Artificial Intelligence for Sustainable Humanitarian Logistics

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INTRODUCTION

Artificial Intelligence (AI) involves the ability of machines to make decisions and do activities smartly with little or no human intervention. It is also famously described as an "agent" that can perceive its environment and perform actions to maximize its chances of achieving its goal. (Nilsson 1996). Since its boom in the 1980s, AI has been judiciously applied to a wide range of sectors, including social media (e.g., user behaviour analysis, language translation), banking (e.g., fraud detection), e-commerce (e.g., recommendation systems, AI-powered assistants), automotive (e.g., auto-pilot, auto-parking, road traffic analysis), healthcare (e.g., early disease detection, the discovery of new drugs, evidence-based telehealth) and even in governmental and justice decisions. This chapter seeks to discuss its application to sustainable humanitarian logistics.

Some of the factors powering the advances in AI include the increasing availability of supercomputing power and cloud resources, the efficient generation and documentation of data through various sources such as blockchain, Internet of Things (IoT), social media, mobile technologies, and the continuous emergence of innovative algorithms. Some of the standard algorithms or techniques used in AI modelling include single or hybrids of Artificial Neural Networks (ANN), Fuzzy Logic (FL) models, Genetic Algorithms (GA), Swarm Intelligence (SI), Random Forest (RF), Support Vector Machines (SVM), Naïve Bayes (NB), Optical Character Recognition (OCR), Natural Language Processing (NLP), among others. These algorithms support AI-based programs in performing specific tasks and can be incorporated into software or tools. In general, AI methods fall under supervised models, unsupervised models, deep learning (DL), reinforcement learning, deep reinforcement learning and optimization (Sun et al., 2020). Other applications of AI include computer vision, robotics, expert systems and speech recognition.

As an Industry 4.0 technology, AI is already a buzzword in logistics management, capable of revolutionizing supply chains (SCs) and unleashing new levels of efficiency. It has become even more accessible and affordable in recent times, making it more available. At large, AI can better coordinate the flow of information, goods and personnel between the elements of any SC network while enhancing its sustainability.

Humanitarian Logistics (HL), a specific field of logistics management, aids efforts in the response system to natural or manmade disasters. It involves the planning and activities to resolve the complicated logistical challenges that might be present. Disaster response management approaches utilizing the latest technologies such as AI are necessary to ensure smoother implementations as poor response to disasters could directly lead to loss of lives. Stages such as Risk assessment, Preparation, Response, and Recov-

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ery/Relief have to be fine-tuned for each type of disaster to ensure more efficient and effective rescue and de-escalation missions. By nature, disasters generally have high levels of uncertainty. In assessing the situation, having accurate and timely information is crucial. Precise prediction of how the situation could escalate is critical to ensure robust preparations. There is also a need for coherent coordination of all the elements (such as personnel, equipment, food, organizations) involved to ensure the smooth transition of all planned activities. AI can tackle each of the highlighted demands while helping to save lives, reduce environmental impact and preserve cultural heritage at the lowest cost possible. The authors of this chapter define *Sustainable Humanitarian Logistics* (SHL) as

the design and implementation of all the humanitarian logistics systems and operations directed to save as many lives as possible (societal) at the least cost possible (economical) while reducing the impact of disasters on the environment (e.g. reducing hazardous debris) and ensuring the conservation of the cultures disasters might impact (cultural).

These four sustainability factors (economical, social, environmental, and cultural) are jointly referred to as the Quadruple Bottom-Line (QBL) pillars from whose lens any activity has to be analyzed before being considered sustainable or not (see, Ülkü & Engau (2020) and Figure 1).

Figure 1. Summary of the QBL pillars

In what follows, a brief introduction to SHL is given, followed by a review of published studies showing the state of research on the application of AI methods to sectors of HL. Most of these studies offer the generation of new algorithms and tools that could be used to enhance specific logistics operations. This is followed by a table showing AI-based decision support tools already available in practice. Future research directions and a Conclusion are then provided.