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Assessing the factors for humanitarian logistics digital business ecosystem (HLDBE) using a novel integrated correlation coefficient and standard deviation - combined compromise solution (CCSD-CoCoSo) method

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A B S T R A C T

This study updates Humanitarian Logistics Digital Business Ecosystem framework coupled with the development of a proposed integrated CCSD-CoCoSo MCDM method to rank factors used in assessing humanitarian and business logistics actor's propensity to use, diffuse, and adopt a collaborative digital business ecosystem platform for their future operational use. Employing nine criteria derived from technology innovation theories and institutional theory, and 28 experts comprising our decision matrix. The findings report perceived relative advantage, perceived safety and security, and infrastructure and expertise as the top three vital criteria that experts believe when addressed in an ecosystem platform for humanitarian and business logistics actors it would encourage a collaboration for their sustainable future operations. With organisational culture and structure as the least prioritised criteria. The study concludes that the CCSD-CoCoSo obtained results are objective, validating, and that this model is useful and suitable for MCDM analysis and policy making.

1. Introduction

Humanitarian and business logistics sustainability are issues talked about globally in the 21st century. Inevitably, disasters occurring annually continue to affect lives, businesses, and economies. For example, the present global COVID-19 pandemic, Ebola (Liberia), earthquakes (Haiti, Nepal), Tsunami (Indian ocean countries), typhoons and tornadoes (USA, Japan, China) and others prompt humanitarian aids to be transported via relief organisations logistics channels (Besiou et al., 2018). The enormous demand, financial constraints and pressures associated with handling such disaster issues prompt support from business logistics companies and other stakeholders due to the high costs involved in the employment of logistics activities in moving needed relief supplies to beneficiaries. And despite these assistance given, such needed help tends to be sometimes on a short-term basis, thereby diminishing such sustainable efforts. To tackle these issues, the United Nations with other stakeholders developed the Sustainable Development Goals (SGD's) (notably under the SDG 17) as a means of curbing these challenges (UN-DESA, 2015). Consistent efforts employed by stakeholders in supporting the SDG's implementation helps make it a reality. Supporting humanitarian logistics operations are mostly done via collaborations between humanitarian and business logistics actors. Thus, complementing each other's effort to address challenges they face. Notable issues not limited to optimisation, sustainability, risks, communication, and decision making employment tools are addressed in such engagements (Bag et al., 2020; Chari et al., 2020; Dufour et al., 2018; Ittmann, 2020; Munyaka

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& Yadavalli, 2021; Mutebi et al., 2020; Rancourt et al., 2015; Sabri et al., 2019; Taymaz et al., 2020; Villa et al., 2017; VonAchen et al., 2016). Although collaborations are beneficial to their operational success, such motivations are sometimes based on intrinsic or extrinsic benefits the actors gain from such efforts. While humanitarian logistics organisations derive financial supports, in-kind donations, expertise, human resources, and others as some intrinsic benefits from the collaborations; business logistics organisations use that as motivation for their staffs, access to resources in areas that are inaccessible to them but accessible to humanitarian organisations**,** risk minimization, and others (S. Gupta et al., 2015; Hotho & Girschik, 2019; Kamstra & Schulpen, 2015). Also, business logistics companies are extrinsically motivated to collaborate with relief actors because of the internationalisation of their operations in other areas which requires Corporate social responsibility (CSR) efforts to build trust in the community they seek to operate in (Kühn et al., 2018); while, humanitarian logistics actors do so to encourage legitimacy, transparency, and accountability on the part of the donors (Kamstra & Schulpen, 2015). Despite the benefits humanitarian and business logistics actor may derive from collaborating to address relief issues, there are still barriers that hinder them from engaging in a collaborative operation.

Barriers hindering humanitarian and business logistics actors from collaborating include but are not limited to asymmetry of organisations mandates and alignment of missions, trust, lack of standardisation, information asymmetry, benefit and value appropriation to actors, and others (Bealt et al., 2016; Dubey, Altay, et al., 2019; John et al., 2019; Li et al., 2019; Nurmala et al., 2017, 2018; Papadopoulos et al., 2017). Addressing such challenges, researchers have advocated for the utilisation of new generational technologies such as big data analytics, block chain, drones, and others to help curb such problems they face when collaborating (Dubey et al., 2020; Dubey, Gunasekaran, Childe, Blome, et al., 2019; Dubey, Gunasekaran, Childe, Roubaud, et al., 2019; Papadopoulos et al., 2017). The United Nations (UN) World Food Programme (WFP), Logistics Emergency Team (LET), and other actors coordinate and collaborate under an inter-cluster, and ecosystem collaborative platform; till date long-term collaborative sustainable ecosystem remains a challenge. For example, LET has been a great asset for supporting humanitarian logistics activities in various part**s** of the world utilising their platforms and resources, nonetheless, they are activated when a big disaster occurs and when called upon (Cozzolino, 2021). Supporting the local capacity sustenance and development before, during and after a disaster needs attention before an international logistics actor intervenes. A goal the UN and other regional bodies strives to attain. Achieving that has it**s** hurdles. For example, Bealt et al. (2016) stressed that in a complex networked system of actors, addressing transparency, best practices, quality of services, collaborations, structuring of organisations, trust, and others are a moving force for such collaborative systems. Adding to that Baffoe & Luo (2020), also conceptually developed a framework called Humanitarian Logistics Digital Business Ecosystem (HLDBE) platform using dimensions such as Big data analytics (BDA), Ecosystem/ Platform(E/P), Governance and Law(G&L), Incentives and Innovation (I&I), Multi-actor Collaboration/ Integration (MC/I), and others as a means in encouraging decision-makers to employ, adopt and diffuse digital platform both locally and nationally; thus, gaining capacity sustenance and resilience prior to obtaining international support despite the magnitude of the disaster. For details on HLDBE see (Baffoe & Luo, 2020). To date, prospective users' willingness to join a digital collaborative ecosystem which serves their needs and supports their humanitarian logistics hurdles is a challenge. Because, it is based on whether to use, adopt, and diffuse a digital platform like HLDBE, a multi-criteria decision making (MCDM) method is proposed (thus, an integrated correlation coefficient and standard deviation with combined compromise solution (CCSD-CoCoSo)) to ascertain from experts who serve as academicians, policymakers, and practicians on the factors that would prompt decision-makers/ senior-level executives of humanitarian and business logistics organisations on their perceived future use, adoption, and diffuse of digital ecosystem platforms such as the one conceptually proposed by Baffoe & Luo. Applying HLDBE conceptual model to technology of innovation and diffusion theories (thus, diffusion of innovation, technology-organisation-environment framework, and institutional theory) to examine from experts' opinion the following are the innovations of this study:

i. Expansion of HLDBE framework

ii. Developing a novel MCDM model, thus, an integrated correlation coefficient and standard deviation (CCSD) with combined compromise solution (CoCoSo) to examine from experts factors that are seen as vital elements that could be utilised to achieve a collaboration between humanitarian logistics and business logistics organisations to use, adopt, and diffuse HLDBE.
iii. Also, to identify from the experts, which financial medium would aid such a proposed platform (thus, HLDBE) to be developed.
iv. More so, to identify the notable continent in the world that may likely use, diffuse, and adopt HLDBE as a future operational tool.

In achieving this objective, an axiological philosophical lens using technology diffusion and adoption driver constructs obtained from a cross-sectional quantitative survey questionnaire conducted on corresponding authors whose papers are among the top 30 cited papers found in Web of Science database from the period of January 2015 to May 2019 were used.

The structure of the paper is as follows: Section 2 focused on literature review, followed by the expansion of HLDBE as section 3, then after the method in section 4; section 5 for application of method; section 6 for results; section 7 for the discussion of the results and ends with section 8 as its conclusion.

2. Theoretical Background and Literature Review

The literature review focused on factors that may prompt decision-makers operating in humanitarian and business logistics organisations to collaborate under a digital ecosystem platform from the perspectives of experts. The articles employed fall in the domain of humanitarian logistics, business logistics, digital ecosystem platform, technology innovation and diffusion theories, and MCDM. Subsequent sections relate to technology use between humanitarian and business logistics organisation actors, followed by technology innovation and diffusion theories dimensions used in examining the perceived opinions of experts on the propensity of senior-level executives of HLO and BLC to utilise a digital business ecosystem platform like HLDBE. Then after a MCDM, thus and integrated CCSD-CoCoSo MCDM method is used to examine factors that are essential and others that need to be improved should a future HLO and BLC actor's collaboration under a digital business ecosystem like HLDBE is developed may serve a sustainable opportunity for their operation.

2.1 Technology employment in Humanitarian Logistics Organisations and Business Logistics Companies

The growing interdependence of humans, NGOs, governments, and private companies on digital technology globally continue to encourage progress and developments in dynamic economies and industries (Marzenna Cichosz, 2018). It's evident that logistics, transport companies, and humanitarian relief actors cannot do without technology as indicated in reports of consultants cited in Marzenna's and European Parliamentary Research Service Scientific Foresight Unit (STOA) works of literature (Capgemini Consulting, 2019; Marzenna Cichosz, 2018). According to the World Economic Forum, it is estimated that the growth of logistics digitisation will rise to 1.5 trillion dollars in the year 2025 thereby prompting the importance of technology in the beneficiaries/ consumer services sector (WEF, 2016). Global dynamic operations both in business logistics and supply chain, the humanitarian relief sector is changing through the utilisation of digital ecosystem platforms. The move to meet the increasing needs of consumers have prompted logistics and supply chain service providers to optimize their operations in an agile, cost-efficient, and consumer centred outlook for their business (Dubey R. A., 2017; Dubey R. A., 2018; de Camargo Fiorini, 2018; Adner, 2006; Govindan, 2018). Due to such employment, collaborations have been made on digital ecosystem platforms with partners, both competitors and non-competitors in leveraging the network efforts in meeting beneficiaries and customer's needs and demand (McKinsey, 2018). Users in the digital ecosystem platform harness the vast volume of data generated to create a system for crowdsourcing, capacity sharing, efficiency, and cost optimisation, eliminating or minimising waste in operations. Despite these benefits, there seem to be some concerns among platform users on issues such as platform dominance, information asymmetry challenges, different business models, differences in corporate laws and regulations which serves as a threat to their collaborative ecosystem existence (Lenkenhoff, 2018). And yet, digital technology is classified as a useful tool that has started to transform the logistics and supply chain industry in many sectors.

Digital technologies used in the humanitarian relief sector also play a significant role in addressing disaster issues globally. Since the 2008's, the United Nations has reiterated the importance of harnessing technology to improve global humanitarian coordination efforts as beneficiaries affected by disasters depend on aid for their sustenance (UN General Assembly, 2008). Significant progress has since been achieved through technology employment in humanitarian operations tailored towards addressing transportation routing problems, inventory shortage, and others (Ragini, 2018). For example, WFP's SCOPE digital platform and others. Despite the call of its use, the humanitarian field is yet to harness more on the use of digital technology for its operations. As a result of that, humanitarian users tend to rely more on commercial logistics and supply chain companies on addressing global humanitarian needs (Kabra, 2017). Not only do humanitarian organisations rely on commercial logistics companies, but business logistics companies also rely on humanitarian organisations in the event of disasters through a joint effort in addressing the challenges they both face. Humanitarian-business actors, practitioners, scholars, and policymakers alike have reiterated the need for a humanitarian-business logistics collaborative effort in addressing such challenges. Names used for such collaborations are inter-sectoral partnerships, public-private partnership (PPP), cross-sector partnership (Nurmala, 2018; Waddell, 1997; Clarke, 2010). Owing to the purpose of addressing internal and external problems they face with a focus on mutual centred benefits and adding to the views of Kovacs, Van Wassenhove, Beamon, Oloruntoba, Thomas, Nurmala, and others scholars searching for innovative ideas and solutions in planning, mitigating, and preventing the impacts of disaster on human lives, economies and businesses in this era of digital technology, stressed that another way of addressing that is the use of data-driven digital ecosystem platform (Kovács, 2009; Van Wassenhove, 2006; Beamon, 2008; Oloruntoba, 2009; Thomas, 2006; Nurmala, 2017; Baffoe & Luo, 2020; Kabra, 2017; N. Nurmala, 2018). Despite the importance of leveraging on the collaborative effort of a humanitarian-business logistics company, little research has focused on that (Dubey R. a., 2016; Bealt, 2016; Nurmala, 2017; N. Nurmala, 2018). This research extends previous research by using technology adoption and diffusion theories to examine the perceived opinion of experts in assessing important factors that future prospective users (thus, humanitarian logistics organisations [HLO] and business logistics companies [BLC]) may factor prior to their decision to use, diffusion, and adoption of a collaborative digital business ecosystem that serve the interest of HLO and BLC actors like the conceptually proposed future platform model by (Baffoe & Luo, 2020).

2.2 Technology of Diffusion and Innovation Factors for Studying Experts Perceived Opinion on Prospective Users Interest to Use, Adopt and Diffuse HLDBE

Empirically examining the perceived interest to use, diffuse and adopt HLDBE among humanitarian and business logistics actors as presented by Baffoe & Luo (2020) on "Humanitarian relief sustainability: a framework of humanitarian logistics digital business ecosystem", we use concepts highlighted in Diffusion of Innovation (DOI) theory; Technological-Organisational-Environmental (TOE) framework, and Institutional theory (Inst' T). These theories underline the essential elements used in soliciting experts' perceived opinion on the importance of HLDBE future use, diffusion and adoption for humanitarian and business logistics sustainability and development (Baffoe & Luo, 2020; Rogers, 1983; Rogers, 2003; DiMaggio, 1983; Lee, 2015; Tweel, 2012). Diffusion of Innovation widely used in understanding the beneficial and unbeneficial factors of an innovation aids decision-makers in their decision to use, adopt, and diffuse new technologies in an organisation. Proposed by Professor Rogers and applied in supply chain, financial, health, and other sectors, its factors have been statistically proven to be beneficial in aiding senior managers or donors to make informed decision on an innovation trail, use, and diffusion in an organisation (Valente, 2015; Brewer, 2016; Christ, 2016; Appel, 2018; Miranda, 2016). Based on the advantages of the innovation, persuasive factors not limited to cost minimisation, elimination of waste, agility of operations, transparency, accountability, profit, and value driven, risk minimisation and others influence their decision of employment. Understanding the pros and cons of the innovation to be employed Roger's reiterated that relative advantage, compatibility, complexity, trialability, and observability are factors that aid in cognitively examining from leaders their perceived interest of use, adoption, and diffusion of such innovation for their organisation (Rogers, 1983; Rogers , 2003; Rogers, 2010). Focusing on the proposed benefits and concerns that may arise from a collaborative hybrid digital ecosystem of humanitarian and business ecosystem as in the case of HLDBE, perceived relative advantage (PRA), perceived drawbacks (PDB), perceived security and safety (PSS) concerns were employed to understand the perceived opinions of experts. Questions and references used to examine expert's opinions on the subject are found in Table 1.

Addressing both internal and external influencing tangible and intangible factors that prompt decision-makers to decide on the use, adoption, and diffusion of an innovation, DePietro (1990), developed the framework Technology-Organisation-Environment (TOE) as an expansion of DOI. With its importance, Gangwar et al. (2015), indicated that managers' understanding of organisations resources, structure and capabilities coupled with the environment they operate in, well inform their decision on the use, diffusion, and adoption of an innovation. Thus, helping decision-makers to perceive the advantages and disadvantages of innovation before its implementation and adoption. Due to it practical implication Zhu (2004), Wang (2007), Wang (2010), and Gangwar (2015), TOE was used to assess the perceived interest of senior-level managers interest to use, diffuse, and adopt the conceptually developed framework platform (HLDBE) from the internal (thus, infrastructure and expertise [IE], Donor/ Top-level management support [DTS]) and external (thus, Normative pressure [NP], Law and Governance [LG]) perspective. For more information on the TOE framework see work of (Tornatzky, 1990). Related questions posed to experts are found in Table 1. With the important nature of humanitarian logistics organisations (HLO) and business logistics companies (BLC) operating in domains that requires attention to economic, political, and societal issues, institutional theory (Inst.T) as developed by DiMaggio and Powell (1983), serves as essential tool in examining innovation use, diffusion, and adoption. The theory also aids senior level managers to understand the micro and macro perspectives associated with organisational structure (OS) and organisational culture (OC) of the organisations associated with an ecosystem platform before a decision to join, use, diffuse, and adopt an innovation. As applied in the logistics field by (Dubey, 2019; Tsai, 2012). Based on the importance of a collaborative digital ecosystem (thus, HLDBE) for HLO and BLC actors in addressing future sustainable issues DOI, TOE, and Inst. T theories were used in understanding the internal and external dimensions prompting actors to use, adopt, and diffuse an innovation from the perspective experts. Please, see Fig. 2 and Table 1 for references, questions, and scale of measurements used.

2.3 Multi Criteria Decision Making (MCDM)

The liability and complexity of making wrong decisions by decision-makers and experts prompts an objective evaluation method of multiple criterias under consideration (Zavadskas et al., 2009). Sustainability, agility, value creation, and developments are pressing issues which are found in all organisations which require consented efforts of diverse actors in a network. Several studies in the logistics and humanitarian domain have employed MCDM but not with respect to a hybrid humanitarian and business logistics study perspective (Budak et al., 2020; Khan et al., 2018; Kim et al., 2019; Rezaei, 2015; Yılmaz & Kabak, 2020). This study seeks to do so. With the diversity of groups of decision-makers in the HLO and BLC sector coming under a common collaborative ecosystem platform to address pressing issues and problems confronting them, comes to a consensus via their diverse views of criteria and multiple attributes that calls for a compromise solution and understanding. Addressing the perceived relative importance given to a decision factor prompting the decision to collaborate as in the case of factors found in Table 1, decision makers may weights the multiple attributes either subjectively, objectively, or integrate them to form a robust means of decision making (Wang & Luo, 2010). Relying on subjective form of decision, weighting methods such as rank order distribution (ROD), point allocation (PA), approximation weighting, Delphi method, and others (Ahn & Park, 2008; Doyle et al., 1997; Hwang & Yoon, 1981; Roberts & Goodwin, 2002). Though subjective weighting aided in decision making, scholars advanced such methods by using an objective form to determine and evaluate the attributes of weights. Not limited to examples of some objective weighting methods are entropy, maximum deviation, standard deviation, ideal point method (Deng et al., 2000; Wang et al., 2020; Wang et al., 2016; Yejun Xu & Zhijian Cai, 2008). Although objective attribute weighting methods are used, still some subjective weighting methods are employed in research. As is the Delphi method employed for obtaining experts' opinion on an attribution. To robustly determine experts weights objectively on the attributes to be considered under the HLDBE context a hybrid multi-attribute weighting method called correlation coefficient and standard deviation (CCSD) was employed (Hanane et al., 2016). See Y.-M. Wang & Luo, (2010) for more details on CCSD weighting method. With the diversity of experts making decision on factors to examine users (HLO & BLC) perceived interest to collaborate under a digital business ecosystem like HLDBE for future operations, we adopted a multi-criteria decision making (MCDM) combined compromise solution (CoCoSo) method to prevent conflicting but objective compromising decision on essential factors prompting such use, adoption, and diffusion. CoCoSo, proposed by Yazdani et al. (2019), has been employed in assessing the progress of EU countries on how they are doing on the SDG's implementation, supplier selection in construction management, and others (Stanujkic et al., 2020; Yazdani, Wen, et al., 2019). To ensure a robust MCDM method is employed to examine the experts perceived interest, we proposed an integrated CCSD-CoCoSo method to aid in objectively obtaining compromised solutions with accurate importance of weights given to criteria and alternatives under study. A subsequent section would elaborate on how the integrated CCSD-CoCoSo was employed in this study.

3. Expansion of Humanitarian Logistics Digital Business Ecosystem (HLDBE) Framework

As proposed and developed by Baffoe & Luo (2020), HLDBE is a digital collaborative business ecosystem that integrates humanitarian and business logistics activities together to sustain and create value among each other using new generational technologies. Their assertion was the need to harness each actor's expertise and resources to serve their needs. Though their conceptual framework and concept may serve as another operational tool, it is still in the initial stage. In an effort to expand the framework, we developed a new framework to describe the HLDBE with its constituents to illustrate the ongoing study for finding an innovation for addressing humanitarian business logistics related problems. Below is the developed diagram found in Fig. 1.

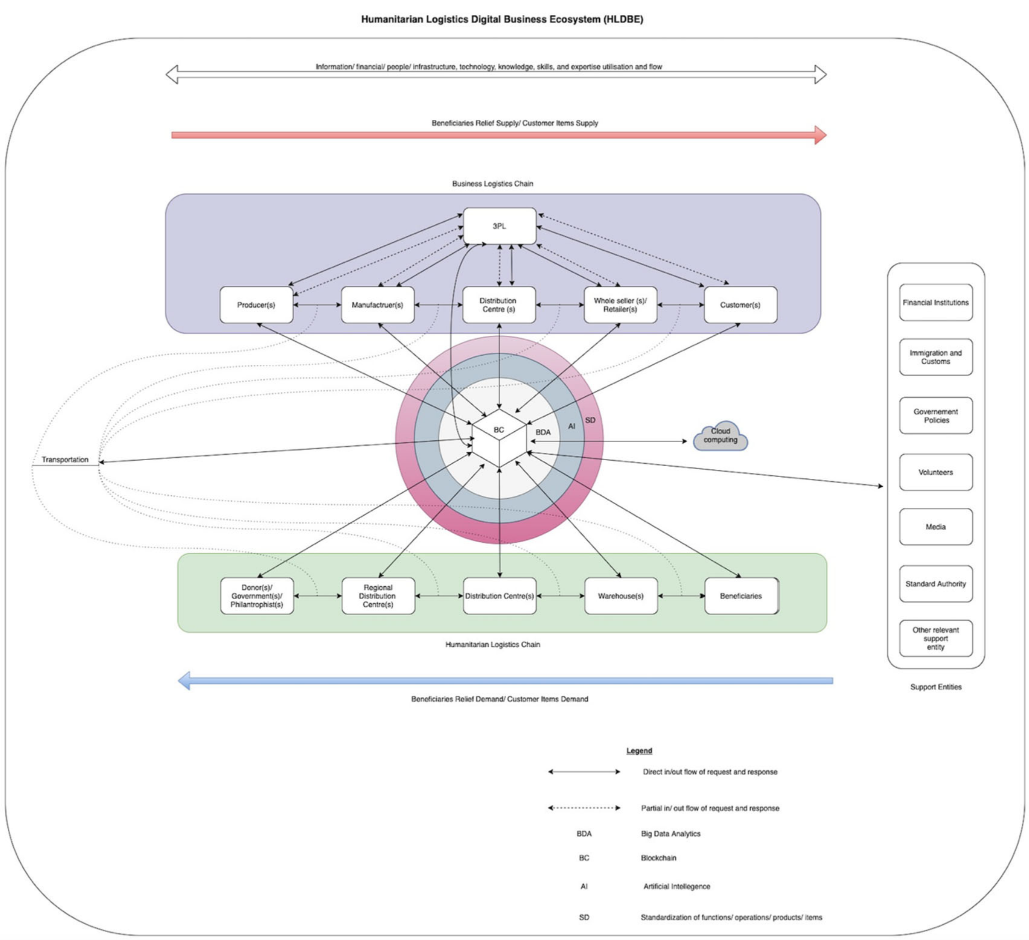

Fig. 1. An update of HLDBE (previously proposed by Baffoe & Luo, 2020). Source: This figure was proposed by Authors. Created with Draw.io software

Table 1
Factors and it Associated Questions

Theory/ Framework	Factors	Definition	Measurement Scale	References
Diffusion of Innovation Theory	Perceived Relative Advantage (PRA)	The operational, functional, environmental, and economic benefits to be derived from HLDBE platform as against traditional system employed	* & **	(Rogers E. M., 2003; Rogers E. M., 1983; Tweel, 2012; Lee, 2015; N. Nurmala, 2018; Davis, 1989; Schnall, 2015; Bienstock, 2010; Gawer, 2014; Moore, 1993; Tiwana, 2013)
	Perceived Safety and Security (PSS)	Safety and security issues such as transparency, accountability, data security risk, and others that may pose as an obstacle in adopting HLDBE by prospective users	*** & **	(Xie, 2017; Schnall, 2015; N. Nurmala, 2018; Shin, 2013)
	Perceived Drawbacks (PDB)	Platform dominance, competition, corporate/ organisation culture, information asymmetry, and costs of acquisition of the HLDBE that may prevent prospective HLDBE users from diffusion and adoption	* & **	(Johnson, 2018; Lee, 2015; Tweel, 2012; Rogers E. M., 2003; de Vasconcelos Gomes, 2018; N. Nurmala, 2018; Nurmala, 2017; Beamon, 2008; Rogers E. M., 1983; Kapoor, 2014; Moore, 1993)
Technology-Organisation-Environment (TOE) Framework	Donor/ Top-Level Management Support	The propensity of donor/ top-level management support of HLDBE	**	(Ho, 2017; Tarofder, 2017; Tashkandi,
	Infrastructure and Expertise (IE)	Hardware (cable network, broadband, and satellite internet connectivity, and	*** & **	(Low, 2011; Wang, 2010; Schumann-
	Law and Governance (LG)	Organisation/Corporate laws, local and international legislative laws governing	** & ***	(Lenkenhoff, 2018; Beamon, 2008;
	Normative Pressure (NP)	Industry regulators (for example, industry or trade associations, non-government organization's associations) would pressure humanitarian -business logistics actors to adopt HLDBE.	**	(DiMaggio, 1983; Lee, 2015; Tweel, 2012)
Institutional Theory	Organisational Culture (OC)	Organization culture type suitable for Humanitarian Business Logistics	****	(Ouchi, 1980; Lee, 2015; Cameron, 2006)
	Organisational Structure (OS)	Organizational structure type that would not be suitable for Humanitarian- Business Logistics actors to collaborate through the adoption of HLDBE	*****	(Ouchi, 1980; Lee, 2015; Cameron, 2006)

Symbol	Measurement Scale
*	1 = Very Negative; 2 = Negative; 3 = Neutral; 4 = Positive; 5 = Very Positive.
**	1 = Strongly Disagree; 2 = Somewhat Disagree; 3 = Neither Agree nor Disagree; 4 = Somewhat Agree; 5 = Strongly Agree.
***	1 = Not at all important; 2 = Low importance; 3 = Neutral; 4 = Very important; 5 = Extremely important.
****	1 = Clan; 2 = Adhocracy; 3 = Hierarchy; 4 = Market; 5 = Other.
*****	1 = Functional; 2 = Divisional; 3 = Matrix; 4 = Other.

The concept of big data analysis, blockchain, AI all part of a new generational technology have been developed and employed to improve traditional logistics mode of operations to a dynamic and digital means of operations (Baharmand & Comes, 2019; Dubey et al., 2020; Govindan et al., 2018; Lalicic & Weismayer, 2021; Papadopoulos et al., 2017; Schmeiss et al., 2019). Blockchain serving as a digital secure and recorded transactional ledger system utilised among different entities has been a more protective way to safeguard data, reduce transaction cost, encourage transparency, and accountability in a chain (Baharmand & Comes, 2019). Also, serving as an unmanipulated transactional system for decentralising of digital financial instruments for both rural and urban entities (Chapiro & Bedi, 2021). A system has been adopted by UNICEF using the Ethereum smart contract blockchain platform to encourage transparency, efficiency, and trust among trading partners (Lomazzo & Hydary, 2020). Based on its concept and utilisation, Blockchain could be an essential value in the development of HLDBE collaborative digital systems. The traditional mode of communication and transactional deals among humanitarian or business logistics companies were based on paper or electronic mode which were not deemed as secure. Thereby prompting data risks, high cost of transactions, transparency, and accountability issues among inter-cluster actors or collaborators in a chain. A major concern for donors, shareholders, and business owners. The important aspect of humanitarian organisations and business logistics actors collaboration is the reliance on secure and reliable information, and failure of that results in already mentioned challenges (Baharmand & Comes, 2019). Finally, blockchain, an element of the HLDBE proposed digital system, can assist in the secure, smooth, cost efficient, transparent, accountable transaction and communication between humanitarian and business logistics actors. Data obtained from the collaborative digital system needs digital analytics for decision-making.

Big Data Analytics (BDA) used in the updated HLDBE is another evolutionary tool utilised in the 21st century for addressing internal and external problems facing both humanitarian and business logistics organisations. Problems stemming from disaster related issues affecting humanitarian organisations. Issues such as the lack of survival needs assessment tool, poor management, lack of proper coordination and collaboration tools, transportation route inaccessibility, information asymmetry challenges, and others all arising from the coordination and collaboration of various actors during a disaster (Dubey et al., 2018; Nasereddin & A L-Khraishah, 2020; Noori & Weber, 2016; Soneye, 2014). Based on the advantageous nature of BDA the ability to obtain structured and unstructured data from GPS, sensors, tracks, smart devices, RFID's, POS, and others smart devices in real-time for informed decisions and projections is achieved (Sanders & Ganeshan, 2015; Wamba et al., 2017). Thus, BDA aids in the effective, efficient, and quality processing of data for users' strategic and operational needs (Hazen et al., 2014). As a result, this has prompted several humanitarian and logistics organisations to explore its potential and benefits (KIRON et al., 2014; Srinivasan & Swink, 2018). Another competitive advantage tool for firms and organisations information and capabilities employed internally and externally for performance, development, and live saving (Akter et al., 2016; M. Gupta & George, 2016; Ravichandran et al., 2005; Wamba et al., 2017). Although, the application of a secure channel of information and transactional flow via blockchain with the analytics of that information for decision making, a good analysis of consumer, beneficiaries, weather patterns using artificial intelligence (AI) paves way for a broader system of value for its users. As in the case of HLDBE. Artificial intelligence employment has aided in the automation of operations and forecasting (Dilmegani, 2020; Kuprenko, 2019; Lalicic & Weismayer, 2021). Employed in automation of warehouses, vehicles, and smart roads which provides drivers with real-time traffic, accident, route optimisation, and weather report to avert delay, cost, and lives. More so, based on its powerful algorithm processing it can also identify errors and contractual risky clauses using previous patterns of information so as to prevent any loss of cost and time. Also, noted for its ability to understand consumer demands and preferences used to predict and offer customized services that encourage trust among customers and firms/ organisations (Kuprenko, 2019). Based on the important elements blockchain, big data analytics, and AI present to helping both users and actors in the humanitarian and business logistics field, we developed this update of HLDBE to indicate how a digital collaborative ecosystem can better serve the humanitarian organization and business logistics organization in resource and capacity utilisation, decision-making, reduction of cost, value creation, risk minimization, transparency and trust among themselves and their partners in were they operate. The proposal of this platform seeks to integrate and bring both actors to collaborate in gaining value that can help the ecosystem (HLDBE) to generate funds based on the values it brings to them in an effort to save and utilize when a disaster arises. Another way to also help traditional organisations to move from the traditional mode of operation to an advanced mode which benefits them. Additionally, we proposed that, such a platform when in operation can also be used to identify resources that may be promptly needed in an event of a disaster as human resources, capacities can be easily identified from a network of chained actors. Also, the AI can aid in the identification and linkage of essential actors such as the customs on current laws that may benefit the HLDBE users. While cloud computing serves as a universal means of storage that can be accessed anywhere when needed. In effect standardisation will be achieved between and among themselves during their operation and communication in the HLDBE system. Based on the ongoing study the formation of the platform actors (thus, owners, members, and regulator(s)) is illustrated in Fig. 2.

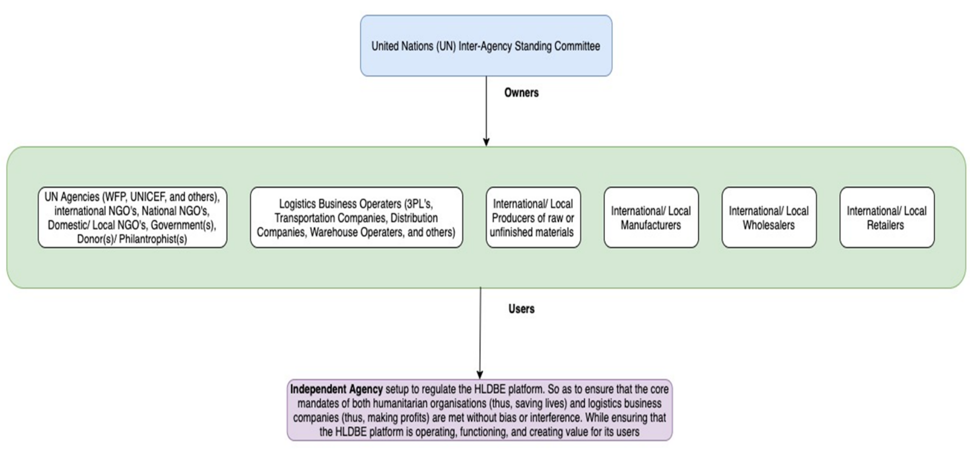

Fig. 2. HLDBE Architecture, Sources: Authors, Created by Draw.io software

The aim of this study is to help understand and examine experts' perspectives on users' perceived interest to collaborate under a digital platform using HLDBE as a case. Secondly, to understand the factors that have a substantial effect on HLDBE use, diffusion and adoption for future sustainability developments for both the humanitarian organisations and business logistics users. More so, to identify financial mediums that can aid in the development and sustainability of the proposed HLDBE platform coupled with continents that may likely be using, adopting, and diffusing such systems for future sustainable operation.

4. Development of an Integrated Correlation Coefficient and Standard Deviation - Combined Compromise Solution (CCSD-CoCoSo) Method

4.1 Mathematical Formulation for integrated correlation coefficient and standard deviation - combined compromise solution (CCSD-CoCoSo) Method

Table 1
Nomenclature

σ_j $Standard\ Deviation\ of\ critierion\ j$
R_j $Correlation\ coeffient\ of\ criterion\ j$
w_j $weight\ of\ criterion\ j$
x_{ij} $decision\ matrix\ of\ alternative\ i\ according\ to\ criterion\ j$
E_i $number\ of\ experts\ of\ alternative\ i$
r_{ij} $normalised\ rating\ of\ alternative\ i\ according\ to\ criterion\ j\ for\ its\ benefit$
S_i $aggregation\ of\ weighted\ comparability\ sequence\ of\ alternative\ i$
P_i $aggregation\ of\ power-weighted\ comparability\ sequence\ of\ alternative\ i$
k_{ia} $arithmetic\ mean\ of\ sums\ of\ S_i\ and\ P_i\ scores$
k_{ib} $sum\ of\ relative\ scores\ of\ S_i\ and\ P_i\ compared\ to\ the\ best$
k_{ic} $the\ balanced\ compromise\ scores\ of\ S_i\ and\ P_i\ models\ and\ \lambda = 0, 0.5, 1$
k_i $finals\ ranking\ computed$ for the CoCoSo model

Following the guidelines by Wang and Luo (2010) on obtaining experts weights for the criterion j, the weight (w_j) was used in the CoCoSo model to obtain the ranking scores computed from the expert's perceived opinion. The CoCoSo model's modus operandi was followed by Yazdani, Zarate, et al. (2019). Nonetheless, based on the normalisation of criteria values for both the benefit criterion and cost criterion, our study only utilised the benefits criterion as there were no cost criterion to normalised as indicated in the work of (Yazdani, Zarate, et al., 2019). Please, see the equations used for both CCSD-CoCoSo below from equation 1 to Eq. (11) and its nomenclature found in Table 2.

Correlation Coefficient and Standard Deviation (CCSD)

$$min \sum_{j=1}^{m} \left(W_j - \frac{\sigma_j \sqrt{1-R_j}}{\sum_{k=1}^{m} \sigma_k \sqrt{1-R_k}} \right)^2 \quad (1)$$

subject to

$$\sum_{j=1}^{m} W_j = 1 \quad (2)$$

$$W_j \geq 0, \qquad j = 1, \dots, m. \quad (3)$$

Combined Compromise Solution (CoCoSo)

1. Decision making matrix

$$x_{ij} = \begin{bmatrix} x_{11} & x_{12} & \dots & x_{1n} \\ x_{21} & x_{22} & \dots & x_{2n} \\ \dots & \dots & \dots & \dots \\ x_{m1} & x_{m2} & \dots & x_{mn} \end{bmatrix}; \ i = 1, 2, \dots, m; \ j = 1, 2, \dots, n. \quad (4)$$

2. Normalisation of criteria values

$$r_{ij} = \left\{ \frac{x_{ij} - \min_i x_{ij}}{\max_i x_{ij} - \min_i x_{ij}} \right. \quad (5)$$

$$S_i = \sum_{j=1}^{n} r_{ij} w_j, \tag{6}$$

$$P_i = \sum_{j=1}^{n} r_{ij}^{wj}, \tag{7}$$

$$k_{ia} = \frac{P_i + S_i}{\sum_{i=1}^{m}(P_i + S_i)}, \tag{8}$$

$$k_{ib} = \frac{S_i}{\min_i S_i} + \frac{P_i}{\min_i P_i}, \tag{9}$$

$$k_{ic} = \frac{\lambda(S_i) + (1-\lambda)(P_i)}{\left(\lambda \max_i S_i + (1-\lambda) \max_i P_i\right)};\ 0 \leq \lambda \leq 1. \tag{10}$$

$$k_i = (k_{ia} k_{ib} k_{ic})^{\frac{1}{3}} + \frac{1}{3}(k_{ia} + k_{ib} + k_{ic}) \tag{11}$$

5. Application of CCSD- CoCoSo Method

5.1 Inter-rater Reliability Check

Checking for inter-rater, two researchers (Z.S.H) and (W.M.J) both masters students in the logistics field independently searched the contact details based on the searching strategy and researcher (B.O.K.B) a doctoral candidate reviewed and adjusted for any inconsistency in the searched data as deposited in Harvard Dataverse (for contacts data searched see ***Blinded for peer review purpose***). The contact details of the experts were publicly obtained as it was found on their published papers. Nonetheless, we also raise a caution that this method is only for publicly accessed information and not for personal contacts that the participants have not shared online. Contrary to publicly shared contacts, researchers are advised to respect respondents' rights and anonymity, by seeking their consent before publicly publishing them (Smith, 2003). Using IBM SPSS 24 the intra-rater judgment score was [intra-class correlation coefficient (ICC):0.723; 95% confidence interval (CI): 0.661-0.773 with p-value < 0.000]. Thus, making the researchers' collated contact details well-searched information as its strength of agreement is substantial, and it meets Kappa's statistics range of 0.61–0.80 for substantial agreement (Landis, 1977). The unit of analysis used were the experts in the various fields used for this study.

5.2 Research instrument

The instrument was adopted and revised from the works of (Tweel, 2012; Lee, 2015). Their validated work focused on cloud computing adoption while this study focuses on humanitarian-business logistics under a digital business ecosystem called HLDBE. Validating the instruments, a pre-test and post-test were conducted via SurveyMonkey online survey platform. Two professors from the humanitarian logistics domain, a professor of logistics and supply chain, one professor of institutional theory and three non-logistics domain experts pre-tested and post-tested the instruments to meet the study's scope, content validity, coherence, logic, clarity, and simplicity of questionnaire instruments in reducing respondent burden, grammar errors. The survey was conducted after the above processes.

5.3 Sample design

Obtaining the required sample size is an essential part to ensure the rigor and quality of the study. A purposive sampling method was employed to solicit from experts their depth of knowledge in their fields of expertise with technology adoption and diffusion theories used in developing the model to be tested (Tongco, 2007). Despite the concern of its non-random selection bias, it is proven that it can provide reliable and robust data for a study (Topp, 2004; Patton, 2014).

5.4 Data screening and pre-analysis

The data was clean, processed, and analysed by Microsoft Excel, IBM SPSS 24. SPSS was used to assess, and correct normality, missing values, and outliers to ensure the data is clear from possible statistical error and bias that may hinder the objectiveness of the result.

5.5 Screening process and strategy for contact details

Respondents information was obtained via Web of Science database using Database: "Web of Science"; Search keywords (searched separately): "humanitarian logistics", "logistics management", "logistics management platform", "supply chain management", "supply chain management platform" , "business ecosystem", "business ecosystem platform", "digital business ecosystem", "big data analytics", "diffusion of innovation", "institutional theory", "technology, organization, environment framework"; Search field: "Topic"; search period: "1st January 2015 - 1st September 2019"; Datatype: "Articles"; Selection language: "English"; Conditional search strategy used (only if search results is more than 10,000):

"Open Access" was selected; Paper selected based on: "Top 30 cited papers on their Total citation score". Experts were chosen because they predominantly serve as consultants and advisors to policymakers and practitioners on issues of interest and concern relating to specific field as is the case of HLO and BLC industry.

5.6 Sample size, data collection, and data analytical methods

A total of 330 contacts was obtained from the survey; nonetheless, duplicated contacts of 19 authors were removed from the search to arrive at a total sample size of 311 for the study. From the administered study, 11.57 % (36/311) response rate was obtained with a non-respondent rate of 88. 43% (275). It was observed that most emails provided by authors of the papers used for this study might have been inactive or have changed their place of work, thereby rendering their previous mail used in their publication inactive. Despite the obtained sample of 36, 1 respondent indicated "NO" to not qualifying for the study, making it a total of 35 respondents. After checking for missing data, responses from participants with 80% or more missing data were removed to have good objective data for analysis bringing the total sample size to 28. The survey was conducted from August 2019 to January 2020.

6. Results

An analysis and summary of respondents' demographic attributes in terms of their gender, region, current position, work years and work expertise are discussed. From the response for work years, majority of the respondents (39.3%) had 5-9 years working experience in the fields they find themselves in, 10-14 years' experience (32.1%), 15-19 years and 0- 4 years all had 10.7%, and 7.1% of the respondents had more that 20 years of working experience in their field of expertise. Furthermore, Associate Professors were the largest respondent in this study with 32.1%, followed by Professors (25%), Postdoctoral Research Assistantship/ Fellowship (14.3%), Other expert positions in the form of Assistant Professors and Adjunct Professors (10.7%), with Assistant/ Associate Lecturers and Senior Lecturers all having a 7.1%, and doctoral student with a score of 3.6%. Because the expertise can specialize in different fields, the research expertise question was a multiple response question. Please, see Table 3 for summary of respondent's demographic used with its associated frequency and percent scores.

Table 3
Respondent's demographics

Item	Frequency	Percent	Item	Frequency	Percent
Expert Location According to Region			*Continent Likely to Use, Diffuse, and Adopt HLDBE **		
Africa	1	3.6	Asia	16	66.70
Asia	8	28.6	Africa	9	37.50
Europe	12	42.9	Europe	11	45.80
Oceania	1	3.6	North America	12	50.00
North America	3	10.7	South America	6	25.00
South America	3	10.7	Oceania	7	29.20
Expert Designation			Gender		
Doctoral Student	1	3.6	Male	22	78.6
Postdoctoral Research Assistantship/ Fellowship	4	14.3	Female	6	21.4
Assistant or Associate Lecturer	2	7.1			
Senior Lecturer	2	7.1			
Associate Professor	9	32.1			
Professor	7	25			
Other (please specify)	3	10.7			
*Area of Expertise of Expert **					
Humanitarian Logistics	4	14.30			
Logistics Management	8	28.60			
Supply Chain Management	12	42.90			
Business Ecosystem	9	32.10			
Supply Chain Management Platform	4	14.30			
Logistics Management Platform	1	3.60			
Business Ecosystem Platform	6	21.40			
Big Data Analytics	9	32.10			
Diffusion of Innovation	5	17.90			
Institutional Theory	1	3.60			
Technology-Organization-Environment (TOE)	5	17.90			
*Financial Support to Establish the HLDBE **					
Philanthropist	13	52.00			
Company / government Donors	16	64.00			
Crowdfunding	14	56.00			
Venture Capital	8	32.00			
Banks	4	16.00			
Angle Investors (individual entrepreneur with a net	4	16.00			

*Note: The symbol * indicates that the question category was a multiple question categor*

The examination of expert's perceived opinion on factors that may prompt future use, diffusion, and adoption of HLDBE by prospective users were done following these steps and the employment of CCSD-CoCoSo methods, as shown in Fig. 3. The analysis was done with Microsoft Excel software.

6.1 Schematic Diagram

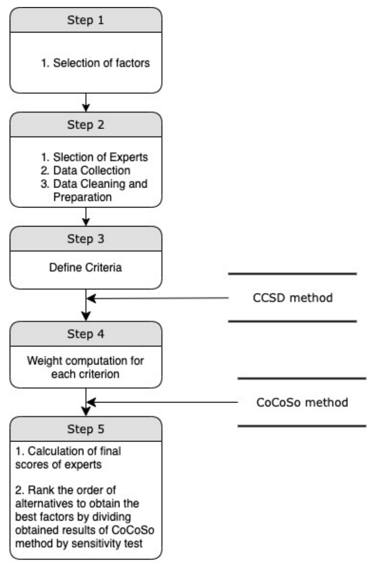

Fig. 3. Overall procedure for expert's section and ranking of alternatives, Source: Authors. Created by Draw.io Software

Factors used for the evaluation are shown in Fig. 2. HLDBE Architecture, Sources: Authors, Created by Draw.io software Table 1 and decision-making matrix serving as data regarding the expert's considered indicators for the perceived interest of users to use, diffuse, and adopt HLDBE are found in Table 4.

Table 4
Initial decision-making matrix according to Expert's opinion on user's propensity to use, diffuse, and adopt HLDBE

x_i	*PRA*	*PDB*	*DTS*	*OC*	*OS*	*NP*	*LG*	*IE*	*PSS*
X1	3.738	3.000	3.000	5.000	4.000	3.000	3.000	2.625	3.333
X2	3.500	3.167	3.000	2.000	3.000	4.000	3.833	3.375	4.333
X3	3.500	3.833	3.667	4.000	3.000	4.000	3.333	3.500	4.667
X4	4.136	3.000	4.000	3.000	3.000	4.000	3.833	4.250	4.000
X5	3.773	2.939	3.751	2.680	2.600	3.188	3.851	3.996	4.292
X6	3.818	4.000	4.667	3.000	2.000	3.000	4.667	4.500	4.333
X7	4.591	2.333	5.000	1.000	2.000	2.000	4.000	3.750	4.667
X8	4.227	4.167	3.667	4.000	2.000	5.000	4.000	4.375	4.000
X9	4.818	3.833	4.333	1.000	4.000	5.000	4.000	3.875	3.000
X10	4.773	3.833	4.000	2.000	3.000	3.000	4.333	4.250	5.000
X11	4.591	4.167	4.000	3.000	3.000	4.000	4.167	4.270	4.000
X12	4.545	2.333	4.000	1.000	1.000	3.000	3.500	4.000	5.000
X13	4.409	2.833	4.000	2.680	2.600	4.000	4.000	3.625	3.667
X14	4.364	3.167	2.000	2.000	3.000	4.000	3.667	3.750	4.333
X15	4.636	2.667	2.667	4.000	3.000	3.000	3.667	4.500	5.000
X16	4.818	3.667	4.000	4.000	2.000	4.000	3.333	3.625	4.000
X17	4.636	2.500	3.000	2.000	3.000	1.000	4.000	3.625	4.333
X18	4.318	2.605	4.000	2.000	2.000	4.000	3.824	3.896	4.244
X19	5.236	3.333	4.333	2.000	3.000	4.000	4.333	4.500	5.000
X20	4.682	3.833	3.333	2.000	2.000	3.000	3.500	3.500	4.464
X21	4.773	3.667	4.000	3.000	1.000	4.000	3.833	3.750	4.000
X22	5.273	3.167	4.000	3.000	2.000	2.000	3.667	3.875	3.667
X23	4.545	2.667	4.000	3.000	2.000	3.000	3.500	4.375	4.000
X24	4.091	3.333	2.333	3.000	3.000	2.000	3.667	3.625	4.333
X25	4.909	3.333	3.667	4.000	3.000	4.000	3.667	3.750	4.000
X26	4.818	2.833	3.333	2.000	4.000	4.000	3.833	3.750	4.000
X27	4.591	1.779	2.428	2.680	2.600	1.083	3.201	3.897	4.901
X28	4.864	3.333	4.000	2.000	2.000	4.000	3.833	4.000	4.333

Source: Computed by Authors.

Table 5

Normalised decision-making matrix

E_i	*Weights Optimisation*	*PRA*	*PDB*	*DTS*	*OC*	*OS*	*NP*	*LG*	*IE*	*PSS*
E1	0.046	0.469	0.158	0.158	1.000	0.579	0.158	0.158	0.000	0.298
E2	0.036	0.643	0.500	0.429	0.000	0.429	0.857	0.786	0.589	1.000
E3	0.054	0.300	0.500	0.400	0.600	0.000	0.600	0.200	0.300	1.000
E4	0.086	0.909	0.000	0.800	0.000	0.000	0.800	0.667	1.000	0.800
E5	0.036	0.693	0.200	0.680	0.047	0.000	0.347	0.739	0.825	1.000
E6	0.054	0.682	0.750	1.000	0.375	0.000	0.375	1.000	0.938	0.875
E7	0.054	0.898	0.333	1.000	0.000	0.250	0.250	0.750	0.688	0.917
E8	0.076	0.742	0.722	0.556	0.667	0.000	1.000	0.667	0.792	0.667
E9	0.036	0.955	0.708	0.833	0.000	0.750	1.000	0.750	0.719	0.500
E10	0.023	0.924	0.611	0.667	0.000	0.333	0.333	0.778	0.750	1.000
E11	0.029	1.000	0.733	0.629	0.000	0.000	0.629	0.733	0.799	0.629
E12	0.013	0.886	0.333	0.750	0.000	0.000	0.500	0.625	0.750	1.000
E13	0.032	1.000	0.129	0.774	0.044	0.000	0.774	0.774	0.567	0.590
E14	0.048	1.000	0.494	0.000	0.000	0.423	0.846	0.705	0.740	0.987
E15	0.054	0.844	0.000	0.000	0.571	0.143	0.143	0.429	0.786	1.000
E16	0.035	1.000	0.591	0.710	0.710	0.000	0.710	0.473	0.577	0.710
E17	0.040	1.000	0.413	0.550	0.275	0.550	0.000	0.825	0.722	0.917
E18	0.024	1.000	0.261	0.863	0.000	0.000	0.863	0.787	0.818	0.968
E19	0.015	1.000	0.412	0.721	0.000	0.309	0.618	0.721	0.772	0.927
E20	0.022	1.000	0.684	0.497	0.000	0.000	0.373	0.559	0.559	0.919
E21	0.025	1.000	0.707	0.795	0.530	0.000	0.795	0.751	0.729	0.795
E22	0.032	1.000	0.356	0.611	0.306	0.000	0.000	0.509	0.573	0.509
E23	0.024	1.000	0.262	0.786	0.393	0.000	0.393	0.589	0.933	0.786
E24	0.049	0.896	0.571	0.143	0.429	0.429	0.000	0.714	0.696	1.000
E25	0.034	1.000	0.175	0.349	0.524	0.000	0.524	0.349	0.393	0.524
E26	0.038	1.000	0.296	0.473	0.000	0.710	0.710	0.651	0.621	0.710
E27	0.041	0.919	0.182	0.352	0.418	0.397	0.000	0.555	0.737	1.000
E28	0.016	1.000	0.466	0.698	0.000	0.000	0.698	0.640	0.698	0.815

Source: Computed by Authors.

Calculating weight and normalisation of the decision matrix were done using Eqs. (1-3) (for the weight using CCSD) and Eqs. (4-5) for the normalised decision matrix. Compilation can be found in Table 5. Analysing the aggregation of weighted comparability sequence (S_i) and aggregation of power-weighted comparability sequence (P_i) Eqs. (6 -7) were employed, while Eq. (8) was used to obtain the summation of the arithmetic mean (k_{ia}) for S_i and P_i scores, the sum of relative scores (k_{ib}) of S_i and P_i compared to the best were done using Eq. (9) and the balanced compromised scores (k_{ic}) of S_i and P_i models using $\lambda = 0, 0.5, 1$ were obtained by equation 10. See Table 6 for details.

Table 6

Calculation details obtained using the CoCoSo method

	S_i	P_i	K_{ia}	K_{ib}	K_{ic}
PRA	0.9160	27.7930	0.1335	6.7620	1.0000
PDB	0.4272	25.3292	0.1198	4.2232	0.8972
DTS	0.5979	25.4333	0.1210	5.0443	0.9067
OC	0.3080	14.4269	0.0685	2.7131	0.5132
OS	0.2102	11.5645	0.0547	2.0000	0.4101
NP	0.5532	23.4287	0.1115	4.6584	0.8353
LG	0.6787	27.4371	0.1307	5.6018	0.9793
IE	0.7389	26.6297	0.1272	5.8185	0.9533
PSS	0.8725	27.7386	0.1330	6.5500	0.9966

Source: Computed by Authors.

The final ranking based on the relative performance score (ki) from the perceived opinion of the experts using the CoCoSo model was done using Eq. (11) and can be found in Table 7.

Table 7

Ranking of expert's opinion on user's propensity to use, diffuse, and adopt HLDBE for their future sustainable operations

	Final score (k_i)	**Ranking**
PRA	3.5982	1
PDB	2.5151	7
DTS	2.8451	5
OC	1.5552	8
OS	1.1771	9
NP	2.6255	6
LG	3.1324	4
IE	3.1900	3
PSS	3.5139	2

Source: Computed by Authors.

Graphically illustrating the ranking of the CoCoSo method divided by the sensitivity test is shown in Fig. 4 and the associated impact of coefficient λ to k_{ic} are displayed in Fig. 5.

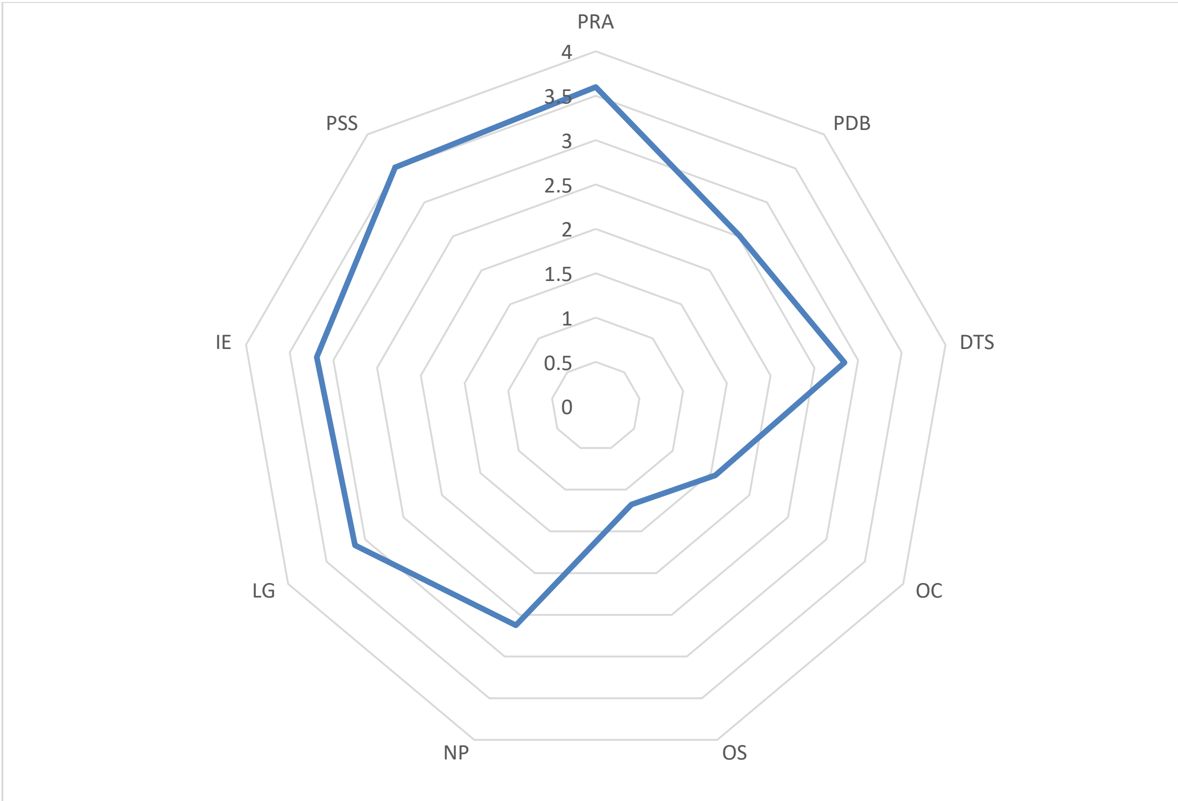

Fig. 4. Graphical ranking of CoCoSo method divided by sensitivity test. Source: Computed by Authors. Created by Microsoft Excel

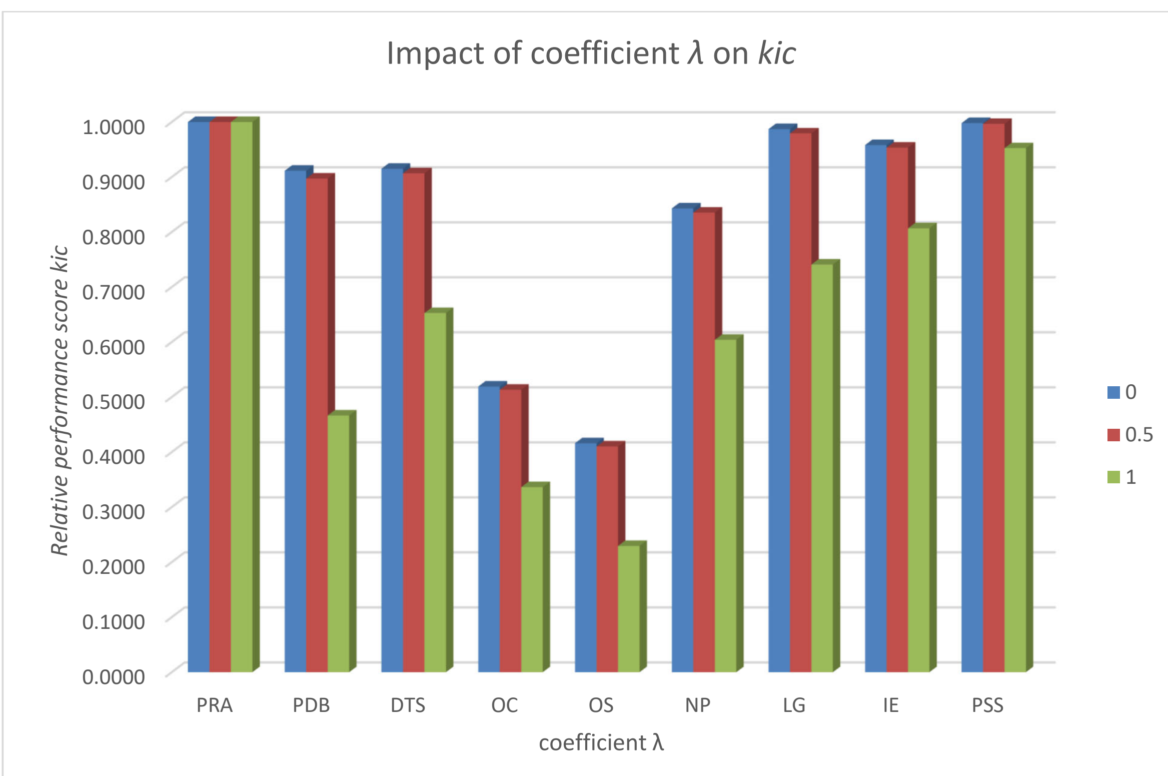

Fig. 5. Impact of coefficient λ on kic. Source: Computed by Authors, Created by Microsoft Excel

Based on the assumption that collaboration of HLO and BLC using advance technology to address humanitarian sustainability issues as importance (Beamon & Balcik, 2008; Dubey et al., 2020; Dubey, Gunasekaran, Childe, Roubaud, et al., 2019; Van Wassenhove, 2006;Kovács, 2009; Van Wassenhove, 2006; Oloruntoba, 2009; Thomas, 2006; Nurmala, 2017; Baffoe & Luo, 2020; Kabra, 2017; N. Nurmala, 2018; Cozzolino, 2021), our study aimed to examine experts' opinion on factors that would prompt prospective users (thus, HLO and BLC actors) to collaborate under a digital business ecosystem like HLDBE. Evaluating the perceived expert's opinions, diffusion of innovation theory, technology-organization-environment (TOE) framework, and institutional theory factors were employed to ascertain the essential factors that prompt prospective users to use, diffuse, and adopt HLDBE for their future sustainable operations. As can be seen applying the CCSD-CoCoSo model it was interestingly observed from the obtained results that experts believe the perceived relative advantage (PRA) of HLDBE is very essential for humanitarian logistics organisations and business logistics companies to collaborate under a digital business ecosystem platform (Cozzolino, 2021). However, their collated view indicates that organisational culture (OC) of these actors (thus, HLO and BLC different cultures) have less effect on their decision. As researchers it was very interesting to know that the culture factor has less significant influence on users propensity to use, diffuse, and adopt HLDBE as it goes against the conflicting norm of both actors (HLO culture focusing on saving lives while BLC on profit making) (Kovács & Spens, 2007; Nurmala et al., 2017). Although this results stressed so, it is very early to state if organisational culture (OC) has less effect on decision-maker's decision to adopt or diffusion of HLDBE for future operational use. We believe more empirical study is needed to ascertain from the perceived interest of prospective users their interests. Using the CCSD-CoCoSo method approach, experts believed that the future use, adoption, and diffusion of a platform such as HLDBE is inevitable, but factors used need to be paid attention to. A summary of the detailed ranking and scores are found in Table 7.

7. Discussion

Prior studies have documented the importance of humanitarian logistics organisation and business logistics companies collaborating under a digital ecosystem platform (Baffoe & Luo, 2020; Cozzolino, 2021) in addressing humanitarian logistics sustainability issues; Cozzolino, for example, reports that platform enables business logistics actors to collaborate in humanitarian relief response. Nonetheless, these studies have focused attention using case study and literature review to elaborate on the importance of HLO and BLC collaboration under a platform. In our study we updated the HLDBE framework by Baffoe & Luo (2020), then proposed and employed an integrated CCSD-CoCoSo method to examine the perceived expert's opinion on factors that would prompt prospective users to use, adopt, and diffuse a digital business ecosystem like HLDBE using technology of innovation theories. Using the CCSD-CoCoSo method, we found that perceived relative advantage (PRA), perceived security and safety (PSS), and Infrastructure and expertise (IE) are the top three influencing factors that experts believe plays a big role in the use, adoption, and diffusion of HLDBE. Findings from the study indicates that experts ranked PRA as the top factor confirming the importance of collaboration, risk, and co-evolution of value actors can leverage from each other from a digital business ecosystem like HLDBE when inception. These findings extend those of (Kayikci, 2018), confirming that logistics digitisation encourages collaboration, economic , and environmental sustainability; (Ebinger & Omondi, 2020), on sustainability and transparency encouraged by employing digital approach; (Giuffrida & Mangiaracina, 2020), incorporating of green practices for sustainability of logistics in an organisation; (Dubey et al., 2020; Dubey, Gunasekaran, Childe, Roubaud, et al., 2019; Papadopoulos et al., 2017), enhancing the optimisation of operations, encouraging trust among diverse actors, risk reduction, and prompt decision making for beneficiaries and consumers using digital technology like big data analytics and blockchain. Also, improvements noted from our enquiry were unrelated to a specific geographical demographics background. Our study therefore stressed on the benefits a hybrid HLDBE platform obtained from a collaborative digital ecosystem platform may help to address the current and future needs of HLO and BLC actors in different geographical locations. Secondly, findings from our study indicates that perceived safety and security (PSS) was the second top ranked factor considered as essential for the propensity to employ, adopt, and diffuse HLDBE for prospective user's future operations. This affirms, (Foege et al., 2019) work on concerns different actors face in an open innovation platform. Safety and security concerns such as transparency, accountability, and others found in an open innovation platform of actors are issues that need attention. Though advance technology such as blockchain (Dubey et al., 2020), big data analytics (Dubey, Gunasekaran, Childe, Roubaud, et al., 2019; Govindan et al., 2018; Papadopoulos et al., 2017; Waller & Fawcett, 2013; Zhong et al., 2015) and other technologies fostering safety, security, accountability, and transparency (Khan et al., 2019) in a platform system, this is a clear indication of the essence of safety and security concerns when designing HLDBE for users. Infrastructure and expertise (IE) were the third essential factor, expert's reiterated on for a collaborative digital ecosystem platform to be used, diffused, and adopted for future use. The study affirms UN's indication of utilising partnership from diverse sectors such as the logistics industry to support infrastructure and innovation as enshrined in UN's SDG 9 (UN-DESA, 2015). Also, the study supports (Schumann-Bölsche, 2018) the availability of needed expertise and infrastructure helps to complement deficiencies HLO and BLC face. Although IE are essential, we noted that not all continents or countries are endowed with such resources. Therefore, making it an important criteria stressed by the experts to be factored on should beneficiaries and consumer preferences enshrined in organization development and growth be addressed. In addition, the study stressed that law and governance is essential after PRA, PSS, and IE are addressed. This also confirms the studies of (Beamon, 2008; Nurmala, 2017; OCHA, 2012; IASC, 2008; Lenkenhoff, 2018) on the essence of a common ethical law that would govern the platform. Concurrently, results from the study indicate that donor and top-level management support (DTS) ranked as the fifth essential factor in prompting the use, adoption, and diffusion of a technology innovation. Affirming that, (Lian et al., 2014) study reiterated on the essence of internal and external factors that may prompt decision-makers to use, adopt, and diffuse a digital ecosystem like HLDBE. Thus, a platform that would encourage the development, protection, risk reduction, and growth of the organisation using innovative technologies, expertise with associated laws to safeguard its employment. Contrary to that, the propensity to use, diffuse, and adopt HLDBE would be difficult as it may not serve the value, protection, and is governed by law associated with their operations.

Noted from the study, normative pressure (NP) was ranked as the sixth essential factor that prompted a future prospective user to use, adopt and diffuse an HLDBE when in use. Though experts believe HLDBE may serve as a beneficial digital ecosystem platform for HLO and BLC actors, not all actors may likely use, adopt, and diffuse HLDBE for their future operation. Although, such may be the case, the study indicates that the influence of industry associations or organisations such actors belong to may also encourage its employment as members may be compelled to follow the norm of the associations. Although pressures from actor's association to an industry/ organization may prompt the use, adoption, and diffusion of HLDBE, experts also believed that there would be a concern for some drawbacks arising in such a platform. As ranked in this study as the seventh factor of importance (perceived drawback [PDB]). Drawbacks such as platform dominance by big players, information asymmetry, platform competition and others. As reiterated by works of (Johnson et al., 2018; Nurmala et al., 2018). Thereby calling for more conscientious effort to mitigate such drawbacks should a digital ecosystem platform such as HLBE be employed to serve the needs of HLO and BLC's. Notably, organizational culture (OC) and organizational structure (OS) ranked as eighth and ninth was deemed by expert's in this study as the least essential factors that may prompt the use, adoption, and diffusion of an HLDBE for HLO and BLC user's future operation. Surprisingly, observed from the findings, HLO and BLC which operate in different cultures and mandates which serve as important factors were attributed as less essential in this study. Although, this study indicates so, we noted and stressed on the essence more study into organisational culture and structure in the designing and implementation as it serves as a hybrid digital ecosystem encompassing different cultures, mandates, and structures which could arise in platform conflicts, dominance, or competition (Ouchi, 1980; Cameron, 2006). More so, our study found that experts believed that the Asian and North American continent are the most likely continent to initiate the use, adoption, and diffusion of HLDBE when inception with Africa and South American continent serving as the least continent that may be ready to employ a digital hybrid ecosystem of HLO and BLC platform serving their future humanitarian and business needs. It was not surprising to us as Asia is the fastest growing technological continent followed by the North American countries. Africa and South America having the least affirms the challenges such continents have in areas such as infrastructure and expertise to revamp the sectors to address its humanitarian logistics and business challenges. See Table 3 for details of continents that are likely to use, adopt, and diffuse HLDBE. Furthermore, the findings from this study indicated that the best financial pool to develop a future HLDBE platform serving HLO and BLC most notable may come from company/ government donors followed by crowdfunding and the least financial pool were noted as Banks and Angel investors. This clearly indicates that for a hybrid humanitarian logistics digital business ecosystem to be developed, used, adopted, and diffused company and government donors should play the leading role to finance such a project and supported by crowdfunding a good way to obtain funding from the general public. Please, see Table 3 for the details.

8. Conclusion

In summary, we presented an updated HLDBE framework coupled with integrated CCSD-CoCoSo model to examine experts' perceived opinion on prospective users' propensity to use, adopt, and diffuse HLDBE for their future operations. To our knowledge CCSD-CoCoSo method has not been employed in any study. This study found that perceived relative advantage, perceived safety and security, infrastructure and expertise were the top three factors that may prompt the use, adoption, and diffusion of HLDBE with organisation culture and structure as the least essential factors. The CCSD-CoCoSo model applied results are objective and valid for analysing such MCDM studies. Hope that this could be applied in other studies and fields. Also, identified Asia and North America continents as the continent's most likely to employ HLDBE when inception with Africa and South American continent serving as the least continent to use, adopt, and diffuse HLDBE. More so, our study identified company/ government donors and crowdfunding as the best financial pool to develop and sustain the HLDBE digital platform. It is worth indicating some limitations to our study. Experts sampled were not largely distributed from all the continents to give a good holistic picture of this study. More so, future research should empirically examine from the perceived interest of decision-makers who work as humanitarian logistics and business logistics actors in disaster-prone areas on their propensity to employ, adopt, and diffuse HLDBE as their future operational tool. Using a random sampling method with a large sample size can also help to improve and give more insights to this research. Also, using other technology diffusion theories such as Technology Acceptance Model (TAM) and others may add more insight to the study. We hope this study will stir up more debates and innovative solutions on the development of HLDBE, its sustainability and management as well as the employment of our proposed novel integrated CCSD-CoCoSo method.

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