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Digital transformation in public-private collaborations: The success of humanitarian supply chain operations

Abstract

Recent years have seen the extensive use of big data analytics, related technological infrastructure, and machine learning applications for digital transformation. The resource dependency related to data-driven applications elicits public-private collaborations (PPCs) between governments and private or non-government organizations (NGOs) for value creation. Such collaborations are effective for the success of humanitarian supply chain operations (HSCOs), particularly in the event of large-scale disasters. By building on resource dependence theory (RDT), our study explores the links between digital transformation, PPCs, and HSCO success. Using structural equation modeling on data collected from 224 key decision-makers and experts, we found that digital transformation mediates the relationship between private-NGO collaborations and HSCO success while host government support moderates it. Our study thus makes an original contribution to RDT and the emerging domains of contemporary digital and data-driven applications in HSCO. The implications and future research directions arising from this study are also discussed in this research paper.

Keywords:

Digital transformation
Big data IT infrastructure
Big data analytics
Machine learning and statistics
Public-private collaborations
The success of humanitarian supply chain operations

1. Introduction

Humanitarian crises—which involve loss of lives, food and water shortages, infrastructural damage, and human displacement—seem to be increasing at an alarming rate. In providing relief during such crises, non-government organizations (NGOs) are highly likely to collaborate with other parties, including governments and private organizations—e.g., multinational enterprises (MNEs) (Pearce, 2003; Waugh & Streib, 2006; Yang et al., 2020). Such cross-sector collaborations facilitate the sharing of superior knowledge and the development of the capabilities that stem from working in different international contexts and being equipped with global best practices (de Lange et al., 2016). This is particularly effective when analytics and digital technologies facilitate superior collaborations, which enable cross-sector network partners to better respond to humanitarian operations and boost supply chain performance. Digital transformation basically refers to procedure through which organizations incorporate technologies to profoundly improve their operations. Big data (i.e., structured and unstructured data), machine learning, and artificial intelligence are examples of such technologies that support digital transformation. Collaborations between the actors, driven by data-driven digital transformation, ultimately create value through timely and accurate flows of data and information (Correani et al., 2020; Akhtar et al., 2022; Papanagnou et al., 2022; Su and Wu, 2024). Arguably, public-private collaborations (i.e., governments, NGOs, and private organizations working together to achieve common goals)—while being by no means devoid of challenges—may enhance the success of humanitarian supply chain operations (HSCOs), as measured to deliver relief in a timely and cost-effective fashion to satisfy beneficiaries and donors (Akhtar et al., 2012; Cozzolino et al., 2017; Akhtar et al., 2022; Li et al., 2023). As per resource dependency theory (RDT), such collaborations may lead to power, resource, and technological imbalances that may ultimately strip NGOs of their operational autonomy and even overall strategic directions, and/or raise issues of financial transparency (Cordery et al., 2019; Banks et al., 2020), eventually reducing the performance of humanitarian operations. Therefore, no consensus has hitherto been reached as to whether public-private collaborations deliver value for money or end up costing more without actually delivering greater efficiency and performance (McEwan et al., 2017; Cordery et al., 2019) of HSCOs.

Digital transformation is defined as a procedure of utilizing connectivity technologies such as big data, machine learning and Internet of Things (IoTs) to fundamentally transform business operations, generating product and service value for the organizations involved,

their partners, and customers (Vial, 2019; Akhtar et al., 2022; Alkan & Kahraman, 2023; Su and Wu, 2024;). Digital transformation basically represents holistic efforts to alter core processes and services, affecting extant organizational policies and practices for the satisfaction of customer needs. Digital transformation in NGOs rethinks how organizations can effectively serve communities and affected people, moving afar merely utilizing digital tools. Manual procedures are transferred to digital systems, and these are continuously updated to improve user satisfaction (Cordery et al., 2023). It, thus, demonstrates a way that changes products and services for sustainable business practices using modern technologies (Su and Wu, 2024). Data driven *digital transformation* suggests an evidence driven approach, developing insights from data in order to inform decisions and actions (Papanagnou et al. (2022). *Digital analytics* may be defined as the deployment of fast evolving technologies (e.g., Artificial Intelligence (AI), IoTs, machine learning, robotics) to examine and investigate information in order to provide ‘live’ personalized engagement on a continuous basis; this may be deployed, for example, to better engage with customers or user (Gupta et al., 2020). Public-Private Collaboration (PPCs) concerns the choice and management of specific mechanisms to guide the allocation of the resources and to fulfill domestic and, potentially, international, welfare functions of government and other involved parties. It involves engaging private players in the delivery of services and the sharing of decision making in this regard (Donahue and Zeckhauser, 2008), Supply chain operations entails the coordination and enactment of the set of activities that comprise a supply chain using what resources are available (Zrdadkovic et al., 2011); humanitarian supply chain operations (HSCO) concerns when they serve a humanitarian purpose, and ensure the distribution of relief goods and services to communities affected by the natural disasters.

Despite the growing importance of PPCs as mechanisms suited to addressing problems such as poverty and inclusive development efforts (George et al., 2024), much of the current research has hitherto offered limited insights into how such collaborations can be better utilized to enhance HSCOs. There is still a limited understanding of how digital transformation, a technical resource often used in HSCOs, may influence the relationship between PPCs and related performance. This is particularly interesting given that organizations depend on digitalization and big data technologies to remain connected and achieve better performance (Akhtar et al., 2019; Akhtar et al., 2020). Given the potential for high network failure/collaboration rates, (Cassandra, 2017), there is a heightened need for a more nuanced understanding of how PPCs can be capitalized upon to enhance HSCOs. More

importantly, there is still a limited understanding of the influence of key resources often used in HSCOs—namely, digital transformation enabled by connectivity technologies, and host government support—on public-private collaborations and HSCO success (Dennehy et al., 2021; Akhtar et al., 202; Cordery et al., 2023; Dohale et al., 2024). The integration of tacit knowledge within and between organizations will be ensured when their collaborations are backed up by specialized capabilities embedded in connectivity technologies (Biuncken and Barwinski, 2020; Dohale et al., 2024), which enable increased collaboration performance. In addition, there is still also a limited understanding of the influence exerted by third parties—such as local governments—on the resource dependency found in inter-organizational collaborations (e.g., Roy and Oliver, 2009). Against this backdrop, we examined the effects exerted by digital transformation and local governments on the relationship between public-private collaborations and HSCO success.

Our study makes vital contributions to literature. Drawing upon insights from RDT (Pfeffer & Salancik, 2003; Hillman, Withers, & Collins, 2009; Jiang, Luo, Xia, Hitt, & Shen, 2023), we developed and tested a model pertaining to how the integration of digital technologies can alter and shape the consequential effects of collaborative efforts. However, RDT argues for the potential presence of tensions between power imbalance and resource dependency (Davis & Cobb, 2009). In other words, it posits that some organizations may become more dependent on others in their efforts to increase their capabilities and provide greater predictability to their operations by leveraging any superior resources possessed by their partners. They may thus lose their relative power and, ultimately, become more vulnerable (Cheng et al., 2014). This may well explain the tensions between NGOs and private organizations in HSCOs. In particular, there is a lack of understanding of the influence of two key resources often used in HSCOs—namely, big data technology/digitalization and host government support—in managing the tensions stemming from resource dependency and thus facilitating HSCO success. Specifically, our study’s field data provide insights into how digital transformation can mediate the potential association between private-NGO collaborations and affect HSCO success. In other words, it is not simply a matter of unlocking resources through NGO-private partnerships. The intervening role played by digital transformation highlights its importance in meeting resource needs; this deepens our understanding of how the resource dependency process plays out. In addition, our study contributes to the scholarly discourse on public-private partnerships (Liu et al., 2014; George et al., 2024) by providing deep insights into the interlocks between public-private collaborations, digital transformation, and HSCOs. Furthermore, it contributes to the

academic understanding of how organizations strive to maximize their performance and gain stability and explains why some inter-organizational collaborations succeed while others fail (Pfeffer & Salancik, 2003; Drees & Heugens, 2013), particularly when they depend on technical and digital resources to deal with extreme crises such as humanitarian disasters (Akhtar et al., 2019). We explored the boundary conditions pertaining to the relationship between potential resource flows stemming from NGO-private collaborations and HSCO success and found that host government support acts as an important contingency factor. A body of research has found that private sector partners may get ‘cold feet’; this may reflect any skill shortcomings that emerge when entering contracts or the opportunism exhibited by either side (Vining et al., 2020). Government support may help facilitate such collaborations and rein in opportunism. Ultimately, ongoing state support defines the impact, worth, and continued flow of the range of resources potentially stemming from private-public collaborations in relation to HSCOs, with NGO-private collaborations being contingent and, at times, contested.

This paper is structured as follows. First, we revisit the literature on RDT and draw out its implications for understanding collaborations in humanitarian relief chains, leading to developing the hypotheses and relative framework. We then present our research method and data collection steps. Finally, after presenting our findings, we draw out their implications for theory, practice, and policy.

2. Theoretical background and hypotheses development

Resource dependence theory (RDT) seeks to explain why certain types of inter-organizational collaboration are conducive to failure or success (Davis and Cobb, 2010). In understanding RDT, it is important to acknowledge the power relations and mutual dependence that exist both within and between organizations or even powerful governments that use all the means at their disposal to achieve their objectives (Drees & Heugens, 2009; Akhtar et al., 2022). In turn, power relations and support are dependent on access to, and control of, vital technical and non-technical resources (Pfeffer & Salancik, 2003; Akhtar et al., 2019). If they have access to key resources that are needed by their collaborators and cannot be readily sourced elsewhere, organizations and governments hold superior positions of power. However, such power relations are not necessarily comprehensively lopsided, with each party potentially wielding power over the other in different aspects—e.g., when one’s ability to access specific resources is potentially offset by the other’s ability to provide opportunities.

In general, the literature on humanitarian supply chains comprises a wide range of aspects such as supply network configuration, coordination, partnership, and performance measurement. However, policy-driven research directions on social sustainability factors need to be better integrated into research on humanitarian supply chains (Anjomshoae et al., 2023).

A recently conducted review of the antecedents and outcomes of innovation in humanitarian supply chains has highlighted the limited amount of research conducted on the role played by innovations suited to enable humanitarian organizations to use supply chains as effective marketing tools toward donors (Altay et al., 2023). Tough operational environments force NGOs to seek new service delivery strategies, which may lead to collaborations and—as argued by RDT (Malatesta and Smith, 2014) or technical RDT (Akhtar et al., 2019)—to the rise of interdependencies (Pfeffer & Salancik, 2003) in humanitarian relief efforts (Kabra et al., 2017; Akhtar et al., 2020). Nonetheless, such interdependencies cause inter-organizational collaborations and government support to be not devoid of challenges for HSCOs in uncertain operating environments (Akhtar et al., 2022).

Considering the challenges presented by power imbalances and the lack of governmental support in relation to preventing collaborations from performing well in HSCOs, we scrutinized the roles played by digital transformation by utilizing big data IT infrastructure, big data analytics, the related relative machine learning/statistical techniques, and the local government support aimed at advancing HSCO. When public-private collaborations (i.e., local or international NGOs, local private companies, MNEs, and host government support) are backed up by specialized capabilities, they will not only enhance knowledge but also the integration of operational data and timely sharing of information within and between organizations, thus assisting in enhancing HSCO success (Akhtar et al., 2018-22; Papanagnou et al., 2022; Dubey et al., 2022). These are then considered examples of pathways suited to the effective management of collaborative discoveries and the resolution of social problems (e.g., Kabra et al., 2017; Pettit & Beresford, 2009). Therefore, it can be argued that reliance on data-driven digitalization, analytics, and insights drawn from data (digital transformation) may enable collaborators to overcome any operational challenges, thus improving humanitarian operations and supply chain performance. Digital transformation involves the transfer of operations into smart supply chains by focusing on digital transformation and related technologies to effectively build information capabilities and navigate turbulent environments (Enrique et al., 2022).

2.1 Digital transformation, public-private collaborations, and HSCO success

Digital transformation is defined as “a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” (Vial, 2019, p.118). Cordery et al. (2023, p. 3) noted that examples of digital transformation in the NGO sector include “*offering new digital services that could not have been previously offered, such as using digital tools (e.g., machine learning) in new ways to engage with beneficiaries in the way that suits them best or using artificial intelligence to guide health care providers and reduce the dependence on medical professionals*”. Digital transformation is mainly about using big data analytics, AI, machine learning, IoTs, and other technological applications suited to provide the real-time responses required in agile operations such as those required in humanitarian disasters. Big data consists of structured (e.g., large volume of Json files) and unstructured (e.g., images and text) data and big data analytics refers to analyzing such data using modern analytical techniques (e.g., machine learning) to get insights for better decision making. By learning from data, artificial intelligence simulates tasks like human intelligence. Additionally, the IoTs is defined as a network of connected devices that correspond and interchange data by utilizing internet. This permits intelligent and more capable collaborations and automation. These applications can ultimately paint a better picture of the problems in-hand and accurate forecasting, resulting in better operational outcomes in relation to tackling any problems. Thus, the formulation and implementation of a digital-transformation-driven strategy with an appropriate digital infrastructure is the key to success for the involved organizations (Correani et al., 2020; Akhtar et al., 2022; Papanagnou et al., 2022; Cordery et al., 2023).

PPCs refer to any joint efforts made by different actors such as governments, private companies, and not-for-profit organizations/NGOs to achieve common goals and tackle grand societal challenges. The public sector (government entities) facilitates companies and not-for-profit organizations by supporting them with infrastructure, the enforcement of law and order, and public services; this enables them to work more effectively together by achieving synergies. Private companies can provide greater financial resources to keep all involved parties together to achieve a focal performance (Akhtar et al., 2012- 2022; George et al., 2024). Public-private collaborations with new technologies such as big data and artificial intelligence can foster HSCO success (Akhtar et al., 2022; Li et al., 2023). PPCs are defined as “*an arrangement of roles and relationships in which two or more public and private entities coordinate/combine complementary resources to achieve their separate objectives through joint pursuit of one or more common objectives*” (Lawther, 2002, p. 33). Due to the

inherent differences between public and private organizations, in which the former being non-profit oriented with predominant social aims whereas the latter being profit-oriented with predominant business aims, the collaboration is likely to simultaneously generate both social and business outcomes (Rufín and Rivera-Santos 2012).

The success of HSCOs depends on multiple factors. The effective delivery of relief aid by humanitarian operators is one of them. It helps to distribute relief goods and services to the most affected people and beneficiaries affected by humanitarian disasters in a timely fashion. Monetary donations and government support play a key role to facilitate aid and supply necessary power to purchase and provide goods and services for HSCOs and relative logistics (Dohale et al., 2024). The success of HSCOs organizations should not only be measured by the number of people organizations provide aid to but also should consider other factors such as the effective assessments for identifying most affected communities and beneficiaries, agility/speed in humanitarian operations, response cost to involved organizations (e.g., donors), and involving local people for home-grown impacts (Stumpf, Besiou, and Wakolbinger, 2023). Anjomshoae et al. (2021) also trusted in multidimensional-based performance factors for HSCO success. The key factors include delivery speed, reporting to donors, logistics costs, funding availability, operational activities, response time, information sharing, and cooperation between involved parties. We, thus, defined HSCO success in relation to the multiple dimensions of these performance measures, which are related to operational outcomes (e.g., reliable services and products, agile responses, costs, and financial efficiency), donor satisfaction (e.g., fast donation-to-delivery times, constant financial support, and satisfaction affected area coverage), and beneficiary satisfaction (e.g., the fair distribution of products and services and reliability of/faith in the involved organizations) (Akhtar et al., 2012- 2022).

2.2 The mediating role played by digital transformation

Resource dependence theory holds that organizations can resolve resource dependencies by collaborating with others (Drees & Heugens, 2013; Hillman et al., 2019; Abdurakhmanov et al., 2021). The literature suggests that inter-organizational collaboration can enhance the positive impact of digital transformation on supply chain effectiveness (Abdalla et al., 2021). However, this leaves open the question of the role played by strategic decision-making, including whether to engage with technological advances and the resources needed to adopt and use them effectively (Oliveira et al., 2022). Digital transformation may be internally focused to deliver a technological edge (e.g., in terms of machine learning or big

data usage), in order to promote a more innovative organizational model—or, from a global or social perspective, facilitate organizations in contributing to the wider social wellbeing (Talafidaryani et al., 2021). Yet, the relationship between resources and digital transformation is ambiguous; a heavy dependency on existing resource structures slows down digital transformation (Maroufkhani et al., 2022; Chen et al., 2024). In other words, if organizations can resolve their resource dependencies through inter-organizational collaboration, their need for digital transformation may become less acute (Chen et al, 2024). However, digital transformation can make operations more efficient (Maroufkhani et al., 2022) and organizational collaborations more effective. Digital transformation is a socio-cultural process (Saarikko et al., 2020) suited to “improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies” (Vial et al., 2019: 121). This process is likely to impose significant resource demands on a firm; inter-organizational collaboration may enable a greater amount of resources to be brought to make digital transformation more feasible. In brief, accounting for digital transformation may help us understand why, given that inter-organizational collaborations may optimize resources, there may still be variations in supply chain effectiveness (or indeed, other digitalization-dependent activities).

In applied terms, while public-private collaborations provide significant competitive advantages through synergistic benefits (Verweij & Satheesh, 2023), they are also associated with disadvantages such as unexpected delays, extra costs, or failure to meet agreed performance targets (Fang, van der Valk, Vos, & Akkermans, 2024). Thus, it is important to address these disruptions through adjustments to contractual and relational governance mechanisms (Rouyre, Fernandez, & Estrada, 2024). In this context, the role played by the activities becomes pivotal for effective public-private collaborations (Saneesh, van Meerkerk, Verweij, Busscher, & Arts, 2023), and the same may be true for private and third-sector collaborations.

While scholars have investigated the use of digitalization in different arenas—including supply chain management (Rai et al., 2006), firm innovation (Nambisan, 2013; Selander et al., 2013; Svahn et al., 2017), global 3-D printing (Biuncken and Barwinski, 2020), government organizations (Effah and Nuhu, 2017), logistics service providers (Cozzolino et al., 2017), businesses (Akhtar et al., 2019), and humanitarian internal coordination (Akhtar et al., 2022), among others—relatively limited focus has hitherto been placed on the study of the use of digital transformation in the context of public-private collaborations for HSCO success [see Appendix A for more details]. To promote digital transformation, organizations can use

advanced technologies to a) automatically collect big data, b) handle social media data (e.g., X, Facebook), open source platforms, special data examining, image analytics, and text mining in real-time, c) design action plans, d) achieve operational agility, and e) predict and plan the distribution of products and services to the disaster-affected areas that need them most (Papanagnou et al., 2022; Akhtar et al., 2022; Dubey et al., 2022; Akhtar et al., 2018).

Digital transformation is argued to not merely be a context for innovation; digital resources are considered an important ingredient for the design and implementation of innovative ways to bring effectiveness to humanitarian operations. As firms are rapidly internationalizing by utilizing digital technologies, digital resources play a vital role in the coordination of international business activities. Hence, the core characteristics of digital technologies are increasingly used to theorize the nature of collaborative innovation to better serve both humanitarian and non-humanitarian operations (Akhtar et al., 2022; Nambisan, 2013). It can thus be argued that public-private collaborations are more likely to engage in digital transformation to overcome any operational challenges; this, in turn, will lead to operational effectiveness and the success of such collaborations. As stated in RDT (Pfeffer & Salancik, 2003; Drees & Heugens, 2013), this could therefore reduce reliance on the specific resources of certain organizations, thus reducing operational bottlenecks because digital technologies could aid in integrating the resources and knowledge uniquely possessed by each party to develop any innovative resource bundles needed for collaboration success. Ultimately, data-driven action plans may reduce the tendency of parties trying to achieve their agendas because data and accurate information can offer neutral and fair solutions. Therefore, it can be argued that public-private collaborations in HSCOs may be more likely to use big data technologies, the related infrastructure, and machine learning (i.e., as a digital transformation strategy) to manage their collaborations in order to reduce the obstacles to better humanitarian outcomes outlined by RDT.

The opportunities for frequent interactions and engagement offered by digital technologies enable collaborators and beneficiaries to share data and accurate information, also increasing transparency and reducing any duplication of efforts among partners, which is key to humanitarian operational success. As argued in RDT (Pfeffer & Salancik, 2003; Drees & Heugens, 2013), digitalization thus facilitates the management of complex tasks and enhances openness and transparency, thus reducing any power imbalance between private and public partners and facilitating HSCO success. Humanitarian performance excellence depends both on effective coordination and big data (e.g., huge volumes of structured and unstructured data), with modern information processing systems assisting in handling

complex and interlocking operations. Humanitarian organizations can either partially or fully automate their operations, depending on their needs and the technical resources available to them. This ultimately contributes to performance factors such as timeliness of response, cost reduction, end-to-end supply chain visibility, and operational quality. Big data technologies and digitalization can capture and harness external data, which would then be integrated with the tangible and intangible resources possessed by the collaborative partners to efficiently and effectively solve any operational problems (Enrique et al., 2022; Dubey et al., 2022; Kabra et al., 2017; Akhtar et al., 2022). Digital transformation also facilitates flexibility and openness through the use of digital technologies, which are vital to improving supply chain performance and success (Enrique et al., 2022). Collaborative partnerships are also associated with the significant costs that arise due to the *not-invented-here* syndrome (Antons & Piller, 2015); this can potentially create bottlenecks, thus hindering the overall success of such collaborations. In such a context, digital transformation and the use of digital technologies can support collaborations, leading to HSCO success. As per RDT (Pfeffer & Salancik, 2003; Drees & Heugens, 2013), organizations depend on the external environment for vital resources, and the relationship between private-NGO collaborations and HSCO success relies on the effective use of collaborative partners' digital assets and resources. Scholarship suggests that digital transformation improves digital business strategies, in turn leading to process improvements and the facilitation of modularization (cf. Bharadwaj et al. 2013). Private-NGO collaborations are reinforced by digital transformation as partners can readily share vital data and information to deal with extreme humanitarian crises. The spread of digital transformation and digital assets across networks of collaborative partners can generate positive digital knowledge externalities, which can be vital to achieve visible improvements in humanitarian operations, greater sharing of knowledge, and enhanced operational preparedness and efficiency (Bharadwaj et al. 2013; Enrique et al., 2022). Hence, by overcoming the challenges raised by resource dependency, as outlined in RDT, digital transformation may mediate the relationship between public-private collaborations and HSCO success. Thus, we propose that:

H1. *Digital transformation mediates the relationship between private-NGO collaborations and HSCO success.*

2.3 The moderating role played by host government support

As noted above, RDT holds that inter-organizational collaborations may alleviate or resolve any dependencies caused by a lack of internal organizational resources (Drees &

Heugens, 2013; Hillman et al., 2019; Abdurakhmanov et al., 2021). However, at the same time, inter-organizational collaborations can attract the attention of regulators; this may be simply due to collaborations closing the door on potential competitors or alternative providers. Hence, the literature suggests that legislative changes can moderate the potentially beneficial effects of inter-organizational collaborations (Drees & Heugens, 2013). This can define the boundary conditions of RDT regarding the beneficial effects of inter-organizational collaboration. At the same time, the literature on RDT posits that firms are often unable to mitigate any uncertainty and reliance on the wider social system; this implies reliance on government agencies but, at the same time, the inability to directly influence them (Hillman et al., 2019). Yet, government intervention can take many forms, including the allocation of contracts (Abdurakhmanov et al., 2021) and the promulgation of laws (Drees & Heugens, 2013). However, it can also include a wider range of actions aimed at facilitating the activities of collaborating organizations. In complementing the literature on the effects of contracting and legislating, we explored how a broader range of government interventions may moderate the beneficial effects of inter-organizational collaboration in resolving any resource challenges.

In applied terms, private-NGOs collaboration and HSCO success also depend on other contingent factors. One important such factor can be the support provided by the governments of disaster-affected countries. Scholars have identified the vital role played by institutions in shaping the strategic choices and behaviors of firms (cf. Peng, 2003). We argued that the governments of the countries in which disasters have occurred play a key role in any humanitarian relief operations by enabling collaborations among local and international NGOs, local private companies, and MNEs to achieve HSCO success. In fact, such host governments facilitate the involved actors in the timely provision of humanitarian aid, thus reducing any potential delays that may occur due to reliance on resources, as per RDT. Without the cooperation and permission of the host governments, NGOs are unable to deliver humanitarian services. Scholarship suggests that the repression of NGOs by the host governments can lead to negative outcomes such as human rights abuses (Chaudhry & Heiss, 2022), affecting transnational NGO collaboration and advocacy in host markets (Fransen et al., 2021). In some instances, powerful governments do not allow NGOs to enter their countries and deliver aid, causing more suffering to civilians. Therefore, host government support is a crucial element in private-NGO collaboration leading to HSCO success. With host government support, NGOs are in a better position to mobilize the resources stemming from collaborations with cross-sector partners, which are vital to enhancing their efficiency

and effectiveness in delivering value to extreme disaster-affected communities. Host-government support can reduce uncertainty arising due to operating in an unknown environment, which in turn mitigate search and transactional costs of collaborations. This thus reduces any unhealthy reliance on the resources of specific partners, as suggested in RDT. In this regard, host governments can mitigate any resource constraints by legitimizing and accepting humanitarian relief operations, offering local networks and administrative and support infrastructure to humanitarian operations, and sharing local knowledge and needs—all of which are of paramount importance to the timely delivery of aid—and by providing collective goods (Boddeyn & Doh, 2011; Akhtar et al., 2012). When private organizations (e.g., MNEs) are involved in supply chains, host government support plays a vital role in regulating and underwriting the relationship. Host government support can further regulate the relationship in order to ensure that any focus on profits held by private organizations does not detract from the quality of relief, to offset any power imbalances outlined by RDT, to help identify any suitable private sector partners, and pressure NGOs to constructively engage with them (Yaziji & Doh, 2009).

Host-government cooperation is also fundamental in achieving the desired outcomes when private organizations and NGOs are involved in the provision of public goods (Boddeyn & Doh, 2011). Additionally, host government support is needed to scale up any humanitarian operations, as it can connect internationally involved parties with those local players who can ensure that the support is targeted at the neediest people. In other words, host government support can ensure that any collaborations make a difference on the ground, can further regulate the relationship to ensure that any involved parties emphasize humanitarian operations, and can reduce any power imbalance or negative repercussion of resource dependency (Akhtar et al., 2021; Boddeyn & Doh, 2011; Roy & Oliver, 2009; Yaziji & Doh, 2009). On the other hand, the lack of host-government support can exacerbate search costs and uncertainty for MNEs, and NGOs involved in humanitarian disasters which can negatively affect HSCO success. In such situations NGOs and other collaborating partners dealing with humanitarian disasters might have to depend on their own knowledge and understanding which could create additional risks for collaborating partners to deal with unfamiliar environment with lack of government support. This can lead to higher failure rates of HSCO in reaching out to beneficiaries and communities affected by the humanitarian disasters, which can increase operational and transactions costs. The preceding discussion led us to suggest the following:

H2. *Host government support positively moderates the relationship between private-NGO collaborations and HSCO success.*

Figure 1 graphically summarizes our hypotheses and the constructs involved. Appendix A shows the details of the studies hitherto conducted and the relative knowledge gap discussed above. Past studies have placed little emphasis on the roles played by digital transformation and host government support for HSCO success.

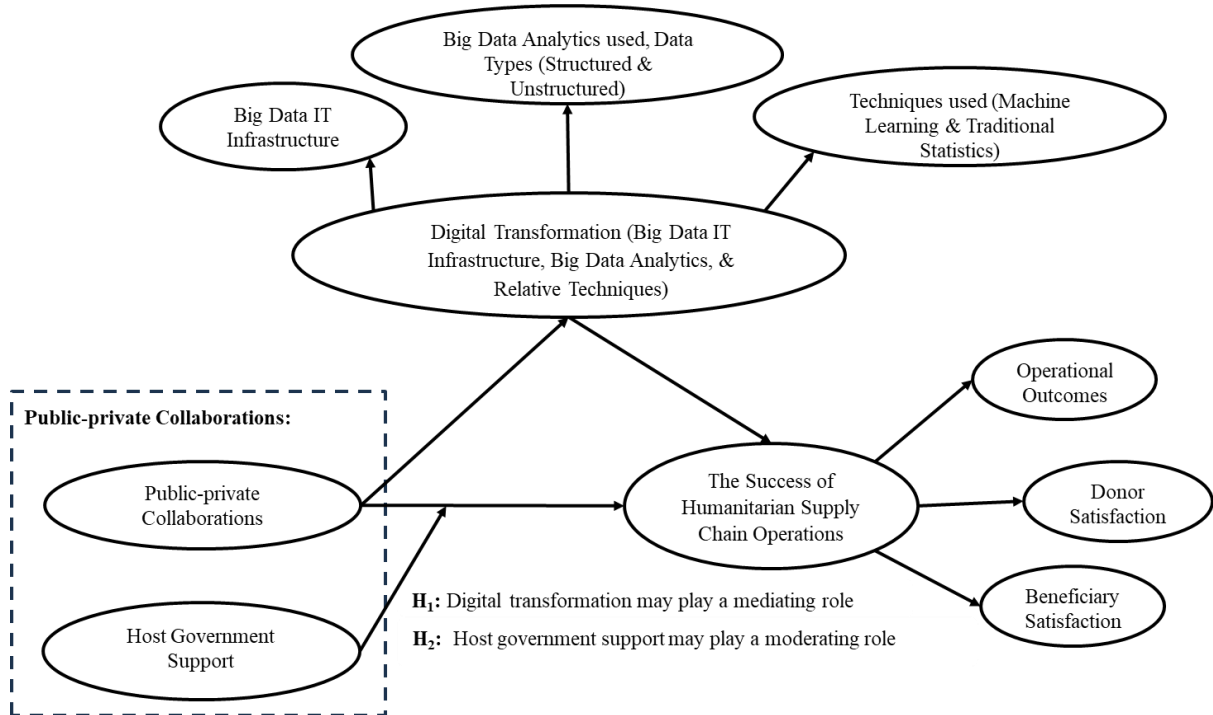


Fig. 1. Relationships between the underlying constructs.

3. Research methodology

3.1 Sample and data collection

We selected our sample from the population of private organizations, including MNEs, and NGOs that provided healthcare, sanitary, food, shelter, and bedding services in response to humanitarian disasters. We based our units of analysis on the effects of collaborations, along with host government support. Our sample organizations had been involved in national and international humanitarian operations and were based in both developed (e.g., the UK, France, and Japan) and developing countries (e.g., Pakistan and Sri Lanka). The main reasons underpinning our selection of these organizations were the lack of research in this domain and the need to provide insights into the many opportunities for the adoption of emerging technologies and the digital transformation of operational activities suited to foster better

collaborations among the main actors and other involved parties, thus building on collaboration and performance (Akhtar et al., 2012; Kabra et al., 2017; Vial, 2019).

We selected a diverse set of participants—such as country directors, IT managers, operations managers, logistics, and supply chain coordinators, project managers, and relevant government officials—as a suitable research sample in possession of the required knowledge and information, such as supply chain and international operational experience, big data management, big data analytics, and digitalization (see Table 1 for further details). We conducted a pilot survey to facilitate this procedure and ensure that the participants had used digital platforms/digital transformation and big data and had been extensively involved in collaborative activities with relevant parties, such as international and local NGOs, donors, host government officials, and local representatives, among others. Following many personal visits and email reminders, we received a total of 224 survey responses out of 635 invitations (i.e., a response rate of 35%) and used them to perform the structural equation modeling (SEM). The characteristics of our research participants are given in Table 1.

Table 1
Research participants.

	Categories	No	%
Job title	Country director	31	13.84
	IT manager	55	24.55
	Operations manager	38	16.96
	Logistics and supply chain coordinator	32	14.29
	Project manager	36	16.07
	Relevant government official	34	15.18
Organization	NGOs and government officials	121	54.02
	Private organizations, including MNEs	103	45.98
	Healthcare	42	18.75
Service/product type	Sanitary	37	16.52
	Food	76	33.93
	Shelters and bedding	69	30.80
No of employees	<50	56	25.00
	<250	96	42.86
	>250	72	32.14
Total		224	100.00

3.2 Measurement scales, variables, and relevant quality checks

To define the measurement scales, we followed comprehensive and well-established strategies. We started the procedure by reviewing the relevant literature to identify the themes and items best suited to develop the construct—i.e., related to measuring the collaboration aspects of MNEs and NGOs—based on studies that explored the concepts (e.g., Akhtar et al.,

2012; Kraus et al., 2014; Wu et al., 2014; Akhtar et al., 2022; Li et al., 2023). Similarly, other studies related to the use of big data technologies and digitalization/digital transformation helped us to establish initial guidelines for the collection of material relevant to the development of the scales (e.g., Chen & Zhang, 2014; Chen et al., 2012; Correani et al., 2020; Akhtar et al., 2022; Papanagnou et al., 2022; Cordery et al., 2023). More studies (e.g., Akhtar et al., 2012, 2018, 2019, 2022; Anjomshoae et al., 2021; Stumpf, Besiou, and Wakolbinger, 2023) provided guidelines suited to develop the dependent variables (i.e., performance, operational outcomes, and donor and beneficiary satisfaction) and host government support (e.g., Roy & Oliver, 2009; Akhtar, 2022; Dohale et al., 2024). These studies helped us to explore the specific context of our study as well as to identify guidelines suited to the development of the underlying measures. To the best of our knowledge, there were no previously available scales for these specific constructs (please see Appendix A for such a knowledge gap); therefore, to develop them, we followed a comprehensive procedure, as suggested by past studies conducted under similar circumstances. In brief, we reviewed the relevant literature and then conducted a pilot survey. We followed this by performing an exploratory factor analysis (EFA) with varimax rotations, eigenvalues ≥ 1 , and scree plot checks.

We measured the construct—i.e., the collaborations—utilizing 15 items. We did so because of the multiple actors involved (i.e., international and local NGOs, and donors) and because we wanted to measure collaborations along each dimension. Additionally, we measured the host government's role by employing five items. Due to their multidimensional inputs and outcomes, digital transformation (the mediating construct) and HSCO success (operational outcomes, donor satisfaction, and beneficiary satisfaction) comprised 15 and 17 items, respectively. For instance, the full implementation of technology-driven strategies involves multiple layers (e.g., big data IT infrastructure, big data analytics, and their related techniques). To ensure the robustness of our measures, we needed to verify these layers. Similarly, we needed to measure HSCO success comprehensively by considering all key successful outputs. We measured all items on a seven-point Likert scale (1 = strongly disagree, 2 = disagree, 3 = slightly disagree, 4 = neither agree nor disagree, 5 = slightly agree, 6 = agree, 7 = strongly agree). Further details for these constructs are given in Appendix B.

Regarding common-method variance (CMV), we referred to the literature to develop a systematic questionnaire and its measures, which we then further refined utilizing exploratory factor analysis (EFA). As suggested by other researchers (e.g., Podsakoff et al., 2003; Tourangeau et al., 2000), we avoided any unfamiliar and technical words, negatively worded

items, and double-barreled questions. We also clustered the questions with different construct items (not in the same conceptual dimensions). If not considered, these aspects could be a source of CMV (Podsakoff et al., 2003; Tourangeau et al., 2000). The anonymity of the survey was ensured and conveyed, and single-informant bias was avoided by collecting data from different manager types (country directors, IT managers, operations managers, logistics and supply chain coordinators, project managers, and relevant government officials).

We used a sample size guideline with an anticipated effect size of 0.3 and a statistical power of at least 0.8 at 0.05% probability, along with six latent variables and 36 items. The minimum sample size indicated was 161; ours was 224, as samples of more than 200 cases are often used for SEM. Post-hoc statistical power analysis also supported a very high observed statistical power (0.99), with four predictors and $R^2 = 0.24$ at alpha level 0.05. Moreover, once we had collected the data, we performed Harman's one-factor test; this yielded multiple factors explaining the greater variance observed in comparison to a single-factor solution or other combinations. The marker variable technique (the variable being the number of cases with which the respondents dealt daily) and small correlations provided a reasonable proxy. The latent factor technique used to address CMV also did not highlight any issues.

Additionally, we performed chi-square difference tests to check for non-response bias, early to late respondents, types of respondents, types of organizations, the variety of products or services they provided (e.g., healthcare and food), and the size of organizations (i.e., number of employees), and found no significant differences. Moreover, by conducting further tests we found no statistically significant mean differences between the respondents from private organizations and NGOs. The detailed results are shown in Table 2. These comprehensive and systematic measures mitigated any potential for CMV and thus ensured the reliability of the findings.

Table 2
Comparing mean difference test (*t*-test)

Variable/construct	Mean rating		Standard deviation		Statistical difference p-value (F)
	Private (<i>n</i> = 103)	NGOs (<i>n</i> = 121)	Private (<i>n</i> = 103)	NGOs (<i>n</i> = 121)	
Private collaborations with international NGOs	6.30	6.31	0.46	0.50	0.13 (2.26)
Private collaborations with local NGOs	6.18	6.24	0.50	0.54	0.19 (1.74)
Private collaborations with donors	6.21	6.26	0.42	0.45	0.29 (1.13)
Use of big data technologies and digitalization (DT)	6.30	6.25	0.39	0.37	0.22 (1.53)
Host government support	6.19	6.24	0.46	0.50	0.17 (1.89)
HSCO success	6.23	6.21	0.36	0.35	0.29 (1.11)

4. Results

4.1 Descriptive and exploratory factor analysis

The descriptive results are listed in Table 3 by means of a correlation matrix. The mean values show that collaborations between private organizations and NHOs were rated at over 6 on our seven-point Likert scale. Similarly, digital transformation scales and performance indicators were rated toward the top end, showing positive correlations (see the correlation matrix for details).

Table 3

Descriptive statistics and correlation matrix of underlying constructs.

Constructs	Mean	σ	1	2	3	4	5	6
1. Private collaboration with international NGOs	6.30	0.48		0.60	0.53	0.15	0.68	0.14
2. Private collaboration with local NGOs	6.23	0.51	0.61		0.71	0.13	0.72	0.14
3. Private collaboration with donors	6.20	0.52	0.54	0.72		0.13	0.71	0.15
4. Digital transformation	6.30	0.80	0.16	0.15	0.14		0.13	0.37
5. Host government support	6.20	0.50	0.69	0.73	0.72	0.14		0.14
6. HSCO success	6.21	0.35	0.16	0.15	0.16	0.38	0.15	
7. The marker variable, (languages)	3.02	0.52	0.02	0.03	0.01	0.01	0.04	0.06

(Mean); σ (standard deviation); $n = 224$; the correlations are significant at [$p < 0.01$ (values > 0.16): $p < 0.05$ (values > 0.10 and < 0.17)], except for values < 0.10 , with the unadjusted correlations presented below the diagonal

To further refine our constructs and test our hypotheses, we took a two-stage SEM approach. First, we executed a series of quality checks through measurement models: item reliability (alpha), composite reliability, convergent validity, and discriminant validity. We excluded a few items (DT2, DT12, and PER16) because of low loadings. Second, we tested the hypotheses by examining the structural correlations between the constructs. To establish and improve the different models, we also utilized p -value and fit indices (e.g., $CFI \geq 0.90$; $TLI \geq 0.90$; $RMSEA \leq 0.08$) (Kline, 2023).

The exploratory results are listed in Table 4. The reliability values were found to range from 0.89 to 0.97, thus demonstrating a good level of consistency. All loadings (λ highly significant at $p < 0.01$) were found to converge very well. Additionally, the average variance explained (0.68 to 0.77) and construct reliability values were found to fall in the 0.90s, providing further confidence for the measures used. We assessed discriminant validity by measuring the correlations between the constructs, which were found to not exceed the value of 0.85 —see Table 3—with the highest value being 0.73. In addition, the square of correlations (ϕ^2) for each pair of constructs was observed to be lower than the average variance explained (Kline, 2023).

Table 4

Construct reliability and validity, evaluation of measurement models.

Constructs	Items	α	λ	AVE	CR
Private collaboration with international NGOs	PCIN	0.92	0.72	0.66	0.85
Private collaboration with local NGOs	PCLN	0.94	0.80		
Private collaboration with donors	PCD	0.94	0.90		
	DT1	0.96	0.76	0.68	0.97
	DT3		0.71		
	DT4		0.71		
	DT5		0.76		
	DT6		0.83		
	DT7		0.76		
Digital transformation (DT)	DT8		0.88		
	DT9		0.85		
	DT10		0.78		
	DT11		0.80		
	DT13		0.85		
	DT14		0.77		
	DT15		0.85		
	HGS1	0.90	0.75	0.70	0.92
	HGS2		0.83		
Host government support	HGS3		0.84		
	HGS4		0.81		
	HGS5		0.81		
	HSCO1	0.97	0.87	0.77	0.98
	HSCO2		0.85		
	HSCO3		0.83		
	HSCO4		0.82		
	HSCO5		0.76		
	HSCO6		0.79		
	HSCO7		0.89		
HSCO success	HSCO8		0.78		
	HSCO9		0.87		
	HSCO10		0.79		
	HSCO11		0.90		
	HSCO12		0.83		
	HSCO13		0.77		
	HSCO14		0.74		
	HSCO15		0.86		
	HSCO17		0.86		

α = item reliability; λ = loadings; AVE = average variance explained; CR = construct reliability; any missing items (e.g., DT2) were deleted due to low loadings

Figures 2 and 3 show the development of the second-order construct (i.e., private-NGO collaborations) and its relevant statistics (correlations, loadings, t-statistics, and p-values). All factor loadings were found to be greater than 0.7, thus strongly supporting the second-order option (we took 0.5 as a common cut-off point).

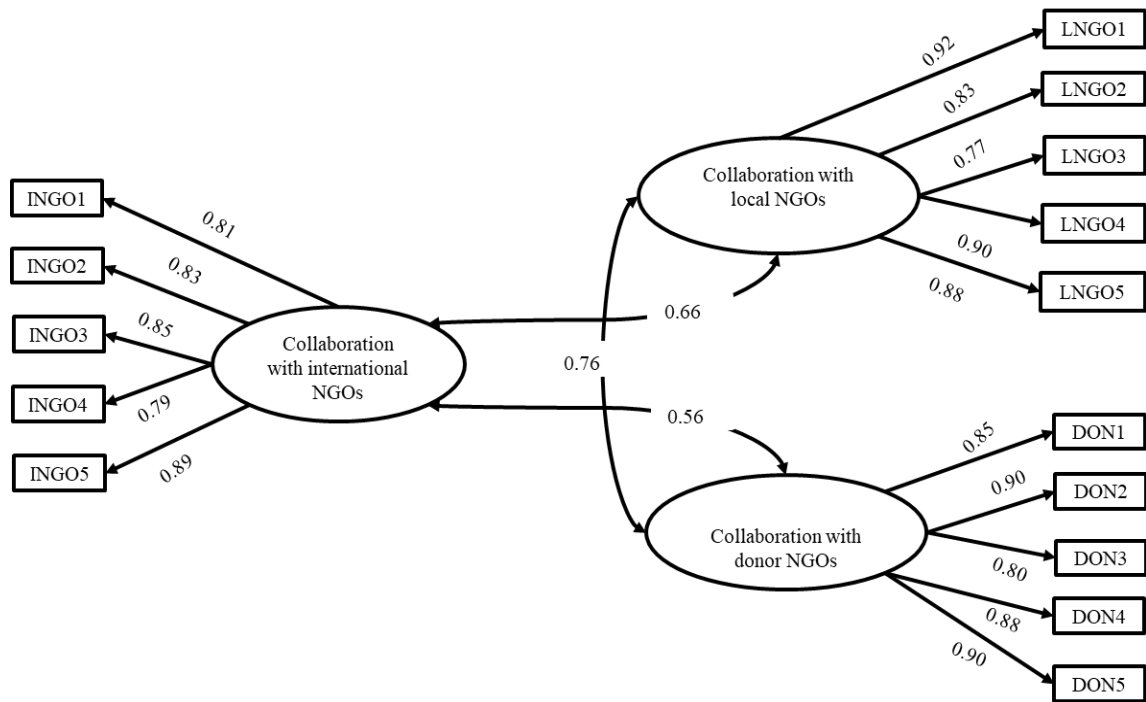


Fig. 2. Private-NGO collaborations as a second-order construct, correlations, and loadings

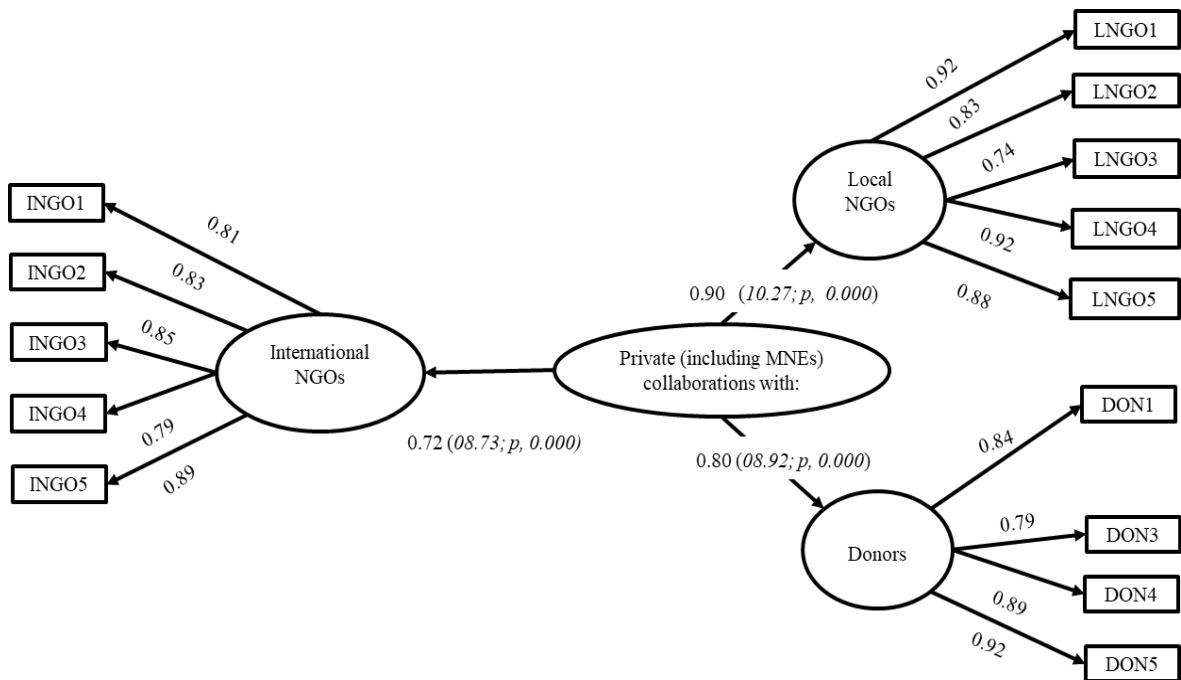


Fig. 3. Private-NGO collaborations as a second-order construct

4.2 Hypothesis testing results

Table 5 provides the results of the hypotheses testing and the alternative models. In Hypothesis 1 (H1), we posited that DT would play a mediating role between private-NGO collaborations and HSCO success. To test our mediation model, we utilized two methods: 1) a four-step mediated procedure proposed by Baron and Kenny (1986), which is well

established and provides additional model statistics for comparison (see Table 5), and 2) bootstrapping—a fairly new method to cross-validate our results. In the first step, we assumed a positive correlation between private-NGO collaborations and HSCO success. Based on the structural results, we found this to be supported with $\beta = 0.15$; in other words, we found the correlation to be statistically significant (the p-values and relative statistics are provided in Table 5). In the second step, we assumed private-NGO collaborations to be positively correlated with DT and, in the third one, we posited DT to be positively correlated to HSCO success. We found both these correlations to be supported with $\beta = 0.14$ and $\beta = 0.39$, respectively. Finally, the correlation between private-NGO collaborations and the success of HSCO was found to become non-significant—from $\beta = 0.15^{**}$ (2.100) to $\beta = 0.09$ (1.205)—showing a full mediation and demonstrating the central role played by DT in HSCO success (H1 was thus found to be supported). The effect size of our mediation was found to be medium, with $f^2 > 0.15$. The fit indices, with an R^2 value of 0.24, were also found to support the model—see Table 5 for details.

Additionally, the bootstrapping method was found to show that private-NGO collaborations are positively correlated with HSCO success ($\beta = 0.15$, $t = 2.110$, $p, 0.037$) and mediator ($\beta = 0.14$, $t = 1.982$, $p, 0.042$). The mediator (DT) was also found to be positively correlated with HSCO success ($\beta = 0.34$, $t = 5.800$, $p, 0.000$). The direct effect of private-NGO collaborations on the success of HSCO was found to become insignificant [$\beta = 0.05$, $t = 1.220$] with the introduction of the mediator, with the confidence intervals ranging from 0.09 to 0.10 (bias-corrected).

Table 5
Models, structural results, and fit indices.

Variable/construct	Model 1	Model 2	Model 3	Final model
Private-NGO collaborations → HSCO	0.15 (<i>p</i> , 0.036) (2.100)			0.09 (1.205)
Private -NGO collaborations → DT		0.14 (<i>p</i> , 0.042) (1.982)		0.14 (<i>p</i> , 0.040) (1.990)
DT → HSCO			0.32 (<i>p</i> , 0.000) (5.371)	0.39 (<i>p</i> , 0.000) (5.462)
Host government support				0.14 (<i>p</i> , 0.044) (1.975)
Private-NGO collaborations x host government support				0.13 (<i>p</i> , 0.046) (1.963)
R^2	0.12	0.16	0.20	0.24
χ^2/df	1.965	1.790	1.926	1.804
RMSEA	0.066	0.060	0.064	0.060
CFI	0.950	0.954	0.962	0.953
TLI	0.937	0.947	0.953	0.946
IFI	0.950	0.954	0.963	0.952

In Hypothesis 2 (H2) we proposed that host government support would positively moderate the relationship between private-NGO collaborations and HSCO success; our results using SEM supported with $\beta = 0.13$ and $p = 0.046$. H₂ is graphically shown in Figure 4. HSCO success thus improves in the presence of high host government support and high private-NGO collaborations.

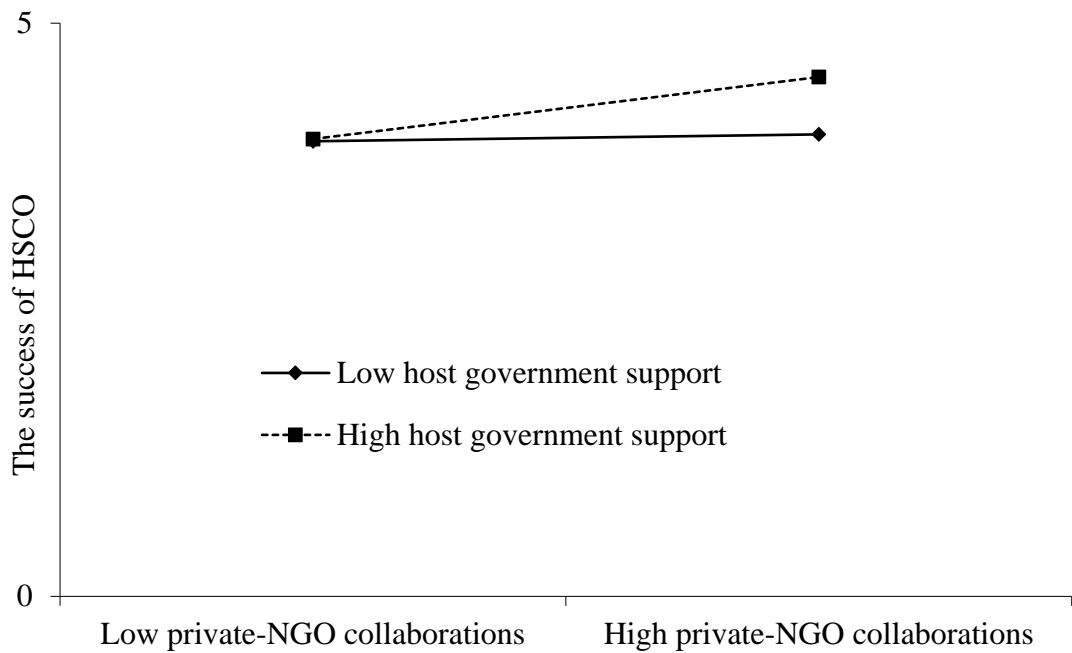


Fig. 4. Interaction effects.

5. Discussion and conclusion

Digital transformation is very important for organizations to cope with volatile, uncertain, complex, and ambiguous challenges (Akter, Biswas, Vrontis, Cooper, & Tarba, 2023); it thus transcends a firm’s boundaries, processes, structures, roles, and interactions and redefines its value chains, strategies, and governance mechanisms (Cennamo, Dagnino, Di Minin, & Lanzolla, 2020). Yet, digital transformation also has a dark side, as marketplace dominance by digital incumbents has dubious consequences for consumers, and amplifies any biases in decision-making processes—e.g., by the algorithms underpinning artificial intelligence (Lanzolla, Lorenz, Miron-Spektor, Schilling, Solinas, & Tucci, 2020).

Beyond merely opening new opportunities for multiple stakeholders, digital transformation has broader implications for value creation and capture; thus, exploring its role at various levels of analysis and cross-fertilization from various realms/disciplines becomes crucial (Appio, Frattini, Petruzzelli, & Neirotti, 2021; Nambisan, Wright, & Feldman, 2019). Moreover, as recently stressed by Nambisan and George (2024), as the existing socio-political structures and factors may sometimes limit the effectiveness of digital solutions, it is vital to adopt a socio-technical design perspective, which offers alternative arrangements of digital and socio-political elements while tackling societal grand challenges. We believe that our study makes an important contribution in response to the aforementioned call.

Based on data drawn from 224 HSCO cases involving NGOs, private organizations (including MNEs), and government representatives, we examined the effect of digital transformation and host government support on the relationship between public-private collaborations and HSCO success. Among other things, we found that digital transformation—effected by building big data infrastructure, the use of big data technologies, and machine learning applications—positively mediates the relationship between private-NGO collaborations and HSCO success and that host government support moderates such relationship.

5.1 Theoretical implications

The literature shows that inter-organizational collaborations may alleviate or resolve resource dependencies (Drees & Heugens, 2013; Hillman et al., 2019; Abdurakhmanov et al., 2021). Yet, an abiding debate persists in regard to whether RDT can explain organizational performance due to power imbalance and mutual dependence (Hillman et al., 2019). It has been argued that, while this may be very difficult to prove, resolving resource dependencies may help the organization contribute to societal well-being (ibid.). At the same time, the literature cautions against the relationship being directly causal, suggesting that it may be mediated by socially constructed dimensions such as legitimacy and autonomy (ibid.). Yet, digital transformation is itself a socio-cultural process (Saarikko et al., 2020), and hence may also have mediating effects in supporting collaborations to achieve their objectives. In brief, in seeking to unpack the relationship between resource enhancement through collaboration and HSCO success, we introduced a further dimension that centers on the ability to effectively deploy new technologies. In doing so, we provided an alternative mechanism suited to further our understanding of how digitalization may be viewed from an RDT perspective—i.e., digitalization may itself unlock new resources, but digital transformation is itself heavily resource-dependent. The literature on RDT further posits that organizations cannot effectively mobilize their resources in isolation in the wider socio-political context. Governments can support the activities of firms in many ways, the most obvious being favorable legislation and the provision of contracts (Abdurakhmanov et al., 2021; Drees & Heugens, 2013). Hence, government support can define the boundary conditions of the potential relationship between resolving any resource dependencies through collaboration and the ability to have a positive societal impact—in this instance, through HSCOs. To summarize, we shed light on what may mediate the effects of resolving resource dependencies on socially relevant outcomes, and what moderates such effects.

Accordingly, our findings offer important implications for future research. A stream of literature suggests that, in partnering with for-profits, NGOs may be able to access a range of resources greater than the one they would on their own (de Lange et al., 2016). On the other hand, recent work has cast doubt on the relative value for money of such partnerships, arguing that they may lead to much greater costs in service delivery, thus leaving NGOs and collaborative performance much worse off (McEwan et al., 2017; Hussler & Payard, 2019). In seeking to bridge such seemingly contradictory findings, by building on RDT, we enhanced our understanding of the influence of two key resources often used in HSCOs—namely, digital transformation and host government support—on the relationship between NGO-private sector collaboration and HSCO success.

Our study makes an original contribution to the literature on technical RDT and HSCO success by demonstrating how digital transformation contributes to improving the performance of private-NGO collaborations in humanitarian operations and supply chains. By identifying the important mediation role played by digital transformation in HSCO success, we provide a fine-grained view suited to showcase the vital role played by digital assets when multiple cross-sector partners are involved in dealing with extreme humanitarian crises. Our findings evidence that digital transformation—as effected through the use of big data technologies, their related infrastructure, and modern data-driven techniques—acts as an enabler of HSCO success, a role that had hitherto not been associated with digital technologies in the literature. Therefore, private-NGO collaborations in HSCO are more likely to make use of big data techniques and digitalization to enhance their success. This is mainly due to the key role played by digital transformation in reducing any reliance on specific assets held by powerful partners, a key bottleneck outlined in RDT in relation to collaborations. Digital transformation is suited to overcome this operational inefficiency by offering increased coordination, openness, transparency, bundling of resources and knowledge, data and information access and accuracy, and managing complex tasks. Therefore, our key original contribution pertains to outlining the ‘under-studied’ role played by digital transformation along with private-NGO collaborations. Our findings offer novel insights as digital transformation had hitherto been under-investigated as a mediating mechanism. We thus add value to research by specifically outlining the mediating role played by digital transformation in enabling private-NGO collaborations to achieve greater HSCO success by minimizing the challenges outlined by RDT.

Again, we contributed to the cross-sector and humanitarian supply chains literature by identifying important boundary conditions concerning the influence of private-NGO

collaborations and HSCO success. We did so by finding that host government support acts as a vital contingent factor that supports private-NGO collaborations and HSCO success. We also found host government support, as a moderator, to be crucial in enabling HSCO success. Our findings show that, when host governments become involved in private-NGO collaborations, they moderate the correlation between such collaborations and HSCO success. Our findings highlight how host governments can play a three-fold role. First, in line with their core social service delivery function, they can intervene on the side of NGOs, ensuring that the latter's core mission is not diverted and/or that expenditure remains under control despite the involvement of for-profit actors. Second, they can intervene on the side of private organizations as a result of ideological convictions pertaining to the greater efficiency of the for-profit sector stemming from any close ties held by senior civil servants or politicians with particular firms, and/or from the fact that donor nations may tend to direct any relief business to private organizations (including MNEs) from their own country. Finally, they can strategically engage with partners and/or enact regulations aimed at managing their collaborations (e.g., Boddewyn & Doh, 2011), ensuring that they work symbiotically and seeking to reconcile their respective agendas while, again, ensuring service delivery efficiency. Governments can regulate the relationships and mitigate any negative consequences stemming from reliance on any resources provided by private for-profit actors that, as suggested by RDT, would ultimately be driven by returns, rather than delivery. Many governments actively promote collaborations between the for-profit and not-for-profit sectors, and sympathetic ones may further drive any business of this kind towards private organizations, resulting in state interventions in this sphere being viewed favorably. This does not mean that the challenges outlined by RDT will necessarily be resolved; rather, they may be mitigated to such an extent that no side will be left worse off, at least in the short term. Finally, in an age in which governments have become, after years of retreat, much more interventionist, our findings highlight one area in which government interventions may be particularly beneficial if they allow NGOs to operate effectively. Overall, our findings suggest that host governments can play an important role along with any resources nurtured through digital transformation by private-NGOs collaborators in supporting HSCO success.

Given that it focuses on markets and networks, rather than on an RDT actor-centered approach, the relevant literature has sometimes been referred to as a 'friendly competitor' to RDT (Davis & Cobb, 2010). They share common ground by building on Coasian notions of power and assigning great importance to the quality and density of social relations; the former placing greater emphasis on the social structures that mediate and embed these. Our

findings not only supplement such work by highlighting how, in enhancing information volume and quality, the usage of big data technologies can support, sustain, and supplement these relationships, enabling the micro-level deployment and sharing of more detailed evidence, but also underline the key moderating role played by governments and their associated institutions. There is room to further draw on the insights from the relevant literature, building on and extending its common ground with RDT.

5.2 Practical and policy implications

We hereby outline the several practical and policy implications of our findings for organizations and policymakers striving to achieve improvements and excellence in HSCOs. First, the effect of digital transformation in supporting private-NGO collaborations and HSCO success suggests that the managers of those organizations involved in supporting humanitarian causes can devote additional financial resources to the development of the digital skills of their current workers, upgrading their digital and analytical expertise to make them better able to capitalize on technologies and techniques suited to improve organizational processes, especially HSCO success. NGOs should also better communicate the benefits of such technologies and the development of big data capabilities to the various end users of their services and products. Importantly, large-scale disasters cannot be easily tackled by NGOs on their own; private organizations (including MNEs), with their big data technical capabilities, along with host government support can strengthen humanitarian operations. The transfer of technical knowledge from private organizations to NGO managers is useful for long-term success and sustainability in humanitarian operations. This can lead to a better joint-learning platform in which educational institutions can also play a role in enhancing local digital skills by working in partnership with private organizations, NGOs, and governments.

Second, our findings indicate the vital role played by host government support in facilitating private-NGO collaborations and facilitating HSCO success. These findings suggest that host governments should set up enabling environments for local and transnational NGOs by removing any administrative and regulatory measures that can facilitate the collaborations of cross-sector partners in dealing with extreme disasters.

Third, policymakers could facilitate organizations engaging in humanitarian relief by developing capabilities and analytical skills in the use of big data technologies and digitalization. In this regard, it would be important to remedy any data governance-related issues, especially by introducing policies and initiatives aimed at facilitating the effective use of data to generate social value for humanitarian operations. Positive local government

involvement in private-NGO collaborations is key to achieving better performance in HSCOs; therefore, local governments should play a stronger moderating role.

Last, our findings suggest that inter-organizational collaborations can provide NGOs with an effective mechanism suited to leveraging the expertise of private organizations to the end of improving the link between humanitarian organizations and their local communities. Such collaborations can safeguard the effective utilization of NGO resources. Given these demonstrated positive bottom-line implications of the adoption of big data technologies and digitalization, other NGOs may be incentivized to institute changes geared toward more widely embracing these innovative approaches. Indeed, big data technologies and digitalization approaches help to reduce organizational bureaucracies and thereby improve efficiency. Moreover, our findings also suggest that the managers of NGOs and policymakers need to make greater efforts toward nurturing trustworthy relationships with a diverse set of stakeholders for the efficient exchange of valuable knowledge and resources to enhance the effectiveness of relief operations.

5.3 Limitations and future research directions

Our study's limitations are akin to those of other survey-based ones of a similar nature; we discussed this in the method section and explained how we sought to redress such limitations. We tested our theoretical framework by means of data drawn from the humanitarian industry. As the underlying constructs may behave differently in commercial sectors and the effects of governments in moderating the relationships between organizations may vary, future research could use data drawn from other industry settings. More specifically, governments are likely to have different agendas or play positive and negative roles when regulating the relationship between two private for-profit actors; these may range from mitigating market excess to actively promoting one at the expense of the other for strategic, ideological, or other reasons. Additionally, RDT is undergoing rapid changes, and the impact of future technologies may have various consequences, while existing technologies may bring further unforeseen ones in their wake. Future researchers could focus on unstructured data, particularly on how different forms of such data—such as video mining, comment mining, surface mining techniques, and image processing—could help organizations improve their service quality. Machine learning techniques and open data sources could also provide interesting insights; thus, the use of digitalization and big data science provides many opportunities for future research. There is also further scope to examine the governance issues related to big data applications and performance across complex supply chains. Future studies could also focus on how collaborative business models

are changing in highly digital-oriented ecosystems and on their impacts on collaborative performance. Such studies could draw insights from the literature on global supply chains and examine how digital business models shape the social and economic upgrading of global humanitarian operations. Our study, which provides further insights into the intersections between private-NGO collaborations, the use of digitalization and big data science applications, host government support, and HSCO success, may assist future researchers in further examining this complex and emerging topic.

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Appendix A

Key studies, focus, and relevant variables.

Studies	Key focus	Independent variable	Mediating variable	Dependent variable
<i>Digitalization and non-humanitarian focus</i>				
(Rai et al., 2006)	IT-enabled organizational capabilities	Information Technology	Capabilities	SC performance
(Chia, 2007)	New digital technologies and business development links	Social media, mobile, analytics, and embedded devices	N/A	Business improvement
(Nambisan, 2013)	Product and service innovation, relative resources, and digital tools as innovation enablers	Information technology	N/A	Innovation processes and innovation outcomes
(Selander et al., 2013)	Non-focal actors cannot rely on a single ecosystem for innovation, operating across digital ecosystems with better capabilities	N/A	N/A	N/A
(Akhtar et al., 2018)	Dynamic data and information processing capabilities mediate the relationship between the use of the Internet of Things (IoTs) and operational agility	The IoTs	Dynamic data and information processing capabilities	Operational agility

(Effah and Nuhu, 2017)	Institutional barriers to digitalization, as well as inadequate and unreliable online access—use institutional theory for government budgeting	N/A	N/A	N/A
Sussan and Acs, 2017	Digital entrepreneurial ecosystem (conceptual)	N/A	N/A	N/A
(Svahn et al., 2017)	Identified how four interrelated competing concerns—capability (existing vs. requisite), focus (product vs. process), collaboration (internal vs. external), and governance (control vs. flexibility)-incumbent firms and digital innovation	N/A	N/A	N/A
(Alkan and Kahraman, 2023)	Digital Transformation and supply chains	N/A	N/A	N/A
Chel et al., 2024	Challenges of digital transformation	Macro-level	N/A	Macro-level
<i>Digitalization and humanitarian focus</i>				
(Bui et al., 2000)	Global Information Networks and relevant issues for multinational large-scale humanitarian operations	N/A	N/A	N/A
(Maiers et al., 2005)	Effective information and communication systems and issues such as organizational structures, coordination, security, politics, and funding.	N/A	N/A	N/A

(Haselkorn and Walton, 2009)	Information and communication tools to support humanitarian organizations	N/A	N/A	N/A
(Prasad et al., 2018)	Big data analytics for better humanitarian outcomes, identifying nodes in networks and different humanitarian interventions (e.g., education and healthcare)	N/A	N/A	N/A
(Cassandra, 2017)	The use of ICT in humanitarian relief domains has varying degrees of success and highlights gaps in the areas of workforce readiness, ethical understanding, and funding	N/A	N/A	N/A
(Crane et al., 2017)	The use of ICTs in a natural disaster in Nepal, ICTs helped people gather information, express needs, and cope emotionally. It also helped relief agencies by allowing for networking and coordination among actors	N/A	N/A	N/A
(Kabra et al., 2017)	Improving the level of education, and skills, and facilitating people with other resources such as appropriate IT and data mining training—the unified theory of acceptance and use of technology	SC performance expectancy, effort expectancy, social influence, and facilitating conditions	Operational innovation, moderation	IT adoption

(Meier, 2017)	Exploring success, challenges, and the ethical issues around the use of technology (e.g., privacy, safety, power, and agency).	N/A	N/A	N/A
(Palen and Hughes, 2017)	A chapter surveys the rapid rise of social media in a range of disasters, highlighting the tendency to fail and how non-technological factors strongly influence the use of social media itself on collective socio-behavioral scales	N/A	N/A	N/A
(Freeman et al., 2018)	Conducted an integrative literature review on the role of ICT and big data in disasters. Included in the review were 113 studies. Most studies used qualitative methods over mixed or quantitative ones	N/A	N/A	N/A
(Hajnal, 2018)	The book presents a study of selected NGOs and other civil society organizations in several policy areas and calls for further research on information and communications technology for humanitarian operations	N/A	N/A	N/A
(Kalkman, 2018)	Humanitarian technologies are often used in volatile countries for security reasons	N/A	N/A	N/A
Akhtar et al., 2022	Coordination,	N/A	N/A	N/A

	humanitarian operational excellence, big data, and processing systems			
Cordery et al., 2023	NGOs' performance and digital transformation	N/A	N/A	N/A
Dohale et al., 2024	Barriers of humanitarian supply chains	N/A	N/A	N/A

Appendix B

Constructs, brief item descriptions, and codes.

Constructs	Brief item descriptions
Public-private collaborations: Private organizations' collaboration with international NGOs	<ol style="list-style-type: none">1. Our (private organizations, including MNEs) collaboration with international NGOs is effective2. We collaboratively provide digital support to our partner international NGOs3. Our analytical teams work closely with international NGOs to support their operational activities4. Our experts effectively collaborate with international NGOs as required5. We collaborate with international NGOs on different services.
Private organization collaborations with key local NGOs	<ol style="list-style-type: none">6. Our collaboration with local NGOs is effective7. We support local NGOs as requested8. Our analytical teams work closely with local NGOs to support their operational activities9. Our experts effectively collaborate with local NGOs10. We collaborate with local NGOs on different services
Private organizations' collaboration with key donors	<ol style="list-style-type: none">11. Our collaboration with donors assists us financially12. We actively collaborate with donors13. Our collaborative donors are committed to helping affected people14. Our donors strongly encourage us to make decisions collaboratively with them15. Our donors help us financially to provide different services
Host government support	<ol style="list-style-type: none">1. The host government provides timely information on laws and regulations2. The host government actively supports us to make our operational activities agile by easing the customs clearance procedures3. The host government strongly supports us in our local operational activities4. The host government encourages collaborative work between MNEs/private organizations and NGOs, ultimately supporting affected people together.5. Overall, host government support is important for us to provide our services effectively.
Digital Transformation (the use of big data, the related infrastructure and techniques that fundamentally change business operations and practices):	<ol style="list-style-type: none">1. We use automated data capture systems for big data collection2. We utilize the Internet of Things (e.g., sensors attached to the Internet) for data collection3. Our IT systems efficiently handle social media data (e.g., Twitter, Facebook) in real-time4. We frequently utilize open-source platforms (e.g., MapReduce, Apache Hadoop, and Python/R-software)

	<p>to process big data</p> <ol style="list-style-type: none"> 5. Our IT systems constantly evaluate feedback from relevant people (e.g., the images of damaged areas uploaded by others/collected through drones, feedback provided by affected people/volunteers, and GPS data) 6. We use spatial data (e.g., images) to understand the situation of disasters 7. Image analytics help us prioritize the most affected areas and respond accordingly 8. To respond to disasters, we also utilize real-time videos coming from different sources (e.g., volunteers, affected areas, news) 9. Text mining (e.g., analyzing tweets, generative artificial intelligence—GAI) is used to examine the situation of disasters 10. Insights (produced by our digital teams) from a huge volume of data are used to implement action plans 11. We frequently use machine learning techniques (e.g., text mining, GAI, predictive analysis, and neural network analysis) to predict the needs of people affected by disasters 12. Our analytical and digital dashboard, supported by machine learning techniques, helps to detect demand patterns in affected areas 13. Traditional statistical techniques, combined with digital technologies, provide better solutions for agile responses to disasters 14. We use digital technologies to predict which products are most needed 15. A variety of techniques, supported by digital technologies, are used for unstructured (e.g., image mining and text mining) and structured (e.g., regression analysis and cluster analysis) data, predicting which products are mostly required when different types of disasters occur
<p>HSCO success (operational outcomes and donor and beneficiary satisfaction)</p>	<ol style="list-style-type: none"> 1. Our operational services are reliable 2. Our ratio of purchased products to delivered products is high (e.g., > 98 %) 3. Our response time is agile 4. Reliable products are delivered in most needed areas 5. We effectively deal with environmental aspects in our operational/SC activities 6. Our financial efficiency (i.e., total donor cost - total budget cost)/total budget cost or benefit/budget ratio) is high 7. Our operational costs are low 8. For donor satisfaction, our donation-to-delivery times are short 9. Our donors are satisfied with our coverage of the affected areas

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10. Our donors constantly support us
 11. Overall, our donors are satisfied with the success of our HSCOs
 12. Our donors frequently appreciate our efforts
 13. Our beneficiaries believe that our products are fairly delivered to the areas where they are urgently required
 14. Our beneficiaries are satisfied with our services
 15. Our beneficiaries are satisfied with our assessment of the damaged areas
 16. Our beneficiaries believe that our products are reliable
 17. Our beneficiaries have faith that our products are fairly delivered to the people most in need
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