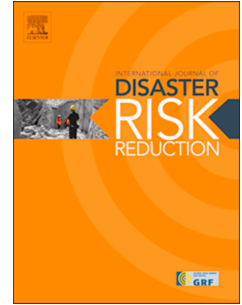


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Technological Advancements in Humanitarian Aid

Editorial

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1. Introduction

In the rapidly evolving landscape of humanitarian aid, technological advancements have created new possibilities to improve the efficiency, effectiveness, and sustainability of humanitarian operations. However, the humanitarian sector is associated with slow technology adoption rates and poor information and communication technology infrastructure (Frost et al., 2022). This necessitates exploring how technology can be contextually embedded and how the sector's peculiarities can be addressed to achieve “technological advancements in humanitarian aid.” This is the purpose of this special issue.

Humanitarian organizations have long suffered from a disconnect between headquarters decision-making and execution in the field due to the poor visibility of headquarters over field operations (Zarei et al., 2019). Digital technologies have shown the potential to fill this gap and offer a more connected and coherent humanitarian value chain. Humanitarian organizations enabled with information and communication technologies show a faster response and better coordination for relief operations (Ghadge, 2023). That is why the humanitarian aid arena has witnessed a shift, although much slower than in the commercial setting, towards emerging technologies in the past decade. Blockchain, big data, 3D printing, drones, and more recently Artificial Intelligence (AI) have found their applications in the sector. The application of blockchain contributes to visibility, traceability, trust, and transparency in humanitarian supply chains (Baharmand et al., 2021). AI and big data offer more agility and resilience (Dubey et al., 2022). Drones complement human skills for delivering lifeline medical aid such as vaccines or blood to remote areas, as well as remote sensing and surveillance of affected areas (Rejeb et al., 2023).

Overall, the convergence of technological advancements and humanitarian aid is the future of the field (Van Wassenhove, 2022). This special issue is a step forward to facilitate this convergence by providing space for discourse at the intersection of technology and humanitarian aid.

2. Overview of the Special Issue Content

The special issue involves seven articles employing a blend of quantitative and qualitative methods. While the special issue was open to traditional and emerging technologies, all the published articles study emerging technologies. The key topics addressed include advancements in cash and voucher assistance, new applications of data mining, AI, and drone management.

Cash and voucher assistance (CVA) was the main theme of the issue, with four out of seven articles having been published. The use of CVA in humanitarian aid has gained significant traction in recent years, driven by its potential to provide efficient and dignified assistance to vulnerable populations (Vogel et al., 2022). Research has highlighted the multidimensional implications of CVA, emphasizing the importance of coordination, effectiveness, and cost-efficiency in addressing pressing issues such as food insecurity and promoting local economic empowerment. The following summaries provide an overview of four articles that explore the opportunities and challenges associated with the digitalization of CVA:

Maghsoudi et al. (2023) evaluated the risks and benefits of digitalization in CVA programs in conflict-affected settings. The article explores the impact of digital technologies on identification, registration, value transfer, and monitoring processes. While digitalization can improve cost-efficiency, timeliness, and quality through enhanced data security, functionality, and financial inclusion, the article also identifies risks related to technology, operational capacity, contextual limitations, and infrastructure challenges. It emphasizes the need for careful consideration and mitigation strategies when implementing digital technologies in CVA programs.

Abdelgawad et al. (2023) examined the state-of-the-art of digital delivery mechanisms for CVA in refugee crises. The article highlights the lack of consensus in the literature and practice on the most effective delivery mechanisms, such as bank accounts, mobile money, and prepaid cards. The research underscores the need for quantitative studies to assess the performance and compare delivery mechanisms across different contexts and beneficiary groups. Additionally, it identifies gaps in academic publications and practical guidelines for using digital delivery mechanisms in CVA.

Juntunen et al. (2023) explored the digitalization of CVA in the humanitarian context through a systematic review of the literature and case-based evaluation. The article discusses the impact of digital cash transfers on transfer security, transparency, data responsibility, and transaction costs. The study highlights the potential benefits of digitalization, such as cost reduction and increased financial inclusion, while also addressing challenges like delays, security issues, and trust issues that vary by region. The findings emphasize the importance of contextual factors in determining the success of implementing digital cash transfers.

Hart (2024) presented a cross-institutional analysis of design trends, enablers, and challenges in blockchain-enabled CVA delivery in humanitarian programs. By examining six pilot projects across four countries, her research applies human-centered design theory and case study methods to generate insights. The findings highlight frictions related to context, agency, and participation, proposing a framework for analysis based on process, people, program, and

product. The study concludes that the success of implementing blockchain technology in CVA is highly dependent on design, context, and stakeholder engagement.

The other three articles included in the special issue adopted quantitative approaches with AI employed in two. All three articles employed quantitative methods for efficient decision-making. Two of them focused on a novel technique based on AI for data analysis, while the third centered around a new technology (UAV) used for humanitarian aid purposes.

Khanmohammadi et al. (2023) considered multi-modal mining for humanitarian aid utilizing public social media as the main source for the research. They employed AI-based algorithms to extract insights from multimodal data, including text and images, with imbalanced datasets to achieve more effective humanitarian aid. They demonstrated that their proposed approach could lead to improved accuracy and precision of decision-making.

Nguyen et al. (2023) studied the possibility of using AI-enabled games to enhance the decision-making process in humanitarian aid. Various scenarios are generated within a simulated game used by the Australian Defence Science and Technology Group to consider the impact of different policies. The analysis results confirm that using the AI-enabled Adversarial Coevolution framework can enhance the efficiency and effectiveness of logistics planning for humanitarian aid.

Ghosh and Kuila (2023) studied the utilization of Unmanned Aerial Vehicles (UAVs) for data collection in disaster-affected areas. They formulated the problem using a mathematical model and subsequently developed a gravitational search algorithm. This algorithm considers a fitness function that incorporates energy efficiency, delay reduction, and load balancing for edge servers. Notably, their proposed search algorithm demonstrates superior performance compared to other evolutionary solution methods.

3. The Way Forward

While the special issue provides novel insights, technological advancements in humanitarian aid is still a burgeoning discourse, both for researchers and practitioners, with promising future research avenues. This section reviews future research opportunities for various relevant areas and proposes research directions arising from the convergence of technological advancements and humanitarian aid.

- **Emerging technologies:** An array of emerging technologies has the potential to be employed in humanitarian aid, with some being already employed or to be employed soon, such as drones, AI, blockchain, and 3D printing (Rodríguez-Espíndola et al., 2020), and some with applicability in remote future, such as airships, wearable devices, sensors, and digital twin. These technologies can offer breakthroughs to provide humanitarian aid more efficiently, effectively, inclusively, and sustainably. Future research needs to prioritize these areas:

- Addressing data protection and ethical considerations related to emerging tech
- Digital literacy for humanitarians and beneficiaries, upskilling and training needed to work with emerging tech

- Spillovers of digital tech for delivering humanitarian aid, such as digital discrimination and gender divide

- Cybersecurity and digital resilience for humanitarian aid

- **Digital transformation:** It is a systematic change towards employing digital technologies for better value creation, with three distinct stages: *a*) digitization (e.g., conversion of analog into digital information), *b*) digitalization (e.g., the addition of digital components to existing systems), and *c*) digital transformation (e.g., comprehensive digital platforms and digital business models) (Verhoef et al., 2021). It offers firms a more malleable, agile, and resilient design (Hanelt et al., 2021); very much-needed characteristics for humanitarian organizations when facing various contextual circumstances and different disasters.

Digital transformation is still in its infancy in humanitarian aid, and most humanitarian organizations still being either in the first stage (digitization) or, at its best, in the early second stage (digitalization). There is still a long way to go before intra-organizational comprehensive digital platforms and inter-organizational digital ecosystems can be reached. The migration requires a paradigm shift from reactive to anticipatory humanitarian aid (OCHA, 2021). Future research can study how humanitarian organizations can advance to these stages, what are the challenges on the path, and how can the lessons learned from the commercial setting be contextualized for them. Maturity models and longitudinal studies can shed light on the path paved and the next stages to come.

- **Cash and voucher assistance (CVA):** As the transition from in-kind to cash-based humanitarian aid accelerates, CVA will remain a dominant research stream for the years to come. CVA articles in the special issue (Abdelgawad et al., 2023; Hart, 2024; Juntunen et al., 2023; Maghsoudi et al., 2023) underscore the growing interest in leveraging technological advancements to enhance the delivery and effectiveness of CVA in the humanitarian context.

Despite the growing body of knowledge around CVA, several knowledge gaps persist; the role of CVA on health outcomes of infectious diseases such as AIDS/HIV and tuberculosis (Boccia et al., 2016; Heise et al., 2013), implementation challenges for humanitarian organizations (Holm-Nielsen et al., 2022), gender equality, gender-based violence, and women's empowerment (Blackwell et al., 2019), CVA's implications for humanitarian logistics (Heaslip et al., 2018), and alignment of blockchain technology with CVA (Hart, 2024) are some the under-researched areas to be addressed by future research. The articles in the SI highlight the need for continued exploration, stakeholder engagement, and context-specific strategies to address the associated challenges and risks.

- **Simulation, forecasting, and heuristic algorithms:** The development of new algorithms for data analytics, simulation, as well as new forecasting approaches are research directions to improve prediction accuracy and prescription effectiveness. While the field has enjoyed a growing number of studies using various data analytics and operations research techniques, future research requires a stronger practical orientation to create more impactful research (De Boeck et al., 2023). Developing models that consider incomplete data, an intrinsic characteristic of data in humanitarian aid, is also vital for future research.

Metaheuristic algorithms have mostly focused on one phase of the disaster. We need metaheuristics that integrate pre- and post-disaster phases. As for forecasting, the field requires approaches that offer forecasts on the supply side, especially unsolicited donations, forecasting for rapid-onset disasters, and forecasting in the mitigation and preparedness phases (Altay & Narayanan, 2022). Finally, quantitative studies should propel the field toward stronger theory building and testing (Gupta et al., 2019).

- *Relevance, relevance, and relevance!*: The research in the field of humanitarian aid has been criticized for lack of relevance for practitioners (Besiou & Van Wassenhove, 2019; Kunz et al., 2017). Much of the research we do in academia has little meaning or limited applicability to practitioners. This especially applies to emerging technologies, where conceptual models can be developed hastily to show the benefits of such technologies devoid of considering the relevance and contextual specificities of humanitarian aid.

Future research on technological advancement should be relevant, contextually applicable, and strongly related to humanitarian practice. This can only be done when we move from hype to impact (Van Wassenhove, 2022) and from aiming to generate universal knowledge to generating actionable knowledge that is particular, situational, praxis, and contextually embedded (Coughlan & Coughlan, 2002). Defining research objectives jointly with practitioners, conducting participatory research, and validation of results with practitioners are some of the ways to ensure relevance in future humanitarian aid research (Sabri et al., 2019).

- *Ethics*: Little research has been done on the ethics of using new technologies in humanitarian aid. Technological advancements are associated with ethical dilemmas and unintended consequences unknown to humanitarians, donors, and beneficiaries. Drones can be used as war machines and to collect data illicitly, if fallen into the wrong hands (Sandvik et al., 2017). AI can be used in the rapid targeting and elimination of civilians in mass quantities (McKernan & Davies, 2024). Biometric data of refugees can leak to the governments from which they fled (Human Rights Watch, 2021). These are just some of the examples showing that new technologies can steer the aid sector into uncharted waters with acute ethical tensions and undermine the principle of “*do no harm*”.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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