Technological innovation for humanitarian aid and assistance

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During the World Humanitarian Summit in 2016, former UN Secretary-General Ban-Ki Moon urged the global community to commit to the 'Agenda for Humanity' to address the challenges in the humanitarian sector with the aim of preventing and helping reduce human suffering during crises. Technological innovation in humanitarian assistance is perceived as an enabler in achieving these commitments. The object of this study into the fast-moving, dynamic and emergent field of humanitarian technological innovation is to analyse the impact of these innovations as transformative tools for both people in need and those providing humanitarian relief. The report provides an overview of the current state-of-play and developments with regard to ICT-related innovation in humanitarian assistance. Based on the concerns, opportunities and benefits identified, the study provides a set of policy options to further technological innovation in humanitarian assistance.

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List of abbreviations

AU	African Union
AI	Artificial intelligence
ALNAP	Active Learning Network for Accountability and Performance
AM	Additive manufacturing
AR	Augmented reality
ASEAN	Association of Southeast Asian Nations
ATM	Automated teller machine
BCG	Boston Consulting Group
BRC	British Red Cross
CADD	Computer-aided design and drafting
CBI	Cash-based intervention
CSIRT	Computer Security Incident Response Team
CTP	Cash transfer programming
DAC	Development Assistance Committee
DEVE	European Parliament's Committee on Development
DFID	Department for International Development
DG	Directorate-General
EC	European Commission
ECG	Electrocardiogram
ECHO	European Civil Protection and Humanitarian Aid Organisation
EDO	European Drought Observatory
EEAS	European External Action Service
EFAS	European Flood Awareness System
EFFIS	European Forest Fire Information System
EHA	Evaluation of humanitarian action
EIC	European Innovation Council
ELHRA	Enhancing learning and research for humanitarian assistance
EMS	Emergency Management Service
EN	English
ER	Extended reality
ERCC	Emergency Response Coordination Centre
EU	European Union
FAO	United Nations Food and Agriculture Organization
FbF	Forecast-based finance
FTS	Financial tracking service
GAHI	Global Alliance for Humanitarian Innovation
GDPR	General Data Protection Regulation
GIS	Geographic Information System
GMES	Global Monitoring for Environment and Security

GPS	Global Position System
GSNS	Global Satellite Navigation System
HBR	Harvard Business Review
HHI	Harvard Humanitarian Initiative
HIA	Humanitarian Information Activity
HIF	Humanitarian Innovation Fund
HOT	Humanitarian OpenStreetMap Team
HPC	Humanitarian programme cycle
HRP	Humanitarian response plan
IASC	Inter-Agency Standing Committee
IATI	International Aid Transparency Initiative
ICRC	International Committee of the Red Cross
ICT	Information and communication technologies
ICVA	International Council of Voluntary Agencies
ID	Identity document
IDL	International Disaster Law
IDP	Internally displaced persons
IFRC	International Federation of the Red Cross and Red Crescent Societies
IGO	Intergovernmental organisation
IHL	International Humanitarian Law
iNGO	International non-governmental organisation
ILO	International Labour Organisation
IO	International organisation
IOM	International Organization for Migration
IoT	Internet of things
IRIN	Integrated Regional Information Networks
IT	Information technology
IVR	Interactive voice response
M&E	Monitoring and evaluation
MEP	Member of Parliament
MOOC	Massive open online course
MSF	Médecins sans Frontières
mVAM	Mobile vulnerability analysis and mapping
NGO	Non-governmental organisation
NTNU	Norwegian University of Science and Technology
ODA	Official development assistance
OECD	Organisation for Economic Co-operation and Development
OHCHR	Office of the United Nations High Commissioner for Human Rights
PV	Participatory video
R&D	Research and development
RRP	Regional response plan

SAR	Search and rescue
SCHR	Steering Committee for Humanitarian Response
SDG	Sustainable development goals
SMS	Short Message Service
STOA	European Parliament Science and Technology Options Assessment Panel
UAV	Unmanned aerial vehicle
UK	United Kingdom
UN	United Nations
UNCTAD	United Nations Conference on Trade and Development
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UN-Habitat	United Nations Human Settlements Programme
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
UNOCHA	United Nations Office for the Coordination of Humanitarian Affairs
USA	United States of America
VR	Virtual reality
WFP	World Food Programme
WHO	World Health Organization
WHS	World Humanitarian Summit
WRS	World Refugee School
XR	Extended reality
3D	Three dimensional

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Executive summary

Providing timely and adequate humanitarian assistance to people affected by a humanitarian crisis is an increasingly challenging task, due to the growing needs of people and the increasingly complex nature of the crisis. Conflict and protracted crises leave 135.7 million people in need of international humanitarian assistance (UNOCHA, 2018). The current scale of humanitarian need is placing the humanitarian system under considerable strain. During the World Humanitarian Summit (WHS), former United Nations (UN) Secretary-General Ban-Ki Moon urged the global community to commit to the 'Agenda for Humanity' to address the challenges in the humanitarian sector with the aim of preventing and helping to reduce human suffering during crises. The Agenda outlines 5 core responsibilities and 24 transformations to better meet the immediate humanitarian needs of affected populations, whilst reducing risk and vulnerability (UN, 2016a). UN Member States, international and local non-governmental organisations (NGOs), the private sector and other stakeholders in the humanitarian domain have announced their commitment to the 'Agenda for Humanity' (UN, 2016b).

Technological innovations in humanitarian assistance are perceived as an enabler in realising these joint ambitions and addressing the challenges. Actors are actively engaging in the innovation process and assessing the requirements for, and impact of, technological innovation in humanitarian assistance. Overall, technological innovation in humanitarian assistance is multi-faceted, as it is approached, perceived and experienced differently by the various stakeholders

Document structure and methodology

The objective of this study is to analyse the impact of technological innovations in humanitarian assistance as transformative tools for both people in need as well as humanitarian actors. The report provides an overview of the current state-of-play and developments with regard to technological innovation in humanitarian assistance and presents policy options based on identified opportunities and concerns. Although humanitarian innovations go beyond ICT and/or digital technologies, including, but not limited to, innovative shelter, sanitation and water solutions, the study is oriented towards digital- and ICT-enabled technological innovations. Furthermore, the research focuses on the use of technological innovations in prevention and preparedness, including disaster risk reduction and their use during as well as following a humanitarian crisis. The process of innovation in a humanitarian setting is not included in this research. A qualitative research methodology has been adopted, combining a literature review and input from experts through expert interviews.

The research focuses on four research topics which are reflected in the structure of the document:

1. The context for, and ambition of, technological innovation in humanitarian assistance, including relevant policies and agreements as well as developments and trends.
2. The adoption and application of technological innovations relevant in the various stages of humanitarian assistance and an assessment of their desired as well as undesired impacts.
3. The concerns and opportunities related to technological innovations in humanitarian assistance considering the humanitarian context and the ambitions set out in various policies and agreements.
4. The options to further technological innovation in humanitarian assistance through policy, by addressing concerns and exploring opportunities identified.

The humanitarian landscape

To understand technological innovation in humanitarian assistance it is vital to understand its context, the humanitarian landscape. The objective of humanitarian assistance is to save lives and alleviate suffering by meeting humanitarian needs during various types of emergencies (Humanitarian Coalition, 2018a). Underlying the humanitarian work are the four humanitarian principles that guide the work of humanitarian organisations: humanity, neutrality, impartiality and independence.

International humanitarian assistance is provided by a wide range of organisations, agencies and inter-agency networks (Humanitarian Coalition, 2018b), including organisations such as the International Red Cross and Red Crescent Movement (ICRC), national and international NGOs, governments, intergovernmental organisations (IOs) such as UN agencies and the European Union (EU) as well as entities that provide funding or coordination (ALNAP, 2017). Additionally, civilians and local communities are often first-responders in crisis situations. The UN has the official mandate to support the coordination of international humanitarian agencies to deliver humanitarian assistance in a cohesive and effective manner (ECHO, 2007). In 2005, the UN implemented a coordination mechanism called the 'cluster approach' to improve coordination of humanitarian response. The humanitarian programme cycle is a coordinated set of activities undertaken to prepare, manage and deliver humanitarian response operations. EU humanitarian aid is provided at both the EU level as well as by the Member States and is framed in an international approach by the UN, ICRC, NGOs and others, in support of local response. The provision of humanitarian aid and assistance is based on different frameworks, policies and agreements, such as International Humanitarian Law (IHL) and International Disaster Law (IDL), Humanitarian Charter and Minimum Standards in Disaster Response by the Sphere project, Organisation for Economic Co-operation and Development/Development Assistance Committee (OECD/DAC) criteria for the evaluation of humanitarian aid (EHA), and European Consensus on Humanitarian Aid.

Some 210 million people in 134 countries were in need of humanitarian assistance due to conflict and crisis around the world in 2017 (Development Initiatives, 2018a), and 23.5 per cent of them were in three countries: Yemen, Syria and Turkey. In 2017, 60 per cent of all assistance was channelled to 10 countries facing complex crises involving conflict, with 14 per cent to Syria and 8 per cent to Yemen (Development initiatives, 2018a). In response to the increasing number of crises around the world, the volume of international humanitarian assistance increased for the fourth consecutive year in 2016, reaching a total of almost USD 26.4 billion (Development Initiatives, 2017). However, the pace of growth has slowed, with an increase of just 6 per cent between 2015 and 2016, compared with annual increases of between 12 and 21 per cent in the previous three years (Development Initiatives, 2017), and continued to slow down in 2017 with a 3 per cent increase from USD 26.4 billion in 2016 to USD 27.3 billion in 2017 (Development Initiatives, 2018a). The High-Level Panel on Humanitarian Financing (2016) estimated a funding gap of USD 15 billion in 2016.

Where donors struggle to meet the humanitarian demand, private donors – both donations and private investments - are a critical source to fill the gaps. Between 2012 and 2016, the private sector contributed between 23 and 27 per cent of total international humanitarian assistance (Development Initiatives, 2017). In 2017, private donors provided USD 6.5 billion of the total USD 27.3 billion (Development Initiatives, 2018a).

Technological innovation in humanitarian assistance

Digitisation and digital transformation are all around us and are transforming the way we live. The availability of technology is also fundamentally transforming humanitarian assistance: the availability and usage of mobile phones and social media platforms by people affected by humanitarian crises, geospatial technologies and unmanned aerial vehicles (UAVs) to detect humanitarian crises, biometric identification to facilitate humanitarian support, a shift to digital payments as relief provisions with e-vouchers and mobile money are just some examples of this. Technological innovation is embraced as a way forward to better address the needs of those affected by humanitarian disaster, and to address the challenges faced in humanitarian assistance as also formulated in the 'Agenda for Humanity'. Interpretations of what this entails however vary between actors. Compared to other sectors, the funds dedicated to research and development (R&D) in humanitarian aid are limited.

Various global initiatives, such as the Global Alliance for Humanitarian Innovation (GAHI) and the Humanitarian Innovation Fund (HIF) facilitate (technological) innovation in humanitarian assistance. In addition to this, humanitarian organisations engage in innovation activities with the development of in-house capabilities. Furthermore, private sector engagement includes more traditional procurement and corporate social responsibility (CSR) activities as well as co-creation initiatives.

The increase in activity has led to a debate on ethics, technical standards and responsible innovation as well as 'information as a right'. Frugal innovation and innovation in and with local communities are considered vital to foster local ownership and engagement.

Adoption of technological innovations in humanitarian assistance

Adoption of technological innovations in different stages of the humanitarian programme cycle (HPC) was assessed in this study on the basis of the following parameters: (1) the description and functionality of the technological innovation, (2) the effects of the technological innovation in humanitarian assistance, and (3) the feasibility of the technological innovation in humanitarian assistance. Overall, relatively few scientific evidence-based impact and cost effectiveness assessments of technological innovation in humanitarian assistance have been conducted in comparison with traditional applications.

Given the transformative nature of innovations, they do not adhere to traditional structures and processes. In the case of humanitarian assistance, the technologies can be applied to various activities of the HPC. To provide a structured overview the authors of this study have categorised the technological innovations under three main stages inspired by the UN cluster approach:

- **Preparedness**, including activities such as needs assessment and analysis, strategic planning and mobilisation;
- **Response**, including activities such as humanitarian service delivery, programme implementation and monitoring;
- **Recovery, reconstruction and disaster risk reduction**, including activities facilitating increased resilience and opportunities for those affected by crisis.

The following technological innovations were assessed for the 'preparedness' stage of the HPC:

- Data preparedness
- Citizen reporting with mobile devices
- Crisis mapping with geospatial information

- Internet of things (IoT)
- Artificial intelligence (AI)
- Data visualisation
- Innovative financing

In the 'response' stage of the HPC, the following technological innovations were assessed:

- Digital identity documents (IDs)
- Biometrics
- 3D-printing
- Cargo delivery drones
- Cash transfer programming (CTP)
- Monitoring and evaluation

The following technological innovations could play a role in the 'disaster risk reduction' phase:

- Smart cities
- Educational technologies

Conclusions

To address the challenges facing the timely and adequate delivery of humanitarian assistance and to continue addressing the needs and alleviate the suffering of those affected by crises, various commitments were made during the WHS in 2016. Technological innovation has been embraced to facilitate the new way of working and collaboration with the private sector has been welcomed. The conclusions of this study reflect the varying perspectives on technological innovation in humanitarian assistance and seek to further technological innovation in humanitarian assistance to contribute to the 'Agenda for Humanity'.

Technological innovation in humanitarian assistance is maturing and growing. The innovation process is a vital element in the narrative on technological innovation in humanitarian assistance. Innovation transforms the way in which humanitarian assistance is organised and executed, it redefines relationships between actors in the field and it affects financial flows. As such, technological innovation in the domain of humanitarian assistance can facilitate new ways of addressing the humanitarian financing gap. It also enables a shift of focus from response and recovery to prevention and preparedness and offers opportunities for increased local ownership and engagement. However, the use of technological innovation in humanitarian assistance raises serious concerns about the protection of the most vulnerable due to privacy and cyber security issues and it requires shared technological standards. Finally, the use of technological innovation requires different ways of working, skills and capabilities of humanitarian organisations and other actors.

Policy options

Technological innovation in humanitarian assistance is a multidimensional topic and requires careful examination. A number of possible policy options to further technological innovation in humanitarian assistance are outlined as a transformative tool for both people in need as well as humanitarian actors. The insights and options are structured along three interrelated dimensions: 1) the ambition and objectives of technological innovation in humanitarian assistance; 2) the technological innovation process in humanitarian assistance; and 3) the application and implementation of technological innovation in humanitarian assistance. The policy options presented in the final chapter of this study seek to address the main barriers that are preventing the successful implementation and/or adoption of technological innovation in the delivery of humanitarian assistance.

1. Introduction

Providing timely and adequate humanitarian assistance to people affected by a humanitarian crisis is an increasingly challenging task due to the growing needs of people and the increasingly complex nature of the crises. Some 135.7 million people need international humanitarian assistance in 25 countries due to conflict, and protracted crisis (UNOCHA, 2018). This is expected to remain the main driver of humanitarian need in 2018. Most countries affected by humanitarian crisis are affected by multiple crisis types including conflict-fuelled crisis as well as natural hazards (Development Initiatives, 2017). Increased frequency of natural disasters caused by climate change continue to generate increased humanitarian needs in 2018. The scale of humanitarian need is placing the humanitarian system under considerable strain. The gap between humanitarian needs and available resources has widened, with only an estimated 62 per cent of the financial needs covered by the available funding (High-Level Panel on Humanitarian Financing, 2016).

To address these challenges, with the aim of preventing and reducing human suffering during crises, former UN Secretary-General Ban-Ki Moon urged the global community during the 2016 World Humanitarian Summit (WHS) to commit to the Agenda for Humanity. The agenda outlines five core responsibilities and 24 transformations to better meet people's immediate humanitarian needs, whilst reducing the risk and vulnerability to crisis (UN, 2016a). The changes it calls for have the potential to transform the humanitarian landscape (UNOCHA, 2017a). UN Member States, local NGOs, international NGOs, the private sector and other stakeholders announced their commitment to the Agenda for Humanity during the WHS (UN, 2016b).

In realising the aforementioned joint ambitions and to address the challenges, actors are exploring the potential of technological innovations in humanitarian assistance. For example, data preparedness is being considered an essential part of preparedness activities (Homberg, 2017). Data preparedness is considered key when exploring opportunities to further data-driven decision-making (UNOCHA, 2017b). It is about gathering data, often with technological means, to better assess the risks, vulnerabilities and needs of communities, and to take preventative actions as well as ensure timely, efficient and effective response in case of humanitarian crises (Homberg, 2017). Technological innovations in humanitarian assistance require changes in the current way of working, whereby both concerns and barriers to implementation need to be addressed. On the other hand, technological innovations are driving fundamental changes in humanitarian assistance. For example, the increase of global connectivity and social media is altering the interaction between those providing assistance and those receiving assistance. During the earthquake in Haiti in January 2010, affected people reached out for assistance via social media through mobile devices (United Nations Foundation, UNOCHA, Vodafone Foundation, Harvard Humanitarian Initiative, 2011). Furthermore, actors are actively engaging in the innovation process and assessing the requirements for 'humanitarian' innovations. Additionally, concerns about data protection and responsible use of data when adopting technological innovations in the delivery of assistance are considered. With regard to the innovation process, elements to strengthen local systems such as frugal and local innovation are considered (UNCTAD, 2014).

Overall, technological innovation in humanitarian assistance is multi-faceted, as it is approached, perceived and experienced differently by the various stakeholders involved.

2. Document structure and methodology

2.1. Objective

The overall objective of this study is to analyse the impact of technological innovations in humanitarian assistance as transformative tools for both people in need as well as humanitarian actors. The report will provide an overview of the current state-of-play as well as developments with regard to technological innovation in humanitarian assistance.

The report brings together available information on the application of technologies in the various stages of the Humanitarian Programme Cycle (HPC, see section 3.3). Considering the ambitions and priorities set forth in the Agenda for Humanity, the study focuses on the use of technologies in prevention and preparedness, including disaster risk reduction, and the use of technology during and following a humanitarian crisis. The study provides an overview of the current technological innovations in humanitarian assistance and provides insight about their potential desired and undesired impacts.

Furthermore, based on the concerns and opportunities identified throughout the research, the report ends with a set of policy options to support a coherent long-term strategy for humanitarian assistance using technologies for the benefit of the people in need.

2.2. Methodological approach applied

To achieve the objective, the research focused on four research topics:

5. The context of, and ambition with, technological innovation in humanitarian assistance, including relevant policies and agreements as well as developments and trends.
6. The adoption and application of technological innovations relevant in the various stages of humanitarian assistance and an assessment of their desired as well as undesired impacts.
7. The concerns and opportunities related to technological innovations in humanitarian assistance considering the humanitarian context and the ambitions set out in various policies and agreements.
8. The options to further technological innovation in humanitarian assistance through policy, by addressing concerns and exploring opportunities identified.

The research followed a qualitative research methodology, combining both a literature review as well as input from experts through expert sessions and interviews. Additionally, an abductive approach was adopted, drawing insights from literature reviews and validating them through expert interviews and vice versa. This allowed a mutually re-enforcing process of data collection.

The research was conducted with a three-step approach:

1. Data collection through a literature review, expert interviews and panel sessions;
2. Analysis of literature and interviews based on a set framework of criteria; and
3. Drawing insights and conclusions, leading to an exploration of policy options.

2.2.1. Literature review

This study involved a review of the most recent and relevant literature, with a particular focus on literature published between the years 2013 and 2018. This literature includes but is not limited to publications by academic institutions such as the Harvard Humanitarian Initiative (HHI), international

organisations (IOs) such as the EU, and NGOs such as the International Committee of the Red Cross (ICRC). In addition to this, journalist publications, such as Integrated Regional Information Networks News (IRIN News) and publications by private sector organisations are included.

The literature review reflects the four research topics, focusing on:

- A broad exploration of the context of technological innovation in humanitarian assistance, including trends, developments, agreements and policies.
- An identification of technological innovations in humanitarian assistance and their applications relevant in the various stages, including prevention and preparedness as well as response during and after the crises.
- An identification of benefits and concerns regarding technological innovations in humanitarian assistance based on previously conducted assessments and evaluations, as well as case studies.

The literature review provided input for the expert interviews, and in turn the expert interviews provided input for the literature review as experts were asked to share their recommendations with the research team. Additionally, throughout the literature review, possible interviewees were identified.

2.2.2. Expert sessions

Inputs provided during two expert meetings are included in the study: the STOA High Level-Expert Meeting on Technologies for Humanitarian Aid, held at the European Parliament in Brussels on 7 September 2017, and the Roundtable Discussion on High Tech for Humanitarian Aid, held at the European Commission (EC) in Brussels on 23 February 2018 (see Annex for the lists of panel members).

2.2.3. Interviews

Interviews were conducted with participants from a variety of organisations to ensure that perspectives from multiple experts and stakeholders were included in the research. The experts were specifically selected to represent the variety of stakeholders engaged in technological innovation in humanitarian assistance. Interviewees were representatives from the private sector, humanitarian organisations, academic scholars and policy makers. The interviews focused on the experiences and insights of the respective interviewee. Additionally, to include a wide variety of perspectives, a set of criteria were considered while selecting the interviewees, including type of organisation, nationality and gender of the expert. The interviews followed a semi-structured approach. The team used an interview protocol (see Annex) and was also able to explore specific areas of expertise, in line with the expert being interviewed. In total 11 experts were interviewed for this study.

The interviews focused primarily on research topics two and three, and to a lesser extent on topics one and four. The expected outcome of the interviews was an improved understanding of the types of technological innovations currently being used and explored in humanitarian assistance, the experiences with these technological innovations, their potential and vulnerabilities. In addition to this, the interviews provided insight about the humanitarian principles and other sector specific standards. Furthermore, interviewees shared their experiences with technological innovations in humanitarian assistance as well as their (potential) positive as well as negative impacts. The output was captured in interview reports, which were shared with the interviewees for approval.

2.3. Scope and limitations

Due to the sensitive nature of technological innovation in humanitarian assistance, the very nature of assistance and its impact on human lives, as well as the complex multi-stakeholder context which includes a variety of actors with differing roles, perspectives and interests, it is vital to specify the scope and limitations of this study.

Although humanitarian technologies go beyond digital technologies, including, but not limited to, innovative shelter, sanitation and water solutions, the research for this study was focused on digital technologies and ICT innovations.

Furthermore, the project focuses on the use of technological innovations in the HPC stages of humanitarian assistance. Given the transformative nature of innovation, they do not adhere to traditional structures and processes. In the case of humanitarian assistance, the technologies can be applied to various activities of the HPC. To provide a structured overview the researchers have categorised the technological innovations under three main stages inspired by the UN cluster approach (see section 3.4):

- **Preparedness**, including activities such as needs assessment and analysis, strategic planning and mobilisation;
- **Response**, including activities such as humanitarian service delivery, programme implementation and monitoring; and
- **Recovery, reconstruction and disaster risk reduction**, including activities facilitating increased resilience and opportunities for those affected by crisis.

The **process** of innovation in a humanitarian setting is recognised as an important element in the discussion about technological innovation in humanitarian assistance, but it is not the focus of this study and therefore it is not independently assessed. Also, given the speed of technological change, the research is conducted in a fast-paced and active domain. It should therefore be stated that the research cannot provide an all-encompassing static overview of all activities in this field. Instead it provides insight into the current trends, activities and development.

Additionally, technological advances are occurring rapidly and continuously. Therefore, in line with the project specifications, the study will focus on currently available and in use solutions as well as emerging technologies with high potential. Predictions on 'unknown-unknowns' technologies are not included in the study. Furthermore, due to the dynamic nature of the topic and the limited number of interviews foreseen in the study, there was a restriction to the number of experts that could be consulted.

2.4. Document structure

This report consists of seven chapters and its structure reflects the four research topics. Following the introductory remarks in Chapters 1 and 2, the humanitarian landscape, the challenges it is facing, and the way forward formulated by the humanitarian community to overcome these challenges are elaborated on in Chapter 3 'Setting the scene: humanitarian assistance'. Technological innovation is perceived as an integral part of this approach, therefore the trends and developments with regard to technological innovation in the current landscape of humanitarian assistance are explored in Chapter 4 'Technological innovation in humanitarian assistance'.

Chapter 5 'Adoption of technological innovations in humanitarian assistance' zooms in on the application of technological innovation in the delivery of humanitarian assistance. Based on the insights gathered about the humanitarian landscape and the developments with regard to technological innovation in humanitarian assistance, a framework of criteria for assessment is developed. Each technological innovation in humanitarian assistance is positioned on the HPC according to its (potential) use. Due to the transformative nature of several of these technologies and their impacts on existing systems, the positioning of a specific technology within the current model is at times challenging. Therefore, the chapter contains three main categories inspired by the UN cluster approach. The transformative potential of the technology is also described.

The report ends with an identification of concerns and opportunities in Chapter 5, based on the main study findings. In Chapter 6 the main conclusions are drawn with regard to the priorities of the Agenda for Humanity described in Chapter 3. This leads to an exploration of policy options in Chapter 7
.

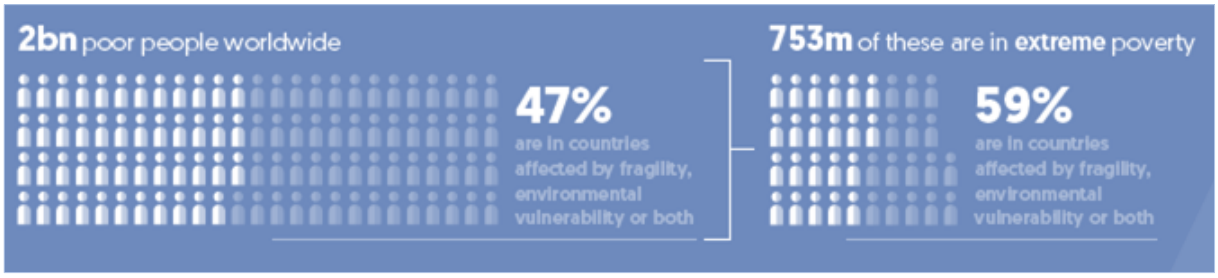
3. Setting the scene: humanitarian assistance

To understand technological innovation in humanitarian assistance it is vital to understand its context: the humanitarian landscape. Technology and technological innovation are merely an enabler to achieve humanitarian objectives. This chapter therefore sets out to describe the core of humanitarian assistance, its organisational structure and main actors, as well as an overview of the main legislative and policy frameworks. Additionally, developments and commitments which in turn fuelled the advance of technological innovation in humanitarian assistance are explained.

3.1. The need for humanitarian assistance

The objective of humanitarian assistance is to save lives and alleviate suffering by meeting humanitarian needs during various types of emergencies (Humanitarian Coalition, 2018a). Natural disasters such as earthquakes, droughts, epidemics and floods, as well as man-made emergencies such as armed conflicts, or complex emergencies which include a combination of factors, may cause humanitarian crises during which people need life-saving assistance. Furthermore, crises may lead to displacement and migration of affected people, who may need international humanitarian assistance (ALNAP, 2017). The impact is increasingly severe due to a variety of factors such as climate change, fragility of states and poverty (ECHO, 2008). Poverty (people living on under USD 3.20 a day) and extreme poverty (people living on under USD 1.90), vulnerability and crisis are interlinked and mutually reinforcing. In 2017 this dynamic is still of significance: the Global Humanitarian Assistance Report of 2018 estimates that 2 billion people worldwide are poor, of which 47 per cent are based in countries affected by fragility, environmental vulnerability or both. Furthermore, 753 million of these people live in extreme poverty (Development Initiatives, 2018a) (Figure 1).

Figure 1 – Link between poverty and risk in humanitarian crisis



Source: Development Initiatives, 2018a

The Humanitarian Assistance Report 2018 also states that due to a lack of sub-national data local variations in community resilience may be hidden. Furthermore, crisis may often have a destabilising effect on neighbouring countries. In 2017 the number of displaced people grew for the sixth consecutive year to an estimated 68.5 million (Development Initiatives, 2018a). In addition, protracted and recurrent crisis are a pattern over the last years. In 2017, 17 of the 20 largest recipients of official humanitarian assistance were long- or medium-term recipients (Development Initiatives, 2018a).

Although the exact figures may differ due to variations in definitions in publications by reputable global organisations, they are included in this study to offer perspective on the scope and scale of the humanitarian challenges facing the global community. 210 million people in 134 countries were in need of humanitarian assistance due to conflict and crisis around the world in 2017 (Development Initiatives, 2018a). The humanitarian need was mainly driven by complex crisis involving conflict, with

23.5 per cent of people in need in three countries: Yemen, Syria and Turkey. In 2017, 60 per cent of all assistance was channelled to 10 countries, with 14 per cent to Syria and 8 per cent to Yemen. Natural disasters such as hurricanes in the Caribbean caused significant destruction and violence forced the mass displacement of the Rohingya population from Myanmar (Development initiatives, 2018a).

3.2. Humanitarian principles

Derived from the core principles of the ICRC, the four humanitarian principles are **humanity, neutrality, impartiality** and **independence**. These principles guide the work of most humanitarian organisations (ECHO, 2017b). Commitment to the principles is also expressed at institutional level by many organisations. A Code of Conduct for organisations in disaster relief, including a set of common standards and commitment to the principles, has been signed by more than 492 humanitarian organisations (UNOCHA, 2012). The EU is committed to upholding these fundamental principles (ECHO, 2008). They distinguish the work of humanitarians from other activities. Adherence to the humanitarian principles helps humanitarians to carry out their work while it facilitates access and acceptance (UNOCHA, 2012).

The principle of **humanity** states that human suffering must be addressed wherever it is found. No distinction should be made between places or populations (ECHO, 2008). The purpose of humanitarian action is to protect life and health and ensure respect for human beings. Moreover, special attention should be paid to the most vulnerable. The principle of **neutrality** states that humanitarian actors should not favour sides in providing aid or engaging in controversies of a political, racial, religious or ideological nature. The principle of **impartiality** prescribes that aid should be delivered based on needs assessment without discrimination, giving priority to the most urgent cases of distress and making no distinctions based on nationality, race, gender, religious belief, class or political opinions (Haider, 2013). No discrimination between or within affected populations should occur (ECHO, 2008). The principle of **independence** presumes the autonomy of humanitarian objectives. Humanitarian action must be autonomous from the political, economic, military or other objectives that any actor may hold about areas where humanitarian action is being implemented (Haider, 2013).

According to these principles, the sole purpose of humanitarian aid should be to relieve and prevent suffering due to humanitarian crises (ECHO, 2008). Humanitarian work should be distinguished from other activities, such as political, religious or military activities (UNOCHA, 2012). The European Consensus on Humanitarian Aid for example states that humanitarian aid should not be a crisis management tool, which means that its sole purpose should be the alleviation of suffering. The 'do no harm' principle is considered the minimum requirement underlying policies and aid approaches (ECHO, 2008).

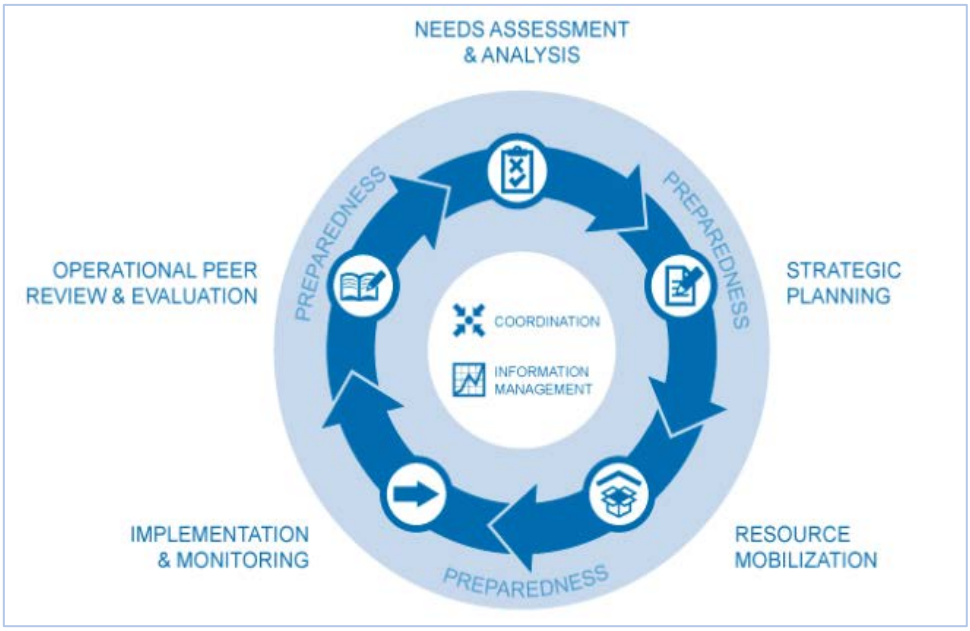
3.3. Humanitarian programme cycle

To provide humanitarian assistance humanitarian actors work together in a structured manner. The HPC was developed by the Inter-Agency Standing Committee (IASC), a mechanism for inter-agency coordinator of humanitarian assistance (IASC, 2012). IASC is composed of nine full members and nine standing invitees[1]. The HPC is a coordinated set of activities undertaken to prepare, manage and

[1] The full members are: Food and Agriculture Organization of the UN (FAO), UNOCHA, the United Nations Development Programme (UNDP), United Nations Population Fund (UNFPA), the United Nations Human

deliver humanitarian response operations and is composed of the following stages (Humanitarian Response, 2018): 1) Needs assessment and analysis, 2) Strategic response planning, 3) Resource mobilisation, 4) Implementation and monitoring, and 5) Operational review and evaluation (Figure 2). It was developed to focus on the needs of affected people, facilitate targeting the most vulnerable, enable increased funding and greater accountability for humanitarian actors (Humanitarian Response, 2018).

Figure 2 – Humanitarian programme cycle



Source: Humanitarian Response, 2018

3.4. Actors in humanitarian assistance

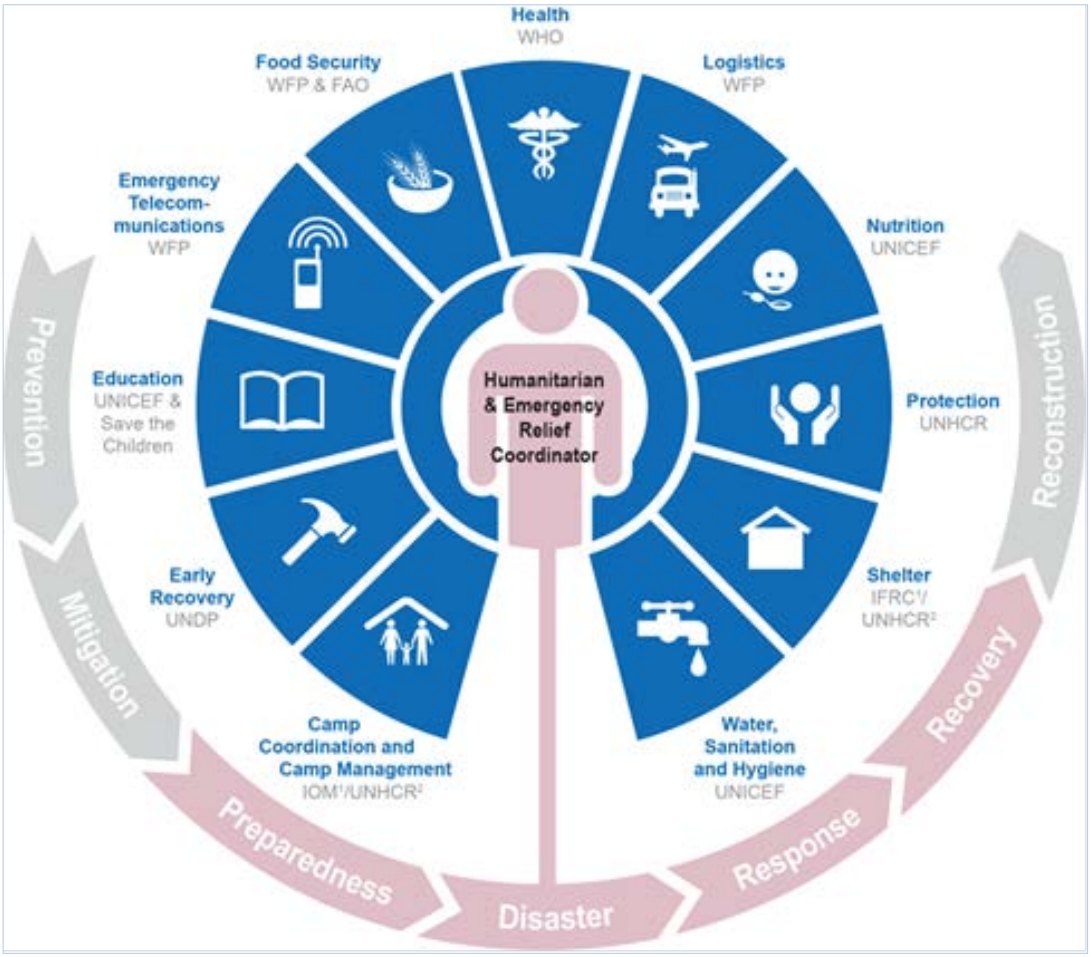
International humanitarian assistance is provided by a wide range of organisations, agencies and inter-agency networks (Humanitarian Coalition, 2018b). The humanitarian system is 'the network of inter-connected institutional and operational entities that receive funds – directly or indirectly from public donors and private sources, to enhance, support or substitute within country responses in the provision of humanitarian assistance and protection to a population in crisis' (ALNAP, 2017, p.5). These entities are operationally or financially related to each other and share common goals, norms and principles in humanitarian action. They include organisations such as the ICRC, national and international non-governmental organisations, governments, IOs such as UN agencies and the EU, and entities that provide funding or coordination (ALNAP, 2017).

Settlements Programme (UN-Habitat), the United Nations Children's Fund (UNICEF), the United Nations High Commissioner for Refugees (UNHCR), the World Food Programme (WFP) and the World Health Organization (WHO). The standing invitees are: ICRC, the International Council of Voluntary Agencies (ICVA), IFRC, InterAction, International Organization for Migration (IOM), Office of the Special Rapporteur on the Human Rights of Internally Displaced Persons (IDPs), the Office of the United Nations High Commissioner for Human Rights (OHCHR), the Steering Committee for Humanitarian Response (SCHR) and the World Bank.

United Nations

The UN has the official mandate to support the coordination of international humanitarian agencies to deliver humanitarian assistance in a cohesive and effective manner. The UN holds the central and overall coordinating role to promote a coherent international humanitarian response, specifically the Office for the Coordination of Humanitarian Affairs (OCHA) (ECHO, 2008). UNOCHA serves as the secretariat for critical inter-agency coordination mechanisms such as the Inter-Agency Standing Committee, rapid-response tools, such as the United Nations Disaster Assessment and Coordination system, and the International Search and Rescue Advisory Group. In 2005, the UN implemented a coordination mechanism called the 'cluster approach' (Figure 3) to improve coordination of humanitarian response. Each cluster refers to a group of organisations that provide a common sector of humanitarian assistance such as education, shelter or nutrition. The objective of the cluster approach is to enhance partnership and complementarity between UN agencies, the ICRC, international organisations as well as local and international NGOs (Humanitarian Coalition, 2018b). Additionally, many other organisations outside the EU and UN framework provide assistance, for example local and private citizen initiatives.

Figure 3 – The UN cluster approach



Source: UNHCR, 2018

The European Union

European Civil Protection and Humanitarian Aid Operations (ECHO) is provided by the Member States and at the EU level and is framed in an international approach by the UN, ICRC, humanitarian NGOs and others, in support of local response. The guiding principle for action within the EU as well as abroad is that national authorities carry primary responsibility over protection of populations (ECHO,

2008). The EU and its Member States fund partner humanitarian organisations to provide assistance on the ground when there is a humanitarian need, whether in an armed conflict or the wake of a natural disaster. Depending on the specific needs and the nature of each crisis, the EU and its Member States provide: material assistance (food, clothes, medicine, shelter, water, sanitation etc.), cash and/or vouchers that can be redeemed for food or other items, technical and logistical assistance, and funding of infrastructure and personnel (refugee camps, field hospitals etc.) (Council of the European Union, 2015).

In 2001, the EU Civil Protection Mechanism was established to enable coordinated assistance from participating states to people affected by disaster in and outside of Europe. In November 2017, the European Commission announced plans to further strengthen civil protection response (ECHO, 2018a). Established in 2013, the Emergency Response Coordination Centre (ERCC) is at the operational heart of the EU Civil Protection Mechanism and serves as the coordination platform for civil protection and humanitarian aid. It collects data, monitors risks and prepares plans for response (ECHO, 2018b).

3.5. Funding humanitarian assistance

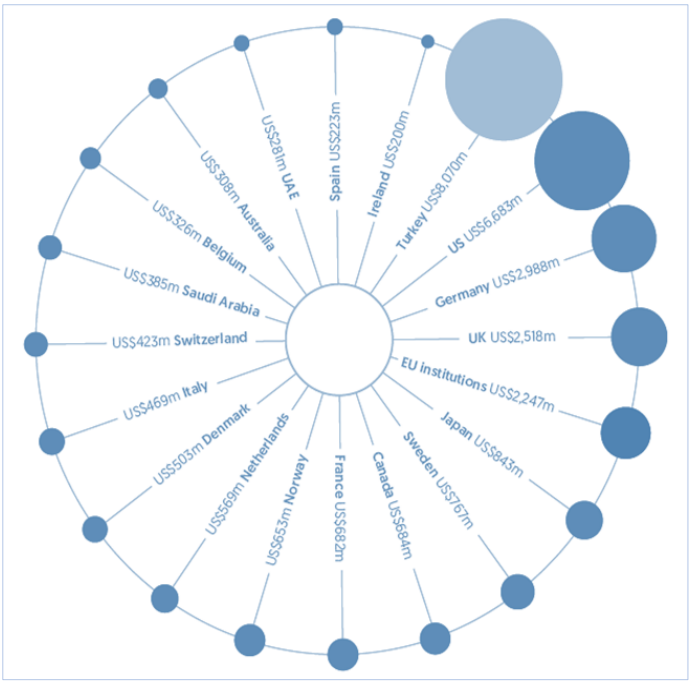
In response to the increasing number of crises around the world, the volume of international humanitarian assistance increased for the fourth consecutive year in 2016, reaching a total of almost USD 26.4 billion (Development Initiatives, 2017)[2]. However, the pace of growth has slowed with an increase of just 6 per cent between 2015 and 2016, compared with annual increases of between 12 and 21 per cent in the previous three years (Development Initiatives, 2017), and continued to slow in 2017 with a 3 per cent increase from USD 26.4 billion in 2016 to USD 27.3 billion in 2017 (Development Initiatives, 2018a). The High-Level Panel on Humanitarian Financing (2016) estimated a funding gap of USD 15 billion in 2016.

In 2016, a total of EUR 13 billion was spent on humanitarian aid by all DAC[3] countries (OECD, 2018a). DAC is a unique international forum of many of the largest funders of aid. The total amount of funding of official development assistance (ODA) was EUR 137.86 billion in 2016 and it slightly decreased to EUR 137.1 billion in 2017 (OECD, 2018a).

The EU is the world's largest humanitarian donor when funds allocated by Member States and spending of ECHO are combined (OECD, 2018b). The initial EU budget of ECHO, as programmed in the EU's Multi-annual Financial Framework (MFF) 2014-2020, amounts to approximately EUR 1 billion per year (ECHO, 2017e). The Global Humanitarian Assistance Report of 2018 identified the 20 largest contributors of humanitarian assistance to be governments and EU institutions (Figure 4). For five consecutive years public donors – governments and EU institutions – contributed an increasing amount to international humanitarian assistance.

[2] The figure includes only the humanitarian assistance directed internationally by donors.
[3] DAC is the OECD's Development Assistance Committee. There are 30 members of DAC, including the EU which acts as a full member of the committee. Asian Development Bank, African Development Bank, Inter-American Development Bank, International Monetary Fund, United Nations Development Programme and the World Bank participate as observers.

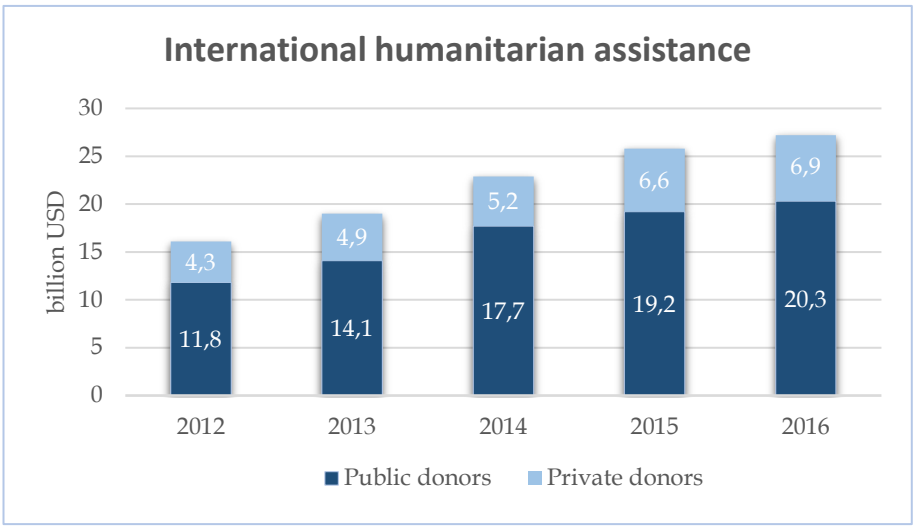
Figure 4 – 20 contributors of the largest amount of official humanitarian assistance in 2017



Source: Development Initiatives, 2018a

Where public donors struggle to meet the humanitarian demand, private donors – individuals, trusts and foundations, and private companies - are a critical source to fill in the gaps. The potential of private donations is gaining increasing attention. Between 2012 and 2016, private donors contributed between 23 and 27 per cent of total international humanitarian assistance (Figure 5). These private donations consist for approximately 70 per cent of donations by individuals (Development Initiatives, 2017, p. 51). In 2016, private donors spent USD 6.9 billion (EUR 6.562 billion) on humanitarian assistance (Development Initiatives, 2017). Around 25 per cent of total international humanitarian assistance came from private donors (Global Humanitarian Assistance Report 2017).

Figure 5 – International humanitarian assistance



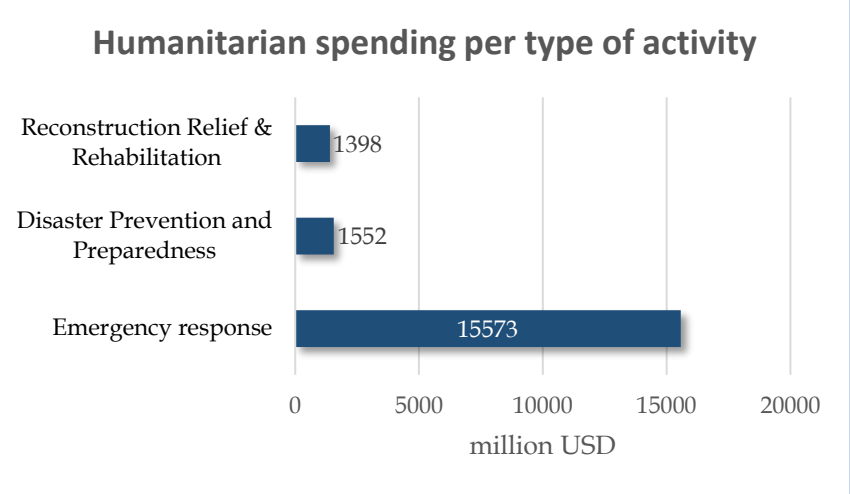
Source: Development Initiatives, 2017

Besides donating, the private sector invests. However, giving to crisis-affected areas can be a high risk for private investments. Some funding mechanisms can help decrease the risk for private investments. Examples of this are impact bonds (upfront financing to deliver an identified outcome), guarantees (repayment if a public entity fails to meet obligations), and insurance against political risks (Development Initiatives, 2017, p. 54).

Most of funding available for humanitarian aid is spent on emergency response, with only limited funding available for disaster prevention and preparedness (Tableau, 2018) (Figure 6). In addition, a wide variety of other resources, such as for example remittances, complement humanitarian assistance.

Humanitarian assistances reaches people affected by crisis through various channels and chains. In 2016, USD 12.3 billion or 60 per cent of all direct government funding went to multilateral agencies (primarily UN agencies) in the first instance. 20 per cent of all direct government funding went to non-governmental organisations (NGOs). The UN states that a growing majority of this in turn went to international NGOs (iNGOs), who received 94 per cent of all funding to NGOs in 2017, up from 85 per cent in 2016. There was a slight increase in direct funding to national NGOs, from 1.6 per cent of all NGO funding in 2016 to 2.4 per cent in 2017. Furthermore, direct funding to southern international NGOs increased from 1.7 per cent to 1.9 per cent, and local NGOs received just 0.3 per cent directly of all international humanitarian assistance reported to financial tracking service (FTS) in 2017, a rise of just 0.2 per cent from 2016. Internationally affiliated NGO's went from 0.7 per cent in 2016 down to 0.5 per cent in 2017. However, the report notes that improved reporting, with lower volumes of funding being categorised as 'undefined', may in part explain the changes seen in 2017 (Development Initiatives, 2018).[4] In 2016 11 per cent of funding went to undefined NGO's in comparison to the 1.2 per cent in 2017.

Figure 6 – Humanitarian spending per type of activity in 2014

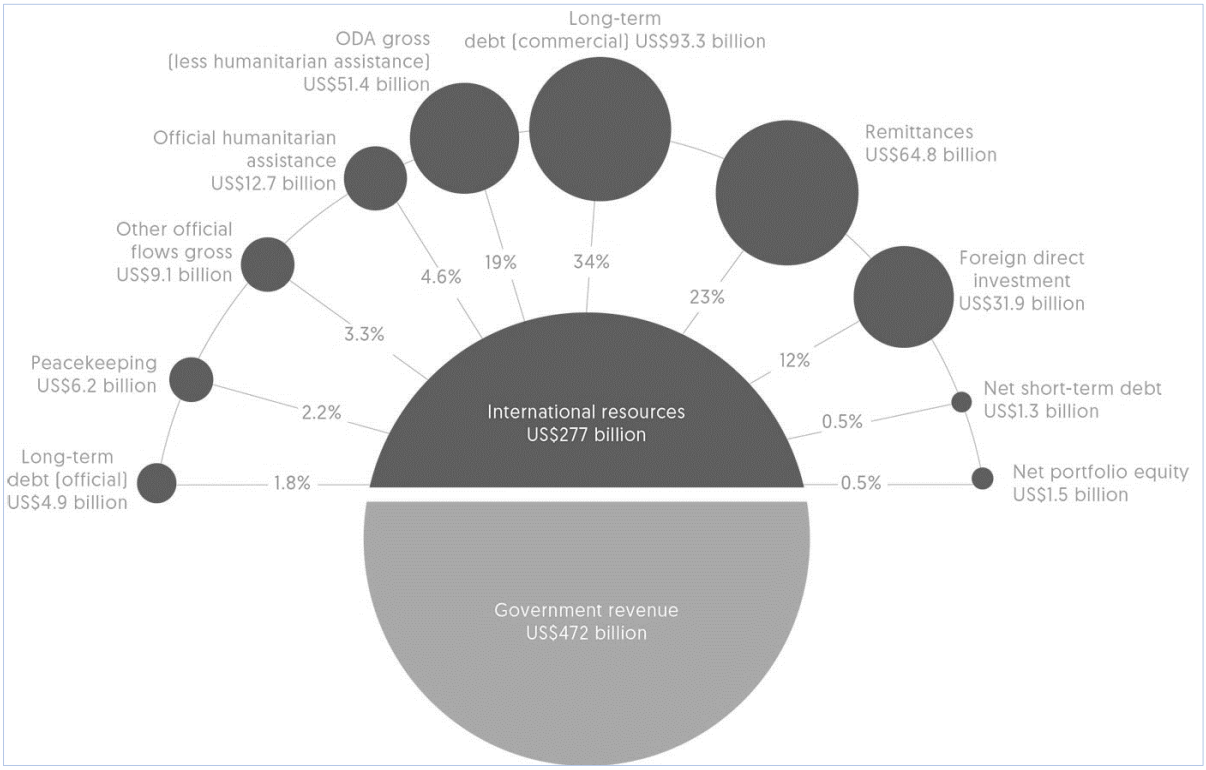


Source: Tableau, 2018

[4] The source shows humanitarian assistance to each category of NGOs as a percentage of the total humanitarian assistance channelled through NGOs as reported to FTS only; it does not show funding channelled to categories of NGOs as a percentage of total international humanitarian assistance.

Other domestic and international resources complement humanitarian assistance. Figure 7 illustrates the resource flows to the 20 largest recipients of humanitarian assistance in 2016 (Development Initiatives, 2018a). Governments of affected countries should be the primary responders to crises using their own revenues. The Global Humanitarian Assistance Report states that 'In the 20 countries receiving the most international humanitarian assistance, the proportion of analysed resources from domestic government non-grant revenue was 63% in 2016' (Development Initiatives, 2018a, p.30).

Figure 7 – Resource flows to 20 largest recipients of humanitarian assistance in 2016



Source: Development Initiatives, 2018a

3.6. Current legislative framework, policies and agreements

In addition to the commitments made, humanitarian action should follow a set of internationally recognised standards and principles (ECHO, 2008). Humanitarian assistance is based on a legislative framework, policies and agreements on both international as well as European level. Short summaries of their main elements are included in this section. It is vital that technological innovations in humanitarian assistance adhere to these standards and that those engaged in the innovation process in the humanitarian domain are aware of these standards. The objective of this study is to analyse the impact of these innovations as transformative tools for both people in need as well as humanitarian relief providers. These legislative frameworks, policies are agreements form the basis for the assessment framework provided in chapter 4.

International level

Geneva Conventions

The Geneva Conventions comprise four treaties and three additional protocols that establish the standards of international law for humanitarian treatment in war. They provide the justification for the provision of relief to civilians and wounded military and impose upon the ratifying countries the obligation to allow assistance to be provided (Rysaback-Smith, 2015). The conventions and protocols

seek to protect people who are not taking part in hostilities, such as civilians and aid workers, and those who are no longer participating in hostilities such as wounded, sick and prisoners of war (ICRC, 2010). All EU Member States have ratified the four Geneva Conventions and their additional protocols (ECHO, 2017e).

Humanitarian access is a challenge in many armed conflicts. Governments and de facto authorities do not always welcome assistance and impose access constraints on humanitarian organisations, as a result of differing ideas about civilian protection, tactical/policy considerations, doubts about the true objectives of humanitarian actors and fears of foreign influence (GSDRC, 2015). Access can be restricted as a result of security related concerns such as active hostilities and attacks against humanitarian workers and facilities; but also, as a result of bureaucratic restrictions and interference in the delivery of assistance by various different state- and non-state parties to the conflict. In some conflicts, restrictions placed on humanitarian access has been a deliberate move on the part of the conflict parties to harm civilians (UN, 2015, p. 13). Organisations such as the EC, the UNOCHA and the ICRC have conducted various studies on effective access strategies but there is 'very little publicly documented evidence' on the exact ways in which different humanitarian organisations have overcome specific instances of controlled, limited and restricted humanitarian access (GSDRC, 2015).

For the outside provision of humanitarian assistance, state consent is required. Although multiple legal regimes govern humanitarian relief operations depending on the situation in which relief is provided (including occupation, international armed conflict, non-international armed conflict, and peacetime emergencies), the emphasis on state consent is common in all (Ryngaert, 2013). The refusal to give consent has raised questions about whether humanitarian actors can provide assistance without obtaining consent to operate.

International Humanitarian Law

International Humanitarian Law (IHL) is a set of international rules, intended to limit the effects arising from armed conflicts, including humanitarian issues, and is applicable in times of armed conflict. It is intended to protect people affected by armed conflict and limit parties involved in conflict in the use of methods and means of warfare (ICRC, 2003). The four Geneva Conventions constitute the core treaties of IHL (ICRC, 2014).

International Disaster Law

International Disaster Law (IDL) focuses on the preparation for, response to and recovery from natural hazards as well as human-made disasters such as large-scale industrial accidents. In 2007, the IDL guidelines were adopted by the Geneva Convention signatories and the ICRC. Additionally, the Sendai Framework for Disaster Risk Reduction was adopted in 2015 by UN member states and sets out four priorities for action (Irish Red Cross, 2018) (see section 3.7).

Code of Conduct for the International Red Cross and Red Crescent Movement and Non-Governmental Organisations in Disaster Relief

The Code of Conduct sets the standard of humanitarian behaviour in the humanitarian sector and was drafted in 1992. It strives for independence, effectiveness and impact in disaster response by NGOs and the ICRC. In cases of armed conflict, the code of conduct is applied in conformity with IHL (IFRC, 2017). Its main provisions are that humanitarian aid is given based on needs alone and without any political or personal interest. The code of conduct consists of 10 principles (ICRC, 1994, p.3 -5). It also describes the working environment sought by host, donor and inter-governmental organisations to facilitate effective delivery of humanitarian assistance. These include recognising the independence

and impartiality of the organisations, the facilitation of rapid access and timely flow of goods, provision of a coordinated disaster information and planning service and access to information. Additionally, the code emphasises the recognition of local and foreign partners as equal and valuable (ICRC, 1994). These provisions should also be respected in technological innovations.

Sphere - Humanitarian Charter and Minimum Standards in Disaster Response
The Sphere project was launched in 1997 by a group of international donors and NGOs to develop a set of minimum standards in core areas of humanitarian assistance. There are currently no common regulatory standards for technological innovations in humanitarian assistance. Various organisations have independently or jointly set up guidelines, codes of conduct and principles (The Sphere Project, 2018).

The Humanitarian Charter is the cornerstone of the Sphere Project to which organisations adhere voluntarily. It defines the rights of people affected by humanitarian crises and promotes three fundamental humanitarian principles: the right to life with dignity, the distinction between combatants and non-combatants, and the principle of non-refoulment. In addition to 6 overarching core standards, the Sphere project sets minimum standards in five specific core sectors; 1) water supply and sanitation, 2) nutrition, 3) food aid, 4) shelter and site planning, and 5) health services (The Sphere Project, 2018).

OECD/DAC criteria for the Evaluation of Humanitarian Aid
The OECD/DAC evaluation criteria are at the heart of Evaluation of Humanitarian Aid (EHA). In 1991, DAC developed a set of principles, later refined into criteria, to facilitate the evaluation of development initiatives. These criteria were adopted for the evaluation of aid delivery in complex emergencies. The criteria for assessment are related to effectiveness, impact, efficiency, relevance and appropriateness, coverage, connectedness and coherence (ALNAP, 2006). Technological innovations should facilitate humanitarian assistance in a manner that is compliant with these criteria.

European Union
European Consensus on Humanitarian Aid
The European Consensus on Humanitarian Aid is the policy framework for the EU response in humanitarian crises (ECHO, 2017c). It defines common objectives and the scope of humanitarian aid, states common principles and good practices, and establishes a common framework to deliver humanitarian aid (ECHO, 2017d). The objective of EU humanitarian aid is 'to provide a needs-based emergency response aimed at preserving life, preventing and alleviating human suffering and maintaining human dignity wherever the need arises if governments and local actors are overwhelmed, unable or unwilling to act' (ECHO, 2008, p.6). Technological innovations should facilitate these objectives.

The Consensus includes assistance, relief and protection during humanitarian crises, both man-made as well as natural disaster, and in their direct aftermath, and facilitates the provision of assistance. It is also stated that EU humanitarian aid should take long term development objectives into account and is linked to development cooperation as outlined in the European Consensus on Development (ECHO, 2008).

3.7. The new way of working

To address the challenges facing the humanitarian domain commitments were made during the WHS which have led to various humanitarian reform initiatives to 'define, implement and measure new ways to address and prevent crisis' (Development Initiatives, 2017, p.12). Former UN Secretary-General

Ban Ki-Moon put forward the Agenda for Humanity which consists of five core responsibilities and 24 strategic transformations to address and reduce humanitarian need, risk and vulnerability (UN, 2016a) (Figure 8). The Agenda for Humanity is intended as a framework for action to achieve the overall objective: to reduce the suffering of millions of people, and address and reduce humanitarian need, risk and vulnerability. The commitments are referred to as 'The New Way of Working' because it is transformative in nature and aims to offer a concrete path to remove obstacles for collaboration towards collective outcomes.

Figure 8 – Agenda for Humanity: five core responsibilities and 24 strategic transformations

Source: World Humanitarian Summit, 2016b

With regard to humanitarian assistance, the scope of this study and its research questions, the following points are of special relevance (WHS, 2016b):

- **Transcend the humanitarian-development divide** and **anticipate crisis**, focusing on investing in preparedness, local stability and risk reduction. The Agenda for Humanity illustrates an ambition to transcend the differing stages and adopt a comprehensive and holistic approach.

- **Reinforce local systems**, which includes investing in local capacities and capabilities, reinforcing local systems and including the most vulnerable. Moreover, the Agenda for Humanity embraces local ownership and empowerment.
- **Invest in humanity** by addressing the humanitarian financing gap, through a diversification of resources, increasing efficiency and shifting from funding to financing. The Agenda for Humanity seeks to address the humanitarian financing gap through a variety of means including increasing efficiency, as well as exploring other ways of financing.
- **Improving accountability** towards both donors as well as local populations, by increasing transparency and insight in processes.

Commitment to Action

With the endorsement of the World Bank and IOM, UN Secretary-General Ban Ki-Moon and the heads of UNICEF, UNHCR, WHO, UNOCHA, WFP, FAO, UNFPA and UNDP, made a 'Commitment to Action' based on the Agenda for Humanity. It is considered a key document as it defines the 'new way of working' for the UN system and the broader humanitarian and development community. It calls for increased collaboration and a reduction of working within silos (WHS, 2016-a). 'The new way of working' calls for working towards achieving: pooled and combined data, analysis and information; better joined up planning and programming processes; effective leadership for collective outcomes; and pursuing financing modalities to support collective outcomes (UN, 2016a).

Grand Bargain

The Grand Bargain was first proposed by the UN Secretary General's High-Level Panel on Humanitarian Financing to address the finance gap in humanitarian assistance. It is an agreement between more than 30 of the biggest donors and aid providers, which aims to get more means into the hands of people in need. It proposes the following changes: an increase of cash-based programming, an increase of funding for local response by providing 25 per cent of global humanitarian funding to local and national responders by 2020, and harmonising reporting requirements and reducing bureaucracy (The Grand Bargain, 2016). Furthermore, organisations committed to shifting from annual to multi-year humanitarian funding to enable to shift from meeting immediate humanitarian needs to addressing the root causes. The OECD states that short term finance may prevent alleviating the divide between humanitarian action and development programming (OECD, 2017).

Sendai Framework for Disaster Risk Reduction

The Sendai Framework for Disaster Risk Reduction 2015-2030 provides a global approach to disaster risk management policy and operations (UNISDR, 2015). In June 2016, the European Commission published an Action Plan which aims to guide the implementation of the Sendai Framework in EU policies. The Framework sets seven targets and four priorities for action to prevent new and reduce existing risks for disaster. The 4 priorities for action are 1) understanding disaster risk, 2) strengthening disaster risk governance to manage disaster risk, 3) investing in disaster risk reduction for resilience and 4) enhancing disaster preparedness for effective response and to 'Build Back Better' in recovery, rehabilitation and reconstruction (UNISDR, 2015).

This study will focus specifically on technological innovations that facilitate or support the commitments made in the Agenda for Humanity, Commitment to Action, Grand Bargain and the Sendai Framework for Disaster Risk Reduction.

3.8. Key conclusions

- The objective of humanitarian assistance is to alleviate suffering in accordance with international law, humanitarian principles and specific ways of working captured in codes of conduct.
- The humanitarian sector has been facing a number of challenges. This led to a renewed ambition during the WHS 2016 for increasing efficiency and effectiveness of humanitarian assistance delivery, the availability of resources, increasing transparency and accountability. Technological innovations are seen as a means to facilitate these ambitions referred to as 'The New Way of Working'.
- There are currently no common regulatory standards for technological innovations in humanitarian assistance. Various organisations have independently or jointly set up guidelines, codes of conduct and principles. It is vital that technological innovations in humanitarian assistance also adhere to international legal framework, policies and agreements and that those engaged in the innovation process in the humanitarian domain are aware of them.

4. Technological innovation in humanitarian assistance

The context of humanitarian assistance has been described in the previous chapter of this report. The study focuses on current technological innovations in humanitarian assistance. It is therefore important to understand the current activities facilitating technological innovation in humanitarian assistance. In this chapter background information is provided concerning humanitarian innovation. It does not offer an exhaustive overview but instead provides insight into the major trends and developments, as well as the key actors and activities involved. The chapter ends with a framework of criteria that will be used for assessing technological innovations in humanitarian assistance in Chapter 5.

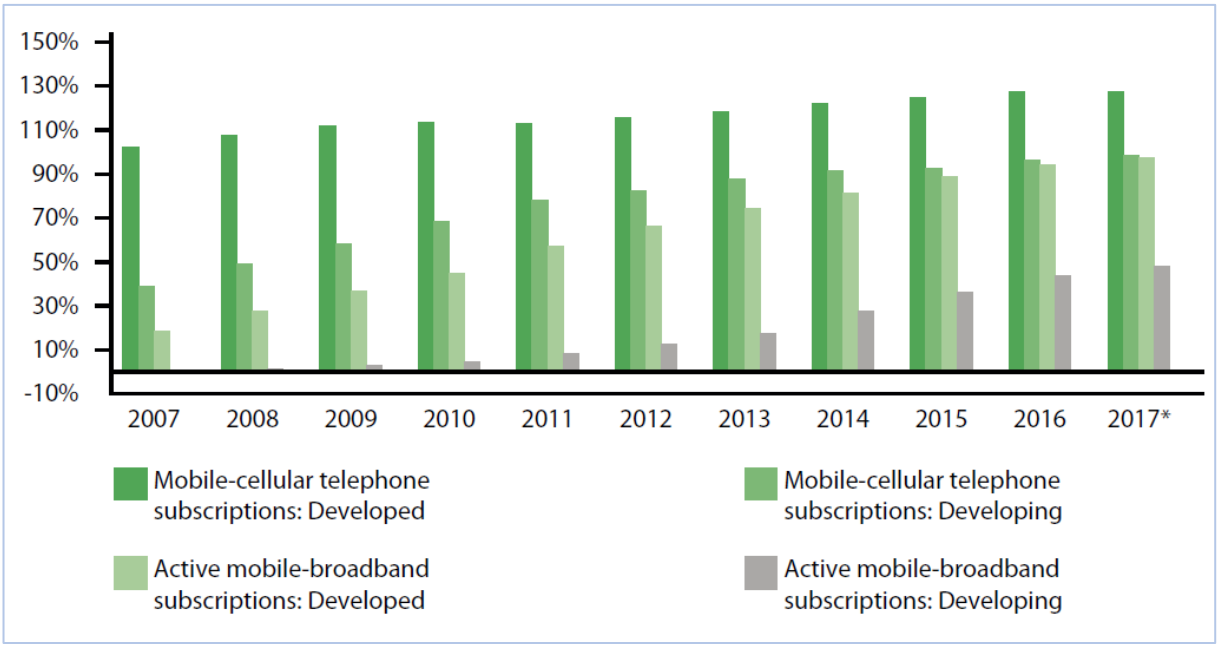
4.1. Digitisation and digital transformation

Digitisation and digital transformation are all around us in the digital age and transforming the way we live. Technology is perceived as an instrument within the current humanitarian space, but also as a transformative tool to alter the foundations of humanitarian action (Sandvik, Jumbert, Karlsrud and Kaufmann, 2014). Digitalisation in risk prone and crisis affected countries is significantly transforming the context in which humanitarian assistance is delivered and humanitarian aid providers operate. The availability and usage of mobile phones and social media platforms by people affected by humanitarian crises, geospatial technologies and unmanned aerial vehicles (UAVs) to detect humanitarian crises, biometric identification to facilitate humanitarian support, a shift to digital payments as relief provisions with e-vouchers and mobile money are all fundamentally transforming humanitarian assistance. A well-known example of digital transformation in humanitarian assistance is the partnership between the government of Jordan, WFP, Mastercard, UNHCR, Cairo Amman Bank and IrisGuard Inc. which introduced iris scan payment in Jordan's Zaatari and Azraq refugee camps, enabling the use of digital money deposited on e-cards to buy food and access basic services with an eye scan (UN, 2018). The programme is known as Building Blocks and was started in early 2017 (Juskalian, 2018).

There is a growing 'digital divide' in science and technology among and within developed as well as developing countries (UN, 2018). To ensure inclusiveness there is for example a broad accord in the Addis Ababa Action Agreement to craft a cohesive strategy ensuring parity in data access and use across regions (UN, 2018). Social and digital exclusion are interlinked, given that differing access to technology can contribute to socio-economic stratification (UN, 2018). Especially in an increasingly digital world, digital inclusion is important. A recent study by the UN Department of Economic and Social Affairs (UN DESA) highlighted that 'very little is known about the potential impact of new technologies on low-income countries' as existing studies are mainly focused on large economies such as the United States of America (USA), the EU and China, and little attention has been given to developing countries (Bruckner, LaFleur and Pitterle, 2017). The UN e-Government survey focussed on 'e-government for leaving no one behind' and stated that addressing the needs of the most vulnerable is vital in creating resilient and sustainable societies and technologies offer the opportunity to reach them (UN, 2018, p.27). At the 2003 UN World Summit on Information Society it was stated that the benefits of technology are unevenly distributed between countries and within societies. The UN committed to turning 'the digital divide into a digital opportunity for all' (UN, 2018, p. 28). Fixed- and mobile-broadband prices are falling, making ICTs more accessible and affordable (UN, 2018) and an increased use of mobile devices is globally visible with wireless access to the internet as well as mobile phone connections. Figure 9 depicts the increasing penetration rate (%) for mobile-cellular telephone subscriptions as well as active mobile broadband subscriptions in both

developing and developed countries from 2007 to 2017. However, it is recognised that despite the progress, most of the world's population remains offline. There is therefore an increased risk that vulnerable groups will fall further behind in the digital society without access to the internet (UN, 2018).

Figure 9 – Increased access to cellular networks and wireless internet in both developing and developed countries



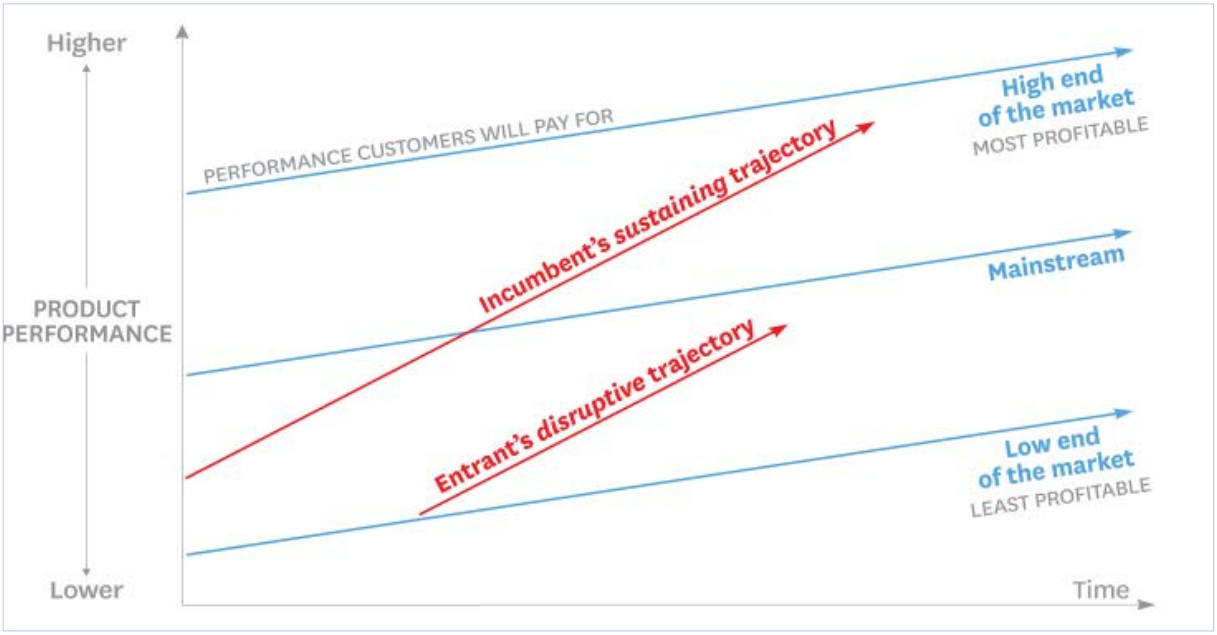
Source: UN, 2018 (*2017 figure is an estimate)

4.2. Innovation

The innovation lifecycle is formulated differently by each organisation; however, each version consists of similar elements. Curran, Huff Eckert and McCaffery (2011) refer to the stages of discovery, incubation, acceleration and scaling with a variety of loop-backs in ideation and selection, design and development, and launch and measurement. There are a variety of innovation types including product innovation, process innovation and system or business model innovation. For example, with regard to the humanitarian context, the development of an innovative shelter unit is a product innovation, the use of social media to collect data could be perceived as a process innovation and the exploration of innovative financing as a potential system innovation.

Frequently the term 'radical innovation' or 'disruptive innovation' is used when discussing innovation as a transformative tool. However, Christensen, Raynor and McDonald (2015) state that the theory's core concepts have been widely misunderstood and its basic tenets frequently misapplied. Consequently, organisations may choose the wrong strategic approaches, thereby reducing their chances of success. Disruption describes a process whereby a smaller company or entrant with fewer resources is able to challenge an established business. This company targets the customer needs and segments that are either overlooked or ignored by the established business as these focus on improving their existing products and services for existing customers. The entrants gain a foothold in low-end segments or new markets by providing suitable and cheaper products and services. Subsequently they will move upmarket to mainstream customers (Figure 10). Moreover, they often build different business models from the established businesses to gain a foothold.

Figure 10 – Process of disruptive innovation



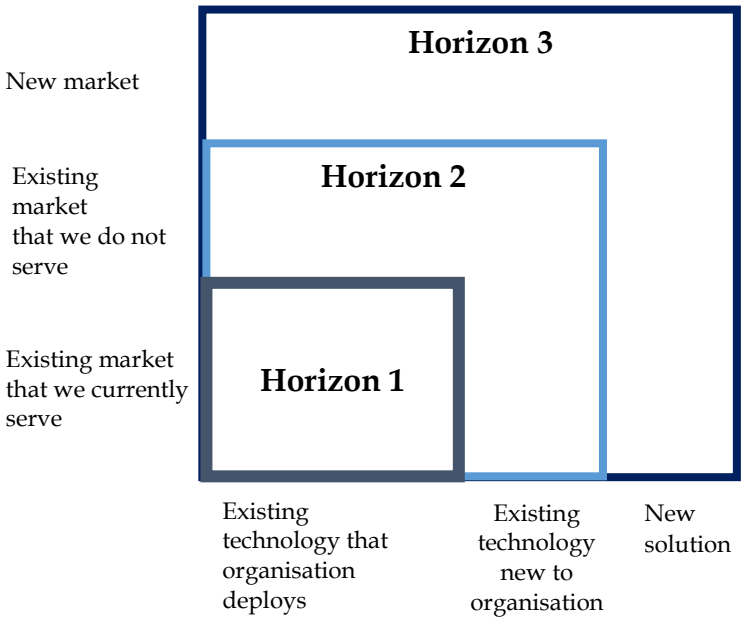
Source: Christensen, Raynor and McDonald (2015)

When mainstream customers start adopting the products and services in larger volumes, the disruption has occurred. It is important to note that disruptive innovation is a process which can take time: 'Complete substitution, if it comes at all, may take decades, because the incremental profit from staying with the old model for one more year trumps proposals to write off the assets in one stroke' (Christensen, Raynor and McDonald, 2015).

The more dominant and prevalent form of innovation is 'incremental innovation'. Incremental innovation concerns an existing product, service, process, organisation or method whose performance is enhanced or upgraded. Where 'radical innovations' create major disruptive changes, 'incremental innovations' continuously advance the process of change. The nature of innovation and the rate of technological change greatly differ from sector to sector (The innovation policy platform, 2018).

The Three Horizons of Growth model offers a means to better understand the approaches actors adopt in innovation (McKinsey Quarterly, 2009). The framework (Figure 11) provides a thinking frame for understanding innovation for an organisation's current state and for its desired future state. The first horizon 'defend and extend core businesses' represents the current core business or system and focuses on improving the system and maximising its performance and value. The second horizon 'build momentum of emerging new businesses' encompasses the emerging opportunities for the business or organisation such as new markets, products or services. These emerging opportunities could generate value in the future but may require significant investment. And horizon three 'create options for future business' can be perceived as the desirable future state which requires transformational change. Organisations must manage their activities along the horizons concurrently. The organisations over time move from horizon 2 to horizon 1, and from horizon 3 to horizon 2. Moreover, the three horizons are sometimes referred to as 'known', 'partially known' and 'unknown' solutions.

Figure 11 – The three horizons of growth model



Source: Created by the authors for the purpose of this study

The 2017 Emerging Technologies Hype Cycle by Gartner (2017) identifies three megatrends for businesses in the next five to ten years. These include 1) Artificial Intelligence, including but not limited to drones, autonomous vehicles, machine learning and smart robots; 2) Transparently Immersive Experience, including Augmented Reality (AR), Computer-Brain Interface and Virtual Reality (VR).; and 3) Digital Platforms, including blockchain and the Internet of Things.

4.3. Innovation in humanitarian assistance

A variety of interpretations of the meaning of 'technological innovation in humanitarian assistance' exist. Some innovators may focus on the iterative process of innovation and its humanitarian character, whereas others focus on the usage of new technologies in providing humanitarian assistance, or on the discussions about the impact of subsequent changes on the system of humanitarian assistance. Each perspective brings forth opportunities as well as concerns. However, the fundamental concern is the adherence to the core humanitarian values, alleviating suffering and assisting those in need, and the identity of being a humanitarian.

The Oxford Department of International Development coined two worlds of humanitarian innovation: 'One which falls solely into the institutionalised practice of a small number of humanitarian actors, and which focuses on upwards accountability to donors and traditionally takes a more 'top-down' approach in implementing solutions for affected populations; and another which fosters and builds on the existing innovative capabilities and systems of local communities' (Bloom and Betts, 2013). UNOCHA (2014, p. 5) defined innovation as 'means of adaptation and improvement through finding and scaling solutions to problems, in the form of products, processes or wider business models'. The concept can be applied to almost all specialised areas and may include technology but it is not reducible to technology. In addition, **innovation** should not be confused with **invention**. Innovation does not require the creation of something novel, it may also include the adaption of something existing to a different context. Furthermore, there is no threshold for change to qualify as innovative, as it includes both disruptive as well as incremental innovations (UNOCHA, 2014, p. 5).

A range of humanitarian international organisations have engaged in 'the innovation turn' (Bloom and Betts, 2013). The field of humanitarian technological innovation is fast moving and emergent in nature. An emphasis on technological innovation in organisational language, culture and activities has been embraced by the humanitarian system, for example embracing experimentation in the cold phase and creative thinking about solutions (GPPI, 2016). The Harvard Business Review (Allen, 2012) states that the language and culture that emanate from the executive level is like a mantra expressed in organisational expressions and philosophies that moves through the entire organisation. Consequently, they get adopted and interpreted as actions to be followed. Innovation is high on the agenda for many humanitarian organisations, for example WFP and UNICEF. According to UNOCHA, technological developments, the demand for new business models, private sector engagement and partnerships are the main factors driving innovation in humanitarian assistance. It is recognised that the trajectory of humanitarian assistance is unsustainable and humanitarian tools and services are in many cases ill-suited to modern emergencies, which often occur in urban instead of rural setting, and have a complex and/or protracted nature (Betts and Bloom, 2014). However, 'despite the dramatic change in the operating environment, the structure of the humanitarian system has remained essentially closed and unchanged. As a result, pressure is building to fundamentally alter the way business is done, and many humanitarian actors and donors are looking to innovation as a vehicle for introducing these changes' (Betts and Bloom, 2014, p.6).

Above mentioned aspects explain the differing interpretation and implementation of 'innovation' between actors. Some perceive it as the implementation of technologies, others as a new way of creative thinking. In relation to this differing interpretation and approaches to technological innovation, the engagement with third parties such as academia and private sector varies (GPPI, 2016). On the one hand, new innovative products and processes are sought. On the other hand, there is a strong demand for a new business model as the current trajectory of humanitarian assistance is considered unsustainable (Betts and Bloom, 2014).

In addition, the humanitarian domain has some specific characteristics. For example, humanitarian goods are often considered public goods, and rather than benefiting only a 'customer', the provision is considered benefitting all involved, including governments and the global community. Therefore, humanitarian service delivery is often considered a public service predominantly funded with public funds. Furthermore, the domain is averse to risk due to the potentially detrimental consequences of failure in a humanitarian setting and organisations operate under ethical constraints (Betts and Bloom, 2014). With regards to the latter characteristics, opinions vary if these are unique characteristics and if consequently the humanitarian domain should be treated differently when pursuing innovation. For example, with regards to aversion to risk and the need for standards, companies also innovate under, be it different, strict legal requirements and customer expectations.

4.4. Innovation actors

The shape of the humanitarian system is ever-changing. Organisations whose principal function is not humanitarian action, such as academia and businesses, interact with humanitarian actors in a broader complex system of collective humanitarian work. Furthermore, humanitarian action is often undertaken by people affected by crisis, local communities and diasporas (ALNAP, 2017). The 2016 WHS called for increased collaboration with other actors such as academia and the private sector, including both local entrepreneurs, start-ups as well as multinationals. These actors are actively involved in technological innovation in humanitarian assistance. This paragraph includes a few of the

organisations engaged in humanitarian innovation; it does not provide an all-encompassing overview of all the organisations involved.

Various global initiatives facilitate (technological) innovation in humanitarian assistance such as Global Alliance for Humanitarian Innovation (GAHI) and Humanitarian Innovation Fund (HIF), as well as local initiatives such as Grand Challenges Canada, a Canadian NGO which provides funding to further innovation on the basis of the Grand Challenges model introduced in 2003 by the Bill and Melinda Gates Foundation (Grand Challenges Canada, 2016). Additionally, humanitarian organisations engage in innovation activities with the development of in-house capabilities, such as '510' within the ICRC. Donors have welcomed and urged partnerships with private sector actors to increase the availability of new skills and expertise in the sector (Sandvik, Jumbert, Karlsrud and Kaufmann, 2014). There are various collaborative partnerships between humanitarian organisations and private sector actors, for example the collaboration between WFP and MasterCard. They have been working together since 2012 to deliver innovative solutions to help create a world with Zero Hunger (World Food Programme, 2018). The project Building Blocks launched in 2017 in Jordan's Zaatari refugee camp is part of this collaboration (see section 4.1). Although the use of private sector technological solutions to digitalise humanitarian processes is welcomed by most, this also facilitates a discussion about a business model transformation, which brings about criticism and concerns about the core humanitarian values. Cooperation with private sector actors can take various forms including a more traditional relationship in which humanitarian organisations procure products and services from private sector actors, to a form of partnership in which humanitarian organisations and private sector actors 'co-create' products and services.

Private sector innovation has been driven by the incentive to 'get there first' with new products and business models. The humanitarian sector is supported by a financial structure that does not provide such incentives (Betts and Bloom, 2014). With growing resource constraints, the humanitarian sector seeks for contributions from the private sector. Initially private actors were an alternative source of funding, but in recent years the private sector started to play different roles as well. Private businesses can be subcontractors or private sector expertise can play a role in driving innovative programming, such as IKEA Foundation's partnership with UNHCR to develop new shelter options (Pantuliano, 2018) or MasterCard's collaboration with humanitarian organisations where they look for scalable solutions around a challenge by combining their different fields of expertise. Modes as well as motives of private sector engagement in the humanitarian sector vary. There are philanthropic contributions from foundations and individuals. Private companies have corporate social responsibility initiatives that connects humanitarianism to their brand. Some private businesses see opportunities in solutions for disaster situations that might be commercialised. There is a growing number of 'social entrepreneurs' that see potential in this kind of humanitarian enterprise. While the humanitarian sector seems to be drawn to the private sector's funding and expertise, there still exists hesitance about whether businesses that seek profit in the first place can uphold humanitarian principles (Betts and Bloom, 2014).

The core activities of humanitarian innovation conducted by the UN, NGOs, the private sector, universities, think tanks and governments could be categorised into three broad categories (Betts and Bloom, 2014):

- Grants and Finance, e.g. the IKEA Foundation, ECHO Innovation financing and HIF;
- Research and Development, e.g. UNICEF Innovation Labs, Medecins sans Frontieres (MSF) Innovation, and HHI;
- Collaboration and Partnership, e.g. UN Innovation Network, UNHCR Innovation Circle and events by Department for International Development (DFID) and ECHO.

4.5. Funding for humanitarian innovation

Compared to other sectors, the humanitarian sector's spending on R&D – an important driver of innovation – is lagging (Dassel, Wong and Li, 2017). The reason for this is twofold. Firstly, humanitarian actors are concerned that there is a lack of investment-worthy R&D ideas. Secondly, there is a concern that even if R&D investments resulted in high-quality ideas, the sector would not adopt or scale the innovations (Dassel, Wong and Li, 2017).

There is little public information available on how much humanitarian actors precisely spend on innovation or R&D. In many of the financial statements it is not clear what budget is available for innovation. Humanitarian organisations are client-driven and the budgets they receive from donors are oftentimes earmarked with little room for innovation, so it might be evident that there is little budget available for innovation purposes. Furthermore, the funding that is available oftentimes goes to innovation labs and specialised departments, which although necessary to facilitate the current processes, is far from operations in the field, local partners and the affected people it is meant to help (Praag, 2017).

Due to the existing pressure on availability of funding, the majority of funds is spent on the humanitarian sector's core business, the provision of assistance itself instead of innovation. However, donors of humanitarian assistance are increasingly making funds available for innovation due to an increased awareness of the need to innovate to ensure continued provision of assistance in the future (Devex, 2017).

Global Alliance for Humanitarian Innovation

GAHI strives to scale innovation in the humanitarian system. Various governments, NGOs, humanitarian innovation initiatives, IOs and businesses are members of GAHI. It is believed that elements to adapt the humanitarian system are in place, but that three steps need to be collectively taken to facilitate the process of adoption and scaling (GAHI, 2018):

- 'Get concrete': innovation efforts should be tied to concrete outcomes. Among other objectives, GAHI focuses on delivering on The Grand Bargain.
- 'Manage risks': GAHI seeks to address ethical concerns as well as practical risks of unfettered innovation in a humanitarian context.
- 'Ground Change in facts and foresights': GAHI facilitates evidence-based and long-term sustainable and impactful innovation.

Humanitarian Innovation Fund

The HIF was set up in 2010 and seeks to support organisations and individuals to identify, nurture and share innovative and scalable solutions to the challenges facing effective humanitarian assistance (HIF, 2017, p.2). HIF is a programme of Enhancing Learning and Research for Humanitarian Assistance (ELHRA). ELHRA is an initiative supported by United Kingdom (UK) Aid, Sida, the Ministry of Foreign Affairs of the Netherlands and the EU which aims to improve humanitarian outcomes by facilitating partnerships, research and innovation. It is an independent grant-making organisation focused on, as the name suggests, humanitarian innovation and open to the variety of actors active. Additionally, HIF provides lessons learned and insights on effective humanitarian innovation and shares this evidence-base globally. They formulated the following six strategic priorities for 2018-2020 (HIF, 2017):

- 'End to End solutions': HIF facilitates the entire innovation lifecycle;
- 'New Partnerships': HIF will support collaboration and new partnerships;

- 'Local engagement': HIF will design its programmes to further operational and local engagement;
- 'Bigger Problems': HIF will focus on complex systematic challenges and go beyond product innovation;
- 'Innovation ecosystem change': HIF will bring together humanitarian and innovation perspectives to further strengthen the humanitarian innovation ecosystem;
- 'Creating tools': HIF will create and share tools and capabilities for humanitarian innovation.

EU funding

Horizon 2020 is the EU Research and Innovation Programme with EUR 77 billion available between 2014 and 2020 (EC, 2017a, p. 5-6). Within this programme, in November 2017 the EC launched the first European Innovation Council Horizon Prize, of a total of six, on Affordable High-Tech for Humanitarian Aid. It facilitates the development of innovative solutions for the delivery of humanitarian aid with the frugal application of technology. The prize has a value of EUR 5 million which is expected to be allocated in five awards of EUR 1 million each (EC, 2017b).

In addition, the pilot programme European Innovation Council (EIC) brings together the parts of Horizon 2020 that provide funding, advice and networking opportunities for entrepreneurs, small companies and scientists to scale up innovations internationally. EIC for example offers grants for challenges such as 'Early warning for Epidemics' and 'Blockchains for Social Good' (EIC, 2018).

4.6. Principles for technological innovation in humanitarian assistance

There are currently no common regulatory standards for technological innovations in humanitarian assistance. Therefore, technological innovations in humanitarian assistance should adhere to international legal framework, policies and agreements for humanitarian action. In addition, some humanitarian actors and organisations have independently or jointly set up guidelines, codes of conduct and principles for technological innovation.

User-centric and local thinking

With regard to innovation in a humanitarian setting, the importance of the needs-based approach and thereby user-centric innovation is stressed. Design thinking revolves around user-centric development of innovative solutions. The need to recognise the specific culture, context and social norms of the humanitarian setting is stressed by humanitarian practitioners and innovators alike. This includes starting new developments with the context and users in mind (horizon 3, see section 4.2 and particularly Figure 11), and when transferring existing technologies to the humanitarian setting identifying the specific user and context requirements (horizon 2). In this line, frugal innovation is considered to meet the needs of people in low income countries better. 'Frugal innovations are new design and marketing strategies that put high-quality products and services that have been simplified and adapted to local circumstances within reach of the 'bottom of the pyramid' and the new middle-class in emerging economies' (Centre for Frugal Innovation in Africa, 2018).

Information as a right

Access to information plays an essential role in the social and political processes of our societies. People affected by humanitarian crisis as well as humanitarian aid providers are increasingly reliant on ICT. Given the opportunities technological developments provide, for example the continuous availability of information through the internet, it is vital to mention that currently there is a lack of

clarity about the rights to information of people affected by disaster and the corresponding obligations incumbent upon governments and aid providers (Scarnecchia, Raymond, Greenwood, Howarth and Poole, 2018). 'Information as a right' is a key topic of discussion in the exploration of technological innovation in humanitarian assistance.

The Signal Code is developed by the HHI and identifies five rights to information that people have during disaster: 1) the right to information, 2) the right to protection, 3) the right to privacy and security, 4) the right to data agency, and 5) the right to rectification and redress (HHI, 2017). The goal of the Signal Code is to provide a foundation for the future development of ethical obligations for humanitarian actors and minimum technical standards for the safe, ethical, and responsible conduct of Humanitarian Information Activities (HIAs) before, during, and after disasters strike. Based on these rights, obligations are identified which in turn should form the basis of technical standards for products and services. The rights are derived from multiple sources on international human rights, humanitarian law and other standards that apply to HIAs.

Various experts interviewed for this study spoke about privacy concerns and referred to the General Data Protection Regulation (GDPR) as an inspiration for a standard for privacy protection in humanitarian assistance. The EU's GDPR came into force on 25 May 2018. The GDPR brings a uniform approach to how data protection is managed in the EU. It has been created to strengthen data protection rights for EU citizens and aims to bring comprehensive protection of personal data for the technological era. There are significant penalties for organisations found to be non-compliant (Capgemini, 2017b). It is important to stress that it applies to data protection in the EU only. However, experts interviewed as part of this study referred to the GDPR to stress the significance of privacy concerns and validity of concerns around protection of data, the fast pace in which technology develops and the need to develop legislation that matches.

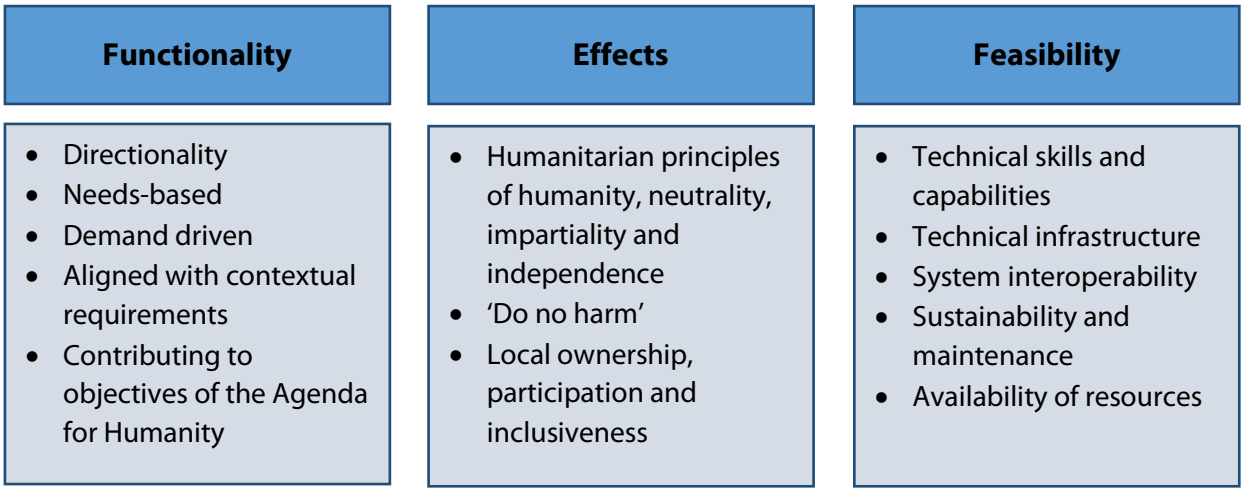
4.7. Criteria for assessment of technological innovations

A framework of criteria was drafted by the study authors based on existing standards to facilitate the assessment of the technological innovations in humanitarian assistance and humanitarian assistance in general. The approach focuses on the technological innovations themselves and their impact, and to a lesser degree on the innovation process and learning from this process (Obrecht, Warner, and Dillon, 2017). The framework is drafted based on input gathered through literature review and from experts during the interviews as well as expert sessions. The elements in the framework are drawn from a variety of sources including the HIF/ALNAP Working paper on evaluating humanitarian innovation.

The following structure is upheld (Figure 12):

1. The description and functionality of the technological innovation
2. The effects of the technological innovation in humanitarian assistance, and
3. The feasibility of the technological innovation in humanitarian assistance).

Figure 12 – Assessment criteria



Source: Created by the authors for the purpose of this study

With regard to *the description and functionality of the technological innovation*, in addition to a description of the technology and its implementation in humanitarian assistance, the need it addresses is explored and thereby the relevance of the technological innovation (Obrecht, Warner, and Dillon, 2017). The criteria is based on the Sphere Project's core standard on people-centred humanitarian response (The Sphere Project, 2018) and OECD/DAC criteria for assessment on relevance and appropriateness (ALNAP, 2006). Technological innovations should not just be 'new', they should be demand driven, with the needs of people affected by humanitarian crises in mind (Obrecht, Warner, and Dillon, 2017).

With regard to *the effects of the technological innovation in humanitarian assistance,* the improvement in quality, efficiency or effectiveness are explored (Obrecht, Warner, and Dillon, 2017). These value propositions are dependent on current practices and approaches. Based on the OECD/DAC criteria for the EHA the criteria focus on effectiveness, impact and efficiency (ALNAP, 2006) (see section 3.6). Furthermore, the intended or unintended (potential) positive or negative impacts of the technological innovation are explored. Considering the fundamental principles of 'do no harm' (Obrecht, Warner, and Dillon, 2017), in this specific study, unlike other studies (Rathenau Instituut, 2011), we consider the humanitarian principles, specifically with regard to privacy, doing no harm and the visibility of the most vulnerable.

Inclusion and participation of people affected by humanitarian crises in all stages of humanitarian action is sought by humanitarian actors, and remains a challenge (Bloom and Betts, 2013). ALNAP builds on the OECD/DAC criteria for humanitarian performance assessment and considers aspects of accountability and participation of local communities (ALNAP, 2017). OCHA states that 'Humanitarian action recognises and supports the capacities and accountability of national and local actors and reinforces the self-reliance of affected people' (OCHA, 2016, p. 42).

The importance of accountability towards both European citizens as well as people affected by humanitarian crises with regard to the use of funds as well as the implementation of aid to alleviate suffering is considered vital by humanitarian organisations. Accountability measures include financial control and reporting on humanitarian operations, evaluation and measuring results and effectiveness, cost- and impact analysis of different response options, quality assurance, transparency, participative approaches to assistance, and communication (ECHO, 2008).

With regard to *the feasibility of the technological innovation in humanitarian assistance*, the cost effectiveness, skill needs and infrastructure are considered. This is also sometimes referred to as uptake or sustainability of the technological innovation (Obrecht, Warner, and Dillon, 2017). A challenge to be considered here is the absorptive capacity of both humanitarian organisations as well as, given the importance of local ownership, the countries and communities affected by humanitarian crisis.

4.8. Key conclusions

- Technological innovation is embraced as way forward to better address the needs of those affected by humanitarian disasters and to address the challenges in humanitarian assistance as also formulated in the 'Agenda for Humanity'.
- This has led to increased engagement with private sector partners, shifting the dynamics at times from donor and recipient to joint developments in collaborative partnerships.
- There are various global initiatives to facilitate (technological) innovation in humanitarian assistance such as GAHI and HIF, as well as local initiatives such as Grand Challenges Canada. Additionally, humanitarian organisations engage in innovation activities with the development of in-house capabilities, such as '510' within the ICRC, large scale projects with multi-nationals such as MasterCard, as well as innovation labs and hackathons with start-ups.
- The increase in activity has led to a debate on ethics and technical standards, responsible innovation and 'information as a right'.
- Frugal innovation and innovation in and with local communities are considered vital to foster local ownership and engagement.

5. Adoption of technological innovations in humanitarian assistance

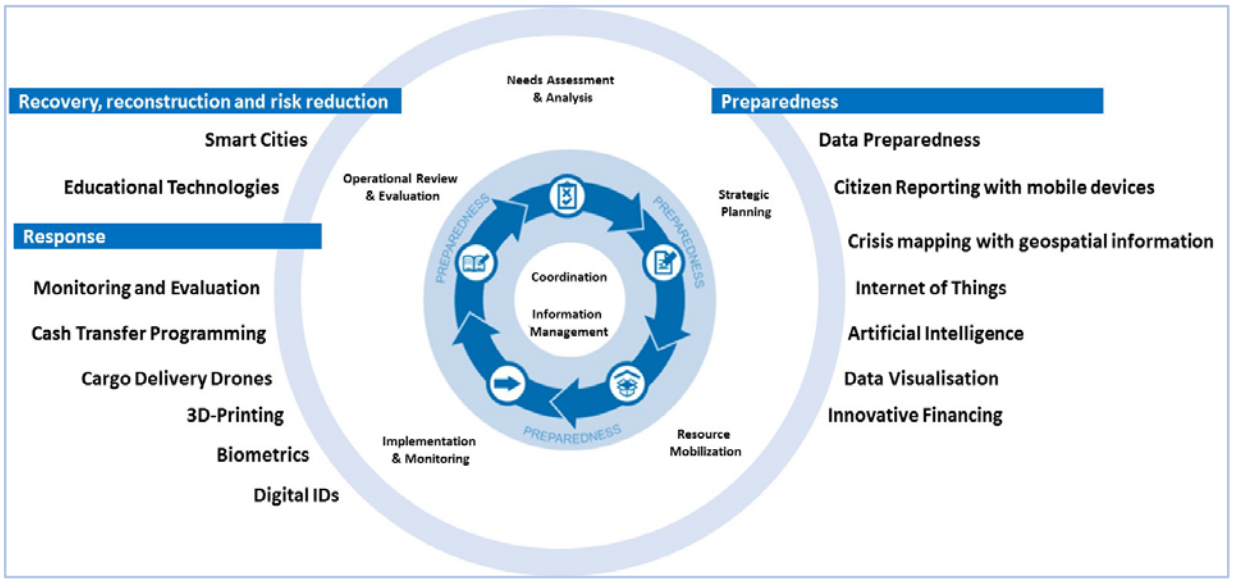
In this chapter, the technologies identified are plotted in relation to the HPC. Given the transformative nature of technological innovations, the technologies often apply to multiple stages of the HPC. To provide a structured overview the authors have categorised the technological innovations under three main stages. The categorisation is inspired by the UN cluster approach and mirrors in large part the process of disaster risk management:

- **Preparedness**, including activities such as needs assessment and analysis, strategic planning and mobilization;
- **Response**, including activities such as humanitarian service delivery, programme implementation and monitoring; and
- **Recovery, reconstruction and disaster risk reduction**, including activities facilitating increased resilience and opportunities for those affected by crisis.

5.1. Technological innovations

Based on the literature review and expert interviews certain technological innovations in humanitarian assistance have been identified as the most interesting/relevant for this study (Figure 13).

Figure 13 – Overview of technologies and applications covered by the study



Source: adapted by the authors for the purpose of this study from Humanitarian response (2018)

5.2. Preparedness

The Agenda for Humanity sets the objective to invest in preparedness, risk reduction and local stability. Technological innovations can provide opportunities to facilitate the shift from response, as the core humanitarian activity, to preparedness. According to a Boston Consulting Group (BCG) study (2018) increased investment in early preparedness could reduce the costs of humanitarian response by more than 50 per cent and save more lives by facilitating swifter response. However, due to disincentives such as invisibility of preparedness activities (Van Aalst, Kellett, Pichon and Mitchell,

2013), spending on preparedness and resilience remains relatively limited. The UN urged governments to spend at least 1 per cent of development aid on preparedness by 2020, which is currently just a half per cent (Moloney, 2017).

Innovators often state that technology is 'neutral'. Although opinions may differ on this, it is vital to realise that to achieve a positive impact with all types of technological innovations in all the stages of the HPC, political will, institutional and individual capacity need to be in place. For example, technology can enable forecasting, prediction and early warning. However, international and local response capacity needs to be in place to take adequate risk reducing measures in a timely manner.

In this section technological innovations that are applied in the preparedness phase are elaborated. The HPC includes the following activities: needs assessment and analysis, strategic response planning, resource mobilisation, implementation and monitoring, and operational review and evaluation. In the preparedness phase, we focus on the first three stages. Humanitarian relief aid is provided to those affected by disaster within 72 hours after the disaster and is based on a rapid assessment of need and identification of people (also referred to as 'beneficiaries'). It is deemed vital to assess the specific needs of local communities, support local markets and prevent provision of unnecessary goods (Humanitarian Coalition, 2018a). According to various humanitarian organisations, good quality data on crisis-affected or vulnerable people and the resources available to these people would facilitate identification of people in need thorough evidence-based needs assessments (Development Initiatives, 2017, p. 12). To strategically plan relief aid, data collection is therefore vital.

5.2.1. Data preparedness

Data preparedness refers to the ability and capacity of humanitarian organisations to be ready to responsibly and effectively deploy and manage data collection and analysis tools, techniques and strategies in a specific operational context before a disaster strike. Because the availability of high quality data is deemed vital in the humanitarian response phase to base informed decisions upon in the critical first hours after a response, humanitarian actors should make sure the elements to effectively gather, manage and analyse data are in place before a crisis. Raymond and Al Achkar (2016) state that frequently there is a disconnection between data, decision-making and response. If there is no readiness to employ the right data collection and analysis tools in the initial response phase after a crisis, the needed evidence for informed decision-making and response will not be available rapidly enough to matter. A lack of readiness can also cause 'big data disasters' (Raymond and Al Achkar, 2016). The adoption of (data-based) technologies into the humanitarian system requires humanitarian organisations to diminish potential risks associated with date collection and usage.

Harvard Humanitarian Initiative's paper on data preparedness is the first issue in the Signal Program's ongoing Standards and Ethics white paper series (Raymond and Al Achkar, 2017). This paper seeks to provide a blueprint for how the concept of data preparedness may be put into practice by members of the humanitarian data ecosystem along 5 stages:

- Standard setting (rules and norms that govern data usage) and risk analysis,
- Requirement planning (what data is needed and how will it be collected and processed) and stress testing (obstacles to executing the data preparedness plan),
- Coordination and consultation (sharing the plan with key stakeholders),
- Capacity-building and training (at the community level on how to use disaster-related data),
- Evaluation and improvement.

If there is a lack of data preparedness, apart from the lack of data, the consequences could be data disparity (incomplete, insufficient or inaccurate data), data deluge (large amount of data affects the ability to make sense of information), data distortion (improper and inaccurate analysis) or data damage (irresponsible data usage can cause harm) (Raymond and Al Achkar, 2016).

Data is a vital component of humanitarian assistance. Data can be used in many ways: gathering real-time information about the needs of people, connecting with communities, or to create situational awareness through e.g. mapping (AIDF, 2016). For example, the WFP used mobile Vulnerability Analysis and Mapping (mVAM) to get an insight in the food situation in the besieged city of Haditha. The data collected showed extremely high food prices and shortages in the city. WFP was able to use this data to reach and enter the city and provide enough food to feed 15,000 people for a month (Morrow, Mock, Bauer and Browning, 2016). In the following paragraphs, data-based technologies to assess needs, plan strategically and mobilise resources will be discussed.

5.2.1. Citizen reporting with mobile devices

Functionality

New communication technologies and mobile device ownership enable local communities to report on their situation and needs. Affected people are increasingly involved in reporting and thereby contributing to situational awareness during a humanitarian crisis. Citizen reporting can occur through crowdsourcing or mobile data collection.

Crowdsourcing refers to many people actively reporting on a situation around them, often using mobile phone technology and an open source software platform. Crowdsourcing can consist of information that people deliberately send to for example a devoted Short Message Service (SMS) line. For example, the Red Cross makes use of a software program to send out a text-message to groups of registered donors, such as contacting different groups according to the blood type they need. In one day the Red Cross sent alerts to 2000 Type O donors, asking them to donate blood at the nearest clinic. In two hours more than 500 donors came to hospitals to donate. Contacting these donors via traditional methods like calling would have taken them about a week (Korenblum, 2012). Another example is the Shahada Haiti project where crowdsourcing was used for needs assessments. A dedicated SMS-line was opened for people affected by the earthquake in Haiti in 2010. Volunteers translated the text received and the information was gathered and mapped at an online platform. This information was used by USA marines to deliver aid to people in need (Ushahidi, 2010).

Mobile data collection involves citizens reporting on certain themes in a more structural manner, through designed surveys which collect specific information from a target audience (UNDP, 2013). For example, in a nutrition survey in Kenya mobile phones were used instead of face-to-face interviews. This saved the humanitarian workers hours in travel, interviewing and processing of these interviews while the quality of data did not decrease. There was no significant difference found between the data collected this way and the data collected by mobile phones (Card, 2017). In Ghana humanitarian workers used to carry out (health) surveys in face-to-face interviews which are extremely time, cost and human capital intensive. They started using Interactive Voice Response (IVR), a combination of pre-recorded messages with touch-tone technology that allows a direct participant response and collects meta data like the date, time, duration of calls and linguistic preferences. In 13 days, 827 respondents completed the survey via an automated phone call and the cost per survey came to USD 5 per respondent. Although IVR has challenges (e.g. it lacks the soft touch and complexity of an actual human) the saved costs and time were remarkable (Vogel, Goertz, Suhuyini, Boots, Dorval and Wang, 2016).

Another source for the information can be social media, for example tweets using a specific hashtag. Information that is gained through these technologies can offer insights for needs assessment and response planning as well as serve as feedback to improve aid programming. When a crisis occurs, social media often provide information that helps with the identification of the people in the disaster area. On the one hand, existing data is used to gain insights, and on the other hand people affected by crisis actively report on their situation and needs in real time. For example, Facebook introduced the Safety Check in 2014, a feature that enabled users to alert people about their safety when their area is affected by a disaster (Flury, 2017). Furthermore, when in in January 2015 heavy floods displaced and affected over 230.000 people in Malawi the ICRC had to provide assistance in a challenging context because large parts of the country were unmapped, and it was therefore often unclear where affected people were located. The project 'Missing Maps' sought to overcome this informational disadvantage. The IFRC collaborated with Facebook who provided them with population density data and many volunteers to map and find people who were critically vulnerable but were not recorded in existing maps (Verhulst, 2017).

Effects

Social media is present in daily lives of many people. An increasing percentage of the world population owns a mobile device. Therefore, it can be a powerful tool to reach people. Social media accelerates the speed and breadth of communication (Chan, 2018). Citizen reporting can gather massive, location specific data in real-time with lower running costs than more traditional, oftentimes paper-based methods. It can boost citizen engagement by establishing bottom-up channels of communication. Crowdsourced data tends to be more difficult to manipulate and less vulnerable to biased interpretation, thereby potentially increasing independence and credibility. Furthermore, platforms and surveys can be customised to include for example voice recordings, photographs and automatic geo-tags. These forms of citizen reporting can at times be done anonymously and therefore also be more open for sensitive data, for example about corruption (UNDP, 2013).

The elaborated technologies that enable citizens reporting are dependent on those same citizens who create situational awareness through reporting. Thus, these technologies require incentives for citizens to continuously participate, which can be a challenge. Furthermore, there is a potential bias towards educated and well-off citizens who are used to let their voice be heard (UNDP, 2013). Also, these technologies require specific capacities and capabilities. In the case of crowdsourcing and surveys a tailored platform is needed to obtain the data and the technical expertise is needed to design the surveys.

Social media oftentimes do not aim to be objective and can sketch a misleading image. This can be a source of intentional or unintentional misinformation (Carr, 2013). For example, after the attack in Manchester some people decided not to reply on Facebook's Safety Check because they did not want to contribute in overexposing an 'unlikely' type of threat (Flury, 2017). Furthermore, social media can be the catalyst for unrest and conflict (Chan, 2018). Another issue with the use of bottom-up information is the concern about privacy and data protection. If this is not taken care off, citizens safety and privacy can be at stake. Lastly, social media may not reach everyone when it matters the most. Vulnerable people might not have access to it or connectivity issues after a disaster may cause problems.

Feasibility

The use of social media by citizens, public authorities, and humanitarian organisations generates a large amount of data. Gathered data can be analysed for different purpose, during different stages of the disaster response cycle. Analysis tools – for example in combination with AI - can be used to quickly analyse data at different social media platforms (Anson, Watson, Wadhwa, and Metz, 2017). There is a large amount of readily available tools and platforms for data collected through mobile surveys and crowdsourcing (UNDP, 2013). All in all, the use of bottom-up data can help the humanitarian response phase through indicating what is happening, who is affected and what aid might be needed. For example, crowdsourcing via SMS and Twitter already aided the 2010 Haiti cholera response, but it was realised afterwards that the cholera outbreaks could have been detected two weeks earlier than they actually were. Investing in smarter systems for analysing big data sets can save much time, money and lives (Belliveau, 2016). Also, when Ebola spread, the WFP used mVAM to set up an SMS survey in a couple of weeks, so data could be collected and analysed despite of the quarantines and restrictions on the movement of humanitarian staff. With the surveys costing USD 5-6 per questionnaire, the data collection costs were reduced with 50 per cent in comparison to face-to-face interviews (Morrow, Mock, Bauer and Browning, 2016).

However, there are costs associated with developing the right analysis tools and designing surveys. Furthermore, social media contains personal data and handling that type of data comes with restrictions. Hence, not all data might be accessible or truthful. In addition, where services are available, alert messages and information communicated should be understandable and take into consideration the various linguistic and cultural diversities because when a disaster strikes there is no time to translate the alert in different languages.

5.2.2. Crisis mapping with geospatial information

Functionality

Crisis mapping is the real-time gathering, display and analysis of data during a crisis (World Bank, 2017). Crisis mapping allows large number of people and actors to contribute information. This can be done on the site of a disaster or remotely. Interlinked with mapping is Geographic Information System (GIS). It is a computer system for gathering, managing, analysing and displaying many types of data, including geospatial information. Geospatial information refers to data on a place or a set of geographic coordinates. GIS visualises layers of information into maps and three dimensional (3D) models and can therefore reveal deeper insights into data, such as patterns, relationships, and situations—helping users make smarter decisions (ESRI, 2018). GIS has been used for three decades in the humanitarian sector. For example, in Angola GIS has helped tremendously in rebuilding the electricity network. With the help of GIS 20-year-old maps could be updated and many insights on new developments and underutilised power sources were found. This provided all the information for the forecasting and long-term planning and created access to electricity for more than 30,000 households in Angola (Rabley, 2010). GIS can also assist in activating a quick response after a disaster struck, in detecting early outbreaks of an infectious disease and it can be used for planning (Potyraj, 2016).

Additionally, images required via UAV such as drones and satellite can be input for GIS and mapping (Folger, 2009). An example is the damage assessments that were done with drones in Vanuatu after cyclone Pam struck in 2015. This was the first operational project as part of the World Bank's UAVs for Resilience Programme. Over 100 drone flights were carried out to quickly assess the disaster damage. Although the use of drones instead of persons on the ground reduced time and effort to collect the data, it took significantly more time (25 days) to carry out the manual analysis of the data collected in

order to make sense of the imagery. Therefore, new methods are needed to automatically analyse aerial imagery or disaster areas (Soesilo, Meier, Lessard-Fontaine, Du Plesses and Stuhlberger, 2016, p. 24). Despite challenges, drones assessed areas with damaged houses more quickly than any other available method (Meier and Soesilo, 2015). The gathered information could be mapped to offer a clear overview of the situation on the ground. 'Mapping' is currently the most common and most popular drone application. It is used to produce accurate two and three dimensional maps, as well as elevation models of terrain. In the humanitarian sector, this set of technological applications enables aid teams to coordinate their response by creating situational awareness or gain insights in needs of affected people. Mapping technologies are used e.g. for connecting data sources, for terrain analysis to predict distribution times, and to share crisis related information. An example is the work of Humanitarian OpenStreetMap Team (HOT), which strives to make mapped information even more widely accessible. HOT provides and creates free, regularly updated maps for humanitarian aid workers to coordinate their response. Another example of mapping, interlinked with citizen reporting, is the Ushahidi project in Haiti, where volunteers and diaspora all over the world translated and mapped text messages of affected people on an online open platform. This information was used by aid workers for needs assessment and delivering aid timely and in the right places (Ushahidi, 2010).

For crisis mapping in Europe there are two flagship programmes, developed by the European Commission, which are currently reaching their full operational capacity: Copernicus for earth observation and Galileo for satellite navigation (European Parliament, 2017). Copernicus, previously known as GMES (Global Monitoring for Environment and Security), is the EU's Earth Observation Programme which makes it possible to use vast amounts of global data from satellites and from ground-based, airborne and seaborne measurement systems to provide information to help service providers, public authorities and other international organisations. Its data is free and open for all kind of users (Copernicus, n.d.). One of its six services is the Copernicus Emergency Management Service (Copernicus EMS), providing all actors involved in the management of natural disasters, man-made emergency situations and humanitarian crises with accurate geo-spatial information derived from satellite remote sensing and completed by data available in situ or open data sources. Copernicus EMS consists of two components: a mapping and an early warning component. The mapping component, operational since April 2012, has a worldwide coverage and provides maps based on satellite imagery. The products generated by the service can be used as supplied (e.g. as digital or printed maps). They may also be combined with other data sources to support geospatial analysis and decision-making processes of emergency managers. Consequently, the mapping component can support all phases of emergency management: preparedness, prevention, disaster risk reduction, emergency response and recovery. The early warning component of Copernicus EMS consists of three systems: the European Flood Awareness System (EFAS), which provides overviews of ongoing and forecasted floods in Europe up to 10 days in advance; the European Forest Fire Information System (EFFIS), which provides near real-time and historical information on forest fires and forest fire regimes in the European, Middle Eastern and North African regions; and the European Drought Observatory (EDO), which provides drought-relevant information and early-warnings for Europe (Copernicus, 2018).

Galileo is the EU's Global Satellite Navigation System (GNSS), providing accurate positioning and timing information. Galileo is under civilian control, contrary to the existing US Global Position System (GPS) and its Russian counterpart GLONASS. Operational since December 2016, Galileo offers three initial services: an open, free service for positioning, navigation and timing; a public regulated service, for government-authorised users to provide service continuity during emergency or crisis situations; and a Search and Rescue (SAR) service, involving operations for locating and helping people in

distress. Galileo's SAR service is Europe's contribution to the international distress beacon locating organisation COSPAS-SARSAT, which is an international satellite-based SAR distress alert detection and information distribution system. COSPAS-SARSAT is used to detect and locate emergency beacons activated by aircraft, ships and individuals, providing accurate, reliable and timely alert and location data to help operators find people in need (COSPAS-SARSAT, 2018).

When combined, the Copernicus and Galileo programmes can be of even more value for emergency and crisis management (GSA, 2017). Since Galileo determines a precise position anytime and anywhere on the globe while Copernicus provides information on the Earth's surface, its atmosphere and marine systems, the joint use of both systems results in multiple benefits for its users (GSA, 2016).

Effects

The great advantage of these technologies is that by using ICT and using open data platforms people on the other side of the world can contribute information their time and skills (World Bank, 2017). For example, in July 2018 Copernicus published 22 downloadable maps due to a significant number of displaced people leaving the conflict and drought affected areas in western Afghanistan and moving towards the main regional city Herat. The maps that were published provided information for operational analysis in the field, aiming to provide basic needs for the people in Herat and those left in villages affected by the drought (Copernicus, 2018). Advantages of using drones to gather data for mapping is that they can operate in cloudy, dense and urban settings. Moreover, they can produce more precise and smaller scale images of places and terrain than e.g. a helicopter or a satellite. However, a major concern with mapping is the use of sensitive data. In the example of the Ushahidi project in Haiti, people shared their personal data with information on their location and situation. This sensitive data was held on an open platform. This caused debate about the potential trade-offs between timely response and privacy considerations. People who had sent messages had not formally given consent to use the data in this manner. However, it was argued that using the data meant that affected people could be helped in an efficient and sometimes life-saving manner (Ushihadi, 2010).

Feasibility

Crowdsourcing platforms seem to be inevitable in the humanitarian sector. Even though this application is also the source of the debate on privacy and consent, it is stated that its use has improved operations in multiple disasters because of increased situational awareness. Furthermore, the usage of drones is maturing. The challenges shift from simply flying drones to process, analyse, and store the data. Right now, humanitarian organisations rely on external service providers for drone usage. Moreover, drones are not included in standard kits that humanitarians bring with them if they are responding to a disaster. This results in drones frequently being too late in the response phase (FSD, 2016). Purchasing a drone and its maintenance comes to about EUR 23.000 excluding costs of repairs (Soesilo, Meier, Lessard-Fontaine, Du Plesses and Stuhlberger, 2016). However, one satellite image of a specific area at a certain date with good resolution can cost up to EUR 4.500. A single 20-minute drone flight can capture up to 800 very high resolution images, ;aking mapping more effective and precise than a satellite image for less costs in the long run. The challenge here is the analysis of these images by skilled users (Soesilo, Meier, Lessard-Fontaine, Du Plesses and Stuhlberger, 2016).

5.2.3. Internet of things

Functionality

Internet of things (IoT) refers to the system of connected devices that enables smart technology that learns and adapts in response to data collected. Devices are not limited to phones and computers but can be all sorts of 'things' like thermostats, cars and health trackers. Sensors in these devices transmit

gathered data about e.g. temperature, location, and light to a computer that analyses the data. Through software this data is presented in a user-friendly way in the form of for example a digital dash board (Espinoza, 2017). The more advanced devices can also affect or adjust data (Quek, 2017).

Within the humanitarian sector, IoT is believed to increase efficiency in several ways. The technology has already been tested in the field in the form of sensors on bridges in flood-prone areas and smart thermometers for medicine transportation (Espinoza, 2014). On the one hand this technology is a preventative tool that can alarm people when risk is occurring. It can be used to signal disasters at an early stage through the connection between remote sensors and software that results in a dashboard with information about disaster parameters. On the other hand, it can be used to track and monitor measurements. An example of the latter is a sensor that tracks how often a hand wash tool is used to measure the success of a sanitation solution. IoT is therefore a central theme in the narrative of 'smart infrastructure' or 'smart cities'.
For example, in Rwanda SweetSense is placing Wifi or cellular connected sensors on water pumps. These sensors register data about water supply, demand, hourly flow rates, usage, performance, seasonality and peak periods. The sensors may add 10 per cent costs to the handpump (USD 100 for the sensors and USD 6 – USD 10 a month for data transmitting) but the sensors are able to increase the uptime by 80-90 per cent, reducing the cost per unit (10,000 litres) of water. In Kenya a similar project has increased the functioning of hand pumps by 31 per cent (from 67 per cent to 98 per cent), ensuring a much more stable flow of water in villages (Biggs, Garrity, LaSalle and Polomska, 2016). Furthermore, in most developing countries people use wood and charcoal to cook and heat their homes. The indoor air pollution caused by this contributes to approximately 4 million deaths each year. The 'Global Alliance for Clean Cookstoves' initiative aims to enable 100 million homes to start cooking with clean and efficient cooking solutions. IoT sensors play a role in this initiative by measuring the black carbon emitted by stoves and monitoring and enabling projects that disseminate improved cookstoves (Biggs, Garrity, LaSalle and Polomska, 2016).

The technology can be utilised in a variety of domains, including camp management as well as health care. For example, STAMP2 is a sensor collecting patient data such as electrocardiogram (ECG), heart rate, oxygen saturation, temperature and respiratory rates. This data can be sent from the sensor to a central server for monitoring and analysis. With this data abnormal changes in behaviour or health can be tracked and alert doctors. The sensor can be used in areas with outbreaks like Ebola as a 'Smart Band-Aid'. The fully equipped sensor-enabled band aid costs around USD 100 with a battery life of 10 days. The STAMP2 sensor can be used to improve the response time in critical areas, to detect viruses earlier and monitor them more safely and efficiently (Biggs, Garrity, LaSalle and Polomska, 2016).

Also, to illustrate the potential of IoT, Johnson (2018) developed a concept IoT application that could improve transparency in the work of the British Red Cross (BRC). If BRC workers were provided with a very simple IoT button that provides a positioning point, to be pressed every time they helped someone, this information could be put on an interactive map. This way one could easily see for example on a 24-hour basis where help is provided. This application could also be used while providing humanitarian assistance and can give an informative overview of where distributions take place. Even though a simple IoT button might not provide detailed information on the way in which assistance is provided, it gives an overview of where humanitarians are working, something that is usually a struggle in the first days of a response (Johnson, 2018).

Effects

The kind of information gained from IoT is often positioned as limitless. The potential effects therefore rely heavily on its applications. In the example of Johnson (2018) one might only gain insight on the amount of times a button is pressed, in other systems data of different types of sensors can provide enough information to forecast a disaster. Furthermore, IoT can be an efficient, time and money saving tool, especially if different devices communicate with each other. An optimum utilisation of energy and resources can be achieved by applying this technology. When possible bottlenecks, breakdowns and damages to the system occur, there will be an alarm (Quek, 2017).

Nevertheless, there are disadvantages and challenges with this technology. The complexity of IoT makes it vulnerable. For example, if a IoT surveillance system for important medication in a remote area breaks down, this could result in a major loss. Furthermore, in the humanitarian reality basic challenges such as the lack of connectivity or power would hamper successful application of this technology.

Feasibility

IoT can be considered an emerging technology with limitless applications. However, although there are ideas and concepts about how it can be used in humanitarian assistance (e.g. the above mentioned concept Johnson (2018)), many of the applications still need to be piloted or brought up to scale. IoT is based on the interlinkage of available infrastructure, hardware and software. In the humanitarian sector, most known use cases are not too complex, due to challenges of lacking infrastructure or costly procurement processes of hardware. However, IoT could for example improve efficiency of operations using data, it could empower camp residents to contribute to more people-centred services and it could monitor the delivery of services. In the Za'atari refugee camp in Jordan for example, UNICEF Jordan (2017) designed an IoT solution that was supposed to track real-time information on the fill rate of a waste water tank. With software, trucks would then be guided via the most efficient way to empty different tanks. However, the lack of internet connectivity in the refugee camp made it impossible to let refugees share real time data via their mobile devices. Another idea was to install sensors on the tanks, but this was ruled out because of the high costs of procurement and maintenance (UNICEF Jordan, 2017). The solution they came up with was more a data analysis tool than an IoT solution: every time a truck empties a water tank, the driver measures the fill rate using a laser meter, the information is logged on a tablet, the software analyses the data and predicts when the tank will be full to better plan the process of emptying them. Every time data on a measurement is entered into the system, the prediction will get more accurate. All in all, there is a great potential for IoT, but obstacles such as lack of connectivity or high costs hamper implementation of the technology in the humanitarian sector.

5.2.4. Artificial intelligence

Functionality

Artificial intelligence (AI) is the theory and development of computer systems that can perform tasks that would usually require human intelligence, such as visual perception, speech recognition, decision-making and language translation. AI machines can learn from experience and adjust to new inputs. In many cases, AI is used in relation to big data. Big data refers to extremely large and complex data sets that may be analysed computationally to reveal patterns and trends in order to gain situational insights. An increasing amount of data is collected and shared by affected people and humanitarian actors. Collecting, processing, analysing and disseminating this data is hugely challenging in crisis settings, due to insecurity, unpredictability, remote access, fragile public services, and, in many cases, poor telecommunications and limited connectivity (O'Brien, 2017).

Revenue generated from direct and indirect application of AI is believed to grow from USD 1.4 billion in 2016 to nearly USD 60 billion by 2025. The International Data Corporation estimated that the use of cognitive systems and AI across multiple industries can drive worldwide revenues to more than USD 47 billion in 2020 (Akhtar, Mikic, Wong, Wang and Ngernlim, 2017). In May 2018, the 'AI for Good Global Summit' took place to demonstrate the potential of AI to advance sustainable development and humanitarian practices (UN Global Pulse, 2018).

In the humanitarian sector, AI is believed to be able to contribute at different levels and stages of aid activities and the technology can be applied to a variety of activities. For example, an UNESCO study (2015) showed that to be able to teach every child in the world an additional 27.3 million primary school teachers need to be recruited. Especially in developing countries trained teachers are scarce. At the moment there are only a few applications of AI in the educational field while it shows the potential to provide customised teaching and automated assessment of essays, making sure teachers have the time to focus on the children (Akhtar, Mikic, Wong, Wang and Ngernlim, 2017). Also, in developing countries there is often a shortage in medically trained workers. AI can provide solutions for this problem: recently AI applications have been developed that can substitute and/or complement highly educated and expensive experts by analysing medical data and images. An experiment that tested these AI applications against 21 trained oncologists showed that the applications performed just as well as the doctors in detecting cancerous cells (Akhtar, Mikic, Wong, Wang and Ngernlim, 2017).

Furthermore, AI has great potential in increasing the agricultural efficiency in developing countries. The livelihoods of some 2.5 billion people on the planet depend on agriculture. In the period between 2005 and 2015 USD 9.5 billion in the agriculture sector was wasted because of crop diseases and infestations (Markova, Baas, Conforti and Ahmed, 2017). Recent developments in image recognition allowed researchers to scan over 50.000 photos of plants to help farmers identify crop diseases in an early stage using their smartphone. In an experiment the smartphone was able to identify 99 per cent of the infected crops and the farmers were able to intervene (Akhtar, Mikic, Wong, Wang and Ngernlim, 2017).

After disasters, access to reliable real-time information is crucial for first responders. They need to understand the extent of damage and its impact on lives. WFP is exploring the potential of AI to help in this critical phase of the response by harnessing AI to analyse data to assess de impact of a disaster. The analysis can inform their response and deliverance of live-saving assistance. An example is mapping where AI could help detect and extract features such as buildings and roads from satellite imagery (World Bank, 2017). Other applications of AI that WFP is looking into are AI-powered vehicles and UAVs that could help deliver assistance to hard-to-reach or dangerous areas (Opp, 2017) and AI-based survey chatbots that can operate in different languages and communicate with people affected by crisis. All in all, applications of AI seem endless, from improving the use of big data to coordinating response in the critical phase just after a disaster strucks.

Effects

Organisations can boost productivity by automating processes, optimising rational decision making with help of AI and simplifying complex tasks with AI support (Capgemini Consulting, 2017a). AI can contribute to the humanitarian sector by analysing big data sets, draw insights and make decisions. Humanitarian processes could be made more efficient and decision making could be more evidence-based. AI is said to be able to take over work that traditionally required human intelligence and

therefore, some say it could cause job losses. On the other hand, some say new employment opportunities will occur in the form of AI solution developers (Capgemini Consulting, 2017a). There is a focus on positive potential of AI, but Kaspersen (2017) argues that there should be more emphasis on the attached risks. There are some challenges and concerns associated with AI. Firstly, it remains unclear and non transparent how AI machines reach their outcomes (Kaspersen, 2017). Secondly, AI is dependent on availability of large, real-time high-quality data sets to fuel the engine of AI machines. With that, data management needs to get attention as well. Thirdly, new tasks or substantial changes of tasks may require an entirely new AI solution. Fourthly, the current humanitarian work force is not yet sufficiently equipped to work with AI solutions. Fifthly, a concern is the neutrality of AI developers. In principle, computers are as biased as their developers. As neutrality is one of the humanitarian principles, this could be a tension that needs to be addressed when harnessing AI. Lastly, AI makes autonomous decisions. This raises the question of accountability for unforeseen and undesired decisions.

In that line of reasoning it was concluded at the 'AI for Good Conference' that 'AI should augment human analysis, not replace it'. Although AI can be used to for example identify objects in a fraction of the time human analysis would require, it 'may fail to both detect certain nuances and to interpret results based on context and changing circumstances, which is critical to supporting operations on the ground' (UN Global Pulse, 2018). In addition, it was concluded that 'AI can help bridge the digital divide and create an inclusive society' depending on the questions asked and data provided. For example, space images of roofing materials can be an indicator for poverty and postal records can help estimate trade flows. Overall, the consensus was that that 'responsible use' of AI will determine its impact (UN Global Pulse, 2018).

With regards to the concerns, Dan McQuillan urges humanitarians to prevent 'neo-colonial tendencies' with AI, stating 'By claiming neutrality and universality, algorithms assert the superiority of abstract knowledge generated elsewhere. By embedding the logic of the powerful to determine what happens to people at the periphery, humanitarian AI becomes a neo-colonial mechanism that acts in lieu of direct control' (2018).

Feasibility

Chatbots – just one of many applications that could build upon AI - allow communicatin with more people, at a fraction of the cost, in almost real time and thus better target assistance to those most in need (Opp, 2017). Although AI can cut costs of human workforce, human AI solution developers are still needed. AI has the potential to take humanitarian response to the 21st century and it can transform the lives of millions of people. However, there has been limited attention to applying it with a focus on humanitarian and developmental challenges (Opp, 2017), and thus there is still room to explore the potential of AI in humanitarian assistance.

When it comes to the use of big data, the challenge of interoperability needs to be overcome. Many organisations in the humanitarian field gather data. To successfully harness data to help people in need, the right infrastructure should be in place to share fragmentally collected data within a secured network. This will contribute to creating a complete picture of a crisis and the humanitarian efforts (O'Brien, 2017).

5.2.5. Data visualisation

Functionality

Data can support situational awareness and decision-making processes. However, visual insights at times reach people in a more effective manner. There are different ways to visualise data, e.g. through photos, videos, infographics or even Virtual Reality (VR). In this section, we will elaborate on those technologies.

VR, a form of Extended Reality (XR), is the term used to describe a three-dimensional, computer generated environment which can be explored and interacted with by a person (VRS, 2018). Immersion in virtual reality through wearing VR glasses gives you the sense of being physically present in a non-physical world. In the humanitarian sector, data visualisation can be used for resource mobilisation as well as a sort of monitoring and evaluation tool. An example of the first application is the use of Virtual Reality to inform donors of aid programmes.

At a 2015 UNICEF fundraising conference, attendees watched Clouds Over Sidra, a VR film that follows 12-year-old Sidra, a Syrian refugee living in the Za'atari camp in Jordan. The event raised USD 3.8 billion, over 70 per cent more than projected, and one in six people donated after watching the film – twice the normal rate (Hartley, 2017). VR videos that allow viewers to take an immersive 360-degree tour of refugee camps and informal settlements are being harnessed as 'the ultimate empathy machines' to persuade policymakers, donors and citizens to pledge more humanitarian relief (Anderson, 2015). Ryot, a start-upm uses VR technology to let people not only read about humanitarian crises, but actively transport them there in order to encourage them to donate to NGOs working on the ground or to sign petitions (Streep, 2016). Other aid organisations use VR to offer donors a better understanding of how their money is spent on the ground (Overly, 2016).

Another example of data visualisation for monitoring and evaluation is Participatory Video (PV). It is a form of media in which a group or a community creates their own film in order to explore different issues, voice concerns and tell stories (Muñiz, 2017). For example, the Dutch Embassy in Uganda produced such videos with EyeOpenerWorks about agriculture projects they funded. Beneficiaries of agricultural projects were trained to produce a make a video about how the projects impacted their lives. After collecting and editing all the footage, a collective session was held to check if the produced video clips indeed showed a realistic and complete image of the actual impact of the agricultural projects (EyeOpenerWorks, 2018).

Effects

A Nielsen research found that nearly half of the people who viewed the VR content were likely to donate afterwards (48 per cent), compared with just over one-third for more traditional means of encouraging donations (38 per cent). The most affected metric was recommendation intent, as over half (51 per cent) increased their likelihood to recommend the featured charity after viewing it in VR, compared with only 42 per cent for midroll. In the same experiment each participant was also provided USD 20 in artificial currency that they could choose to donate to a pre-set mix of charities. VR content motivated larger donations than traditional advertising for 10 of the 12 experiences, with VR driving as much as three times the dollar value driven by traditional advertising (Nielsen, 2017).

Finding clear insights from Monitoring and Evaluation (M&E) activities can be a challenge for humanitarians. PV has proven itself as a tool to overcome this. PV can facilitate a cost-effective, multi-stakeholder dialogue that provides insights for improvement of aid programmes for a community perspective (Bovenmars, 2017). Although PV can be an insightful tool, it has more focus on qualitative

rather than quantitative data – the kind of data that donors often seek. What's more, PV requires the training of community members which can be time consuming and is also dependent on capability and capacity of community members. It is stated that VR has the potential to combat detachment of donors who feel disconnected from the results of their money and that it can create an 'empathic connection and presence' to those people affected by crisis more effectively than photos or videos can (Overly, 2016).

However, virtual reality is not without its barriers and limitations. When attitudes towards Syrian refugees in Europe became sour, an Amnesty International project in Syria let activists capture images of the situation in Aleppo. Those images were used to create a VR solution that could place viewers on the bombed-out streets of the city while a civilian activist explains the dangers faced by those who stay in Aleppo. Strikingly, the activists were put at real risks when capturing the necessary images. Moreover, due to the dangers and unproductiveness of the situation, it took much longer to collect the footage (Overly, 2016). Although it can be helpful to show suffering of affected populations to donors to trigger them to donate more money, one could ask in what way the lives of affected people are directly improved by this technology. Moreover, one could assume that there is an interest behind the making of a VR video of one certain context and perhaps not for another one.

Feasibility
VR is already being used and implemented in the humanitarian sector as both a training and awareness tool. However, the potential of XR as a training or educational tool for those caught up in conflict and to assist humanitarian workers is still largely under-explored (ICRC, 2017). When it comes to the maturity of the technology, one could say that the hardware is already very well developed, but the speed of content development is lagging (Williams, 2016). While the technology matured and the cost of production has come down considerably, the technology required is still more sophisticated and expensive than that needed to shoot regular film or still photography. Production time also tends to be longer, meaning projects need more time and money to deliver (Overly, 2016).

5.2.6. Innovative financing

Functionality
The 'Grand Bargain' is the name for a package of reforms to humanitarian funding, launched at the WHS. Thirty representatives of donors and aid agencies produced 51 commitments to make emergency aid finance more efficient and effective. One of the pillars is innovative financing. This is a term used for financing approaches and models addressing development challenges that are not sufficiently addressed by traditional aid flows and which may try to leverage additional financing – often from the private sector – and/or attempt to provide financing more quickly and efficiently, with more reliability and greater impact. Innovative financing includes a range of models or approaches such as social enterprise, impact investment, transaction taxes and levies on goods and services (Future Humanitarian Financing, 2018).

An example is Forecast-based Financing (FbF). This is a system to fill gaps in the humanitarian system by using the science of weather and climate to anticipate possible impacts in risk-prone areas and mobilise resources automatically before an event. In Togo, this pioneering machine learning approach feeds into a FbF mechanism for scaffolding disaster preparedness planning with financial preparedness: pre-allocated funding necessary for rapid mobilisation of pre-defined early action is triggered to support 'just enough, just in time' preparedness, based on scientific forecasts. FbF was developed with the Togo government and Red Cross, with support from their German counterparts.

The Togo collaboration won the 'Edge of Government' innovation award at the World Government Summit (Ijjasz-Vasquex, Jongman and Suarez, 2017).

Effects

FbF can be a transformative tool that invests money in prediction and mitigating risks rather than response and recovery. For example, in Ethiopia WFP has been able to reduce their spending by 18-29 per cent by purchasing goods at the optimal time. They could do this because of multi-year funding, as they were able to flexibly allocate the resources at the most optimal time as they were earmarked for prevention for a longer time period (Cabot Venton and Sida, 2017). The Red Cross also did a case study in Bangladesh where regular floods have a major impact on the vulnerable population there. They found that an innovative cash-transfer program providing transfers based on a forecast of a flood rather than the event itself could have an impact of at least 3 times the value of the initial investment. So, every dollar invested based on forecast would save USD 3 in beneficiary losses, a potential saving of 30 per cent in losses for this vulnerable population (The Red Cross, 2016). Natural disasters cost Australia around USD 6.3 billion each year and this is expected to rise to USD 23 billion by 2050. A forecast-based investment of USD 250 million a year in prevention would reduce these costs by 50 per cent over that period, making forecast-based-financing a very profitable investment (Slatyer, 2016).

There are important hurdles in implementing FbF. Firstly, donors are not too excited about funding activities that are not within the response and recovery phase. Secondly, it can be a challenge to work with local governments: their willingness and capacity are key for success, however at times local governments do not have the necessary tools, such as computers, or the infrastructure is lacking.

Feasibility

If FbF is going to be scaled up, more local capacity and local funding is needed. What is more, to realise the potential of innovative financing a shift in earmarked funding towards preventative measures is needed.

5.2.7. Key Insights

The Figure 14 below highlights the main insights about the technologies described in section 5.2.

Figure 14 – Key insights on technological innovations in the preparedness phase

	Functionality	*Effects*	*Feasibility*
Data preparedness	• Improving preparedness can reduce cost of response. • Investing in data preparedness enables better prevention and response. • Data preparedness is interlinked with many other technological innovations.	• Concerns about 'do no harm'. Potential risks of data collection and usage need to be diminished such as privacy and cyber security. • HHI warns for data disparity, data deluge, data distortion, data damage.	• Disincentive to invest in preparedness such as invisibility of activity. • Political will is required. • International and local capacity needs to be in place.
Citizen reporting with mobile devices	• Enables demand driven and context specific needs assessments. • Digitisation of data collection enables cost reduction over traditional methods.	• Enables citizen engagement with bottom-up communication channels. • Concerns about inclusiveness (e.g. of people without access to devices or connectivity issues). • Concerns about data protection and privacy. • Social media can fuel disinformation.	• Citizens need to be incentivised to participate. • Digital infrastructure needs to be in place to collect and analyse the data. • Many tools and methods are readily available and need to be made context ready.
Crisis mapping with geospatial information (GIS)	• Crisis mapping enables shared operational awareness. • Maps enable context specific needs assessment and demand driven response.	• Drones may enable local ownership by increasing operational awareness. • Concerns about the protection of sensitive data. • Ongoing dialogue needed on privacy and consent.	• Long history of using GIS in humanitarian domain. • Increased local engagement requires technical infrastructure and skills.
Internet of things (IoT)	• IoT has the potential to increase operational efficiency and reduce costs. • IoT can be applied to various stages of	• Potential effects rely heavily on its application. • Concerns about data protection and cyber security.	• IoT is an emerging technology: only small scale pilots in place. • Insufficient digital infrastructure and

	humanitarian assistance.	• Effects are relatively unknown due to limited application in the domain.	costly procurement hamper scaling.
Artificial intelligence	• AI has the potential to increase productivity, optimise decision making and simplify complex tasks. • AI could be applied to different activities in humanitarian assistance. • AI is globally emerging as a transformative technology.	• Concerns about the humanitarian principles due to autonomous decision making. • Algorithms are not intrinsically ethical, responsible use dictates the effects of AI. • Concerns about AI as an 'unknown' technology. • Concerns about data protection and cyber security.	• Skilled workforce is limited. • Insufficient digital infrastructure and system interoperability needs to be overcome. • Room to further explore potential functionality in humanitarian domain.
Data visualisation	• Already used in humanitarian domain. • Good experiences with VR and PV in resource mobilisation. • XR has potential for training and education purposes.	• Enables empathic connection and presence thereby increasing understanding and donation.	• Many VR and PV tools available to adopt in humanitarian domain. • Technology is matured and costs are reducing, but still more costly than traditional methods.
Innovative financing	• High potential to reduce costs by shifting to prevention and preparedness, e.g. Forecast-based Financing (FbF). • Current models appear to best fit natural disaster situations.	• Initial research indicates significant cost reduction. • Enables local communities to take preventative measures and reduce impact of crisis.	• Promising pilot programs, not yet scaled. • Shift towards multi-year funding for prevention and preparedness necessary. • Political will necessary to shift financing and activities. • Local capacity, willingness and skills necessary to implement prevention and preparedness measures.

Source: created by the authors for the purpose of this study

The following categorisation within the three horizons of growth becomes apparent:

- Crisis mapping with GIS and data visualisation are 'known' technological innovations in humanitarian assistance and already being adopted.
- Citizen reporting and data preparedness as well as innovative financing could be considered 'partially known' with adoption in certain places and pilots running. The research suggests that these technologies will offer increased efficiency and cost reduction.
- IoT and AI can be considered relatively 'unknown solutions'. These technologies appear to be promising and offer potential solutions for the challenges the sector is facing. However, the exact application and effect will have to be explored further.

5.3. Response

Promptly after disaster struck, the response phase starts. The response phase is divided between immediate response, under 72 hours after a disaster, and the response in the first 12 weeks. Relief aid is the aid delivered to those affected by disaster within 72 hours after the disaster. During the response phase different activities will be executed: from initial search and rescue to identifying affected people and delivering aid. In this section we will focus on technologies that 1) register and identify affected people, and 2) enable providing and delivering assistance.

ICT innovations enable identification and registration of people who have been affected by a humanitarian crisis. During times of chaos or disaster, documents are often the last thing on affected people's minds, but the first problem they run into when they are seeking assistance. Moreover, globally 2.4 billion people do not have official identification documents (Peña-López, 2016). So, identification and registration of affected people in need of assistance is important. It is needed to distribute aid equally. Moreover, it can help in identifying who is affected and who is missing. Beneficiary data tracking platforms collect and store sensitive data about receivers of humanitarian assistance (Raymond, Scarnecchia, and Campo, 2017).

Registration of refugees or beneficiaries is crucial to monitoring of identification data, providing new identification documents, and keeping track of the number of refugees. It also helps protecting refugees from for example forced return, arbitrary arrest and detention. It is needed for them to gain access to aid and assistance and therefore it can decrease the amount of fraud in distribution of aid (Lodinova, 2016). Interlinked with identification and registration are the technologies of digital identification documents (ID) and biometrics (see 5.3.1 and 5.3.2).

After registering and identifying affected people, the assistance and deliverance of aid takes place. New technologies can transform the way that deliverance of aid to affected people is done. The deliverance of assistance in the shape of food and non-food materials can be done by drones. The production of aid goods can be reshaped by for example 3D printers. Moreover, instead of delivering actual goods, vouchers or payments can be done directly to beneficiaries, giving them more autonomy to choose what they need. Blockchain can make the distribution process more transparent.

5.3.1. Digital ID

Functionality

A digital ID for every person on the planet is what tech companies and humanitarian actors have been advocating for at the ID2020 Summit at the UN headquarters in New York in June 2017. This digital ID would be linked to fingerprints, iris scans, personal information, medical records and other personal

data. The data would be protected using blockchain technology – a technology that will be further elaborated in 5.3.5.

Effects

The potential of digital IDs is significant and already being applied in a domain closely aligned with emergency action and its humanitarian principles. Digital IDs are actually already being used for development purposes. They can smoothen the access to a range of basic and empowering services, such as healthcare and education. In Botswana digital identification through biometrics resulted in a 25 per cent savings in pensions and social grants by identifying duplicated records and deceased beneficiaries. In Nigeria digital identification reduced the federal pension roll by 40 per cent (World Bank Group, 2015). Furthermore, according to researchers, digital IDs achieve gains for governments in efficiency and convenience that can lead up to savings of USD 50 billion per year by 2020 (Dahan and Sudan, 2015). Additionally, in line with the WHS ambition to increase transparency, in 2010 Guinea-Bissau used digital identification to identify 4.000 non-existent workers on the public payroll. Nigeria found 43.000 ghost workers in a first phase of a digital identification pilot saving USD 67 million (Dahan and Sudan, 2015).

Furthermore, digital IDs are promising for helping refugees and displaced populations regarding access services. Having a digital identification would especially be useful for refugees who do not have official identity papers (Ng, 2017). It is believed that digital IDs may support female empowerment: according to the International Labour Organisation (ILO), women make for 70 per cent of working hours globally but only receive 10 per cent of all income flows (The Guardian, 2013). Enhancing the income of women is seen as one of the most effective anti-poverty measures. The money women earn is mostly spent on nutrition, education and clothing for the family, directly impacting poverty. A digital ID can help ensure that the money women earn also reaches these women (Sudan, 2013).

Nevertheless, there are challenges to be overcome. Opponents name interoperability and vulnerabilities in existing identification systems as major concerns (Mathuros, 2018). In case of an incident, such as for example data privacy breaches, with digital ID, individuals will have a lot to lose. They need control over how their identity-related information is used and by whom. Their data needs to be secured and protected at all costs. Moreover, they should be assured that it will not affect access to basic services or democratic rights. If these promises are not in place, digital identity has little chance to fulfil the potential (Mathuros, 2018).

Feasibility

The ID2020 Alliance aims at having a working prototype in 2020 that has been implemented with governments and UN agencies (ID2020, 2018). By 2030, the Alliance targets to have facilitated the scaling of a safe, verifiable, persistent digital identity system, consistent with Sustainable Development Goal (SDG) 16.9 – providing legal identity for all including free birth registrations (ID2020, 2018). Many organisations joined forces to achieve this target. World Bank estimates that it will cost USD 12 billion to achieve identification for all of which the World Bank will invest USD 750 million in ID-related projects in three years (Mathuros, 2018).

However, one could wonder how realisable this digital ID really is when currently 1.1 billion people are not formally registered and do not have identity papers (Mathuros, 2017). Furthermore, before implementing digital ID, important stakeholders such as governments should be aboard. Moreover, protection and privacy of citizens should be guaranteed which will be a challenging task.

5.3.2. Biometrics

Functionality

Biometrics are biological or physiological characteristics which can be used for automatic registration (Lodinova, 2016). Those characteristics include fingerprints, facial structure, iris or retinal patterns, DNA, voice and signature (Ng, 2006). In the humanitarian sector, such as at refugee camps, biometric data can help register people who are in need of assistance. For example, in Kenya a biometrics system using fingerprints is used to ensure targeting of beneficiaries, so food is only distributed among them and fraud and abuse can be avoided. The investment in the project was USD 5.14 million. During the first 8 months of using the system, the amount of food required to feed the refugees was reduced by more than 11.000 metric tons (Kebede and Johnson,2015). Another example is the EyeCloud project of UNHCR, IrisGuard and Cairo Amman Bank in Jordan. Syrian refugees are registered using portable iris-scanners. Their biodata enables them to receive cash-based assistance at normal Automated Teller Machines (ATM) without an ATM card, but with biodata (Lee, 2016).

Effects

Because oftentimes refugees do not have identity papers, donors turn to using biometrics to ensure secure and accurate registration. Once they are entered in the system, they can access services and their movements for example from one camp to another can be tracked. According to Andrew Hopkins, chief of identity management and registration at UNHCR, using biometrics is highly efficient. It helps distributing aid equally, rightfully and cost-effectively (Ensor, 2016). Biometrics or more general refugee registration is crucial to monitoring of identification data, number of refugees etc. It can foster freedom of movement and it also protects refugees from e.g. forced return, arbitrary arrest and detention (Lodinova, 2016).

There are some major concerns with the use of biometric data. Firstly, there is a massive accountability gap and a tension with individual rights since people do not have control over their own data. Secondly, there can be defects in the systems or data is not properly protected. It can be a potential weapon in the hands of authoritarian governments. Thirdly, local cultural or religious beliefs should be kept in mind since they can cause objections that should be taken seriously. Furthermore, there could be a function creep which means the gradual widening of use of the collected data beyond the purpose it was collected for in the first place. What's more, some people state that the use of biometric data is de-humanising in the sense that storage of biometric data – data on elements that make up our unique identities – reduces human beings to numbers. Lastly, physical privacy can be at stake. There are concerns with the stigma of biometrics. Other concerns are actual harm by the technology itself, such as radiation and the hygiene of devices (Lodinova, 2016).

Feasibility

Using biometric information to identify is not new: using a person's fingerprint is a unique way to identify that person (Ng, 2006). The use of biometrics is seen as a very valuable tool for validating the registration process, but it is a costly method (Lodinova, 2016). Furthermore, before applying this type of data at a larger scale, the above-mentioned ethical concerns should be addressed.

5.3.3. 3D printing

Functionality

3D printing is a form of additive manufacturing (AM) in which spare parts or whole products can be 'printed' following a prototype created in a computer-aided design and drafting (CADD) programme.

The technology creates products by gradually layering down material one layer at a time to recreate a three-dimensional object (Vasciuk, 2011).

In the humanitarian sector 3D printing can be used to produce needed goods for e.g. a variety of activities, including, health sanitation and shelter (Fearn, 2014). For example, in Kathmandu a lot of pipes are fixed in an improvised manner, using anything people can find for example bicycle tires. Within a few hours the humanitarian team designed a fitting that connects two pipes and let a portable 3D printer, running on a car battery, print the fitting for USD 0.40. The connected pipes supplied 18 households (75 people) with running water (James and James, 2016).
Another example is the work of technology-based NGO Field Ready in Nepal after the 2015 earthquake. Many of the waterpipes that were part of relief efforts lacked functioning fittings and washers. The NGO digitally designed a water fitting in just 45 minutes. At the camp, a 3D printer was connected to a laptop powered by a car battery. It took 2 hours to produce the water fitting which fitted perfectly and made the leaking waterpipe functioning (Jones, 2015). 3D printers could be deployed directly to disaster zones to allow life-saving supplies to be made where and when they are most needed (Mis, 2015). For example, midwives in Africa were facing a shortage of umbilical cord clamps, which prevent dangerous infections in mothers and children. The clamps are scarce and when they are available prices can range quite drastically, from USD 1 to USD 3 apiece. A 3D printed clamp costs USD 0.60 and can be made when needed. The printed clamps have already resulted in a reduction of neo-natal umbilical sepsis (James and James, 2016).

Effects
3D printing can significantly improve the effectiveness of disaster response (Jones, 2015). 3D printing can save costs and simplify logistics and supply chains. Relief agencies are estimated to spend up to 80 per cent of their income on logistics. Producing items in the field rather than shipping them could cut these costs (Mis, 2015). What is more, the hardware – the actual 3D printer – is with a USD 600 affordable (Jones, 2015). 3D printers can also offer flexibility: people may not want to use a provided shelter because it conflicts with cultural arrangements for sleeping, cooking and washing in the affected community. 3D printing technology would be useful if it allowed flexibility to produce a shelter according to local needs, while not resulting in a significant additional cost per unit (Fearn, 2014).

However, there are also challenges concerning this technology. Firstly, it is essential that 3D printing helps to support efforts to build local economies, rather than replace local tradesmanship in designing and building the tools that NGOs need to use in their work (Fearn, 2014).

Feasibility
3D printing is already used by NGOs to produce items needed for assistance (Jones, 2015). However, this technology has not yet been deployed at a very large scale. Right now, NGOs are still experimenting with application of 3D printing. Sniderman, Rajan, and Baum (2016) with reference to shelters, state that experimentation with 3D printing should adhere to clear ethical standards.

5.3.4. Cargo delivery drones

Functionality
A drone is a small UAV. Drones can be used in a variety of ways. A few of the many applications are mapping, search and rescue, and light cargo delivery (FSC, 2013). In the humanitarian sector multiple parties carry out tests with drone cargo delivery. AngelsWing, a South Korean start up carried out test flights in Nepal to deliver medical supplies and purified water bottles to a health camp. The total

distance flown was limited to 2 kilometres due to visual line of sight regulations. Another well-known actor in the field of drone usage, Matternet, had pilots in e.g. Bhutan, Papua New Guinea, Dominican Republic and Malawi (FSD, 2014, p.37). In Malawi, they experimented with transporting laboratory samples for early infant diagnosis of HIV. The 93 test flights ranged between 1 and 10 kilometres. A cost comparison with road transport demonstrated that in this case, transportation costs for cargo UAVs are higher than road delivery, but default rates of HIV tests decrease by a faster delivery of the samples (UNICEF, 2016).

Effects
Especially 'last mile' delivery is a costly challenge for the humanitarian field. Cargo often has to reach remote villages covering rough terrain which takes a lot of gear and time. Around 40 per cent of vaccines supplied to these areas expire before they can be administered, which is a significant waste of money and materials (Soesilo, Meier, Lessard-Fontaine, Du Plesses and Stuhlberger, 2017). Therefore the use of drones might help optimise the supply chain and increase efficiency in the humanitarian sector. (Soesilo, Meier, Lessard-Fontaine, Du Plesses and Stuhlberger, 2017, p.36)

Because drones are flexible and deploy quickly (once the appropriate infrastructure is provided), they are explored because they could play an important role in last mile delivery. Drones can deliver cargo in two ways: 1) landing on the ground and deliver the items or 2) parachuting the cargo. The latter is not allowed in many countries and can raise safety concerns. Regulatory issues present a challenge in the use of drones. In most countries drone regulations do not include provisions on cargo delivery, and when it is included it makes it oftentimes difficult or illegal (FSD, 2014). Only in some cases drones offer cost savings over traditional delivery methods such as road delivery (FSD, 2014). However, drones can be reliable and consistent and therefore, they can deliver exactly what is needed based on actual demand, regardless of infrastructure or ground conditions. Hence, in conflict areas drones can be operated where it is too unsafe to do road delivery. The pitfalls include severe weather conditions which can cause problems for operating drones. Furthermore, if drones become common in humanitarian assistance, a challenge could be that multiple drones are using the same air corridor.

Feasibility
Unlike drone technology that is used for mapping, the delivery of cargo with drones has not matured to the degree that it is readily available. This use of drones for delivery is still nascent and although explored by companies and public agencies, not yet widely adopted. However, it is a rapidly emerging technology and many humanitarian actors are working together to make the cargo drone a reality (FSD, 2014). The technologies, infrastructure and regulations are still developing. Cargo delivery by drones is at an early stage of commercialisation and therefore, determining the costs for humanitarian organisations is difficult (FSD, 2014).

5.3.5. Cash transfer programming

Functionality
Cash transfer programming (CTP) is a cluster of ICT innovations that enable the deliverance of aid in direct payments, thereby replacing the traditional aid in form of delivered goods. Cash transfer can be done through for instance cards, e-transfers or mobile money. The primary types of CTP are (conditional and unconditional) cash transfers, cash-for-work and vouchers. All types aim at delivering timely and cost-effective assistance to crisis-affected populations, while at the same time supporting the local economy (MercyCorps, 2015). The type of CTP, its value, disbursement mechanism, frequency and duration determine how CTP is executed. Some cash transfer programs are designed

to reach long-term development targets, but in humanitarian assistance it is mainly used in the response and early recovery phase.

Cash transfer programming can enable recipients of humanitarian assistance to choose how best to meet their needs. An estimated USD 2.8 billion of international humanitarian assistance was allocated to this in 2016, a 40 per cent increase from 2015 (UN, 2018).

Compared to conventional transfer mechanism that can include long queuing and unsafety for users, e-transfers might be more efficient, safer and cost-effective. Moreover, it is more discreet for the recipient. E-transfers include smart cards, mobile vouchers or mobile money. Mobile money that is used to send money to a mobile account is oftentimes a suitable modality for CTP (GSMA, 2017). Assistance can be received in the form of a mobile voucher for cash-out or in the form of a mobile voucher with a specific purpose. Displaced people that need assistance are increasingly digitally connected and live in places covered by mobile networks. Mobile phone coverage rates of displaced people are close to those of the overall world population (GSMA, 2017). Mobile money services may be more widespread than banks in areas where displaced people stay. All in all, mobile money or e-transfers can often times be a suitable option for CTP.

Blockchain is a way to track ownership of assets without the need for a central authority (WFP, 2018). It is a decentralised public ledger that automatically tracks all transactions that take place across a digital peer-to-peer network. The platform provides a greater ability to monitor individual transactions (be they of currency, contracts, or escrow) among known or unknown parties. This technology increases transparency and therefore decreases the chance of fraud, data mismanagement or corruption (Shannon and Ware, 2016). Moreover, it reduces the usual transaction costs associated with moving money across different currencies, countries and financial institutions (Shannon and Ware, 2016). WFP is a pioneer on implementing blockchain in humanitarian assistance. In the Azraq Refugee Camp in Jordan, refugees pay for their food by means of entitlements recorded on a blockchain-based platform. Blockchain enables WFP to provide effective and efficient assistance while cutting costs. CTP that uses blockchain are faster, save costs and are more secure. WFP combines it with biometric scanning to reduce (identity) fraud risk (WFP, 2018).

Furthermore, the Building Blocks pilot from WFP was focused on replacing the financial third party (the bank) with blockchain. The beneficiaries' information and entitlements are stored in the blockchain so when a store or organisation requests authorisation for a purchase the blockchain is 'contacted' instead of a bank. WFP has access to and control over the private blockchain, so WFP has the rights to make changes to the beneficiaries' data without having to go through a bank. The reconciliation and accounting are much cheaper and easier because of this pilot. The results were astonishing: WFP has saved 98 per cent of administrative costs with Building Blocks (Dodgson and Genc, 2017).

Effects

CTP is seen as a flexible and dignified option to deliver assistance. Delivered goods are not always what people need. Cash can address the actual need of affected people by giving them autonomy to choose what they need. The World Bank stated that cash can have multiplier effects in the local economy with an average of 1.8 (ranging from 1.3 – 2.5). In Zimbabwe a study found that every dollar of cash transfer generated USD 2.59 in income compared to USD 1.67 for food aid (Cabot Venton and Sida, 2017).

CTP is also seen as a rapid and cost-effective tool because of low distribution cost. The cost of the different transfer modalities according to the UNICEF DRC Cash Program is shown in Figure 15 below.

Figure 15 – Cost of different cash transfer modalities

Type of cash transfer (in CTP)	Cost of transfer
Direct cash	0.33 per cent
Open market or Fair	1.8-2 per cent
Micro-finance	1.9-2.8 per cent
Cash through local traders	5.2 per cent
E-voucher Fair	6 per cent

Source: Cabot, Venton and Sida, 2017, p.20

CTP usually does not rely on logistics-heavy systems like distribution of food or other materials. Blockchain can be used to transfer money, cutting out the banks and reducing fees. This means more money reaching the beneficiary. A pilot started by Disberse saved the NGO's 2,5 per cent in fees (e.g. international shipping fees. This may seem small, but this money was enough for three children to go to school for a whole year (Dodgson and Genc, 2017).

CTP as an alternative for traditional deliverance of aid is growing. In 2015, USD 2 billion was spent through CTPs (Development Initiatives, 2018b). The High-Level Panel on Humanitarian Cash Transfer recommends scaling up of CTP and urges donors to systematically ask 'why not cash?'. It was stated that there is a need for a common approach with comparable terminology and data to enable the scaling of CTP (Development Initiatives, 2018a).
There are also challenges and concerns for CTP. A functioning market that can meet the cash receiver's demand is required. For e-transfers a working technical infrastructure and connectivity are needed. Most fragile states are least prepared for CTP due to the lack of these requisites (Capgemini, 2017a). It may be evident that a cash-based economy rather than a community that rely on barter is needed. In markets with a limited supply of goods or services that have the risk to be unable to meet the demand, injecting cash as assistance can cause inflation, shortages or price distortions.

When e-transfers are used, inclusiveness can be a real challenge in the sense that vulnerable groups may not have access to a mobile phone or are not digital literate. Furthermore, too much dependence on the money can provoke tensions in the community. Lastly, the exact way of delivering the money is still subject of debate.

Feasibility
CTP is an already used method in the humanitarian sector. It is considered more cost-effective and less logistically challenging than distributing conventional aid packages. Still, the current programmes are analysing the cost-efficiency and cost-effectiveness. It is vital to keep monitoring these developments to assess the feasibility of CTP as an enabler of the 'Agenda for Humanity'.

5.3.6. The importance of data for monitoring and evaluation

Through monitoring and evaluation (M&E), challenges and bottlenecks can be identified and processes optimised. M&E is seen as a time-consuming and costly activity which is often considered as necessary to fulfil the core business of humanitarians: providing assistance and alleviating suffering. It is believed that M&E could be conducted in a more efficient manner with technological

innovations. In this section, we will elaborate and assess harnessed technologies that aim at improving efficiency of M&E.

Improving accountability towards both donors as well as local populations by increasing transparency and insight in processes is an ambition set forth in the 'Agenda for Humanity' (WHS, 2016b). Over the years, significant emphasis is placed on M&E. Because data collection is increasingly digitised, data for monitoring purposes can be collected faster and more efficient. Data preparedness refers to the readiness of humanitarian actors to harness high-quality data for rapid decision-making. This also means that a functioning system of data collection should be in place even before a disaster strike. Because an increasing amount of data can be and is collected throughout the humanitarian process, M&E can make use of this data. AI can be harnessed to analyse the vast amount of data and to distil lessons learned. The gained insights out of big datasets cannot only be used for M&E purposes but can also contribute to better prevention and preparedness. All in all, technologies enable efficient data collection as well as data analysis that can improve the entire humanitarian programme cycle. Data collected throughout the entire process is stored on data platforms. Some platforms make data accessible for volunteers to process the data, for example map it for better needs assessment.

However, different actors use different data platforms. Besides concerns of data protection, this also causes fragmentation. In 2008, the International Aid Transparency Initiative (IATI) was founded. IATI is a global campaign to create transparency in the records of how aid money is spent. IATI is a standardised format to easily access, compare and analyse information on how aid money is spent. By making data on aid spending better accessible, IATI wants to increase accountability and indirectly improves spending so that it reaches the aimed target. The initiative hopes to thereby ensure that aid money reaches its intended recipients. Data is now available from more than 600 donor governments, multilateral agencies, foundations, NGOs and private sector organisations (IATI, 2017). By the end of 2017, 73 per cent of Grand Bargain signatories were publishing open data to the IATI Standard and 85 per cent of these were publishing data on their humanitarian activities (Simbodyal, 2017).
Some of the technological solutions that can be used for improving M&E processes are handheld devices for digital data collection, mobile phone-based feedback mechanisms, remote sensing with satellites or delivery tracking, communication with online platforms and broadcasting with radios and other forms of media. A concrete example of the use of technology in M&E in a long-term project of an international NGO which used to distribute multiple paper-based surveys to remote areas each month, which took a lot of money and thus, time. When the filled in surveys returned, the questionnaires had to be entered into a database before analysis could take place. Nowadays, data is collected remotely through 20 tablets. The purchase costs of the iPads and the investment necessary to roll out digital data collection paid back itself after just one survey (Dette, Steets and Sagmeister, 2016).

Another NGO replaced all its paper-based monitoring over the last three years after a headquarter decision to support data collection software. Each field office now has five basic smartphones that cost around USD 100 each, which humanitarian workers collect before going on assignments. As they enter survey responses in the field, data is immediately sent to a central database via a mobile data connection. The NGO found that digital data entry not only improved data quality, but also decreased the time needed to administer surveys by more than 50 per cent. The fact that surveys record place and time information created strong incentives not to enter false responses (Dette and Steets, 2016).

Effects

Utilising ICTs in M&E processes does not come without challenges. Firstly, integrating ICTs into an organisation's operation requires budget. Furthermore, employees need to be trained, otherwise low capacity and resistance to change will cause problems. Secondly, M&E processes should be adapted to using ICT tools to fully exploit the potential. Furthermore, an overreliance on digital tools that gather oftentimes quantitative data can result in disconnection with context. When data is electronically and remotely gathered, project visits are not necessary and this may cause a lack of contextual understanding. What is more, if data and privacy are not fully protected, participants being evaluated could be at risk. Lastly, people without access to ICTs or who are digitally illiterate might be left out from participation. This can be potential for selectivity bias (Raftree and Bamberger, 2014). However, if integration of ICTs in M&E processes is carefully planned rather than forcing ICTs into M&E, it could be of great benefit to M&E activities. Especially in insecure environments it is deemed vital to assess whether the aid reached the right people or not. Where gathering data remotely has its limits, in this context it could be really helpful. Nevertheless, a prerequisite remains that people have access to devices and electricity, which is not always the case in those contexts.

Feasibility

Using technological solutions in M&E is emerging. However, there are ICTs with potential that have not yet been fully explored. This process would benefit from greater documentation on evidence of utility and impact of ICT for M&E (Raftree and Bamberger, 2014). Furthermore, there is little hard evidence of their effectiveness.

5.3.7. Key Insights

The Figure 16 below highlights the main insights on the technologies mentioned in 5.3.

Figure 16 – Key insights on technological innovations in the response phase

	Functionality	*Effects*	*Feasibility*
Digital ID	• A digital ID for everyone was advocated at UN ID2020 Summit. • Already being used in development domain to improve services and transparency. • May enable SDG commitments.	• Potential for refugees and displaced populations without papers. • Potential for female empowerment. • Concerns about privacy and data protection.	• Limited technical infrastructure and system interoperability create barriers.
Biometrics	• In combination with digital IDs used in refugee camps.	• Digital IDs and biometrics are used to provide CTP because people are without papers. • Can be used to better manage provisions and conduct registration and camp management. • Concerns about privacy, data protection and consent.	• Biometrics beyond fingerprints is relatively new and ethical concerns need to be addressed. • Technical infrastructure and skills required to adopt the technology.
3D printing	• Can be used to print required goods.	• Concerns about 3D printing replacing local craftmanship. • Effects and benefits are unclear due to limited research.	• Not yet adopted at a large scale in the humanitarian sector. • Concerns about limited capacity as well as dependency on digital infrastructure.
Cargo delivery drones	• Drones can be used to deliver humanitarian assistance. • Can overcome issues of limited access and infrastructure.	• Can reduce the cost of the 'last mile' delivery of assistance. • Can reduce delivery times as it is not limited by ground conditions.	• Cargo drones are being explored by companies as well as public agencies, however not yet widely adopted. • Costs not yet reduced and drone regulations do often not include provision on cargo delivery.

Cash Transfer Programming (CTP)	• Providing cash instead of products has been adopted by the humanitarian domain, it is currently being digitised with blockchain technology. • Potential for response, recovery as well as long-term development.	• Can improve timely delivery, cost-effectiveness and safety at delivery points. • Enables local ownership. • Blockchain technology enables transparency and reduces transaction costs. • Concerns about data protection and privacy.	• CTP is seen as a flexible and dignified option to deliver assistance. Ambition of UN is to systematically ask 'Why not cash?'. • Feasibility of CTP is dependent on local on market conditions. • Organisations differ on the preferred type of CTP.
Monitoring and evaluation (M&E)	• Data can be used to improve M&E activities. • IATI is a good example of the potential of data in M&E to increase transparency.	• It can offer better insights to improve operations. • Concerns about data protection and privacy.	• The humanitarian domain is increasingly using technological innovations for M&E. • Digitising operations is costly. • Staff needs to be trained.

Source: created by the authors for the purpose of this study

The following categorisation within the three horizons of growth becomes apparent:

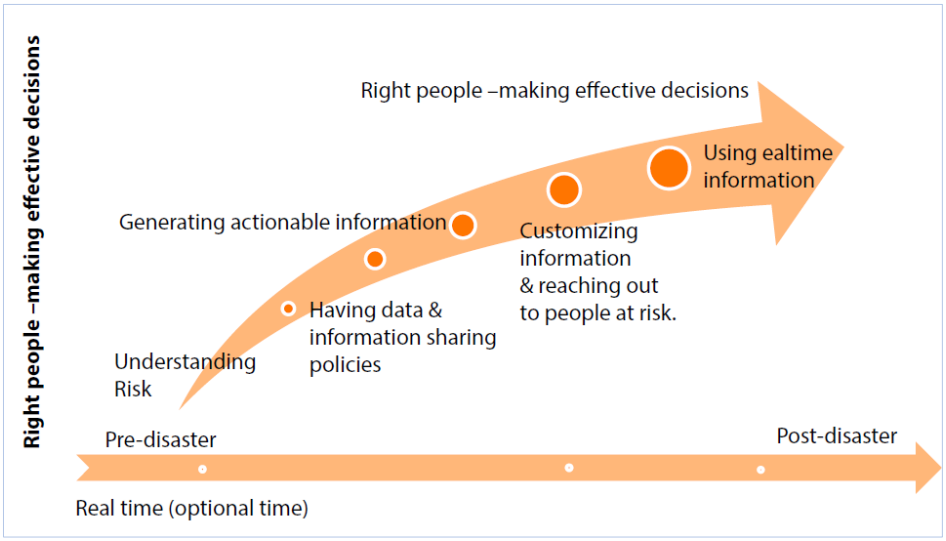
- 3D printing can be considered 'known' in the humanitarian domain as it is meant to replace a current service (in the existing market they already serve), and its limited scaling may be due to a perception that the technology will lead to insufficient cost-effectiveness and efficiency improvements. In addition, M&E through digital means is known in the humanitarian domain.
- Digital ID and biometrics are 'partially' known as they have yet to be adopted on a large scale and are providing a new type of service. In addition, CTP is 'partially known' as it is being adopted in different forms. Furthermore, the initial results are promising with regard to increased efficiency and effectiveness.
- Cargo delivery drones can be considered on the border of 'unknown' as the application is currently being explored.

5.4. Recovery, reconstruction and disaster risk reduction

As formulated in the 'Agenda for Humanity', the main focus of humanitarian assistance is the response phase, however it is the intention to put more emphasis on reducing risk and other preventative measures. Technologies enable a shift to increased prevention and preparedness. With regard to the reconstruction phase, there are innovative solutions to 'build back better' to reduce risks and increase the resilience of local communities. However, these are often engineering solutions, which fall outside the scope of the research. With regard to IT solutions, of specific interest are Smart Cities. Furthermore, experts referred to educational technologies as a novel way to ensure the continued educational development of people affected by humanitarian crises, thereby fostering resilient communities in the future.

Similarly to the previously mentioned 'data preparedness', e-resilience refers to the ICT contributions to resilience, particularly at community level, and involves the use of ICT during all phases of disaster risk management (prevention, reduction, preparedness, response and recovery) to reduce the risk and impact of disasters as well as maintain progress towards sustainable development. It entails two dimensions: ICT for prevention, reduction and preparedness, and ICT for response and recovery (UN, 2018). The process of e-resilience is shown in Figure 17.

Figure 17 – Process of e-resilience



Source: UN, 2018

E-resilience is adopted in a variety of settings and it may be categorised or known under other activities or technologies. For example, the Department of Hydro Med Services in Bhutan provides hazard related information on meteorology, hydrology, snow and glacier early warnings on its website. Their hazard monitoring systems is linked to sensors which send real-time data generating actionable information which activates sirens in the high-risk areas to warn local communities. The One Billion Coalition for Resilience uses data analytics and other tools to map the resilience of local communities and offer preparedness kits and grants to the communities.

According to a preliminary regression analysis, which studied the relationship between broadband connectivity and disaster impact, as broadband connectivity was increased, disaster impact was reduced (UN, 2018). The report furthermore states that 'e-resilience and the use of ICTs in disaster risk management are part of key e-government initiatives and, used together, can support both the Sendai Framework and the 2030 Agenda for Sustainable Development. Artificial Intelligence, its associated digital technologies, space technology applications and geo-spatial technologies can buttress e-resilience initiatives contributing to all phases of disaster risk management' (UN, 2018, p.62). The importance of institutional and individual capacity building to further these e-resilience initiatives is re-affirmed. The UN Survey (2018, p. 54) states 'Addressed holistically [by governments], e-resilience has the potential to reduce disaster risks and improve disaster management, and it can be instrumental in reducing economic loss and preventing human casualties'.

5.4.1. Smart cities

Disaster risk reduction can be supported by different technologies. An example thereof is IoT. A movement that is tightly interlinked with IoT is smart cities. A smart city is an urban area that uses different types of sensors and devices to supply information that can be used to manage assets and

resources efficiently. This technology allows city officials to interact directly with both community and city infrastructure and to real-time monitor what is happening in the city and how the city is evolving. Smart cities use IoT to for example monitor the vibrations of bridges, buildings, registering traffic and weather conditions (Quek, 2017). For example, in the Singapore Smart Nation program an entirely new city is built 'smart' with high speed, intelligent ICT infrastructures which support all the city systems, services and buildings in an integrated way. They plan on transforming the government and society through innovative use of new technologies. The aim is to create 80.000 new jobs with this initiative, give 90 per cent of the population broadband internet access and have 100 per cent of the school kids with a computer at home (Estevez, Vasco Lopes and Janowski, 2016).

Smart cities are still relatively new and emerging. Therefore, they will not alleviate the suffering of urban populations currently affected by humanitarian crisis (see 3.1). However, smart cities may enable increased prevention and prepared measures, as technologies that are part of the smart cities concept can be embedded in current urban areas. Since smart city solutions are scalable, refugee camps could be run as smart cities, leading to more transparent and efficient use of resources.

To illustrate the potential of smart cities, ABI Research (2017) estimated yearly savings that are achievable when so called 'mega' cities (cities with more than 10 million inhabitants), become smart cities. There are already a lot of mega cities in developing countries and the top-10 of cities projected to become mega cities in the next 10 years are all located in developing countries (UN, 2016). According to ABI mega cities can save up to 21.1 per cent of their costs for citizens, businesses and local authorities by becoming smart. Next to this there is a potential saving of USD 5.4 trillion when all the cities in the world become smart (ABI Research, 2017).

Effects

The potential of smart cities is considered significant. For example, IBM set up a central Operations Centre in Rio de Janeiro. In the central command centre they connected cameras, forecasting systems and a smart map that analyses 60 layers of data from sensors around the city. With the integration of 20 city agencies into this one central command centre the city has decreased the emergency response times by 30 per cent (Soffel, 2013). Furthermore, Cisco created a smart city pilot in Bangalore to serve as an example for the 100 planned smart cities in India. Cisco uses IoT technology to connect the city's services and buildings. By estimate, smart buildings can reduce 40 per cent of the energy that normal buildings consume. The energy management system of the city is estimated to cut costs by 35 per cent (Estevez, Vasco Lopes and Janowski, 2016).

When it comes to smart cities, a lack of information is seldom a bottleneck. The problem oftentimes comes from communication and perception of the information. The translation from gained insights and knowledge to actual risk reduction activities remains a challenge. Privacy and (cyber)security concerns are significant in the humanitarian community, since the impact can be significant if an area and humanitarian operations rely heavily on IoT technology. It has the potential to cause major disruptions in an affected area. Furthermore, concerns are raised about privacy of individuals when a vast amount of data is gathered anout their environment. Another challenge occurs when data needs to be shared cross-border. This will be affected by different national regulations on data sharing.

Urban areas in fragile states have their own specific challenges, like conflict-induced migration and rapidly growing populations (Smith, 2017). A 'conflict sensitive' approach for developing smart cities that tackle unique challenges needs to be developed and tested. Nevertheless, if a smart city functions

well it has great potential to prevent or predict disasters and act upon this information to save many lives and protect infrastructure.

Feasibility
Smart city technology is very promising, although a successful use cases where the potential of the technology was fully exploited to reduce risks are not yet known. Examples are more found in upper-middle income countries. Therefore, the potential for the humanitarian sector is also not yet fully known. Furthermore, whether the full potential of smart cities can be reached is heavily dependent on skills of software developers that engineer the algorithms behind the technology, our ability to safeguard individuals' privacy and on how we can make these innovations inclusive.

5.4.2. Educational technologies

According to a UNICEF report (2017) some 27 million children are out of school in conflict zones. The report focuses on the importance of education for children who have been displaced by man-made or natural disasters. Failure to provide education opportunities to children that forcefully left their homes has great consequences for both individuals and nations (Reliefweb, 2017). The limited capacities of education systems across the region of Syria have left an estimated 731.000 Syrian refugee children out of school and in 2018, more than 5 million Syrian refugee children will require education assistance (UNICEF, 2018). Additionally, the average duration of major refugee situations has increased from 17 years in 2003 to 26 years in 2015 (UNESCO, 2018). The protracted nature of the Syrian conflict is leading school-age Syrian refugee children to become the 'lost generation'. While there are multiple challenges in providing quality education to the world's refugee children, the need for innovative, cost-effective and scalable educational solutions has never been more urgent.

Technological innovation seems promising to overcome these challenges. Many displaced people have access to a smartphone. A mobile device is often one of the few things that people take when they flee their homes in times of crisis: 71 per cent of refugee households own a mobile phone (UNESCO, 2018). Increasingly, mobile technology can provide a lifeline to education bringing education to people where they are. For example, in a pilot in rural India, affordable (around EUR 50 per piece) tablets were given out to students. Teachers were taught how to work with the tablets and incorporate them in their lessons. In just 18 such lessons 26 of the 38 students who until then had never been able to read, had already learned the full alphabet. Teachers stated the kids were more motivated and encouraged through the educational apps that they used to learn (Nedungadi, Jayakumar and Raman, 2014). Another example of educational mobile technology is the 'Read to kids' project in Jordan that gives free access to a digital library through a smartphone application. This app aims at stimulating parents to have shared reading activities with their children (Wagner, 2018). The EduApp4Syria project produced two open source apps which leverage the widespread availability of mobile devices to develop free educational alternatives for millions of Syrian children forced out of school due to conflict (Norad, 2018).

The World Refugee School (WRS) and its partners have developed an online platform to deliver education through e-learning modules for teachers and refugee students. An annual program costs USD 310 per student, which can be reduced to USD 74 if teachers and hardware are already available (WRS, 2018). Another example is the 'Teachers for Teachers' initiative of Columbia University, which offers a professional development programme for primary school teachers in Kakuma in Kenya, combining onsite teacher training with peer coaching and mobile mentoring (UNESCO, 2018).

In addition, education technologies can be used to educate and train humanitarian assistance providers as well as local communities for less cost than traditional means. Skill sets can for example be increased through massive open online courses (MOOC), but also tailor-made in-house curricula with dedicated e-learnings on a shared platform.

Effects

There is a lack of robust evidence that technology has a positive or negative impact on learning outcomes (Wagner, 2018). However, the use of mobile technology can be a strong complement to intensive face-to-face engagement, especially when refugees are experiencing trauma and mental health difficulties. Therefore, digital education tends to be most valuable when connected with 'blended learning' approaches: providing a combination of online and offline learning. This highlights the relevance of digital teacher training in refugee contexts, i.e. preparing teachers to respond to the unique needs of refugees. Teachers can not only address children's physical and cognitive needs but also facilitate their psychosocial well-being and serve as a key resource in achieving normality (UNESCO, 2018). Next to the need for traditional schooling, challenges with educational apps and technologies are that they are dependent on access to electricity and connectivity, for example in the case of 'Read to kids' to download books for offline usage. Lastly, if there is little attention for local context, an app will probably not reach the outcome it seeks.

Feasibility

Educational technologies are widely being adopted by organisations around the world. Academia, public agencies as well as businesses have embraced technological innovations to educate their staff and facilitate interactive learning. According to the Association for Talent Development's 'State of the Industry' report, companies are using a record level of e-learning and they predicts that number will continue to rise because this method is becoming more popular due to increased internet access. The benefits include its potential cost-effectiveness (in comparison with more traditional training methods), as equipment and programs can be used by large numbers of employees, and the relative ease of customizability (TrainingToday, 2018). Regarding the 'read to kids' app, the cost effectiveness as calculated per beneficiary is USD 15 per year (a little over a dollar per month) for unlimited access to reading materials, reading reminders and tips for parents. Cost will go down over time as initial investment included app development, content acquisition and digitisation, and a digital campaign (Wagner, 2018). Given these benefits and its broad use in other domains, adopting educational technologies for training humanitarian staff is worth exploring and adopting further.

If the use of educational application is to be scaled, stronger partnerships between technology experts and experts on refugee education are needed (Wagner, 2018). Although the technology sector has jumped in with many initiatives, a lack of coordination with the humanitarian sector may prevent these efforts from having the most impact. Developers find themselves confronted with the realities of operating in an unfamiliar and challenging context: often multiple agencies are involved and there is almost no steady internet access (UNHCR, 2016). Often the potential of mobile technology to improve education systems remains under-explored. More time is needed to understand how to best leverage it at scale.

5.4.3. Key insights

The Figure 18 below highlights the main insights on the technologies mentioned in 5.4.

Figure 18 – Key insights on technological innovations in the recovery phase

	Functionality	*Effects*	*Feasibility*
Smart Cities	• New and emerging innovation. • Will enable a shift to prevention and preparedness.	• Effects are speculated on, as no use cases are known in humanitarian assistance. • May enable increased local ownership. • Concerns about cyber security and privacy.	• Closely interlinked with AI and IoT solutions. • Requires sophisticated technical infrastructure and digital skill set. • No use cases in the humanitarian domain are known. • Exploration is mostly in middle- and upper-income countries.
Educational technologies	• Can be used for training humanitarian staff as well as people affected by crisis. • Widely adopted in different domains. • Can be tailor-made for the specific target group.	• May be more cost-effective than traditional methods when adopted on a large scale. • Can enable local ownership and participatory approaches. • Enable large groups of people over long-distances to participate and interact directly with each other and a teacher.	• Adopting educational technologies for staff may require limited effort as it is widely used in other domains. • Use of educational technologies in humanitarian settings may require specific development of curricula as well as a digital infrastructure in place which requires maintenance.

Source: created by authors for the purpose of this study

The following categorisation within the three horizons of growth becomes apparent:

- Smart cities and the underlying technologies such as IoT and AI can be considered 'unknown' for the humanitarian sector.
- Educational technologies are on the border between 'known' and 'partially known' because many technologies are currently adopted in the humanitarian domain and new technologies are creating new opportunities in the domain.

5.5. Key conclusions

- Technological innovations have the potential to improve humanitarian assistance; however, they do not always benefit the beneficiary directly.
- Given the transformative nature of technological innovations, the technologies often apply to multiple phases of humanitarian assistance. In this chapter they have been categorised in one of the following three stages: Preparedness; Response; and Recovery, Reconstruction and Disaster

Risk Reduction. For each technology selected, its functionality, the effects related to its use and application, and the feasibility have been assessed.

- When taking the current evidence base in consideration it appears that technological innovations such as data preparedness, innovative financing and CTP offer the most concrete value in supporting the 'Agenda for Humanity'. Not surprisingly, these technologies form the basis of a variety of activities in humanitarian assistance and are interlinked with promising (horizon 3) technologies such as AI, IoT and smart cities.
- Besides potentials, the technologies come with limitations and concerns. Furthermore, the potential of many technologies has not yet been fully explored and most technologies are not yet successfully implemented to reach their full potential.
- The overarching concerns about the application of ICTs in the humanitarian domain include the following:
    - Many technologies still need to be piloted and/or scaled. The risk is that local communities can be negatively affected when they are part of an experiment that might fail.
    - There are not many successful use cases of the use of innovative technologies in the humanitarian sector. Oftentimes the new technologies are not matured enough or are not more affordable than conventional technologies.
    - ICTs often have to do with data. Risk of compromising privacy and data security may have even graver consequences in humanitarian settings.
    - The most vulnerable people might not have access to mobile devices or are digitally illiterate. It can be a challenge to reach them by relying (only) on the technologies.

6. Conclusions

To address the challenges facing the timely and adequate delivery of humanitarian assistance and continue addressing needs and alleviating suffering of those affected by crises, various commitments have been made during the WHS in 2016. The concept of technological innovation in humanitarian innovation is approached and perceived in a variety of ways; from the digitisation of existing processes to completely transforming the system of humanitarian assistance. Furthermore, some may focus more on the aspect of 'innovation' as the innovation process, whereas others focus on 'technology' and the adoption of technology. One could illustrate it with the parable of the ten blind men and an elephant, in which the men conceptualise the elephant by touching it and each man describes the elephant based on his specific experience.

The conclusions of this study reflect the varying perspectives on 'technological innovation' and conclusions are drawn considering technological innovations to meet the intentions set out in the 'Agenda for Humanity'. It should be stated that technology is a means, and not an end in itself, and there are specific concerns with regard to technological innovation in the humanitarian domain. Technology is not inherently negative or positive, but it is not neutral either.

Technological innovation in humanitarian assistance is a priority, it is maturing and growing.
The humanitarian system has actively embraced technological innovation to address the challenges facing the timely and effective delivery of humanitarian assistance and to achieve the objectives set out in the 'Agenda for Humanity' which was illustrated by for example the launch of the GAHI during the WHS. Both national as well as international humanitarian organisation, businesses as well as (inter)governmental agencies are actively involved in the innovation process. Technological innovation in humanitarian assistance has led to a growing awareness of challenges and opportunities. The actors involved therefore differ significantly in their level of expertise with regard to innovation.

The discussion has shifted from 'should we innovate?' to 'how do we innovate?' and 'how do we effectively scale?'. For example, the perception of CTP as a potential alternative for traditional humanitarian aid packages in specific settings has altered significantly over the past years. Providing cash instead of goods is already accepted within the domain, and the way to further CTP is at the centre of the narrative of technological innovation in humanitarian assistance, as is its impact on both the process of aid delivery as well as the humanitarian system. The potential of CTP is recognised and with it also come concerns about the visibility of the most vulnerable, data protection and cyber security. Innovation projects are exploring ways to address these concerns as is illustrated by the WFP Building Blocks pilot which uses blockchain technology to safeguard the privacy of recipients.

Overall, technological innovation in humanitarian assistance appears to be entering into a new phase with more targeted approaches to further innovation. Actors in the domain have become more acquainted with each other – their ways of working, interests and approaches – as well as the transformations occurring within the domain. Efforts are more geared towards addressing barriers to scale.

Technological innovation alters the way in which humanitarian assistance is organised and executed, it redefines relationships between actors in the field, and it affects financial flows.
With technological innovation in humanitarian assistance, humanitarians are engaging with new actors, and thereby become increasingly aware of what their core identity and role as providers of

humanitarian assistance is in relationship with other actors such as people affected by humanitarian crisis as well as private sector actors. Although initial hesitation to collaborate with the 'new' actors may have faded, fundamental question are raised about the core humanitarian values of organisations active in humanitarian assistance and their role in the provision of humanitarian assistance. In addition, as the distance between relief provider and receiver reduces and information is readily available to all, expectations on the quality of humanitarian assistance increase. The narrative of technological innovation is not limited to the application of technologies in the work and the requirements stated in innovation briefs. Technological developments raise additional questions, for example about 'information as a right' which in turn significantly impact the humanitarian system.

Furthermore, developments relate to both the digitisation of humanitarian processes (horizon 1) as well as an apparent change of the humanitarian 'business model' (horizon 3). Both are intrinsically linked, for example the digitisation of humanitarian processes with for example smart devices provide rich data sources and enable IoT and AI related solutions. The transformation is occurring as more and more technological innovations are explored in humanitarian assistance, and it is therefore vital to address concerns about the humanitarian imperative and role of humanitarian organisations.

Technological innovation enables a shift of focus from response and recovery to prevention and preparedness.
Technological innovations can facilitate overcoming the humanitarian – development divide. The concepts of 'data preparedness' and 'e-resilience' can contribute significantly to the ambitions set out in the 'Agenda for Humanity'. Technology offers the opportunity to facilitate the 'new way of working' and move from providing relief to mitigating need. By combining data from a variety of sources, specific predictions can be made about the risk of disaster and its impact on a specific community. The potential is illustrated well by Copernicus' EMS and EFAS, EFFIS as well as EDO.

However, the technological innovations are merely enablers: political and organisational will, financial resources and institutional as well as individual capacity is needed to break the patterns of division and implement local programmes. For example, early warning is enabled by technological innovations and can lead to prevention and/or preparedness. However, barriers such as for example the earmarking of funding for response activities instead of preparedness activities places limitations on the opportunity provided by technological innovations.

Technological innovation offers opportunities for increased local ownership and engagement.
The distance between assistance provider and receiver has reduced significantly due to innovations such as interconnectivity and mobile devices. Technological innovations such as mobile devices have over the past years placed local community as well as people affected by humanitarian crises at the centre of humanitarian assistance. Humanitarian organisations increasingly gather data via mobile devices for example in areas with restrictions in movement of staff. Data collection costs can thereby be reduced, for example mVAM of the WFO reduced its data collection costs with 50 per cent when using questionnaire survey instead of face-to-face interviews during the Ebola crisis. However, the capacity to analyse large data sets and guarantee cyber security and privacy need to be in place to reap the benefits in a timely manner. AI may provide a solution to this challenge in the nearby future. In addition, processes and skill need to be in place to translate insights to action. The humanitarian domain is similarly to the overall job market increasingly in need of employees with a sound digital skill set.

Communication technologies and access to information are transforming the relationship between people affected by crises and humanitarian organisations. For example, risk reduction through IoT and sensors can provide local communities with information through (online) dashboards. The Red Cross pilots the provision of drones to local office to enable relatively affordable and timely risk assessment when crisis occurs. Humanitarian organisations recognise this change and embrace the opportunities. However, because these developments are relatively new, organisations are still exploring the full potential of technology in achieving inclusive and participatory approaches. There are also concerns that technological innovations are developed in the developed countries and are at times not aligned with the needs and capabilities of local systems in the developing countries.

Technological innovation can facilitate new ways of addressing the humanitarian financing gap.
For example, multi-year funding is facilitated by concise predictions on vulnerability and risk through technological innovations. However, translating early warning to prevention and preparedness has been a challenge and will not be solved by solely furthering technological innovation in humanitarian assistance. Barriers to multi-year funding should be addressed to reap the benefits innovation offers. With regard to the ambition of improving accountability, data provides an opportunity to increase transparency which goes hand in hand with accountability. By the end of 2017, 73 per cent of Grand Bargain signatories were publishing open data to the IATI and 85 per cent of these were publishing data on their humanitarian activities. Monitoring and evaluation of humanitarian assistance is facilitated by technological innovation and enables explanation, clarification and justification of actions.

New entrants and the innovation discourse in the humanitarian context have enabled access to new resources as illustrated by the increasing financial contributions from the private sector, as well changed the way in which funds are raised, e.g. through campaigning with VR (horizon 2). It has also led to an exploration of different financing models, such as 'innovative financing' and a discussion on the transformation of the 'humanitarian business model' (horizon 3.) Furthermore, with regard to the 'Agenda for Humanity', increased accountability and transparency are possible by means of technological innovations and insights on effectiveness and impact are gathered. Initiatives such as IATI are possible due to data-related activities.

The use of technological innovation in humanitarian assistance raises serious concerns about the protection of the most vulnerable due to privacy and cyber security issues.
Technological innovation is an important development globally, in as well as outside the humanitarian context. Related to that, concerns about privacy, cyber security and data protection are voiced daily in communities all around the world. These developments have for example led to the implementation of GDPR in Europe. These concerns are also present when it comes to technological innovation in humanitarian assistance, and it is even considered more pressing due to the vulnerability and dependence of people affected by humanitarian crises. Concerns with regard to humanitarian principles, safety and security in the humanitarian sector are valid. Whilst digitalisation is offering opportunities, it is also providing challenges, such as access to the most vulnerable who in areas with limited connectivity may be 'invisible', or dangers if the location of vulnerable groups fall in the wrong hands.

Technological innovation in humanitarian assistance requires shared technological standards.
The Sphere project has led to the development of several technical standards in humanitarian assistance, however these do not yet include technological standards for digital innovations. Given

the concerns about privacy and data protection, as well as the need for technological skills and system interoperability to effectively implement technological innovations in humanitarian assistance, shared technological standards are needed in the sector, especially in co-creation settings with non-traditional humanitarian actors.

The use of technological innovation requires different ways of working, skills and capabilities of both international as well as national organisations and actors.
Organisations adopting technological innovations are recognising the need for different skills and capabilities within their organisation. For example, 'data literacy' is necessary to make optimal use of the potential of data preparedness, and entrant level use of computers and mobile devices to gather information is a necessary first step to collect the data. Additionally, future developments will increasingly require additional as well as different skills in humanitarian assistance. For example, the use of AI in decision-making will require new skills and capabilities in strategic planning. In addition, the technological infrastructure will have to be based on compatibility and interoperability between different systems.

The innovation process is a vital element in the narrative on technological innovation in humanitarian assistance.
The implementation and usage of technological innovation in humanitarian assistance and a process of humanitarian innovation are two different aspects. An assessment of the process of innovation falls outside of the scope of this study. Still, it is an important component in the narrative on technologically innovations in humanitarian assistance. Due to the different perspectives on technological innovation in humanitarian assistance, actors in the domain differ in their approaches to further innovation, such as grand challenges, innovation labs and hackathons. There is a strong discourse on 'the right way to innovate' in the humanitarian domain, including discussion on the directionality of development, user-centred and context specific innovation as well as local and frugal innovation.

In addition to the technological innovations discussed in this report, non- or low-tech innovations have the potential to further the 'Agenda for Humanity'. Overall, it is recognised that technological innovation should not be perceived nor embraced as an all-encompassing solution to the challenges identified by the humanitarian sector in the 'Agenda for Humanity'. Instead it is a tool that can facilitate the necessary steps to be taken in addressing these challenges.

7. Policy options

In Chapters 3 to 5, the report describes insights with regard to three research themes:

1. The context for, and ambition of, technological innovation in humanitarian assistance, including relevant policies and agreements as well as developments and trends.
2. The adoption and application of technological innovations relevant in the various stages of humanitarian assistance and an assessment of their desired as well as undesired impacts.
3. The concerns and opportunities related to technological innovations in humanitarian assistance considering the humanitarian context and the ambitions set out in various policies and agreements.

In this chapter, the policy options to further technological innovation in humanitarian assistance and thereby facilitate the 'Agenda for Humanity' are identified. These options seek to address the barriers for scaling technological innovations in humanitarian assistance and explore the potential of promising technological innovations. The EU and its Member States can support technological innovation in humanitarian assistance and its uptake through a set of mechanisms, for example with financial support or by facilitating dialogue and increasing awareness. Furthermore, as the largest multilateral donor, the EU can set requirements to incentivise the adoption of technological innovations in humanitarian assistance.

Due to the limited evidence-based research available it is not possible to formulate a definitive amount of funding required to further technological innovation in humanitarian assistance. However, the EU agenda for growth, the Europe 2020 strategy, prescribes an investment of three per cent of the EU's GDP in R&D necessary to ensure smart, sustainable and inclusive growth. Following this line of reasoning, one could calculate the amount of R&D funding necessary by the size of the total humanitarian assistance spending.

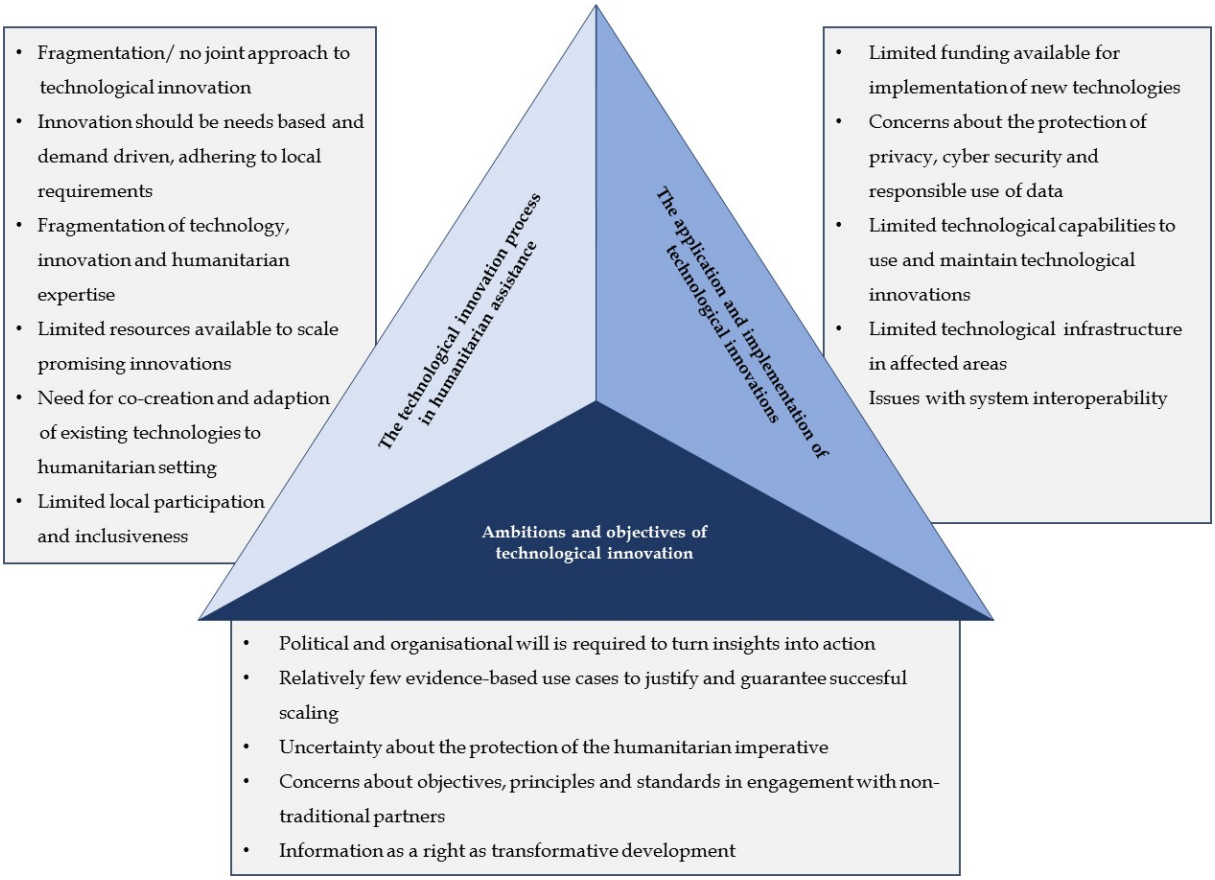
7.1. Addressing barriers to scale

Technological innovation in humanitarian assistance is a multidimensional topic and requires careful unpacking. In structuring the insights gathered in the research, a variety of dimensions are apparent. These dimensions are closely interlinked and related. Due to their interrelated nature, they are structured in the following way to facilitate a better understanding and to guide the exploration of policy options (see Figure 19):

1. **Objective:** The ambition and objectives of technological innovation in humanitarian assistance,
2. **Process:** The technological innovation process in humanitarian assistance,
3. **Application:** The application and implementation of technological innovation in humanitarian assistance.

The main barriers to scaling technological innovations in humanitarian assistance are clustered around these dimensions.

Figure 19 – Dimensions of key insights



Source: created by the authors for the purpose of this study

The research identified several areas in which technological innovations appear to facilitate the commitments set out in the 'Agenda for Humanity' and can enable the improved and continued provision of assistance to people affected by humanitarian crisis. Efforts and resources should be focused on addressing the barriers to scaling, such as concerns about privacy and cyber security, limited technological infrastructure and limited technological skills. Although efforts to further the ideation phase of the innovation process are relevant and necessary, various technological innovations already exist that may contribute to the 'Agenda for Humanity' and increase efficiency and effectiveness of humanitarian assistance when scaled. The policy options seek to address the main barriers to scale, thereby enabling the implementation and/or adoption of technological innovation in humanitarian assistance. One policy option may address several barriers. Instead of repeating them per dimension, these are included once in the option listings.

The potential of technological innovation in humanitarian assistance is recognised especially with regard to strengthening prevention and preparedness efforts. Technological innovations such as data preparedness, innovative financing and CTP, as well as (horizon 3) technological innovations such as AI, IoT and smart cities have the potential to contribute to the 'Agenda for Humanity', specifically with regard to addressing the humanitarian financing gap, overcoming the humanitarian–development divide, facilitating local ownership and increasing transparency.

7.2. Policy options

In this section the policy options are outlined for each of the three dimensions presented above in Figure ***19***.

7.2.1. Ambitions and objectives of technological innovations in humanitarian assistance

The main barriers concerning this dimension are:

Political and organisational will is required to turn insights into action
The potential of technological innovations in contributing to the 'Agenda for Humanity' is recognised and innovation is an integral part of activities seeking to address the challenges the humanitarian sector is facing. However, technological innovation is merely an enabler. Political and organisational will is required to turn insights into actions. For example, the shift from response activities to prevention and preparedness as well as the provision of multi-year funding to enable this shift require political effort and commitment, both of which are in itself necessary steps to further the 'Agenda for Humanity'.

Relatively few evidence-based use-cases exist to justify and guarantee successful scaling
Evidence-based use cases are relatively few and most technological innovations are still in the experimentation or pilot phase. Therefore, the experiences and lessons learned from use-cases should be made widely available to all actors active in the humanitarian domain. For example, use cases such as 'Building Blocks' provide concrete results and an evidence base to further scale technological innovations in humanitarian assistance.

Uncertainty about the protection of the humanitarian imperative
Experts stress the importance of recognising and embracing the core objective of humanitarian assistance as the main driver for technological innovation in humanitarian assistance. Providing timely and adequate assistance to people affected by humanitarian crisis and thereby alleviating suffering should be the main objective of technological innovation according to humanitarians. Although the transformation is embraced, change comes with uncertainty about identity and core values. This should be recognised and addressed to further the transformation of the sector.

Concerns about objectives, principles and standards in engagement with non-traditional partners
Private sector engagement in humanitarian assistance is nowadays more widely accepted. The conversation has shifted from '***should we collaborate?***' to '**how can we collaborate?**'. With this shift come concerns about (potential) differences in objectives, principles and standards. For example, there is no broad consensus yet on standards for technological innovation.

Concerns about the protection of the most vulnerable
Humanitarian assistance is guided by humanitarian principles. Therefore, technological innovations in humanitarian aid should adhere to these principles. A main concern identified is the protection of the most vulnerable, including the biases technology may introduce. This includes the potential invisibility of the most vulnerable, for example the digitally illiterate, people without access to mobile devices, as well as cultural- and gender differences in technology adoption. The research recognises the barriers due to the digital divide.

Information as a right as a transformative development

Although not a barrier, the adoption of 'information as a right' would be a transformative development for humanitarian assistance. It would change the humanitarian demand, responsibilities of actors active in the domain, their activities and subsequently structures. With digitisation changing the humanitarian context as well as the development of technological innovation in humanitarian assistance, the option of 'information as a right' should be further explored as it would significantly influence the way in which technological innovations in humanitarian assistance are perceived and pursued.

The following policy options could address these barriers:

Policy options
The EU should explore the principle of 'information as a (human) right' and its subsequent impacts on both the legal framework as well as the delivery of humanitarian assistance. In order to do so, it should conduct an initial study to identify ways of realising this. This study should have a dual focus, including both citizens in non-crisis situations and recipients of humanitarian assistance. The research can be conducted under Horizon 2020 or Horizon Europe.
The EU and the EU Member States should continue to urge local governments of risk prone countries to take prevention and preparedness measures when receiving early warning signals. Governments should be supported with funding and expertise to implement these measures, for example, through the development financing mechanisms such the neighbourhood, development and international cooperation instrument (NDICI).
The EU and the EU Member States should increase multiyear (earmarked) funding for prevention and preparedness measures that are implemented on the basis of early warning signals as well as innovative financing initiatives. The Humanitarian Aid Instrument should further enable risk mitigation and crisis prevention.
With the EU being the largest multilateral donor, innovation and innovation standards including collaboration between humanitarians as well as humanitarian and non-humanitarian partners such as academia and the private sector should be a standard donor requirement from the EU. Furthermore, donor funding for innovation should target scaling of existing technological innovations in humanitarian assistance. Funding should be geared toward effective and high impact implementation of technological innovations.
With regard to research programmes, the EU should incentivise actors to conduct thorough assessments of pilot programmes through dedicated Horizon 2020 and Horizon Europe programming for technological innovation in humanitarian assistance or Digital Europe programmes. The research programmes should focus on the implementation of technological innovation in humanitarian assistance. In addition, the EU should enable research into new business models for humanitarian assistance through programmes such as Horizon 2020 and Horizon Europe and should fund research on the state of the humanitarian landscape and the role of humanitarian actors with regards to values and ethics in the upcoming five years. This could be financed through innovation and research programmes such as Horizon 2020 and Horizon Europe.
The EU should support the development of a standard for technological innovation in humanitarian assistance. An addition to the sphere project or signal code developed by the HHI and its partners can form the basis of such a standard.

7.2.2. The technological innovation process in humanitarian assistance

The main barriers concerning this dimension are:

Fragmented/no joint approach to technological innovation in humanitarian assistance
Humanitarian organisations must manage their innovation portfolio strategically to ensure it enables the 'Agenda for Humanity'. The current humanitarian innovation efforts at times appear to be fragmented and scattered. To optimally spend the limited resources available, a focused approach is necessary, geared towards scaling a set of promising technological innovations. This can be facilitated by organisations such as GAHI and incentivised through donor requirements. The current innovation activities can be plotted on the three horizons of growth model and managed as a balanced portfolio. On the basis of the current research, technological innovations such as data preparedness, innovative financing and CTP (horizon 2) appear to have the most potential to contribute to the 'Agenda for Humanity'. In addition, technological innovations such as IoT, AI and smart cities (horizon 3) should be explored as they appear promising for the future.

Innovations should be needs-based and demand-driven, adhering to local requirements
The directionality of the process of innovation was stressed in both the desk research as well as the expert interviews. It is vital to start with the needs of people affected by crisis in mind and meeting context specific requirements. This in turn may lead to context specific technological innovations. This is specifically key with regard to product and process innovations. Additionally, given the time and resources required to develop and scale a technological innovation in humanitarian assistance, experts are eager to transform existing technology (horizon 2) to meet the needs of the humanitarian sector.

Fragmentation of innovation, technical and humanitarian expertise
Innovation, technical and humanitarian expertise are not all commonly represented in all teams active in the humanitarian domain. To further the innovation process, the disconnection between technical expertise and humanitarian expertise needs to be addressed by seeking collaboration with external partners. In addition, the digital skillset of the labour force active in humanitarian assistance needs to be improved. For example, data preparedness requires digital skills on multiple levels of the organisations, low cost and sustainable data collection devices in local communities as well as the activity of data preparedness embedded in the HPC.

Limited resources available to scale promising innovations to pilots
Relatively few technological innovations have successfully 'scaled' due to a variety of reasons including - but not limited to - short time horizons, lack of a systematic end-to-end innovation process, inadequate understanding of needs and requirements and risk-aversion. The necessary steps to facilitate successful scaling of innovations should be further explored and shared. Moreover, there is a need for evidence-based use cases to support the scaling of potential technological innovation. Reaping the potential benefits of technological innovations in prevention and preparedness efforts requires significant resources.

Need for co-creation and adaption of existing technologies
In addition to fostering new innovations and providing space for co-creation with partners, the potential of transferring existing technologies to the humanitarian sector and adapting these to the humanitarian context and its specific requirements are stressed as a means to shorten the timescales and limit the required budgets. Humanitarian expertise is required to adapt existing technologies

which have already been successfully applied to other domains. Furthermore, given the pressure on budgets and the wide variety of technological innovations in humanitarian assistance being explored, the need is stressed to pursue joint efforts to bring promising technological innovation, such as CTP, to scale by addressing challenges, facilitating implementation and sharing evidence-based use cases.

Limited local participation in the innovation process

Design theory in essence aligns with the humanitarian ambition of local ownership, inclusiveness and participatory approaches. Although people in risk prone and affected countries are increasingly perceived as innovators, it is a recurring topic in the literature that this should be further supported. Technological innovation in humanitarian assistance is more often than not conducted outside of risk prone countries and without the participation of vulnerable or risk prone communities.
The following policy options could address these barriers:

Policy options
The EU and EU Member States (together with partners in humanitarian assistance) should identify a set of most promising technological innovations and make these the priority in research programmes and funding mechanisms to study opportunities for practical application. From this research, investing in concrete innovations such as data preparedness, innovative financing and cash transfer programming (horizon 2) appear to have the highest potential. In addition, exploring innovations such as AI, IoT and smart cities (horizon 3) will offer opportunities in the future. For example, technological innovations in humanitarian assistance could potentially be embedded in the funding for 'future and emerging technologies' under Horizon 2020's excellent leadership pillar, or the various funding streams available under the societal challenges pillar, which include 'secure society' as well as 'climate action'.
The EU, as the largest multilateral donor, should incentivise user-centric design of technological innovations in humanitarian assistance, thereby ensuring technological innovations fit local requirements. The EU should make it a donor requirement for all its dedicated innovation funding and should continue to support collaborative initiatives which share best practices on user-centric design and participatory approaches such as GAHI and HIF.
The EU and the EU Member States should invest in the development of local ownership in the innovation process as well as the use of technological innovations by fostering dialogue to increase disaster risk reduction, for example, by making disaster risk reduction a priority of the geographic pillar of the Neighbourhood, Development and International Cooperation Instrument (NDICI). In addition, the EU should explore, with regional counterparts such as the African Union (AU) and the Association of Southeast Asian Nations (ASEAN), the potential of a joint innovation programme to increase local disaster risk reduction.

7.2.3. The application and implementation of technological innovation in humanitarian assistance

The main barriers concerning this dimension are:

Limited funding available for implementation of new technologies

Reaping the potential benefits of technological innovations in prevention and preparedness efforts requires significant resources. Adopting technological innovations may be costly due to procurement costs, costs associated with embedding the technology in the (organisations') digital infrastructure

and even training costs. Financial resources in the humanitarian domain are limited and mainly utilised for activities related to service delivery.

Concerns about the protection of privacy, cyber security and responsible use of data

These are recurring concerns in the narrative on technological innovation in humanitarian assistance. The principle of 'do no harm' is considered the minimum requirement underlying all policies and approaches in humanitarian assistance. The protection of data as well as responsible use of data is a significant concern which needs to be addressed to further technological innovation in humanitarian assistance. Specifically, in humanitarian crisis situations where people are vulnerable and dependent, humanitarian aid providers should prevent data breaches and privacy incidents because the potential negative consequences on human lives are significant. Additionally, ethical concerns with regard to data privacy and consent when using data-based technological innovations were identified, for example in the case of digital IDs, biometrics and big data analytics. The research suggests that cyber security concerns are valid due to the disconnect between technological possibilities and capabilities. To ensure the protection of people affected by humanitarian crisis as well as further technological innovation these concerns need to be addressed.

Limited technological capabilities to use and maintain technological innovations

Limited technological capabilities within humanitarian organisations and within local communities hamper the implementation of technological innovations. To further technological innovation in humanitarian assistance, the disconnect between humanitarian expertise and technological expertise needs to be reduced. Technological capabilities are required at all levels to use the technological innovation in humanitarian assistance. However, that this does not mean that the sector is required to choose to either develop in-house technological capabilities or outsource this to an external partner. Humanitarian organisations should have the resources available to develop the necessary technological skills to understand, adopt and implement technological innovations with regard to, for example, data preparedness. When considering humanitarian service delivery by other non-humanitarian organisations, CTP for example, humanitarian organisations require the skills, infrastructure and standards to be in place to assess needs and the appropriateness of innovations.

Limited technological infrastructure in affected areas

Technological skills and infrastructure within humanitarian organisations and in crisis affected areas are necessary to effectively adopt technological innovations. The technological infrastructure in countries affected by crisis may not be mature and robust enough for the technological innovations, and it is often destroyed or affected in a disaster or crisis. Additionally, for long-term sustainability of technological innovations, the technical capacity and capability to ensure long-term maintenance should be in place. Currently, most funding is earmarked for response activities and limited resources are available to enable the transformation required to effectively embed technological innovations in core processes.

Issues with system interoperability between organisations

Organisations providing humanitarian assistance use different systems and tools. System interoperability is necessary to enable several technological innovations. For example, data-oriented technological solutions have high potential for increasing effectiveness and efficiency in humanitarian assistance. Data needs to be made available and shared between different actors and access to joint systems may be necessary.

The following policy options could address these barriers:

Policy options
The EU should continue the EIC pilot to provide access to funding. In addition, the EU and EU Member States should limit prizes for broad challenges and instead focus efforts and investments on 1) a selected set of challenges and ambitions as agreed in the 'Agenda for Humanity', and 2) scaling of existing promising technological innovations.
The EU should facilitate capability building with regards to privacy and responsible use of data through a dedicated skills agenda for humanitarian service delivery. This could potentially stem from an expansion of the Digital Europe programme and could be provided through an online education platform. The EU should make information available on best practices with regards to the protection of privacy and responsible use of data in humanitarian assistance based on its expertise due to the GDPR.
The EU should finance research on cyber security standards for humanitarian assistance through the digital Europe programme. The programme will help European societies and businesses to make the most of the ongoing digital transformation, while the humanitarian sector is facing similar digital transformation challenges.
The EU should facilitate the use of technological innovations in humanitarian assistance by facilitating skill and capacity development of humanitarian workers at both international and national level. The EU has several programmes in place to increase digital skills in the labour force, for example the digital skills agenda and the digital Europe programme. It may be possible to develop a dedicated humanitarian track within these programmes.
The EU should offer privacy and cyber security tools and checks to humanitarian service delivery providers to identify vulnerabilities and address risks. The EU should explore the possibilities of such checks being conducted by ENISA at the EU level and by a national Computer Security Incident Response Team (CSIRT) within each EU Member State.

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Annexes

Expert sessions

During the STOA High Level Expert Meeting on Technologies for Humanitarian Aid, held at the European Parliament in Brussels on September 7, 2017, the following panellists spoke:

- Eva Kaili, Member of the European Parliament (MEP), Chair of the Panel for the Future of Science and Technology (STOA)
- Enrique Guerrero Salom, MEP, Committee on Development (DEVE)
- Jean-Louis De Brouwer, Director for Europe, Eastern Neighbourhood and Middle East, Directorate-General for European Civil Protection and Humanitarian Aid Operations (ECHO), EC
- Andrew Harper, Director, Division of Programme Support & Management, Office of the United Nations High Commissioner for Refugees (UNHCR)
- Cyprien Fabre, Policy Analyst on Humanitarian Issues, Fragility, Conflict, Humanitarian aid, Global Partnership and Policy, Organisation for Economic Co-operation and Development (OECD)
- Alf Inge Wang, Professor, Norwegian University of Science and Technology (NTNU)
- Emi Kiyota, Founder of Ibasho, Ibasho (NGO)
- Imogen Sudberry, Head of the Brussels office of the International Rescue Committee (NGO)
- Agostino Miozzo, Director, Emergency (NGO)

The following experts spoke at the Roundtable Discussion on High Tech for Humanitarian Aid, held at the European Commission in Brussels on February 23, 2018:

- Maria Christina Russo, Director for International Co-operation, DG Research and Innovation (RTD) , EC
- Jean-Louis de Brouwer, Director for Europe, Eastern Neighbourhood and Middle East, DG ECHO, EC
- Marie-Claire Certiat, Managing Director Airbus Group Foundation
- Maarten van Herpen, (Former) Head of Philips Africa Innovation Hub
- Tim Forster, Technical Engineering Advisor, Oxfam
- Klaus Schönenberger, PL Essential Tech, Ecóle Polytechnique Federale de Lausanne
- Dikolela Kalubi, International Committee of the Red Cross (ICRC)
- Vincent Virgo, Shelter Research Unit, International Federation of Red Cross and Red Crescent Societies (IFRC)
- Glada Lahn, Senior Research Fellow, Energy, Environment, and Resources, Chatham House

The Minutes are available at
https://ec.europa.eu/research/eic/pdf/roundtable_tech_aid_minutes.pdf.

Interview protocol

Interviewee		Date	
Function			
Background			
Interviewers			

Objective

The objective of the interview is to get insights into:
The types of technological innovation (currently being used and upcoming) in humanitarian assistance and disaster risk reduction.
An assessment of technological innovation in humanitarian assistance, with regard to opportunities as well as concerns. And input for the assessment framework.
Policy options for technological innovation in humanitarian assistance.
Experiences with participations of new actors in humanitarian assistance, such as private sector actors.

Scope and Participants

We focus on the experiences and insights of the interviewees on the focus areas. We have conducted a literature review and can ask follow-up questions.
Interviews are conducted with participants from a variety of organisations to ensure that perspectives from multiple experts and stakeholders are included in the research. Interviewees are representatives from private sector, humanitarian organisations, academic scholars and policy makers.

Expected outcomes

We expect an improved understanding of the types of technological innovations currently being used, and explored, in humanitarian assistance, the experiences with these technological innovations, their potential and vulnerabilities. Specifically, with regard to the humanitarian principles and other (technical) standards.
As well as, ideas on policy options based on current experiences and gap analysis.

Notes for conducting the interview

The duration of the interviews is approximately 60 minutes. At the beginning of the interviewee, we check if interviewees have the time available. We reschedule and/or focus on priority questions if the time is not available.

We ask interviewees for their consent in participating in this interview. In principle, interviews are not recorded. A report of the interview is drafted by one of the interviewers and send for approval to the interviewee within the week. If a recording is required, the interviewer(s) will request the interviewee to provide consent, prior to the interview.

At the end of the interview, we explain the next steps incl. the interview report being shared within the week. And ask the interviewee if we may contact them for follow-up questions.
The interviews are semi-structured interviews. The following interview protocol does not have to be strictly followed in this order, rather these are points that should/could be discussed. The order can change depending on the natural flow of the conversation and the respective expertise of the interviewee. The interviewers can ask for clarification and check their interpretations and assumptions with the interviewee.

Ask for specifications such as references, illustrations with exact use cases and when possible introduction to other experts or publications.

Part I: Introduction (5 – 10 min)
Getting to know each other and inform about the purpose of the interview as well as the use of results. Manage expectations and answer questions of interviewee. Ask for consent to process the interview and use results in the project.

- Introduce the project
- Motivation for interview
- Expectation management
- Consent

Part II: Technological innovation in humanitarian assistance
Getting to know the major developments in the humanitarian domain with regard to technological innovation. Determining main technological innovations, their application and the results expected and sought. Identifying use cases and experiences with 'new' actor engagement in humanitarian assistance.

	Background of interviewee	• Could you tell us more about your background and expertise? • What are your experiences with technological innovation in humanitarian assistance?
	Background in technological innovation	• What is your understanding of technological innovations in humanitarian assistance? • Have you had experiences with technological innovation in humanitarian innovation?
	Current humanitarian landscape	• What does the humanitarian assistance landscape currently look like? • What has changed over the past 5 to 10 years? • Which changes do you foresee with regard to technological innovation?
	Current and new ICT technologies	• Which technologies do you currently see in humanitarian assistance? • Could you elaborate on the reasons why these technologies are being used in humanitarian assistance? • Could you elaborate on the ways in which these technologies are being used in humanitarian assistance. • Which technologies do you foresee being used, or should be used, in humanitarian assistance? • Could you elaborate on why these technologies will be used, or should be used in humanitarian assistance? • To which phase of the Humanitarian Programme Cycle or humanitarian activity do these technological innovations apply? *Specific area of interest* • Cash Transfer Programming and Innovative Financing
	Adoption of technology and innovation	• What do humanitarian organisations seek to achieve with technological innovations in humanitarian assistance?

		• How does technological innovation occur in the humanitarian domain? • How are humanitarian organisations implementing technology and technological innovations in humanitarian assistance? • Which humanitarian organisations and teams are implementing technological innovations in humanitarian assistance? • *Specific area of interest* • Disaster Risk Reduction
	Collaboration with third parties	• What is the role of private sector organisations in technological innovation in humanitarian assistance? • Which actors are participating, with regard to which technological innovations and in which (use) cases? • What is your perspective on private sector participation in humanitarian assistance, and why?
	Use cases	• Could you provide examples or use cases of technological innovation in humanitarian assistance? • In hindsight, what could have been done differently?
	Other	

Part III: Assessment of technological innovation in humanitarian assistance

	Impact	• What is the impact of technological innovation in humanitarian assistance? • What is being done with these insights and considerations? • What is the transformative power of technological innovation in humanitarian assistance?
	Legal Framework	• Which legal framework(s) need to be taken into consideration for technological innovation in humanitarian assistance? • Does this framework allow for technological innovation in humanitarian assistance? And, if there are gaps, which? • Is this legal framework widely known and adhered to?
	Ethical principles	• Which ethical principles need to be taken into consideration for technological innovation in humanitarian assistance? • Are these principles widely known and adhered to? • How to operationalize these ethical principles with regard to technological innovation in humanitarian assistance?
	(Technical) standards	• Are there standard procedures with regard to technological innovation in humanitarian assistance? • How are standard formulated and by whom? • Are these standards widely known and adhered to?
	Technology categories	• What are the (greatest) opportunities regarding technology in humanitarian assistance? • What are the (greatest) concerns regarding technology in humanitarian assistance?
	Actors	• What is the role of various entities in technological innovation in humanitarian assistance?

		• Beneficiaries • Businesses • Humanitarian organisations • (inter)governmental organisations • ...
	Use cases	• Could you provide examples or use cases to illustrate your expert opinion?
	Lessons Learned	• Are there any lessons learned identified? • Who identifies these lessons and with whom are they shared? • What is being done with these lessons learned?
	Trends/ Patterns	• Which trends or patterns do you recognize with regard to technological innovation in humanitarian innovation? • What are the main developments and/or areas of interests with regard to technological innovation in humanitarian assistance? • What are your main conclusions about technological innovation in humanitarian assistance?
	Other	

Part VI: Policy options

Current policy framework	• Which policies apply to technology innovation in humanitarian assistance? • What is their significance and/or impact? • Which actors are engaged? • Could you provide us with documentation on these policies and their impact?
Gap analysis	• Based on the major trends, developments, potential and concerns with regard to technological innovation, which steps need to be taken and by whom? • Which aspects in technological innovation in humanitarian assistance require more attention? • And more specifically, which aspects require specific (additional) policy? • Could you provide us with documentation supporting your expert opinion?
Policy options	• Are you aware of any policy developments of interest to technological innovation in humanitarian innovation, and if so, which? • Which actors are engaged? • What is your expert opinion on these developments? • Could you provide us with documentation on these developments?
Other	

Part VII: Closing

Wrapping up the interview by summarizing key findings and thanking the interviewee for his/her participation. Explaining follow-up process and requesting addition information and approval for follow-up questions.

Final thoughts	• We are at the end of the interview; do you have any final thoughts you would like to share with us? • Any last comments or questions you want to leave us with?
Publications	• Could you recommend any specific publication(s) to us?
Experts	• Could you recommend any other expert(s) to us?
Follow-up process	• Within the week, we will share with you the concept interview report • May we contact you in the future for follow-up questions and/or check assumptions and ideas with you?
Sign-off	• Thank you for the interview • Share contact information and availability

Interviewees

The following experts were interviewed for this study:

- Mr Ben Parker, Senior Editor with IRIN News
- Mr Maarten van Herpen, (Former) Head of the Philips Africa Innovation Hub at Philips
- Mr Nathaniel Raymond, Director of the Signal Program on Human Security and Technology at the Harvard Humanitarian Initiative (HHI) of the Harvard T.H. Chan School of Public Health
- Mr Rahul Chandran, Director of the Global Alliance for Humanitarian Innovation (GAHI)
- Mrs Stefania Giodini, Interim-Lead of team 510 at The Netherlands Red Cross
- Mr Paul Musser, Vice President of International Development for MasterCard
- Mr Nino Nunes, Global Displacement Tracking (DTM) Coordinator, International Organisation for Migration (IOM)
- Mrs Chloe de Soye, European Commission, DG for European Civil Protection and Humanitarian Aid Operations (ECHO)
- Mr Alexis Marchand, European Commission, DG for European Civil Protection and Humanitarian Aid Operations (ECHO)
- Mr Mathew Keyes, European Commission, DG for European Civil Protection and Humanitarian Aid Operations (ECHO)
- Mrs Anna Dmitrijewa, European Commission, DG for European Civil Protection and Humanitarian Aid Operations (ECHO)

Technological innovation can play a role in addressing the challenges of the humanitarian sector, including preventing and reducing human suffering during crises. The objective of this study into the fast-moving, dynamic and emergent field of humanitarian technological innovation is to analyse the impact of these innovations as transformative tools both for people in need and those providing humanitarian relief. The study provides an overview of the current state-of-play and developments with regard to ICT-related innovation in humanitarian assistance. Based on the concerns, opportunities and benefits identified, the study provides a set of policy options to further technological innovation in humanitarian assistance.

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