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New Technologies in Humanitarian Logistics

Abstract

Objective: The aim of the article is to present new technologies and the possibilities of their implementation by entities involved in the implementation of logistics activities (humanitarian logistics).

Research Design & Methods: To achieve the assumed goal, the method of analysing literature in the area of humanitarian logistics and new technologies related to the so-called digital revolution is used. Based on a literature review, general considerations on humanitarian logistics were related to the needs of business models of entities carrying out humanitarian aid activities in the implementation of new technologies.

Findings: The article outlines the role and importance of new technologies in humanitarian logistics, which is an interesting and prospective research area. All presented examples of new technologies that are used in humanitarian logistics are extremely important for the easy, fast, and effective flow of information, finances, and supplies with humanitarian aid. The key to success is appropriate use of technology while ensuring the security of humanitarian supply chains.

Implications / Recommendations: There is a need to deepen research in the field of humanitarian logistics, because identifying needs and barriers in the implementation of humanitarian logistics processes can significantly streamline and improve the effectiveness of humanitarian supply chains.

Contribution / Value Added: The article shows that the role of new technologies treated as support for aid activities in humanitarian actions is the ability to quickly obtain and disseminate information that guarantees the effectiveness and efficiency of the undertaken actions. New technologies are an element of new business models of organisations involved in humanitarian aid.

Article classification: theoretical/review paper

Keywords: humanitarian relief situations, revolution 4.0, new technologies, humanitarian logistics, business models

JEL classification: H12, H84, Q55, O35

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Introduction

No matter where humans appear, the effects of their activities can be seen. The positive ones include urban development, technical and technological progress, and new discoveries and inventions that improve the quality of life. Unfortunately, the negative ones are more visible, e.g. environmental pollution, environmental degradation, or deepening social inequalities. As a result of their activities, humans bring undesirable situations in the form of initiating armed or ethnic conflicts or causing natural disasters. These situations cause many people to suffer and need the help they can get from entities and people who can provide such help.

In today's volatile world, delivering humanitarian aid is a complex undertaking. The demand for humanitarian aid is growing faster than the capacity to deliver it, resulting in a growing number of people whose life needs remain unmet. Humanitarian actors are required to act to ensure that aid is delivered as quickly as possible. The only way to make relief efforts highly effective is through humanitarian logistics, which should be treated as a key priority in all humanitarian projects.

Humanitarian organisations recognise the need to update their approach to the flow of physical goods (humanitarian resources) and information along supply chains, in order to deliver aid efficiently and effectively. All relief efforts rely on information, which should be timely and reliable. The reliability of information determines where, what, how much, and to whom it will be sent. The rapid transfer of information and data is made possible by the development of digitisation. Therefore, the purpose of the article, based on a systematic review of the literature, is to present new technologies and the possibilities of their implementation by those involved in the implementation of logistics activities (humanitarian logistics).

Literature review

Situations requiring assistance

Increasingly, through the media, we are learning about situations occurring in various corners of the world that require humanitarian aid. Situations requiring humanitarian aid are a collection of numerous and varied events, viewed in the category of disasters. The term "disaster" describes a sudden and unexpected event with negative consequences in the form of the loss of life and property, a phenomenon tragic in its consequences, covering a large area (*Słownik języka polskiego*, 2023). In everyday language, a disaster is a sudden change in the characteristics of the world around us. Disasters are natural phenomena of the development of the world and are the consequences of human activity (destructive action negatively affecting the environment and society) (Hajder et al., 2014).

The most important causes of the emergence of disasters include the following:

1. violations of the natural equilibrium in nature through the indiscriminate use of scientific and technological achievements alien to the natural environment;
2. impediments to the natural regeneration of the biosphere: anthropogenic transformation of the natural environment as well as the massive exploitation of previously pristine areas of the Earth (Hajder et al., 2014);
3. sociopolitical instability and increasing religious, ethnic, political persecution, e.g. the situation in the Caucasus;
4. armed conflicts, e.g. the war in Syria or Ukraine.

The above-mentioned causes of the emergence of disasters make it possible to consider situations requiring humanitarian assistance in two categories: anthropogenic and non-anthropogenic disasters. Non-anthropogenic disasters are situations related to the forces of nature, especially intense precipitation, hurricanes, seismic shocks, landslides, fires, droughts, or the action of another element. These are known as natural disasters, calamities, or cataclysms. The United Nations defines a natural disaster as a situation in which there is a serious disruption in the functioning of a community or society involving human suffering, material, economic, or environmental loss, or an impact that exceeds the ability of the affected community or society to cope using its own resources (UNISDR, 2009). Anthropogenic disasters are events related to the occurrence of armed conflicts, the waging of wars and battles, as well as ethnic, religious, and political persecution and terrorism. They are the result of human actions. They can be referred to as “complex emergencies” (Łupicka, 2011).

Examples of disasters that humanity has experienced – e.g. genocide in Rwanda, famine in Sudan, the war in Ukraine, tsunami in Japan, earthquake in Haiti – indicates that each disaster is unique and causes different effects in the economic, social, economic, and, above all, health and social conditions of the affected population. It undoubtedly allows a preliminary assessment of the differences in the need for assistance in the event of a specific disaster and is the first step in planning humanitarian action (PAHO, 2001).

Humanitarian organisations

The consequences of the growing number of disaster situations include the involvement of many organisations in providing help. This growing trend makes us anxious and fearful on the one hand, and fills us with optimism and faith in people on the other. Negative feelings are related to information appearing in the media about disasters occurring in various and distant corners of the world. Positive feelings are the result of the work of many aid organisations and faith in people around the world who are committed to selflessly helping others in need. These are intergovernmental, governmental, or non-governmental organisations. They differ not only in their institutional and legal forms, but also in the ways in which they are involved in relief operations (directly, indirectly).

The largest group of humanitarian actors consists of entities directly involved in relief operations (PAHO, 2001). A brief description of such organisations is presented in Table 1.

A more detailed characterisation of the actors directly involved in humanitarian aid reveals great diversity of this group. These entities have the largest funds at their disposal. The type and size of the capital depends on the sources of its funding, e.g. they can come from contributions from member states, the European Union, government grants, or private donations. These organisations have the appropriate infrastructure, resources (material and human), and experience along with previously acquired skills and competencies, and are thus the ones with the greatest responsibilities in providing humanitarian assistance.

Those directly involved in humanitarian action can include so-called “grassroots” aid movements. These limitations do not apply to aid involvement by independent volunteers. The involvement often consists of trips of a few days or a few weeks (short term volunteering), with irregular frequency or on a one-off basis. Some activities are carried out over a longer period of time and include multi-month stays in camps.

Table 1. The characteristics of selected humanitarian organisations directly involved in humanitarian operations

Type	Abbreviation	Full name	Description
UN agency	UNDP	United Nations Development Programme	It promotes and supports disaster preparedness activities in member states. In a disaster situation, the UNDP Country Office provides support to the government, helping to report humanitarian needs from other countries and coordinating the work of other UN agencies.
	WFP	World Food Programme	It provides and coordinates humanitarian assistance for food supplies. In the case of large-scale emergencies, it often also takes over as the main coordinator of logistical operations.
	UNHCR	United Nations High Commissioner for Refugees	Its mission is to protect refugees and seek lasting solutions to their problems. The UNHCR coordinates all activities for refugees.
	UNICEF	United Nations Children's Fund	Its main focus is health, education, and care for women and children in developing countries. During an emergency, UNICEF is involved in providing water, food, sanitation, health care, and social assistance, among other things.
International agency	ECHO	European Community Humanitarian Office	It works with non-governmental organisations, especially UN agencies, providing food and other humanitarian aid as well as helping refugees and the homeless.
	OAS	Organisation of American States	A regional organisation that supports its members by assessing exposure to natural disasters and implementing measures to help mitigate their negative effects. It provides technical support and training.
	CDERA	Caribbean Disaster and Emergency Response Agency	A regional organisation established by the countries of the Caribbean Community. It is headquartered in Barbados and includes 16 members. Its main functions include coordinating the response to and recovery from a disaster affecting any of its member states.
Intergovernmental organisations – NGO	IFRC	The International Federation of Red Cross and Red Crescent Societies	It coordinates humanitarian relief efforts in crisis-affected countries through national affiliates, and in their absence, through its own staff. Years of experience and extensive resources make it the largest non-governmental humanitarian organisation.
	ICRC	International Red Cross Committee	It protects and assists victims of armed or civil conflict and oversees compliance with international humanitarian law.
	MSF	Médecins sans Frontières	Its operation is focused on providing medical aid, but it has an extremely rich logistical background and experience in treating water sources, building sanitation infrastructure, and providing temporary shelters.
	-	Caritas Internationalis	It promotes, coordinates, and supports humanitarian aid and long-term reconstruction.
	OXFAM	The Oxford Committee for Famine Relief	It provides funds and technical support for emergency and long-term humanitarian assistance during emergencies.

Source: Own elaboration based on PAHO, 2001, pp. 30–34.

Volunteers often come together in informal groups to form grass-roots movements (grass-roots movements) for aid. Only some of the groups formed in this way transform into more

institutionalised ones and regulate the legal status of their *de facto* activities. Therefore, their activities are more flexible, but also less regular. Entities in this group have capital in the form of time devoted to aid and material resources, most often from in-kind or financial collections (Mazur, 2017).

In addition, individuals and legal entities are increasingly involved in humanitarian actions. Having no direct contact with those in need, they carry out relief activities in an indirect way by taking a number of initiatives to provide financial support to directly operating organisations or donating given items for collections (e.g. blankets, firefighting equipment, medicine, food).

Humanitarian logistics

The diversity of emergency situations and the specificity of the conditions in which humanitarian aid organisations have to operate generates an increasing interest in logistics. In practice, this means that aid organisations use the solutions offered by business logistics while recognising the difference and specificity of the activities undertaken, which aim to help those affected by disasters and reduce their suffering. Therefore, the implementation of humanitarian aid tasks is often called “supply chain for life” (Łupicka, 2011), humanitarian logistics (Pokusa, 2022), or humanitarian supply chain (Marcinkowski, 2019).

In the most general terms, humanitarian logistics, or humanitarian action logistics, refers to the activities involved in organising, planning, directing, and checking the efficient flow of materials, finances, and information from their generation to their consumption to meet the needs of recipients in humanitarian action (European Commission, 2021). Therefore, humanitarian organisations focus on performing the logistical tasks of acquiring the information necessary to ensure an adequate supply of goods and services (humanitarian aid – medicine, medical supplies, water, medical care, etc.) Humanitarian logistics refers to the processes and systems involved in mobilising people, resources, skills, and knowledge to help people in need in areas affected by natural disasters or complex emergencies (Lawry-White et al., 2019). The humanitarian supply chain includes the assessment, procurement, storage and transport, and rapid movement of people and materials, and the main goal is to help as many people as possible (Ramezani & Ghorbani, 2020).

The diversity of emergency situations and the specific conditions of humanitarian organisations equip the logistics of humanitarian actions with a number of non-standard features, and these are primarily:

- enforced speed of action, and thus short time to organise the action;
- the lack of a range of information needed to plan and execute logistics operations;
- limited resources and infrastructure (due to destruction or lack thereof);
- the unpredictability of demand and supply;
- in contrast to the most common approach, i.e. economic logistics, the issue of cost recedes into the background (Jaroszyński, 2011).

Therefore, humanitarian supply chain activities should focus on delivering humanitarian assistance in a coherent and effective manner, through the systematic use of instruments, i.e. strategic planning, data collection and information management, mobilising resources and ensuring accountability, coordinating the functional division of labour in the field, political negotiations, and providing leadership (John et al., 2012). Thus, it is not difficult to agree that the smooth execution of humanitarian action is a challenge of the highest degree of difficulty, and one should

be aware that in the face of unusual and enormous tragedies, it is highly likely that not all those in need will be helped in time.

The effectiveness of the humanitarian action carried out is affected by two issues:

1. It is the matter of the readiness and full commitment of all responsible actors to all actions and appropriate management of the emergency situation. This issue underscores the importance of cooperation among all humanitarian actors, involving the exchange of knowledge and experience as well as the readiness to take appropriate action. This closely involves the monitoring and constant control of areas at risk as well as the creation of an action plan. In addition, all links in the supply chain involved in humanitarian operations become interdependent so that each actor in the supply chain is responsible for supply from the moment the resources are obtained until they reach their destination.
2. All humanitarian aid activities should be guided by three overriding values: humanitarianism, neutrality, and objectivity. Humanitarianism is understood as restoring human dignity and reducing human suffering as well as saving human lives while respecting the individual. The principle of neutrality means “the autonomy of humanitarian and political goals” (Szołtysek, 2010) and thus providing assistance to all those in need, regardless of their affiliation to any group. This principle is particularly applicable during armed conflicts. The principle of impartiality dictates that aid should be provided according to the degree of the urgency of the needs that have arisen and in proportion to them, and not on the basis of any other criterion.

Emerging situation – disasters – require actions in which the main factor in decision-making is the time of providing and reaching help. The activities undertaken so far show that research is unsystematised and does not present a holistic approach, indicating the need for further work to improve the implemented processes (Marcinkowska, 2023).

New technologies in humanitarian organisations

The emergence of the term “new technologies” is associated with the so-called digital revolution or digital transformation, which, due to the specifics and needs of the organisation, should be considered individually. In the literature, “new technologies” are identified with, among other things:

- a collection of technologies and ideas for creating a modern supply chain;
- connecting devices within digital ecosystems, and with deepening integration within horizontal and vertical value chains;
- a conceptual aggregate including the Internet of Things, cloud computing, Big Data analytics, artificial intelligence, and simulation techniques, among others (Placzek, 2018).

Increasingly, aid organisations are recognising the need for a digital transformation involving the implementation of new technologies into their aid efforts. New technologies are first and foremost technological know-how that mark a change in business models. For many entities, this means an evolutionary shift from traditional business models to new models for operating in a digitised world. For humanitarian organisations, changes in business models involve the use of new technologies to increase productivity and efficiency as well as improve processes along the humanitarian chain, and the way organisations communicate and collaborate.

Humanitarian organisations, recognising the need to improve their ongoing relief operations, make decisions to implement new technologies. These are often very difficult decisions due to

financial, technological, or social constraints. Below are some examples of new technologies that humanitarian organisations are trying to implement into their operations through applied humanitarian logistics (Placzek, 2018):

- 1) **Blockchain technology** (the future of supply chains, it can be called a digital ledger, or electronic ledger responsible for recording the list of transactions that take place within the network). In humanitarian logistics, this technology allows one to: monitor and control shipments in real time; improve information sharing; increase security and transparency; provide the ability to store shipping documents, permits, and contracts; and allow smart contracts (contracts can be converted to computer code, where an asset or currency is transferred to a blockchain-based programme).
- 2) **The Internet of Things (IoT)**, which is revolutionising the way humanitarian operations are conducted. The IoT creates a network of devices, vehicles, and other objects capable of collecting, processing, and actively exchanging data. In humanitarian logistics, especially in transportation, IoT solutions provide the ability to connect various assets within a supply chain in a meaningful way, and then allow analysis of the data generated from these connections. This, in turn, enhances the efficient operation of warehouse logistics, humanitarian supply organisations, or fleet management. By transmitting data over the Internet, using RFID facilitates and real-time monitoring as well as tracking supplies and assets increases the efficiency of operations and contributes to faster response times. In addition, using sensors and networked devices, the temperature, location and other parameters of cargo can be monitored, enabling rapid response to unforeseen problems that arise (see: Kolenda, 2016).
- 3) The term **Big Data**, referring to large data sets, which by their complexity must be processed by modern technologies. Big Data technology makes it possible to collect data very quickly and then analyse it to arrive at specific conclusions.
- 4) **Drones** – unmanned aerial vehicles – which are a method for delivering various types of shipments to places that are hard to get to by other means. The most common use of drones during humanitarian operations is:
 - mapping for crisis areas – this applies to traditional two-dimensional cartography as well as already more complex three-dimensional models;
 - delivery from the sky – delivery of medical supplies, food, water;
 - search for the missing (search and rescue operations) – with the use of thermal imaging cameras, large areas of land can be searched very quickly to find the missing;
 - the safety of the needy – ongoing analysis of the situation so that emergency services know in real time where the worst situation is and where they should go first to be able to take care of their safety; with the help of cameras from the sky, the migration routes of refugees are also tracked, or the roads on which trucks with supplies travel (see: Drony w akcji..., 2019).
- 5) **Cloud computing** – in logistics (humanitarian logistics) it is a remedy for the problems associated with changing server space requirements. Distributed computing structures allow remote storage and processing of data (see: IT.integro, 2023).
- 6) **Humanitarian logistics**, which also uses data analysis and artificial intelligence technologies to forecast and plan operations; machine learning algorithms can analyse historical data, weather factors, demographic trends to predict needs and optimise the delivery of humanitarian aid.
- 7) **Virtual and distributed reality (VR and AR)**, which are the future for humanitarian relief organisations. They are used in virtual training and simulations designed for future and current

humanitarian workers. Through virtual and augmented reality devices, new employees can gain the practical experience needed in emergency situations, allowing them to be better prepared for operations.

- 8) **Geolocation**, which enables the determination of geographic location using GPS or IP address. It is used in the management of distributed assets, vehicle fleets, and remote teams of employees.
- 9) **Portals and applications** used to gather in one place information about the activities carried out by all aid organisations in a given territory. These is primarily information on access to medical assistance, sources of drinking water, food, and shelter, but also legal assistance – usually available in two or more languages. The effectiveness of these portals and applications depends on how much the activities of the volunteer groups or organisations in question are reported to their creators and then updated. It is on the action of these entities that the achievement of the economies of scale depends. The more shared, verified information and the more active users, the greater the effectiveness of the tools in question. The capital in this case is the information itself. The possibilities for their flow owing to technology are enormous. The problem which remains is about the effectiveness of their use (Mazur, 2017). We observe that social media platforms have simplified the process of soliciting donations (donation buttons that can be added to pages and integrated into posts) and accelerated the collection of needed relief supplies (e.g. medicine, food, water, and funds) among those interested in helping.

All of the presented examples of new technologies that are being used in humanitarian logistics are extremely important for the easy, fast, and efficient flow of information, finance, and humanitarian supplies. The key to success is the appropriate use of technology while ensuring the security of humanitarian supply chains (including data).

Discussion

The advantages and disadvantages of new technologies

In order to meet the challenges of the modern world, humanitarian organisations are forced to follow current trends in digital reality. Knowledge and use of new technologies allows humanitarian actors to achieve their goals. However, it is important to remember that the adaptation of new technologies in humanitarian logistics brings many advantages, but can also face barriers. Table 2 shows some of the main advantages and barriers associated with the use of new technologies in humanitarian logistics.

Despite these potential barriers, humanitarian organisations are realising the benefits of adapting new technologies and are striving to use them to improve their logistics operations and deliver humanitarian aid effectively and efficiently. New technologies have great potential to improve the efficiency and effectiveness of humanitarian logistics operations.

By understanding how new technologies work and mitigating any potential risks associated with them, humanitarian organisations can benefit from their use in a variety of relief situations. Wise use of new technological solutions allows organisations to operate.

Table 2. The advantages and disadvantages of new technologies in humanitarian logistics

Advantages	Restrictions
<ul style="list-style-type: none"> • rapid and efficient delivery of humanitarian aid (drones, IoT, mobile apps); • the identification and localisation of locations where assistance is needed; • better inventory management, minimising losses, excluding fraud, tracking shipments (IoT, blockchain); • the optimisation of resource utilisation, the automation of logistics activities (robotics, data analytics, AI); • minimise risks for humanitarian workers and volunteers (drones, AR/VR technology, robots); • provide a venue for efficient communication between all participants in the supply chain; • allow communication with all business partners and donates within a consistent interface and any devices (cloud computing); • enable low-cost and easy data archiving, streamlines billing, and reporting processes (big data, cloud computing). 	<ul style="list-style-type: none"> • high implementation costs associated with the purchase of hardware, software, or staff training; • limited infrastructure, including, for example, telecommunications infrastructure; • the dehumanisation of aid; • the lack of trust due to the potential for military use (drones) or information leakage (cloud computing); • the accumulation of large amounts of data at the same time creates a threat in the form of hacking attacks and causes a questionable sense of security to the type of information shared (Big Data); • complexity and a small number of specialists involved in creating businesses using new technologies (blockchain).

Source: Own elaboration.

Conclusions

New technologies – technologies 4.0 – are used by all types of humanitarian organisations. With their help, intergovernmental organisations collect data on needed aid resources, non-governmental organisations have the ability to spread information on aid opportunities among aid recipients, and volunteers are given the ability to acquire the resources needed to carry out aid activities in order to provide direct assistance. This is a necessity that guarantees the efficiency and effectiveness of humanitarian logistics.

Based on the Technology Report (Nonprofit Tech for Good, 2019), one can infer what the future of new technologies in humanitarian logistics will be. In the survey, NGOs were asked to answer how they understand the above-mentioned new technologies (Figure 1).

Figure 1 shows that, in general, NGOs have a good understanding of new technologies, regardless of the continent on which they operate. The differences that occur may be due to, among other things, technological sophistication, access to adequate infrastructure, and the difficulty of attracting employees with skills and competencies in the area of new technologies. Due to the complexity and small number of specialists involved in creating “businesses” using this technology, blockchain shows the greatest lack of understanding (60%).

The effectiveness of the used new technologies varies depending on the type of emergency and current changes in the areas covered by relief efforts. No less so than the impact of new technologies on relief efforts to date is mostly about using the existing solutions in new realities. The use of new technologies by humanitarian organisations generates the need to constantly adapt business models to the way they operate in the growing complexity and uncertainty of emergencies.

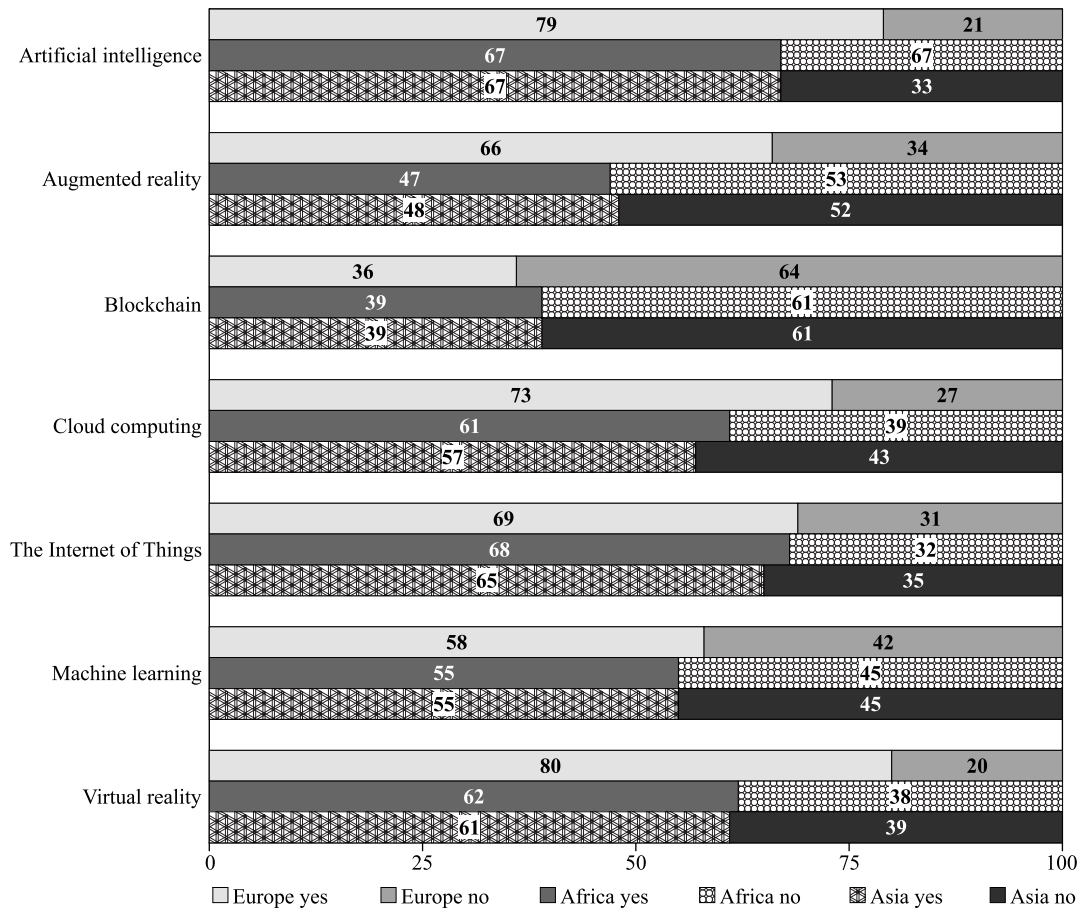


Figure 1. How well NGOs understand new technologies (in %)

Source: Own compilation based on Nonprofit Tech for Good, 2019.

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Research Ethics Committee

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Data Availability Statement

All data will be available and shared upon request.