that proposed projects are affordable, assuring available good value for money, as well as, helping the client and the design team to assess different options, track variations, and keep that costs under control as the project progresses. (Mzyece,2020) In perspective of logistics, quantity surveyors conduct the tasks will vary depending on the nature of the project, but

they might include 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. (Reigber, 2018, Designing Buildings Wiki,2020, Mzyece,2020, MSF,2011) The BOQs help in determining the other logistics requirements like the number of 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 with the workers, and the issues about 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 structure to apply to the table, the different elements, 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. (Mzyece,2020, MSF,2011)

In context of Syrian humanitarian projects, the interviews and literature review demonstrated that humanitarian organizations have been recruiting the trained and qualified technical members to conduct the rehabilitation technical assessment (which consists of BOQ and Scope of Works) since 2013 to quantify the materials required 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) such as it must to sign by beneficiaries and it must to be very clear about supplies. As well as, each beneficiary must sign upon delivery to prove the reception of the specific bill of quantity for his/her house. Thereby, humanitarian organizations need to assure that the determined quantities are measured precisely from beginning. (Reigber, 2018, Mzyece,2020) For instance, Syrian Red Crescent usually assign two volunteers to go into each house, one counts, and one checks double. Because it is donors' money and they need to be precise and fits the beneficiary best.

5. Discussion:

This chapter aims to discuss the above-mentioned results to reach to best frameworks for humanitarian construction logistics. Based on that, this chapter aims to answer on second research question "What are the proposed practices for humanitarian construction logistics?" by discussing the best logistical practices, technologies, and sustainable solutions for humanitarian construction logistics.

5.1 Humanitarian Construction Logistics Strategy

The objective of the humanitarian construction logistics strategy is to implement a holistic and system-optimal approach for construction logistics within humanitarian context, based on real-time data collected and stakeholder consultation. it will organize to address the challenges of coordinating workers, delivering of material timely, and optimizing efficiency and assessing the impacts of alternative regarding sustainability criteria. (Vega et al.,2020) Humanitarian construction logistics need to be considered early in humanitarian, rehabilitation and development projects to minimise the disruptions in the surrounding environment and optimise efficiency. key stakeholder must work to optimize humanitarian construction logistics based on real time data and smart technologies that enable the effective use of efficient logistics and making participatory decision in terms of urban, humanitarian, rehabilitation, and development projects (CIVIC, 2018)

Humanitarian construction logistics 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 allows to respond effectively against unforeseen event while using resources efficiently, resources that in most cases are scarce. Besides that, the challenges faced by humanitarian construction logistics are significantly broader and deeper than those related to issues like movement of material, storage, last mile distribution and information management. humanitarian construction logistics is 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 affected by the flooding, that increased the needs by humanitarian construction logistics 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:

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. Setting up smart construction logistics in advance will prevent most of the disruption. That will not only save money. The results are promising nearly 70% fewer transport movements to construction sites, nearly 70% fewer CO2 emissions, and up to 40% higher productivity at the site. In the end, 3 to 5% lower construction costs were achieved. Smart construction logistics not only benefits society, it also ensures more efficiency within the construction chain. That means investments will eventually pay for themselves. (CIVIC, 2017)

The concept of smart humanitarian construction logistics 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 deserves clearly a prominent place on 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 in which caused by workforce, materials, and equipment clashes. (Magill et al., 2020) A robust and well thought out smart humanitarian construction logistics approach is critical to securing optimum construction site efficiency and safety and decreasing waste. (Whitlock, et al., 2018) The costs of failure of humanitarian construction logistics are high, thereby, setting up smart construction logistics in advance will prevent most of the disruption that will not only save money. The results are promising 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 benefits society and humanitarian organizations, 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) Herein below the modern technologies that could incorporated within humanitarian construction logistics.

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 has 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 such, it creates 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) Tracking is also required by some donors especially within humanitarian constructions. It is best practice within humanitarian organizations to ensure accountability for the materials until they have been used and to avoid incorrect tracking in which can lead to cost and time over-runs. (Disaster Ready,2021) RFID implementation requires 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 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. BIM is currently mainly used in the design phase of a building project. (Oosterwijk,2017)

Both BIM and Construction Logistics Management (CLM) disciplines revolve around timely delivery of resources, either these are 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)

BIM software can integrate logistic information with computational models and 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 supply chain. This is needed to steer humanitarian construction logistics to achieve just in time deliveries, comparing the plan against the actual and steering accurately on humanitarian construction-sites. (Hillegersberg et al., 2020)

The aim of a recent UK studies by universities like Oxford and Yaounde is to investigate how BIM can be applied to construction logistics management. (Whitlock, et al., 2018) Which can be applied else to humanitarian construction logistics. The literature suggests 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) As the literature suggests integration BIM with GIS (geographic information systems) to manage the logistics of a humanitarian constructions. (Oosterwijk,2017) Because of BIM has a number of applications to both the logistical management of materials delivery and distribution, as well as dynamic site layout planning (Whitlock, et al., 2018) That use could potentially add value with a trusted supply chain and disciplined planning using a multiple stream logistic model. (Magill et al., 2020)

According to Whitlock, et al (2018), There are benefits to the application of BIM systems to humanitarian construction logistics These benefits are outlined below.

-Improved understanding of Logistics Information as presentation of logistics information through a three-dimensional platform brings the benefit of improving the

comprehension of site layout data, allowing complex logistics processes to be more easily interpreted by individuals without a construction or logistics background.

- Increasing the ease at which proposed logistics plans can be interpreted 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, 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 allows to health and safety risks to be quickly spotted.

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

-Improved efficiency of logistics planning as 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 BIM adoption in humanitarian construction logistics represent in following issues.

- 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 reverting back to management of 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)

- 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 of humanitarian construction logistics management (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 stakeholder (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 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 the time to the BIM-model for successful management of humanitarian construction logistics.(Oosterwijk,2017)

5.2.3. GIS (Geographic Information Systems):

GIS 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 gather, process, store, manage and analyze geographical spatial data and attribute information conveniently. GIS is a tool for comprehending geography and making 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 about using mapping to improve the data we have and help the humanitarian operations. GIS's practical applications in humanitarian construction logistics aim to to collect importance spatial data to construction logistics management like where the populations with most urgent immediate needs. That keep planners and decision makers; who are not actively on the ground; informed about the evolution of the situation to make their interventions more effectively to address shortcomings. (Heyns,2021)

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

The produced maps can provide context and scale within a single picture frame and comparing maps over different time frames provides insight into the progress of humanitarian constructions' activities like the growth of the camps in which receives a hundreds and thousands refugees on a daily basis. Thereby, the picture is constantly changing in which 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 activities. (Heyns,2021) For example, humanitarian construction logistics is mapping the significant damages and long-lasting failures in infrastructure networks (such as gas, power and water) upon disasters, as well as, mapping the maintenance needs, contractors to repair each site and the logistics activities for each team in order to minimize the sum of the recovery times.

At the end, there are many available information-and-communications technologies that can contain the entire set of data in which support the construction process, transport planning, materials management, and other logistics functions (CIVIC, 2017, CIVIC, 2018). In despite of that, there are some challenges regarding the functioning smart humanitarian construction logistics such as the sub-contractors and suppliers aren't used to work in these systems and the different parties don't adhere with standardized process. Furthermore, extra administrative costs and initial investment's costs are prerequisites to set up the above-mentioned technologies for stipulated construction logistics. (Janné et al.,2020)

5.2.4 Blockchain

The 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 the gaining of access to any needed information. The technology will help in site organization by providing decision-makers with access to all the necessary information for making any decisions with respect to the logistics process. (Almohsen and Ruwanpura, 2013)

Baharmand et al. (2021) and Ko (2016) studied the application of blockchain to humanitarian logistics for more understanding of added values and challenges. They revealed that blockchain application could increase transparency and development among humanitarian operations by providing data to inform more effective and accurate decisions, enabling evidence-based interventions and management, exposing issues for effective remedy and increasing accountability. blockchain application could be added value 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 no one controls on smart contracts. These contracts could be used to tie funding or transactions among humanitarian construction logistics based on agreed rules to ensure all parties are held accountable. For example, person A and person B agree that the ownership of some 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 transfer of ownership (Ko,2016)

In context of blockchain implementation among humanitarian construction logistics, there are main challenges are composed of engagement issues, lack of technical skills, lack of training, lack of resources, privacy concerns, and regulatory problems as well as humanitarian construction logistics is extremely dynamic, as result, its visibility and data tracing can often be poor.(Ko,2016, Baharmand et al.,2021) Effected areas with inadequate infrastructure or capacity would not be appropriate use cases for blockchain

which requires 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. That will ultimately reduce the most causes of poor logistics management such as material unavailability, double handling, and overlapping of activities. It also allows all participants to make their real time contributions by allowing for all parties to put in their requests and necessities among humanitarian construction logistics (Almohsen and Ruwanpura, 2013)

5.3 Construction Logistics Solutions

The key of humanitarian construction logistics 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 can produce enormous cost benefits and value. (Designing Buildings Wiki,2020) The humanitarian construction logistics stipulates incorporating construction solutions within humanitarian logistics which will present a different configuration and will face different challenges, nevertheless maintaining the same goal, i.e. responding to effected population's needs effectively and alleviate the suffering of vulnerable people. (Vega et al.,2020) Therefore, there are many solutions that are adopted by humanitarian construction logistics as following.

5.3.1 Prefabricated Products Within Humanitarian Construction Logistics

Prefabricated Products provide the solution to needs of all kinds shelters and settlements upon and after disaster. Humanitarian construction logistics involved in bring all kinds of products related to high-resistance textile architecture for camps and humanitarian aid uses in emergency situations. These ideal products for emergency situations in remote locations, refugee resettlement, natural disasters, and armed conflicts. (Whitlock, et al., 2018, House Matic, 2021) As well as, the building site; in disaster areas; isn't much bigger

than a building that is going to build there. This means that 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 of construction sites. (Whitlock, et al., 2018, Hillegersberg et al., 2020) A number of benefits can be realized in these factories like increasing precision & quality, reducing overall manufacture/assembly time, increasing safe & clean working conditions, reducing multi-trade interfacing, decreasing on-site workforce numbers, reducing need for material transport and on-site storage. (Whitlock, et al., 2018)

The humanitarian agencies, such as UNFPA, UNHCR and UNICEF, UNOPS and UNDP, IFRC, and others; adopt and set up prefabricated modules worldwide in the 140 countries throughout the world where they have a presence. (House Matic, 2021) These prefabricated building materials are transported from a factory to the construction site. An example of a prefabricated construction part is a wall complete with doors, insulation, and windows. By using these prefabricated elements, or standardized construction elements, the building project becomes less project based. The prefabrication of construction parts in controlled environments in factories reduces the demand for space at construction sites. (Whitlock, et al., 2018, Hillegersberg et al., 2020)

The best specifications for these products are tailoring each humanitarian organization's needs, express assembly, and easy international shipping. (House Matic, 2021) As well as, the materials that arrived at the construction site was assembled immediately, because of the limited space at the building site and time restriction. (Whitlock, et al., 2018, Hillegersberg et al., 2020) In commercial context, prefabricated products are becoming more advance, for example, Chinese company had constructed 10-storey residential tower; named the Living Building; in just 28 hours and 45 minutes by using a prefabricated modular units (معجزة صينية.. بناء مبنى مكون من 10 طوابق خلال 28 ساعة فقط - RT Arabic). These techniques had been adopted by humanitarian context to develop prefabricated approach within humanitarian construction logistics. For example, 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 demands an intense exchange of information between the plant and

the construction site, in order to synchronize the production of components, logistic operations and site assembly, especially in humanitarian operations in which the degree of uncertainty tends to be high. (Bataglin et al., 2018)

5.3.2 Innovative Emergency Shelters

There are many innovations that could adopted by humanitarian construction logistics for submitting inexpensive and sustainable shelters for effected people. This dissertation presents two instances as following.

The first instance about Japanese architect Shigeru Ban who had innovated 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 for columns, walls and beams, as they are locally available anywhere in the world. The tubing is inexpensive, is easy to transport, mount and dismantle, can be water- and fire-proofed, and recycled. (Murray,2015)

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

In result, these solutions must be adopted early in humanitarian logistics stages as their components simply being managed alongside remaining materials and building components within humanitarian construction logistics 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

There are many humanitarian constructions that benefit recently from modern solar solutions to alleviate suffers of effected people. For example, Kubum Solar Water Project was instance about adoption of modern solutions, it was initiated by the growing need for sustainable sources of water for IDPs in Darfur. The logisticians in Caritas-International implemented an innovative solar-powered water pumps to increase water supply. In despite that solar power is frequently criticized for its expense, but it is a long-term solution that has exponential benefits for communities. (Navaratne et al.,2010)

Eventually, the above-mentioned solutions; by humanitarian organizations; could have vast consequences on humanitarian construction logistics in terms of the network of actors involved and designing logistical processes. Thereby, logistics experts must pay attention about consequences on humanitarian construction projects and learn lessons for future. (Vega et al.,2020) Beside to transferring and sharing information about orders and schedules on short time. (Young et al., 2004)

5.4 Team of Humanitarian Construction Logistics:

Humanitarian construction logistics employs many professionals who represent multiple disciplines such as 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 focuses on employment of local people to provide skills and development opportunities in affected locations where unemployment rates are often high. Furthermore, humanitarian organizations consider 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; within cash-for-work scheme; in Syria who well educated population like logistics assistants, engineers and technicians. This results in high economic dependency ratios because of employees' salaries make a significant contribution to the local economies and the communities as the scheme was the sole source of income generation. (Crown Agents,2021) The humanitarian construction logistics focuses else on off/on-sites teams who are dedicated to receive deliveries and distribute materials, equipment and others. (WRAP,2007) For example, on-site materials handling team is prepared to handle the deliveries when arrive, and they relieve work from the craftsmen. That leads to more efficient on-site operations and materials handling costs can be reduced. (WRAP,2007,Janné et al.,2020)

The humanitarian organizations trend recently to integrate logistics team to 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, facilities 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 chain (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, UNICEF Supply Division established new units (construction) in its main supply hub (Copenhagen, Denmark) and in its offices worldwide; even in Syria; which include engineering and logistics experts who manage construction logistics related to humanitarian projects to scale up relief and recovery efforts. (UNICEF,2020)

Reviewing (www.job.sy) ;the most dependable employment website in Syria since 2013 until 2021; shows that construction logistics approach has been rooting gradually in Syrian humanitarian operations by UN agencies, INGOs and NGOs. They have been interesting about hiring professional logisticians to do main functions as following:

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

In result, humanitarian organizations; activated in Syria; assured on importance of humanitarian construction logistics teams in order to organize resources and achieve contracts on deadlines by deploying appropriate logistical team for each project. (Ashmore et al., 2009) For example, Crown Agents have been recruiting the logistical teams of their implementing partners who collect the data and the monitoring criteria on a monthly basis which feedbacks to Crown agents staff then reports to the donor on a monthly basis. This includes quantities of materials that were procured, and the number of infrastructures has been repaired, as well as, general data like numbers of beneficiaries (Crown Agent, 2021). Pace Winds organization had presented the real example during upgrades of several shelters since 2018 until now. The sites were bustling with logistics activities like laborers, trucks delivering building materials, in despite of that, Peace Winds staff performed efficiently 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 with the programme, organising routes through the site, 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 and managing all movements to and from the site; creating and maintaining an organisational delivery management system; planning and maximising the use of delivery vehicles. (Peace Winds, 2021)

The most challenges in terms of humanitarian construction logistics teams, that the sub-contractors and suppliers are not used to adhere to structured logistics arrangements, that lead to increasing planning, increasing coordination, mistakes in labelling of goods and mistakes in the planning documents. This leads to extra work at site with unclear work instructions, missing materials, early deliveries with return flows, etc. All these issues lead to extra costs, which makes it hard to exploit the benefits and to offset the extra costs that comes with the terminal and the logistics arrangement. Add to this that there have been some issues with material handling equipment, delivery errors and that the materials-handling team is an extra cost, and one realizes that the total cost equation might be tough to balance. (Janné et al.,2020) Other challenges represents with safe issue. First condition for rehabilitation, it needs to be safe for the team. it needs to be approved by different parties. The safe intervention means like it needs to be safe for the contractor as in construction wise means like the building would not go down with them inside. It needs to be the people should be welcoming and accepting for this intervention. Because if you cannot force up to someone. They need to be in safe flow, so They can’t do any

intervention in any area where there were no good roads in order to transport the materials and human forces. (Shelter Cluster / Syria, 2021)

5.5 The Quality in Humanitarian Construction Logistics:

Supervision is viewed by many as the key to meet quality standards of humanitarian construction logistics. Due to this, pressures on quality are increased through humanitarian construction projects to keep pace with changes in humanitarian construction logistics. (McCabe,2020) especially throughout implementation to maintain standards. This means supervising teams in the field to ensure that work follows the right specifications and that the quality of construction is acceptable and is compliant with contracts and relevant regulations. (Disaster Ready,2021) For example, material quality is paid proper attention within humanitarian construction logistics process for keeping sufficient focus on right quality, accurate time, accurate place, accurate quantity, and cost (Lundesjö, 2015, Labib,2016) Quality in humanitarian construction logistics is presenting in four categories.

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

Lundesjö (2015) described the challenges could occurred due to the nature of humanitarian constructions like disruptions throughout the construction process along with increasing the material waiting time results in considerable damage and defects. (Lundesjö, 2015, Labib,2016) This can be a cause for concern in quality management

which is implemented by field teams who works in bad circumstances during crisis, as well as, quality management now requires expertise in a huge range of areas and one person can't assure quality of everything on site. Thereby, humanitarian construction projects are far too complex for one logistician person alone to hold all the expertise to assure quality of construction logistics. (McCabe,2020)

At the end, quality considers one of the main pillars of the humanitarian constructions as well as the humanitarian construction logistics process. (Lundesjö, 2015, Labib,2016) quality within humanitarian construction logistics provides the basis for improved forecasting of activities, scheduling, and risk management. It can contribute to certainty in humanitarian construction programme in relation to project timing and the ability of personnel to keep working to plan. The main contractors and sub-contractors should review regularly the implementation of logistics quality standards in which monitored during periodic project reviews. They must review 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 the tendering process. (Lundesjö, 2015, Labib,2016Arewa, 2020) As well as, when material moving throughout several points starting from supplier and ending at the construction site, there is a high possibility of decreasing the material quality required. Consequently, there is a substantial need to urge construction stakeholders to comprehend all the previous information when planning the construction logistics process. (Lundesjö, 2015, Labib,2016)

5.6 Handling within Humanitarian Construction Logistics:

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 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 with primary consideration for safety. (WRAP,2007, Designing Buildings Wiki, 2020) For instances, limiting the amount of materials stored at site and delivering materials after hours to designated materials zones lead to a more structured, clean and tidy production environment as well as makes

materials available for production when needed. This increases productivity, reduces accidents and subsequently also reduces the total cost of operations. (Janné et al.,2020) During the design stage, issues like material laydown and storage areas should identified, demarcated clearly, and managed to prevent the areas becoming overfilled and ensure that they are suitable for the materials. The receipt and storage process 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, that require else 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 literature review, this dissertation presents the handling techniques that could fit humanitarian construction logistics as 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 explained to benefit a more structured and controlled way of working with construction logistics. The CLP clarify 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 materials' specifications (regarding deliveries, packaging, announcing) and the logistical project management in which can differ depending on if the contractor is using a digital delivery system or CCC etc. Since the logistical prerequisites seldom is specified in the contracts, the CLP will fill that gap to minimise communication issues, operator's errors, as well as, 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 an efficient humanitarian construction logistics. It is a tool for coordinating construction logistics to overcome the obstacles of congestion on humanitarian construction-sites; especially in disaster times; by addressing how to use e.g. just in time, construction consolidation centres, dedicated planning systems, and standardising execution process in which simplifies the transition between humanitarian projects. (Andersson et al.,2018) A well written CLP benefits both humanitarian construction logistics and local environment, as it saves costs by encouraging efficient working practices and reducing deliveries. It is progressively developed to describe primary products required for the humanitarian construction projects, method of transportation, expected wastes, methods of removal, as well as, local access routes to be taken by local distributors. (Whitlock, et al., 2018, Disaster Ready,2021)

The challenges of CLP usage are rare like it is often confined only to the site while overlooking the complete construction supply chains. (ANDERSSON et al.,2018)

In addition, CLP as 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. (Whitlock, et al., 2018)

5.6.2 Humanitarian Construction Logistics Guideline

Humanitarian construction logistics has the unique nature as a project-based industry. (McCabe, 2020) It defines as temporary, in despite of that, it requires a very sound structure for the time they last. (Merminod et al.,2014) As it deals 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 effect with some challenges such varied locations, shifting work volume, supply chain management, labor intensive work, changing weather, transient workforce, competing visions between stakeholders (McCabe,2020)

That impose the needs for proposed charter for humanitarian construction logistics which address the both requirements of humanitarian organizations and beneficiaries. In order to achieve that, The guideline is a vital part of the logistics management process which has two key purposes, making sure that humanitarian constructions' requirements are met, as well as, identifying what has to be done, by whom, and when with the statement of scope, objectives, and people who are participating in a project and their roles and responsibilities (Shibani,2021) Considering the complex and the hostile environment, proper logistics guideline contributes to ensure 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. Merminod et al. (2014) WRAP (2007) and other authors in Designing Buildings Wiki (2020) explained the best practices that must state within logistics guideline when designing a material handling system for humanitarian construction project for examples:

- 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, as well as, unnecessary handling or movement should be reduced or eliminated.
- Working conditions and methods should have worker safety as the primary objective, as well as, good site security to minimize materials lost due to theft or vandalism.
- Storage areas should be kept organised and clean, maximising density as much as possible and eliminating damage to materials, as well as, 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, 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)

Humanitarian construction logistics 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 guideline can play to improve coordination and enhance construction operations:

(1) focus on the interface between the supply chain and site activities,

(2) focus on improving the supply chain,

(3) transferring site activities from the site to the supply chain,

(4) manage the site and the supply chain as an integrated domain.

Ekeskär and Rudberg (2016) proposed that a fifth role of guideline which is focusing on fully integration between both the construction supply chain and the site. (Ekeskär et al.,2020)

The five roles that construction logistics can play for humanitarian constructions are demonstrated in below Fig 14 according to Ekeskär et al. 2016, Vrijhoef et al.2000, Tischer et al.,2013, Ekeskär et al. 2016, Janné et al.,2020, and Ekeskär et al. 2020.

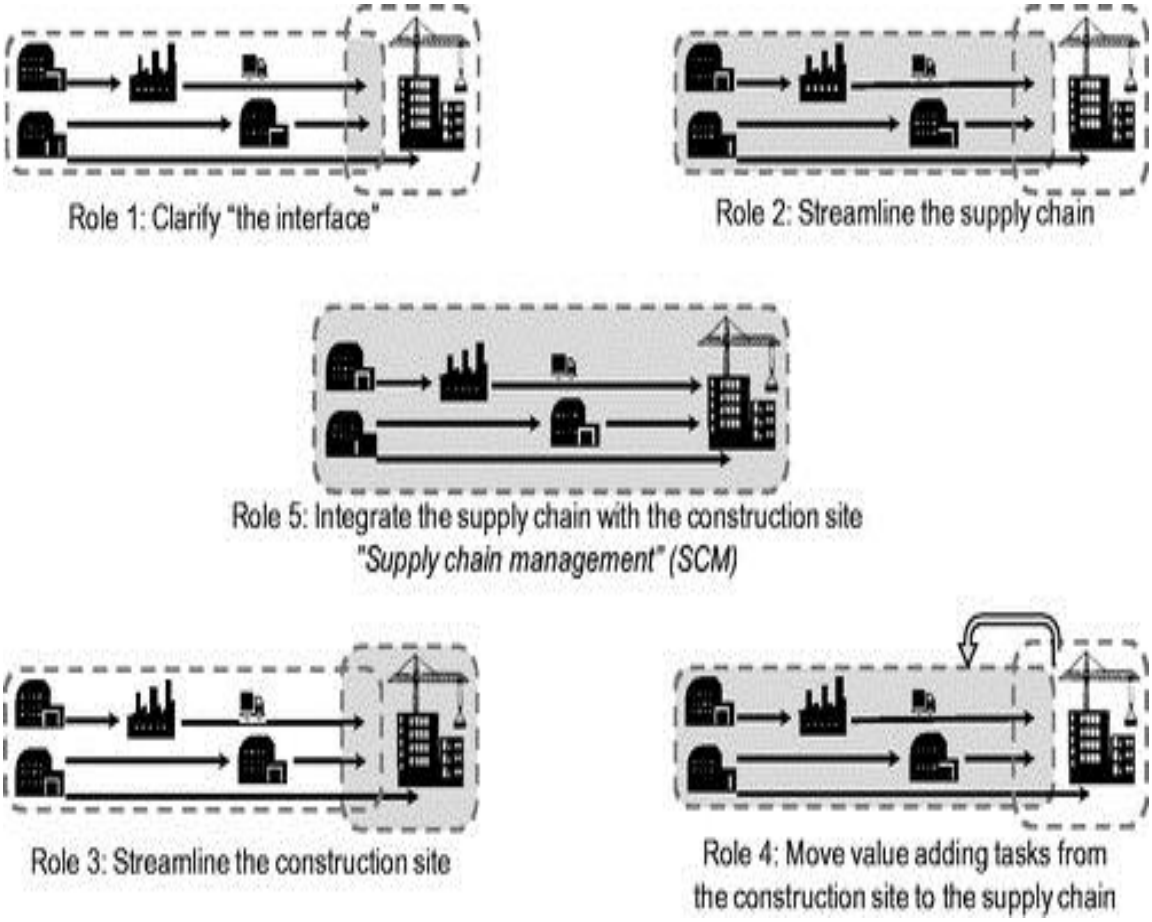


Fig 14: Five roles of construction logistics with humanitarian constructions

At the end, the humanitarian construction logistics guideline ensures that pre-start inspections are applied, load limits should not be exceeded, material movements are directed around the site by appropriate banksman, and similar materials should be stored together to prevent wastage of part utilized items, as well as, ensures that the appropriate practices are applied by 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 center (CCC) is a distribution facility that can be used in the process of managing construction project logistics, channeling 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, reducing waste and other issues such as congestion. Construction materials are delivered from suppliers to the CCC where they are stored until call-off from the site, at this point, CCC operator makes up and delivers a consolidated load. This is done on a 'just in time' basis. This has the advantage of keeping the site clear of obstacles, cutting down on 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 centres (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 centres can setting up jointly for several humanitarian construction projects that makes it possible to keep total stocks and costs low. Containers filled with the correct material produced on a certain day and material can be transported daily to the construction site. (Hillegersberg et al., 2020, Janné et al.,2020) Sometimes construction consolidation centre is situated in middle where several different sites, but it can be more sensible to have two smaller construction consolidation centres, each of which are closer to the respective sites, than one large construction consolidation centre. (Janné et al.,2020)

There are many advantages from implementation CCC approach in humanitarian construction logistics. The usage of CCC has led to fewer deliveries to site and the temporary storage of materials has shifted from the site to CCC. It can be used as a buffer to cover for unplanned changes in the production schedule and to be able to call-off JIT-deliveries when needed. It else can be a lever to excel productivity at site. Fewer deliveries lead to reduced transportation costs less disturbance, increasing in labour productivity

and reduction of material wastes. (Lundesjö, 2011, Whitlock, et al., 2018, Janné et al.,2020) As well as, CCC is place for returning unused materials, removing excess packaging rather than creating clutter on site, detecting Manufacturer errors or damage rather than when delivered to site, and sequencing of materials delivery (Young et al., 2004, Designing Buildings Wiki, 2021) The CCC is multifunctional. From a storage point of view, it can reduce the supply chain cost by reducing the on-site inventory and the possibility to order 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 logistics centre and then shipped out to the construction site, which also would be cost efficient. Since a humanitarian organization can use the logistics centre in several humanitarian projects, the overall safety stock is able to be reduced as all the projects can share the safety stock, which is lowering the total stock. (Lundesjö, 2015)

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

At the end, construction consolidation centre (CCC) in humanitarian construction logistics 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 single point of storage and administration for all deliveries arriving to different sites which store them safely and securely. The daily needs of each site are then fed through consolidated loads, this results in a significant reduction in the volume of daily site deliveries (Lundesjö, 2015). The

consolidation construction centre brings logistics professionals into the humanitarian construction team who are imposing discipline on how materials are supplied to the workplace and taking onsite distribution out of the hands of trade contractors. That frees the contractors to focus on constructing for better products and higher productivity. (Young et al., 2004)

5.7 Delivery Management in Humanitarian Construction Logistics:

Internationally, 30 percent of the overall costs of a construction project are 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, Delivery is the flow of resources used to satisfy a demand of humanitarian organization/s, such as materials, labour, information, skills, and so on. It can also refer to competencies or combinations of resources. (Designing Buildings Wiki, 2020) For example, contractors must follow a variety of delivery methods within humanitarian construction operations. They aimed to follow international standards of delivery like reducing vehicle movements and material consumption and ensuring supplies are delivered just in time. These include agreements with suppliers to make comprehensive improvements in how materials and assemblies are designed, packaged, fabricated and planning and scheduling techniques to deliver efficiently to the workplace. (Young et al., 2004) The effective delivery means like better contracts, optimized routes, better utilization of transport systems, bundling transport legs and volumes. That 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, there are key challenge that is balancing between humanitarian responsiveness and delivery efficiency. The HOs attempt to reduce transportation costs by consolidating deliveries, loading full truck and maximizing the loading of trucks which result in large quantities of materials, unnecessary moving and handling of materials sometimes, as well as, increasing risk of the materials being forgotten or stolen. (Vidalakis et al., 2013,

Ekeskär et al.,2020) In despite of that, the humanitarian organizations tend to more quality in delivery process instead of price focused. (Designing Buildings Wiki, 2020)

The developments in the humanitarian operations, oversupply or sudden bottlenecks in supply of construction products and transport resources require humanitarian construction logistics to have the knowledge and recommended practices; as blow; to react appropriately and rapidly.

- **Delivery Smoothing**

Delivery Smoothing activities involves chronologically distributing tasks over the available timeframe, 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) Delivery smoothing 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 humanitarian constructions logistics is a mean by which 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)

Delivery smoothing constitutes a technique in humanitarian construction logistics that could available to site coordinators, representing an opportunity to both reduce freight requirements and improve labour output; especially within effected areas; by minimising delivery frequency 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 resourced, materials and labour 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 next non-peak periods within projects.

(Whitlock, et al., 2018) The main challenges in front of delivery smoothing with humanitarian construction logistics are lacking standardization, structure, efficient communication and digital support. That can't enable the contractor to plan deliveries and be notified when they arrive. (Lundesjö, 2015). As well as, that could lead to waiting time for the trucks and un-deploying of available space for the delivered material. (ANDERSSON et al.,2018)

- **JIT**

The Royal Institute of British Architects (RIBA) in 2012 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 need to perform constructions without incurring any delays. (WRAP,2007) The effectiveness and efficiency of JIT deliveries can be further improved by the introduction of 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 of lean production. (Designing Buildings Wiki,2021) The handling costs of construction materials can be reduced by JIT practices as construction workers spent 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) As well as, JIT deliveries reduce or even eliminate the need for on-site storage of materials. That improves the site logistics and reduces the risk of damage or loss of materials stored on-site as well as reducing congestion and the associated risks such as safety incidents. (WRAP,2007, Designing Buildings Wiki,2021)

In context of humanitarian, Just-In-Time deliveries (JIT) are a well-known and commonly used especially in effected areas. JIT does delivery of materials and/or equipment as close as possible when needs raised. This enables 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 logistics constructions exemplify 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 just-in-time (JIT) deliveries according to the installation process to avoid storage of materials on the construction site. A supplier might even go further and installing a component, instead of having subcontractor on the construction site doing it. (Ekeskär et al.,2020, Designing Buildings Wiki,2021) On the other hand, wrong JIT planning or sudden changes in humanitarian constructions could leads serious delays. Therefore, the full collaboration between humanitarian constructions' parties and suppliers is the most substantial foundation to apply JIT because late deliveries are considered a primary cause for non-application of JIT. (Labib,2016, Ekeskär et al.,2020, Designing Buildings Wiki,2021) In addition, the humanitarian logisticians; in effected 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)

At the end, JIT is one of the main practices to reduce inventory level in humanitarian construction logistics which shows effectiveness and efficiency in regards of time, cost and quality added through bringing materials when needed (Vidalakis and Sommerville, 2013, Lundesjö, 2015, Labib,2016, Whitlock, et al., 2018)

5.8 Sustainable humanitarian construction logistics

The primary responsibility of humanitarian construction logistics 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. Beside to this fundamental job description, there is new trend to add the description of "appropriate supplies," meaning that they meet the criteria of minimizing pollution, embodied energy, and negative impact on the environment. Procurement should not be based only on cost, timeliness, and availability criteria, but also on verification that the source of material is legal and sustainable, while simultaneously seeking to minimize energy used for the transportation. (Good.,2010) These aspects and descriptions are added to humanitarian construction logistics by humanitarian organizations because of the massive rebuilding

efforts after disasters in which requires 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, means that 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 infrastructure that had previously existed. The intensive demand for raw materials in reconstruction ultimately impacts the environment and the people who depend on it. In order to ensure that the recovery effort following a disaster does not make communities more vulnerable, staff involved in building design and materials procurement should ensure that their material choices take advantage of opportunities to maximize environmental performance. (Good.,2010, Klenk.,2010). Therefore, there are many initiatives like one by Global Shelter Cluster (GSC) and Global Logistics Cluster (GLC) which are working closely on environmental protection in humanitarian logistics and focusing on the reducing the impacts of waste and transport linked to humanitarian operations. As well as, IFRC is one of the several large humanitarian agencies which will be a partner in this project with the GLC. IFRC collaborates in activities related to the green procurement of shelter items, as well as disposal and reverse logistics of construction materials and the application of circular economy concepts to reducing building materials waste. (Wynveen,2021) In result, sustainable humanitarian construction logistics means that the principles of sustainable development are applied to the comprehensive construction cycle, from the extraction and processing of raw materials through the planning, design, and construction of buildings and infrastructure, and is also concerned with any building's final deconstruction and the management of the resultant waste. (Klenk.,2010) The final aim is addressing the needs of the humanitarian community which seeks increasingly to evaluate and refine procurement and supply chain delivery processes to look for increased speed, transparency, reliability, reduced cost and enhanced environmental sustainability. (USAID,2020) Thereby, there are many approaches like green, eco-design, localization, and recycling which are recommended to implement within humanitarian construction logistics as explained in following sections

5.8.1 Green in Humanitarian Construction Logistics:

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 apply on Humanitarian supply chains; which is the management of goods and information among all actors involved in supporting the people in need; are often designed with an emphasis on responding quickly. That usually implies that little thought is given to its environmental impacts. (Vad et al., 2020) These environmental impacts; in context of humanitarian constructions; are 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, pre-fabricate units, and others. (Gårdestedt, 2019) Therefore, green humanitarian construction logistics approach seeks to ensure a minimized adverse impact on the environment resulting from the emergency response systems applied. Applying Green humanitarian construction logistics as a mainstreamed approach will facilitate a swifter recovery and build in the communities with a further opportunity of enabling more innovative, environmentally sustainable solutions to be promoted and established. (IFRC,2021) The best practices of this approach; in 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 usage shorter distances, optimizing product supply approach, prepositioning, and others. (Vad et al., 2020) Thereby, the procurement process is an excelling time to assess and commit to green humanitarian constructions logistics. 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 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 approach 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)

At the end, the aim of green humanitarian construction logistics is integrating environmental and social considerations alongside the typical price and quality considerations into the humanitarian organizations which handle with humanitarian-purposed constructions.

5.8.2 Eco-Design in Humanitarian Construction Logistics

Saving lives and reducing suffering should always remain at the heart of an emergency response operation. Eco-design logistics is 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 approach is supporting actions that minimize environmental impact and resource extraction; reduce the use of energy, water, materials, and land; and prefer renewable resources to nonrenewable. The eco-design humanitarian construction logistics also minimizes 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). Thereby, the humanitarian construction projects that use this approach in logistics will reduce:

- The tonnage of waste sent to landfill 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 could implement green eco-design approach by following many strategies like following:

1. Selection of low-impact materials such as clean materials, renewable materials, low energy content, materials, recycled materials, and recyclable materials.
2. Reduction of material usage such as reduction in weight, reduction in transport/ volume, reduction in energy consumption, reduction in generated waste, remove of products don't 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 about implementation these strategies in humanitarian logistics. The first example about tent pegs, these 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 impacts. 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 couldn't fix the ones made of carbon fiber. For that reason, aluminum turned out to be the 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 made 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 is the degree of commitment by the clients and contractors to reduce their impact on the environment. (WRAP,2007)

At the end, eco-design humanitarian construction logistics encourage to use 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:

This is a model that is increasingly being adopted in the humanitarian organizations worldwide as they seek to increase socio-economic responsibility when delivery of humanitarian constructions and they seek to involve the specialist suppliers and contractors in the design process. (Designing Buildings Wiki, 2020) There was trend reinforced by different humanitarian organizations to purchase all materials locally (trucks, labors, materials…etc.) to address the logistical challenges of emergency sheltering programs like mass distribution even they have to buy local materials at high prices. They pay attention to principle of sustainable management of local resources as usage of alternative materials was not pursued due to transportation issues and the potential for further delays. On the other hand, the shortage of locally materials could delay the implementation of the project. (Ashmore et al., 2009) There are many examples about localization practices which are inserted within humanitarian construction logistics. For examples, OCHA considers forming a team managed by community members to erect some sample tents with drainage ditches with supplying them with tools needed for putting up tents. This will help to 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 family in any refugee camp. (OCHA,2004) Peace Winds conducted 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 with building materials to communities self-organizing construction. That leads to quick installation of safe shelters for refugees themselves (Peace Winds, 2021) IFRC demonstrate that there are opportunities for local procurement, whilst ensuring the quality, sustainability and environmental impact of that procurement process is considered, as well as the capacity to provide high volume if required. IFRC demonstrate that local pre-position stocks allow to less freight emissions, more efficient and cost-effective within humanitarian construction logistics like local pre-position of water-purification units instead of water-bottles. (IFRC,2021)

5.8.4 Recycling in Humanitarian Construction Logistics

Humanitarian assistance demands 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 is resulted in by lack sufficient infrastructure or management systems to handle regularly produced waste, let alone the waste generated by assistance efforts. (USAID,2020) The Authors found that the implementation of a waste management plan can reduce environmental impacts by concerning with reuse and recycling process. (Tischer et al.,2013) Therefore, the logistics managers in humanitarian organizations became paying attention to using building materials with recycled content where practical to reduce demand on natural resources and to lower the project's human and environmental impact. For example, 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 fill. (Klenk.,2010) As well as, they became paying attention to issue of packaging waste; as packaging serves essential functions in commodity delivery and protection within humanitarian construction logistics; which also often becomes an unintended waste stream in the most fragile and strained operational humanitarian contexts. (USAID,2020) Furthermore, humanitarian construction logisticians became to select 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 recycle 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 recovery process. (Klenk.,2010)

The logisticians are involving else in disposal of waste streams which can be sorted on site and returned to the material cycle directly from site although of 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 like minimizing packages that leads to reduce the damage caused to people and the environment while respecting the lifesaving imperative of humanitarian assistance. (USAID,2020) There are many challenges relate to recycling like higher costs incurred

by the collection and separation of waste on site as well as by 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 (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, as well as, the quantity of available debris, transportation and any processing costs should be taken into account in logistics budgeting. (Klenk.,2010)

At the end, the effective humanitarian construction logistics can reduce the costs of disposal by recycling process and implementation of 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 by creating a market for the deconstruction of existing structures and reuse of materials. (Klenk.,2010)

6. Conclusion

Humanitarian construction logistics comprises planning, coordination, and supervision of material flow to, within and from construction-sites. The humanitarian construction logistics approach aims to promote the benefits of good logistics and supply chain management for humanitarian-purposes constructions, recovery, and rehabilitation projects in which saves time and construction costs. This dissertation explored new approach within humanitarian logistics towards to humanitarian-purposes constructions, recovery, and rehabilitations by the systematic investigation, as well as, studying involved materials and academic sources. That leads to establish facts, reach new conclusions, and recommend solutions. The critical exploration for activities of humanitarian organizations based in Syria and their local partners had abled to set feasible approach to optimize the theory for humanitarian construction logistics. The analyzing of these activities in different sectors like shelter, WASH, rehabilitation, cash, and voucher…etc. leads to understand the importance of humanitarian construction logistics throughout planning, designing, and implementing stages. The definitions, framework, components of humanitarian construction logistics explored by the different steps of dissertation through the research processes and procedures to combine humanitarian affairs and construction logistics approaches.

It remains for future research to verify if the results of this 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 what main factors to leverage of humanitarian construction logistics and how to measure humanitarian construction logistics influences on the materials flow to/from humanitarian-purposes constructions and how to decrease the costs of humanitarian construction logistics.

Many existing and new practices that 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 of Syrian case referred to positive role of localization approach where local labor and materials were key factors in effective humanitarian construction logistics.

The localization approach had significant economic impacts on disaster-affected local communities as they work to contribute to their own recovery. Promotion of appropriate local materials and logistical techniques had assisted to reduce the suffers of effected people, as well as delivery humanitarian construction projects in effective, efficient, and quick ways. Promoting concepts within humanitarian construction logistics like material logistics planning (MLP), BIM, blockchain, eco-design and others promotes tidy construction sites and efficient project delivery.

Furthermore, most humanitarian organizations have policies related to environment, but these policies are often not consistently implemented, monitored, and evaluated throughout humanitarian construction logistics. Therefore, there are tremendous approach to incorporate sustainable environmental practices within humanitarian construction logistics as a route to improve the potential of people, communities, and economies worldwide.

The 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 leads later to implement positive logistics initiatives and benchmarking within humanitarian construction logistics for all non-profit/ humanitarian construction projects. That pushes the stakeholders to find a way to integrate the logistics management into the everyday process of humanitarian constructions. Accomplish that required a structured and systematic work procedure for transportation and logistics which should be addressed in the planning stage of a humanitarian construction projects. Besides that, the humanitarian logisticians must integrate concepts like joint distribution mechanism and joint procurement to manage an efficient and cost-effective supply chain, reduce the logistics overheads, and let humanitarian aid workers to concentrate on direct assistance to beneficiaries.

At the end, this dissertation refers to importance of investment in logistics development researches by the humanitarian organizations and other stakeholders for optimal systematic organizational structure for humanitarian construction logistics. That allows for more effective usage of overall emergency funds due to economies of scale and reducing logistics overheads for humanitarian agencies in the field in which mean they

could concentrate on service delivery to beneficiaries. In result, researches are necessary to define the main factors that leads to efficient humanitarian construction logistics management as well as integrate sustainable solutions in overall processes.

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