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Perspective Article

International Business, digital technologies and sustainable development: Connecting the dots

Francesca Ciulli^a, Ans Kolk^{b,*}

^a Department of Organization Studies, Tilburg School of Social and Behavioral Sciences, Tilburg University, Tilburg, The Netherlands

^b University of Amsterdam, Amsterdam Business School, The Netherlands



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ABSTRACT

Building on emerging debates on the ‘dark’ and ‘bright’ side of digital globalization, and calls for considering its environmental and social implications in more detail, this perspective article seeks to ‘unravel’ these components of ‘the digital age’ for International Business (IB). Inspired by the affordance perspective developed in Information Systems research, we offer IB scholars a new approach to ‘zoom in’ on the (potential) role of individual novel technologies in addressing specific sustainable development issues. Three examples illustrate the relevance of this approach for multinationals and for developing innovative research avenues in IB, which extend existing insights on digital globalization.

1. Introduction

Over the last few years, digitalization, i.e., the deployment of novel digital technologies in an organization’s products, processes and/or business model (Autio et al., 2021; Banalieva & Dhanaraj, 2019), has gained increasing interest from International Business (IB) scholars (e.g., Ahi et al., 2021, Autio et al., 2021, Banalieva and Dhanaraj 2019, Birkinshaw 2022, Monaghan et al. 2020, Nambisan and Luo 2021, Ojala et al., 2018, Stallkamp and Schotter 2021), who note implications for firms’ operations, structures and competitiveness, and for the nature of globalization. This rapidly growing body of work has paid ample attention to the changing landscape for multinational enterprises (MNEs), while exploring the extent to which existing IB theories, such as the Uppsala model (e.g., Brouthers et al., 2016, Chen et al., 2019, Monaghan et al., 2020) or internalization theory (Nambisan & Luo, 2021; Nambisan et al., 2019b), might still be suitable or instead need (drastic) changes to explain the transformations triggered by digitalization and by “digital globalization”, i.e., the “globalization of firms’ enabled by digital assets” (Verbeke & Hutzschenreuter, 2021, p. 606). Existing IB frameworks, particularly on global value chains (GVCs), are considered in light of the digital age as well, most notably by Ahi et al. (2021) in their review of digital technologies, such as blockchain and internet of things (IoT), while Kano et al. (2020) mention what they call digital technology-enabled platformization as one of the promising avenues for further multidisciplinary research on GVCs.

In this context, IB scholars have also started discussing both the ‘bright’ and the ‘dark side’ of the digitalization undertaken by MNEs (Verbeke & Hutzschenreuter, 2021), pointing at its impact on several components of sustainable development, a concept we approach in this paper as comprehending ‘people, planet and prosperity’, following initial ideas put forward by the Brundtland commission (WCED, 1987) and later confirmed more widely (e.g., Kolk et al., 2017, UN, 2015, Vinuesa et al., 2020). Prior articles on the ‘bright side’ have observed, for example, that digitalization enables MNEs to improve the livelihoods of the poor (Kolk & Ciulli, 2020; Tatarinov et al., 2022) and to assess and reduce energy consumption in GVCs (e.g., Ahi et al., 2021, George and Schillebeeckx 2022), but from the ‘dark side’ there are concerns about energy intensity and the lack of privacy, equity and inclusivity (e.g., George and Schillebeeckx 2022, Kano et al., 2020, Patchell and Hayter 2021, Sturgeon 2021, Verbeke and Hutzschenreuter 2021, Wettstein et al., 2019, Yi et al., 2022). It should be noted, however, that IB research has addressed the interplay between digitalization and sustainable development in a rather generic way thus far, whilst outside IB (in management, information systems, law, humanities and particularly interdisciplinary technology and society outlets) some more detailed studies can be found (e.g., Anwar and Graham 2020, Christ and Helliard 2021, Correa Tavares et al., 2021, Floridi et al., 2018, Hastig and Sodhi 2020, Vinuesa et al., 2020).

In part, this difference seems to stem from the fact that IB has, until now, focused mostly on digitalization as composite phenomenon, rather

* Corresponding author.

E-mail address: akolk@uva.nl (A. Kolk).

than on the specific underlying technologies, such as Artificial Intelligence (AI), blockchain or cloud computing, as done by these other (sub) fields. Such broad analyses leave less room for unpacking the features, opportunities and shortcomings inherent to each of these technologies and for uncovering their distinctive implications for MNEs' impact on sustainable development. Although MNEs increasingly center their strategies around bundles of multiple digital technologies (cf. Nambisan and Luo 2021), in order to apprehend combined effects it is paramount to first appraise the (potential) role of each individual technology. Concerning the dark/bright side, i.e., the implications for sustainable development, although research has been taking off following a range of calls (e.g., Buckley et al., 2017, Kolk 2016; Montiel et al., 2021, Pisani et al., 2017), the number of in-depth empirical studies is still rather limited in general, let alone with regard to their linkages to specific digital technologies. We therefore argue that investigating the different articulations of the interplay between digitalization and sustainable development is particularly relevant for IB for three main reasons.

To start with, cross-country disparities in digital literacy and in the access to individual digital technologies, infrastructure and connectivity (Nambisan & Luo, 2021; Opp, 2021) are likely to have severe social and economic implications when MNEs (aim to) deploy digital solutions across borders. Second, the diffusion of specific technologies has increasingly elicited national governments' intervention, which has led to a heterogeneous institutional context on crucial topics like data sovereignty and energy efficiency in relation to cloud computing (European Commission, 2022a) or the respect for fundamental rights in the use of AI (European Commission, 2022b). MNEs are therefore confronted with a highly fragmented international context when developing or using a digital solution (Nambisan & Luo, 2021), which affects its environmental, social and economic impact. Third, deploying digital technologies can help address sustainable development issues that manifest differently or are addressed in a dissimilar way across countries, such as inequality or climate change. Hence, while an MNE can use a specific digital technology to tackle a pressing sustainable development issue, this may require a major reconfiguration of traditional activities, relationships, and business models, and the heterogeneity of local conditions can trigger shortcomings and tensions (George & Schillebeeckx, 2022). Overall, digitalization is expected to have a multiplier effect on the complexity that MNEs have to deal with to contribute to the sustainable development goals (SDGs), with different digital technologies having unique implications.

To advance research in this domain, our article offers a new perspective, which builds on the work done by Information Systems (IS) scholars to understand technologies' potential and shortcomings for organizations and society. It shows how the so-called affordance perspective, widely established in IS research (e.g., Du et al., 2019, Strong et al., 2014, Tim et al., 2020) but scantily used in management literature (e.g., Nambisan et al., 2019a) and even less in IB (Nambisan & Luo, 2021; Tatarinov et al., 2022), can help 'connect the dots' between digitalization, IB and sustainable development, by uncovering the opportunities and constraints inherent to individual digital technologies. We define and explain the notion of affordances in more detail in the next section, extending it to the study of MNEs. Section 3 then provides illustrative examples for specific novel digital technologies in relation to people, planet and prosperity. This is followed by Section 4 which indicates promising future research directions in IB.

2. Connecting the dots: An affordance perspective

Digitalization consists of the deployment of novel digital technologies by firms "for multiple purposes and functions" (Grimpe et al., 2022). Over the last few years, both researchers (e.g., Ahi et al., 2021) and practitioners (e.g., Boutetière, Montagner, & Reich, 2018) have engaged in identifying and classifying the major novel digital technologies underlying digitalization. In IB research, Ahi et al. (2021)'s review study on how digitalization influences MNEs' activities identified nine

"advanced technologies" (i.e., IoT, augmented and virtual reality, 3D printing, advanced robotics, cloud technology, cybersecurity, blockchain, big data analytics, simulation) and categorized them in terms of their technological elements and network connectivity. Strange and Zucchella (2017) adopted the "Industry 4.0" umbrella construct and pinpointed four novel enabling technologies in an IB context, i.e., IoT, big data and analytics, robotics and 3D printing. Autio et al. (2021 p. 7) pointed at the difference between "digital communication technologies" and "digital *in situ* technologies". Outside IB, there are other classifications being used, for example, Martinelli et al. (2021) added cloud computing and AI to Strange and Zucchella (2017)'s inventory of Industry 4.0 technologies, and Gastaldi et al. (2022) included augmented and virtual reality as well.

Regardless of the specific categorization, these diverse, albeit to some extent converging, efforts to distinguish technologies that firms can deploy to join the digital age depict a composite picture. They indicate that digitalization is not a monolithic phenomenon, but instead comprises multiple technologies. To unpack the role that individual technologies (can) play for individuals, organizations and the wider society, the affordance perspective has been widely adopted in IS research (Du et al., 2019), while it entered the business literature much later. Majchrzak and Markus (2013) made an early plea for its potential for management scholars, as also and further explicated in recent business and entrepreneurship articles (e.g., Autio et al., 2018, Nambisan 2017, Nambisan et al., 2019a). Most recently, an invited IB research note mentioned affordances as fundamental technology characteristics in digital globalization (Nambisan & Luo, 2021), while Tatarinov et al. (2022) referred to them as one of the properties of digital solutions. Building on and extending these insights, we below argue that the affordance perspective is highly valuable for unraveling the complexity of the relationship between novel digital technologies, IB and sustainable development. Fig. 1 visualizes the key components that will be explained next, starting with affordances, followed by their relevance for sustainable development and MNEs.

2.1. Introducing the affordance perspective from IS

Grounded in ecological psychology (cf. Anderson and Robey 2017, Benbunan-Fich 2019), it was Gibson (1979, p. 127) who established the affordance concept to capture "what [the environment] offers the animal, what it provides or furnishes, either for good or ill". He contended that animals do not perceive the properties of objects in their environment, but rather their affordances, i.e., the behaviours or actions that these objects enable or constrain (Markus and Silver, 2008). IS researchers translated this view for the information technology (IT) setting (Tim et al., 2020) to understand "how the material features of an IT relate to human agency" (Bernardi et al., 2019, p. 1180) or, more widely, "IT-enabled change" (Anderson & Robey, 2017). In such a context, the affordance perspective suggests that, while a digital technology, for example blockchain, has a set of core material properties or features (e.g., blockchain's distributed ledger, cf. Du et al., 2019), these "are necessary conditions for affordances, not the affordances themselves" (Markus & Silver, 2008, p. 619). Instead, affordances are seen to emerge from the relationship between the technology and a specific actor (Tim et al., 2020), representing a "relational concept" (Tim et al., 2020) that denotes the "possibilities for goal-oriented action" afforded to an organization by a specific technology (Markus & Silver, 2008, p. 622).

Importantly, affordances represent potentials or opportunities for action; while a technology may unlock multiple opportunities, an actor may or may not exploit (all of) them (Anderson & Robey, 2017). The other side of a technology's affordances are its constraints, which are limitations that make it difficult for organizations to achieve their goals when using the technology (Du et al., 2019; Leonardi, 2011; Majchrzak & Markus, 2013). Complementary to affordances and constraints is the concept of **actualization**. Since affordances are only opportunities

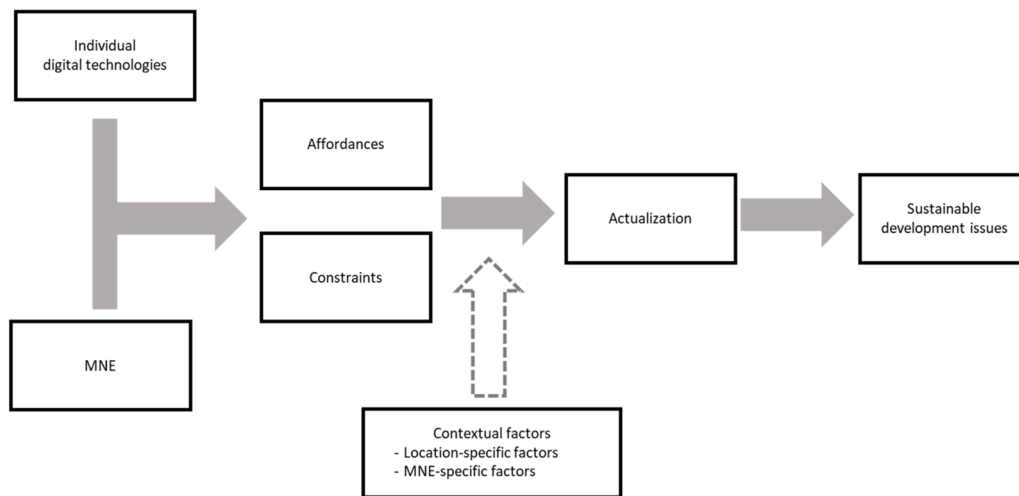


Fig. 1. An affordance perspective on IB, digital globalization and sustainable development.

offered by a technology, they are “actualized” when an organization decides to enact them to realize their value and achieve its objectives (Anderson & Robey, 2017). Actualization therefore indicates “the actions taken by actors as they take advantage of one or more affordances through their use of the technology to achieve [...] outcomes in support of organizational goals” (Strong et al., 2014, p. 70; cf. Du et al., 2019). It also entails acting on a technology’s constraints to mitigate them and/or reduce their negative impact (Du et al., 2019). IS researchers have also pointed at the role of **contextual factors**, which include relevant characteristics of the actor using the technology and of the external environment (Du et al., 2019; Strong et al., 2014; Tim et al., 2020). These contextual factors may positively or negatively affect the realization of a technology’s potential and they therefore need to be considered in the actualization of the technology’s affordances (Anderson & Robey, 2017).

2.2. Linking affordances to sustainable development and the MNE

The peculiarities of an individual digital technology become especially relevant when their role for sustainable development is at stake. This has been highlighted by Kristoffersen et al. (2020), who explored digitalization in relation to circular strategies. They exposed differences across technologies for the circular economy by categorizing them based on their role in the “data flow processes”, i.e., whether technologies enable data collection, data integration or data analysis. In this framework, for example, IoT and blockchain allow to “gather[...] data from various heterogeneous sources”, cloud computing enables “preprocessing and aggregation” of data, while AI makes it possible to “understand [...] the data for underpinning or deriving actionable decisions” (Kristoffersen et al., 2020, p. 248).

While these authors considered multiple digital technologies in relation to one sustainability issue, other non-IB studies have zoomed in on single digital technologies to ascertain their implications for several sustainability issues. For example, Vinuesa et al. (2020, p. 1) emphasized the importance of “systematically assessing the extent to which AI might impact all aspects of sustainable development”. They divided the 17 SDGs along the three dimensions of people, planet and prosperity, in keeping with the United Nations’ 2030 Agenda for Sustainable Development, and examined AI’s positive and negative effects on each of these dimensions and on the underlying individual SDGs. In this way, Vinuesa et al. (2020) brought to the fore that each technology may create different opportunities and challenges depending on the specific sustainable development issue considered.

These insights have been further operationalized in a few non-IB studies exploring how an affordance perspective might help to unpack

the contribution of a specific digital technology to one sustainable development issue. A key example in the management literature is Canhoto (2021), who investigated how machine learning can be harnessed to prevent money laundering and address SDG 16. In IS research, Zeng et al. (2020) also used an affordance lens to uncover how big data analytics can foster the development of smart cities, while Abouzahraa and Ghasemaghaeib (2022) utilized it to examine seniors’ use of wearable devices to improve their healthcare. This literature suggests that investigating the distinctive affordances and constraints provided by individual digital technologies in relation to specific sustainable development issues is key to understanding “the benefits of the digital revolution for the SDGs, while avoiding the many potential pitfalls” (Sachs et al., 2019, p. 810).

Yet, different from other research fields, to date IB research has not really taken such an in-depth approach to the relationship between digital technologies and sustainable development issues. As noted in the introduction, recent years have yielded considerable insight into digitalization but not in the diversity of individual novel digital technologies and in how their development and deployment has implications for MNE and the societies in which they are active. Moreover, most of this IB literature has only tangentially referred to the implications of digitalization for one or more potentially relevant sustainable development areas (e.g., Banalieva and Dhanaraj 2019, Hannibal and Knight 2018). We will below indicate how the affordance perspective can be leveraged for promising IB research approaches, building on six articles on MNEs (included in Table 1) that cover digitalization and sustainable development to the most within the field; these were identified through our reading of the current body of work. We first look at the technology, relating it to how this topic is addressed in the affordance perspective, then at the activities of the MNE which particularly connect to actualization, and thirdly at the IB context (cf. Fig. 1).

We first note that, of the six articles included in Table 1, two consider digitalization “as a whole”, while the other four focus on specific technologies, i.e., digital platforms (Kolk & Ciulli, 2020; Yi et al., 2022), cloud computing (Patchell & Hayter, 2021), blockchain and AI (Tatarinov et al., 2022). However, they fail to offer an approach for systematically identifying a technology’s *potential* bright and dark sides and distinguishing them from other dimensions, such as the *realization* of these potential benefits and shortcomings. The affordance perspective warrants scholars to go beyond digitalization as a whole and a view of individual technologies as mere “advantages”, to appraise their multi-level (i.e., the difference between a technology’s material properties and affordances) and multi-faceted (i.e., a technology’s array of multiple affordances and constraints) nature when they are adopted in an international setting, and acknowledge if a technology’s potential

Table 1
Relevant articles on MNEs, digitalization and sustainable development.

Article	Digital technology focus	Main insights
George and Schillebeeckx (2022)	Digitalization as a whole	Digitalization confronts MNEs with contradictory geopolitical, organizational and market tensions for globalization and localization. If not addressed these tensions hamper the MNE's advantage. The MNE can address them by framing, formalizing and realizing its corporate purpose in novel ways.
Kolk and Ciulli (2020)	Digital platform	A set of digital platforms multinationals have emerged which aim to tackle sustainable development issues. These "sustainability-oriented digital platform multinationals" can provide a significant contribution to sustainability transitions in their home and host countries.
Patchell and Hayter (2021)	Cloud computing	MNEs in the cloud industry have developed green FSAs to couple their network of data centers with renewable energy and, as a result, contribute to the SDGs on climate action and clean energy. Their location choice depends on a set of CSAs, such as open electricity markets, and on the extent to which the host countries are receptive to the MNEs' green FSAs. The cloud MNEs may engage in changing CSAs in their host countries, to align with their FSAs.
Tatarinov et al. (2022)	AI, blockchain, digital platform	In order to maximize their impact, digital solutions addressing wicked problems have to be scaled internationally. During the scaling process an ecosystem is formed around the digital solutions, with different roles and configurations. Four main roles are identified in the ecosystem, i.e., orchestrator, integrator and complementor. Also, four international scaling types are devised, depending on the level of ecosystem versatility and of application adaptation: versatile integration, versatile adaptation, adaptive localization and replication.
Verbeke and Hutzschenreuter (2021)	Digitalization as a whole	The study calls for a balanced approach to the implications of digital globalization for MNEs. The opportunities warranted by digital globalization and emphasized by previous studies are related, among others, to the non-location-boundedness of digital assets, a lower liability of foreignness, the creation of ecosystem-specific advantages and the possibility to leverage "winner-take-all" dynamics. Yet, digital globalization exhibits a "dark side" for MNEs which has been unexplored by prior research. The challenges concern, among others, the importance physical assets may still have and the need for localized complementary resources in host countries, which hamper the internationalization of digital MNEs; the negative externalities engendered by digital MNEs in host countries; the regulatory measures which restrict digital MNEs' access to foreign markets. Nonmarket forces have the power to foster and hinder digital globalization with different societal outcomes that have to be considered.
Yi et al. (2022)	Digital platform	The social responsibility of multinational platforms (MNPs) differs from those of traditional MNEs, particularly because it involves all the members of their global ecosystem. This leads to the conceptualization of "ecosystem social responsibility". The study distinguishes two types of MNPs, global platforms and multidomestic platforms, and proposes that they face diverse challenges related to social responsibility and have different approaches to manage it.

may not be fully realized.

Second, as the affordance perspective puts equal emphasis on the technology and on the actor using it, it contends that the value of a digital technology is not absolute, but hinges on its interplay with the user. Hence, the affordance perspective helps to appraise what a digital technology can entail for sustainable development in light of the unique features of the MNE as organizational form (George & Schillebeeckx, 2022). Relatedly, with the distinction between affordance and actualization, the affordance perspective suggests that having a specific technology does not represent an advantage *per se* for the MNE to tackle sustainable development issues; in order to harness a technology for people, planet and prosperity, and to curb its shortcomings across borders, the MNE has to deploy a set of strategies and practices. The articles in Table 1 address some key strategic decisions for MNEs when dealing with digitalization and sustainable development, such as global standardization vs. local adaptation (George & Schillebeeckx, 2022), internationalization (Patchell & Hayter, 2021) and international governance (Yi et al., 2022). Notably, they also highlight that, in order to fully appraise positive and negative impacts of digitalization, extant IB constructs may have to be revisited, as in the case of the implications for social responsibility of the novelty of multinational platforms' organizational structure (Yi et al., 2022). By encouraging IB scholars to uncover how an MNE may realize the potential of a digital technology in an international setting, the affordance perspective prompts them to appraise to what extent "traditional" IB theories and frameworks apply. Indeed, as a "mid-range theoretical contribution" (Anderson & Robey, 2017), the affordance perspective can be complementary to existing and new IB theories.

Third, the relevance that the affordance perspective assigns to contextual factors, as influencing the realization of a technology's potential, strongly aligns with the key role that IB research ascribes to "context" (Teagarden et al., 2018). Indeed, the six articles all hint at the importance of the context when examining the deployment of a digital technology, by linking it to country-specific advantages (CSA) (Patchell & Hayter, 2021; Verbeke & Hutzschenreuter, 2021), and to the MNE's network (Kolk & Ciulli, 2020) and ecosystem (George & Schillebeeckx, 2022; Tatarinov et al., 2022; Yi et al., 2022). Building on these insights,

to operationalize the context, the first dimension to be considered is the location (Beugelsdijk, 2022). The relevance of the geographical location is an issue of contention in the IB literature focusing on digitalization: while digital assets can be instantaneously accessible "anywhere, anytime" (Autio et al., 2021), minimizing the role of national borders, studies have also acknowledged that the advantages deriving from a digital technology may be location-bound (Autio et al., 2021; Furr et al., 2022; Verbeke & Hutzschenreuter, 2021) and hindered by regional and national pressures towards techno-nationalism (Luo, 2022a; Nambisan & Luo, 2021; Verbeke & Hutzschenreuter, 2021). Therefore, linking the affordance perspective with IB offers a framework to connect the realization of the environmental and/or social value of a technology with the features and heterogeneity of the geographies in which an MNE deploys it. Examples of location-specific (dis)advantages are local market conditions, for example in terms of renewable energy resources for cloud computing (Patchell & Hayter, 2021), local actors' assets (Hennart, 2009; Nambisan & Luo, 2021), such as their digital skills, and the institutional context (Eden & Nielsen, 2020), for instance with respect to regulations on data protection (George & Schillebeeckx, 2022) and artificial intelligence (Furr et al., 2022).

As conceptualized in the affordance perspective, context also includes the characteristics of the focal actor deploying the technology, which is particularly relevant for IB, since "MNEs are complex, unique, and idiosyncratic and path-dependent" (Narula et al., 2019, p. 1246). Building on extant IB digitalization literature, MNE-specific factors include the portfolio of its digital and non-digital FSAs, as "some MNEs are simply better positioned than others to both exploit existing digital assets and bundle them with nondigital resources and capabilities" (Verbeke & Hutzschenreuter, 2021, p. 607). They also encompass the MNE's relationships with external actors. Indeed, digitalization warrants an MNE the "openness" to collaborate with a richer array of external actors in different configurations, like networks and ecosystems (Banalieva & Dhanaraj, 2019; Luo, 2022b; Monaghan et al., 2020; Nambisan & Luo, 2021; Nambisan et al., 2019b). Hence, environmental and social value creation is critically dependent on the relationships (to be) orchestrated by the MNE with external parties (George & Schillebeeckx, 2022; Tatarinov et al., 2022; Yi et al., 2022).

In the next section we will apply these insights and show, through three illustrative examples, how the affordance perspective might help to effectively connect the dots between IB, digitalization and sustainable development.

3. Three illustrative examples

This section presents three illustrative examples of a specific novel digital technology in relation to a sustainable development dimension from an IB perspective, taking the affordance approach as outlined above. For selecting exemplary technologies, we followed the classification proposed by Kristoffersen et al. (2020) and took blockchain, AI and cloud computing as novel digital technologies enabling, respectively, data collection, data analysis and data integration. For sustainable development, as explained in the introduction, we built on the distinction into the three dimensions planet, people and prosperity to examine the implications of each technology for one of these components (SDGs). While the affordance perspective can help uncover concurrently diverse kinds of impacts of an individual technology, our objective is not to illustrate an exhaustive array of sustainable development issues that each technology helps address, but to show the value of the affordance perspective to untangle the link between IB, digitalization and sustainable development. Hence, we chose to zoom into a specific dimension per technology to offer more in-depth insights. This resulted in illustrative examples for blockchain and planet, specifically climate action (SDG13) (Section 3.1), AI and people, especially poverty and hunger (SDGs 1 and 2) (3.2), and cloud computing and prosperity, particularly innovation (SDG 9) (3.3). Each issue was selected by examining academic and gray literature, as well as practitioner documentation, and emerged as the most suitable for illustrative purposes. For each illustrative example that follows next, we first define the focal technology, then elaborate on its affordances and constraints for MNEs, pinpoint key relevant contextual factors and explain the main actions MNEs need to undertake for actualization. To illustrate the implications for IB scholarship of each of these components, we chose relevant “theory areas” (cf. Tippmann et al., 2023), relating to GVC governance, international scaling and location choice. Table 2 summarizes the core components of each illustrative example.

3.1. Blockchain and planet

Blockchain has been defined as “a chain of data blocks each of which is created to record a transaction” (Du et al., 2019, p. 51) which “provides a distributed data structure that is replicated and shared among the members of a network” (Drummer and Neumann, 2020, p. 339). Within the planet dimension, “climate action” is a key issue (SDG13), entailing, among others, the global reduction of carbon dioxide (CO₂) emissions (UN, n.d.a). Blockchain offers a set of **affordances** for MNEs that aim to address climate change. It allows them, for example, to trace and particularly ensure accountability for CO₂ emissions along their GVC, because the data is digital and recorded on an immutable ledger (Lumineau et al., 2021), which means that it cannot be tampered with, changed or destroyed without the consensus of all the other parties in the network. The data on CO₂ emissions is associated with the trail of transactions between GVC partners, and the origin of CO₂ emissions can thus be mapped on the MNE network. Blockchain also affords the potential to automate contracts in light of climate-related requirements along the GVC, thanks in particular to smart contracts which guarantee the execution and enforcement of agreements. As transactions do not “directly rely on the enforceability of the external legal system” (Lumineau et al., 2021, p. 506), through blockchain MNEs can more effectively require their suppliers to respect their CO₂ emission commitments, without depending on local legal enforcement measures that may differ substantially across countries. In this way, the technology may, for example, help to establish automated incentive mechanisms to reward suppliers that limit their CO₂ emissions below a certain

threshold.

However, blockchain also has potential **constraints**. To start with, there is a wide debate on the extent to which blockchain itself is highly energy intensive (Liang et al., 2021; Rossi et al., 2019) and, therefore, its use along an MNE’s GVC may risk increasing energy consumption and CO₂ emissions, especially if a considerable number of transactions are involved. A further constraint is related to the complexity in assuring the quality of the data collected along the GVC. First, the blockchain itself cannot prove the quality of the CO₂ emission data collected among the suppliers, engendering the risk of “garbage in, garbage out”, i.e., “the varying quality of data inflow into a system and its consequent processing” (Ziolkowski et al., 2020, p. 328). Second, immutability does not allow for changing or updating the data collected, if they are incorrect or incomplete (Saberli et al., 2019), hence “extend[ing] the longevity of data of poor quality” (Ziolkowski et al., 2020, p. 328). Therefore, blockchain itself does not assure that the data shared by suppliers on their CO₂ emissions is reliable.

In keeping with the affordance perspective, the MNE has to act upon blockchain’s affordances and constraints, in order to actualize the former and mitigate or overcome the latter along its GVC, to achieve its climate goals. Actualization is however affected by a set of **contextual factors** belonging to the two categories presented previously. Location-specific factors include, first, the institutional context of the GVC: particularly important are national climate change regulations (Pinkse & Kolk, 2012) and their differences across the countries in which the GVC is embedded. Also institutional voids, such as the lack of internet infrastructure and inadequate contract enforcement, can play a key role in the actualization of blockchain’s affordances. The second type of contextual factor is MNE-specific. The relationship the MNE has with its GVC and the GVC characteristics are of relevance here (McWilliam et al., 2020). Key factors may regard the power asymmetry as well as the interplay of trust and control between the MNE and its suppliers (Benito et al., 2019; Sinkovics et al., 2021; Strange & Humphrey, 2019), the fragmentation and geographic dispersion of the GVC (Strange & Humphrey, 2019), and the heterogeneity in the suppliers’ resources and capabilities, both from a digital and a climate action perspective (Khan et al., 2021; Kouhizadeh et al., 2021; McWilliam et al., 2020). Important are also MNE’s existing digital and non-digital FSAs. The former entail for instance the MNE’s expertise in digital transformation, as this is key to elicit the adoption of blockchain along the whole GVC. The latter instead includes both the MNE’s existing “climate-induced FSA” (Kolk & Pinkse, 2008), i.e., its competence in dealing with climate change, and its “ability to establish, coordinate and lead the network” (Kano et al., 2020, p. 605).

The MNE has to coordinate and control its GVC to **actualize** blockchain’s potential to trace and ensure accountability for CO₂ emissions. In this framework, the MNE has to identify the governance mechanisms that are most effective in eliciting its suppliers to have the willingness, resources and capabilities to share data on their CO₂ emissions via blockchain. This means, for example, managing competition- and trust-related concerns among suppliers as well as gaps in internet connectivity. Underlying all this, however, is the governance of CO₂ emission data recording and verification along the GVC to mitigate and preferably overcome data quality constraints. One option may be decentralizing governance through the use of IoT (Saberli et al., 2019), i.e., by promoting the implementation of sensors which record the CO₂ emissions in the suppliers’ factories and logistics network, and automatically feed them on the blockchain. It can also be combined with online or offline auditing by third parties or the MNE itself, to assess the trustworthiness of the CO₂ data recorded by the suppliers. For example, a network of “validators” could be established, in charge of checking the CO₂ emissions data shared by suppliers. Actualizing the affordance to automate contracts through smart contracts consists of negotiating and agreeing with the suppliers on CO₂ emission limits and on the kind of incentives that maximises the positive outcomes in terms of CO₂ emission reduction. The MNE should also evaluate to what extent the provisions of

Table 2
An affordance theory lens to digital globalization and sustainable development: Illustrative examples.

	Affordances	Constraints	Contextual factors	Actualization	Sustainable development outcomes
Blockchain and planet	<ul style="list-style-type: none"> tracing and ensuring accountability for CO₂ emissions along the GVC automating contracts in light of climate-related requirements along the GVC 	<ul style="list-style-type: none"> potentially energy intensive not able to prove the quality of the CO₂ emission data recorded immutability does not allow for changing incomplete or incorrect data 	<ul style="list-style-type: none"> location-specific factors: institutional context of the GVC, e. g., differences in national climate change regulations; lack of internet infrastructure MNE-specific factors: e. g., relationship between the MNE and its GVC; MNE's expertise in digital transformation; climate-induced FSA; capability to lead the network 	<ul style="list-style-type: none"> implement effective governance mechanisms to elicit suppliers' willingness, resources and capabilities to share data on their CO₂ emissions via blockchain manage CO₂ emission data recording and verification along the GVC to tackle data quality constraints agree with the suppliers CO₂ emission limits and incentives that maximize CO₂ emission reduction decide on global standardization vs. local adaptation of smart contracts adopt a more energy efficient consensus mechanism 	Reduction in CO ₂ emissions along the GVC
AI and people	<ul style="list-style-type: none"> detecting and diagnosing farming-related problems, e.g., plant diseases and issues in soil conditions augmenting farmers decision-making skills on inputs, planting and harvesting predicting farmers' creditworthiness and financial needs 	<ul style="list-style-type: none"> quality of predictions and advice dependent on quality and quantity of training data inscrutability of data-driven decisions lack of empathy, intuitive and moral reasoning 	<ul style="list-style-type: none"> location-specific factors: lack of high-quality local training data; farmers' lack of digital skills and knowledge of AI; farmers' unique competences on local farming MNE-specific factors: MNE's local relationships; quantity, quality and location-boundedness of training data owned or controlled by the MNE; location-boundedness of the AI-driven business model-specific advantage. 	<ul style="list-style-type: none"> source local, high-quality training data representative of key location-specific features foster the creation of a local data ecosystem recombine the AI application with location-specific assets and informal institutions adapt the AI-driven business model to local resources adapt the AI application to predict fairly farmers' creditworthiness and financial needs 	Reduction in poverty and food insecurity
Cloud computing and prosperity	<p>Cloud computing:</p> <ul style="list-style-type: none"> storing data remotely on large data centers based on the MNE's needs sharing data at any time and independent from actors' location processing and analyzing data stored remotely through on demand applications <p>Edge computing:</p> <ul style="list-style-type: none"> storing data close to where it is generated transferring data with low bandwidth processing and analyzing data locally in real time controlling and keeping local sensitive data generated 	<p>Cloud computing:</p> <ul style="list-style-type: none"> data protection and security risks related to location of physical data centers high latency high bandwidth needed to transfer data to the cloud data centers' high energy intensity <p>Edge computing</p> <ul style="list-style-type: none"> infrastructure highly dispersed internationally risk of cyber-attacks limited storage capacity limited computation capacity potentially energy intensive 	<ul style="list-style-type: none"> location-specific factors: differences in regional and national regulations on data protection and privacy and on digital sovereignty; local energy mix MNE-specific factors: MNE's relationship with its international customers; integration of IoT in the MNE's manufacturing processes and products; MNE's capabilities in handling the volume of data generated 	<ul style="list-style-type: none"> assess location advantages at the hyper-local, national and regional levels analyze the implications of local regulations on data protection and data flows decide the optimal configuration of edge and cloud computing infrastructure for data-driven innovation decide the optimal location for the data generated by owned or controlled devices to facilitate data-driven innovation 	Increase in innovation

smart contracts should be globally standardized or adapted based on the local context. This implies assessing the smart contracts in light of suppliers' local regulatory institutions, in order to ensure that they fulfill or exceed their requirements. It is still highly contended how blockchain's energy intensity may be addressed, but overcoming this potential constraint is likely to also entail the adoption of a consensus mechanism that requires lower energy consumption.

3.2. AI and people

Although complex to conceptualize univocally (Asatiani et al., 2021; Berente et al., 2021), AI can be defined as the ability of machines to perform cognitive functions that mimic or exceed human cognitive skills (Coombs et al., 2020). Several classifications of what AI entails have

been developed (Benbya et al., 2021). For example, multiple IS studies have identified AI as a "suite of technologies" (Coombs et al., 2020) which include, among others, machine learning, automation, robots and natural language processing (Benbya et al., 2021; Berente et al., 2021; Coombs et al., 2020; Li et al., 2021). AI offers a set of affordances to MNEs that can help to create value for the people dimension, particularly to tackle poverty (SDG1) and hunger (SDG2). Given that "growth in the agriculture sector is two to four times more effective in raising incomes among the poorest than other sectors" (IDA, n.d.) and it is paramount to increase food security, we use this as illustrative example.

AI offers digital MNEs three main **affordances** to reduce poverty and food insecurity among smallholder farmers in developing countries. First, it can detect and diagnose problems such as plant diseases and issues in soil conditions. Particularly thanks to image classification and

analysis, AI applications can identify accurately things that are difficult to detect by humans. Second is the potential to optimize decisions related to inputs (e.g., water, fertilizers), planting and harvesting. Because of its high analytical capabilities, AI can augment farmers' decision-making skills by providing advice on the activities to be undertaken in the farm. Third, it has the potential to predict farmers' creditworthiness and financial needs, in order to increase financial inclusion. Indeed, AI affords MNEs to develop a credit profile, based on "alternative data collected from mobile phones, satellites, and other sources" (IFC, 2020) for large numbers of farmers, particularly those who are unbanked. This would allow for extending access to loans and insurance services to underserved farmers, thus helping them to make the necessary investments for their farms and improve their livelihoods.

AI applications exhibit however also a set of **constraints**. First, the quality of AI's predictions and advice depends on the quality and quantity of the data that are fed into the AI model to train it (Jain et al., 2021). If the data are low quality and not representative of the focal context, the AI application may engender discriminatory and harmful effects. Another key constraint of more complex AI models is the so-called "inscrutability" (Asatiani et al., 2021; Berente et al., 2021) of "data driven decision" (Huysman, 2020), i.e., the more complex an AI model, the more difficult it is for humans to explain "how AI systems produce their outputs" (Asatiani et al., 2021, p. 326). Absent explainable AI, this impossibility to understand the reasoning that drives a certain advice and prediction can lead to a lack of trust among users of an AI application. Moreover, AI models (currently) lack "intuitive and creative thinking, holistic vision, ethical and moral reasoning, emotional intelligence, compassion and empathy" (Marjanovic et al., 2021, p. 400), which are often necessary for decisions with a high social impact.

Local **contextual factors**, inter alia related to available assets, data and institutions, have a key influence on whether and how AI's affordances can be actualized, and constraints mitigated. Examples could be the lack of high-quality local data, in "less digitized" settings (Gwagwa et al., 2021), to train AI models, limited internet connectivity particularly in rural areas and the absence of technologically advanced farming tools. Moreover, farmers may lack awareness of AI and, more widely, they may have low digital skills. On the other hand, they may have valuable knowledge and unique competences on local farming that are important to leverage. Also, as highlighted by Brandl et al. (2021, p. 3), informal institutions "often continue to dominate in rural areas where rural and indigenous communities control economic activities and manage natural resources", which means that AI developed in other contexts cannot be easily transposed. A potentially relevant MNE-specific factor consists of its relational FSAs, i.e., whether the digital MNE has key ties in the local context. The MNE's existing local relationships can be particularly relevant for the creation of a local "data ecosystem", which is necessary to maximize AI's predictive and prescriptive potentials and prevent its harmful effects. Another key FSA is represented by the training data the MNE owns or controls and the extent to which they are location-bound. Moreover, as the MNE has to build a business model around its AI application, the extent to which its AI-driven business model-specific advantage (Bohnsack et al., 2021) is location-bound has a key influence on the actualization of AI's affordances for tackling poverty and hunger in multiple developing countries.

When scaling their solution in foreign markets, digital MNEs have to assess to what extent replication is possible or local adaptation is necessary to **actualize** AI's affordances and address its constraints, in order to lift farmers and their local community from poverty and hunger. It is likely that at least a partial local adaptation of the AI solution and its business model are necessary. To start with, the MNE is likely to require the sourcing of local, high-quality training data representative of key location-specific features, including crop varieties, soil and weather conditions. As the availability of this type of data tends to be limited in rural areas of developing countries, foreign MNEs will need to foster the creation of a data ecosystem, through partnerships or crowdsourcing

with local actors, reckoning with the needs and constraints faced by local farmers and rural institutional contexts (Brandl et al., 2021). Local adaptation is especially relevant for developed-country MNEs that aim to transfer their existing AI applications to developing countries. For example, advice on farming decisions needs to be relevant and viable for local conditions, respect farmers' agency and their "longstanding traditions, norms, and customs" (Brandl et al., 2021, p. 3) and preserve local biodiversity. Hence, to augment farmers' decision-making capabilities, an MNE may have to "recombine" (Grøgaard et al., 2022) the AI application with their location-specific knowledge, assets, competences and informal institutions. From a business model perspective, AI applications must be designed or adapted in order to be affordable to local smallholder farmers and concurrently entail a viable revenue and cost model for the MNE. Finally, to actualize AI's potential to predict farmers' creditworthiness and financial needs, the AI model should be locally adapted in order to ensure fair predictions, not engender or perpetuate bias and discrimination and be complemented with human "ability to get deep insights into and assess intangible social aspects" (Marjanovic et al., 2021, p. 400).

3.3. Cloud computing and prosperity

Our third illustrative example covers the prosperity dimension in relation to cloud computing, which can be defined as "a model for enabling ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services)" (Battleson et al., 2016, p. 209; Mell & Grance, 2011, p. 2). In this context, we also consider edge computing, which consists of "substantial computing and storage resources—variously referred to as cloudlets, micro datacenters, or fog nodes—[...] placed at the Internet's edge in close proximity to mobile devices or sensors" (Satyanarayanan, 2017, p. 30). Practitioners and policy-makers are highlighting the growing complementarity between cloud and edge and the value of using them jointly (e.g., European Commission 2020, Siemens n.d.), as "computing continuum" (European Commission, 2022a; Rosendo et al., 2022), noting that in the coming years edge, as more decentralized computing closer to the user, will become more important in relative terms. Cloud and edge computing represent the fundamental architecture to realize digitalization's potential for economic prosperity (SDG 9), particularly in terms of innovation and technological upgrading. MNE innovation fundamentally hinges on knowledge creation (Cano-Kollmann et al., 2016; Mudambi et al., 2018). As underlined by prior literature, the considerable volume of data that firms have access to, thanks to digitalization, represents an increasingly critical source of knowledge (Côrte-Real et al., 2017; Ghasemaghahi & Turel, 2021; Shamim et al., 2020; Wang & Wang, 2020). We will discuss cloud and edge computing's **affordances** and constraints for MNEs first before moving to their (combined) actualization considering contextual factors.

First, cloud computing affords an MNE to store data remotely, via the internet, on "large centralized data centers" (Joe-Wong & Sen, 2018) managed by a cloud service provider (Guo et al., 2019; Lansing et al., 2019). As storage resources are accessed virtually on demand, an MNE can easily expand or reduce them according to its needs (Battleson et al., 2016). This makes innovation less complex and financially onerous for the MNE, as the cloud saves it from incurring in considerable upfront investments (Benlian et al., 2018) and from building "physical infrastructure on premises" (Zhang & Tao, 2020) in the different locations where it operates. Second, and related, cloud computing grants an MNE the opportunity to share data with all relevant actors at any time and independent from their location (Benlian et al., 2018). Such ubiquitous access to data enables international collaborative knowledge creation and, in turn, innovation within an MNE and with third parties located in different countries (Benlian et al., 2018). Third, cloud computing affords an MNE the opportunity to process and analyze the data stored remotely, at a centralized infrastructure, by accessing on demand

software and applications (Krancher et al., 2018) “that run on virtualized machines instead of physical servers” (Benlian et al., 2018, p. 729). Through these assets, cloud computing gives MNEs a unique chance to leverage massive volumes of data collected across different locations, in order to create advanced knowledge on customers, production processes or products, which enhances innovation (Battleson et al., 2016).

Cloud computing also exhibits **constraints**. To start with, it relies on physical data centers, whose location has critical implications for data protection and security. Transferring data to a remote server through the internet increases the risk of cyber-attacks, but security of data stored on the cloud depends on the data protection regulations in the location where the data centers are established. Moreover, as centralized infrastructure, cloud exhibits “high latency”; this means that processing the data on the cloud and sending the response to the device takes time (Zhang & Tao, 2020), which may be higher the more distant the data center is from the device (Fourie, 2019; Satyanarayanan, 2017). This shortcoming would hinder MNEs from developing and deploying novel smart products and devices that have to respond instantaneously to the inputs they receive, like the self-driving vehicle. The high bandwidth required to transfer to the cloud the considerable volume of data produced by smart devices may be another constraint (Satyanarayanan, 2017; Zhang & Tao, 2020), which increases the risk of disruptions, particularly for MNEs that aim to deploy innovations in locations with different quality in internet connectivity. Another important constraint is related to the high energy intensity of data centers, which significantly contribute to CO₂ emissions if the energy is generated from fossil fuels, hence impacting negatively SDG 13 (or ‘eat up’ renewable energy for other purposes in places where it is scarce).

Edge computing’s core **affordances** strengthen those of cloud computing, but also help to address its main constraints. Specifically, edge affords an MNE to store the data generated by machineries, IoT sensors and smart products “at the edge”, i.e., in a decentralized way, close to where it is generated. This means that data can be stored also with low bandwidth because it does not have to be transmitted to remote data centers (Premsankar et al., 2018; Zhang & Tao, 2020). Edge computing allows an MNE also to process and analyze data locally in real time (Zhang & Tao, 2020). Given the massive volume of data generated by the devices the MNE controls internationally and their increasingly short-term value, storing remotely the data collected and analyzing them at a later time would be complicated and ineffective (Linux Foundation, 2021). Analyzing data directly at the production machine that produces it facilitates knowledge creation that enables prompt process innovation, helping factories become smarter and more efficient. Also, analyzing data close to customers’ smart devices makes the MNE significantly more responsive to their preferences and behavior (Satyanarayanan, 2017), unlocking international product and service innovation opportunities (Ghasemaghaei & Calic, 2019; Lehrer et al., 2018). Moreover, edge computing affords the owner of a smart device to control and keep local the sensitive data generated. This affordance addresses user concerns as well as regulatory measures about the protection of locally-produced data, hence facilitating the adoption and diffusion of new, smart products.

Edge computing’s key **constraints** are related to its dispersed infrastructure, which can be highly complex to establish and manage (Satyanarayanan, 2017), particularly for an MNE controlling a considerable number of smart devices internationally. Edge computing’s distributed infrastructure may also increase the risk of cyber-attacks, threatening data protection. In addition, edge devices have more limited storage capacity (Zhang & Tao, 2020), which can be problematic with the increase in the volume of data produced by smart devices. Moreover, edge computing has a lower computation capacity compared to cloud computing, making it less suitable for complex data analytics (Jiang et al., 2020; Zhang & Tao, 2020). The environmental impact of multiple edge devices, compared to large data centers, is not clear yet. However, considering the exponential growth in smart products, powering a massive number of edge devices internationally could be as

energy intensive as centralized cloud infrastructure (Jiang et al., 2020) and it would be much more difficult to ensure that clean energy is used. This challenges the goal of “decoupl[ing] economic growth from environmental degradation” (UN, n.d.b).

Overall, by affording the collection, storage and processing of massive volumes of data, edge and cloud computing, together, can play a critical enabling function for international knowledge creation and, as a result, for “data-driven” innovation (Babu et al., 2021; Bhatti et al., 2022), i.e., “an emerging approach to enhance innovation by acquiring, analyzing and acting upon [...] data” (Ji et al., 2022, p. 3). However, in order for affordances to be actualized and constraints to be mitigated in an IB environment, **contextual factors** have to be considered. Key location-specific factors are the differences in regional and national regulations on data protection and privacy and on digital sovereignty (ESI ThoughtLab, 2021), whether they mandate local storage and processing of sensitive data and to what extent they impose restrictions to the cross-border flow of data (Nambisan & Luo, 2021). The package of measures on cloud computing is especially noteworthy in the EU context (European Commission, 2022a). The presence of data centers, the local energy mix and the percentage of energy generated from renewable energy sources are other location-specific assets that have to be taken into account (Patchell & Hayter, 2021). The MNE’s relationship with its customers in the host countries is a relevant MNE-specific factor, because it is likely to affect customers’ willingness to allow considerable amounts of data to be collected from their devices and stored and processed at the edge or in the cloud. Another important MNE-specific factor, is the extent to which both the MNEs’ manufacturing processes and products integrate IoT, because this affects the amount of data produced by the MNEs and its international network of customers. Relatedly, the MNE’s capabilities in handling the volume of data generated, and the extent to which such competences are distributed across the organization are also key (Ji et al., 2022).

In this context, **actualization** critically consists, for the MNE, of deciding the optimal location for the data generated by the devices it owns or controls, so as to leverage edge and cloud’s respective affordances and mitigate their constraints. Specifically, the MNE has to decide which kind of data should be stored, processed and analyzed locally, close to or at the end device, and which data, instead, should be transferred to the cloud to be stored, processed, aggregated and analyzed at a centralized infrastructure, even across borders, in order to maximize knowledge creation and, in turn, innovation opportunities. When examining the configuration of edge and cloud computing infrastructure, the MNE should assess the location advantages (Dunning & Lundan, 2008) at the hyper-local, national and regional levels. Indeed, with edge “physical proximity” appears to play a critical role even in a digital ecosystem (Satyanarayanan, 2017) and adds a further level of complexity for the MNE’s location-related decisions, compared to traditional ones (cf. Mudambi et al. 2018). The MNE should also consider local regulations on data protection and data flows, as its configuration of computing continuum has to abide by them. The MNE’s location choice is likely to have relevant implications for data-driven innovation. For example, the extent to which an MNE can innovate its production processes towards smart manufacturing depends on the deployment of edge computing across its international network of manufacturing subsidiaries, but the cloud may also be important to gain more complex insights. And the degree to which, for instance, a multinational electric utility can innovate its services increasingly hinges on the adoption of edge computing where its customers are located, as it can act in real time on the insights it gathers from them, but it also depends on the possibility to aggregate rich, heterogeneous data from multiple locations in the cloud, in order to uncover new patterns (Ghasemaghaei & Calic, 2019; Lehrer et al., 2018; Linux Foundation, 2021).

4. Future research directions

This section indicates the potential of the affordance perspective for identifying promising research opportunities on the interplay between IB, digitalization and sustainable development. We build on the three examples outlined above to illustrate how this can work out in terms of affordances, constraints, actualization and contextual factors (cf. Fig. 1) for a specific digital technology, sustainable development topic and relevant IB theory area (see Table 3 for an overview of main research directions).

4.1. Blockchain and climate action: Promising research avenues on GVCs

The example of blockchain, related to the planet issue climate action in the context of GVCs, suggests several intriguing research opportunities, which leverage the affordance, contextual factors and actualization dimensions. Considering **affordances** and **constraints**, further studies should investigate empirically how the ones pinpointed in Section 3.1 relate to each other (e.g., to what extent the emission savings granted by blockchain along the GVC are higher than the emissions engendered by the technology itself) and whether different kinds of blockchain solutions (e.g., Platt et al., 2021) create heterogeneous bundles of affordances and constraints for climate action along GVCs.

Table 3
Promising future research directions.

	Affordances and constraints	Contextual factors	Actualization
Blockchain and planet	<ul style="list-style-type: none"> To what extent are the emission savings granted by blockchain along the GVC higher than the emissions engendered by the technology itself? Do different kinds of blockchain solutions create heterogeneous bundles of affordances and constraints for climate action along the GVC? 	<ul style="list-style-type: none"> How does a GVC's multiple institutional embeddedness affect the actualization, by the MNE, of the opportunities afforded by smart contracts for climate action? How do resources, capabilities and commitment on blockchain and on climate action along the GVC influence the governance mechanisms adopted by the MNE to trace the CO₂ emissions with blockchain? How do the size and degree of fragmentation of a GVC influence the MNE's governance decisions, to actualize blockchain's affordances for climate action? How do the MNE's digital and climate-induced FSAs influence the governance mechanisms it adopts to realize blockchain's potential to tackle climate change? 	<ul style="list-style-type: none"> What kind of GVC governance mechanisms does the MNE adopt to actualize blockchain's affordances for climate action? How does the MNE foster the sharing on the blockchain of quality CO₂ emission data by all GVC relevant partners? How does the MNE design the rules and agreements that underlie the smart contracts on climate action along the GVC?
AI and people	<ul style="list-style-type: none"> How do local data quality and quantity influence the detection of problems faced by smallholder farmers, the optimization of their decisions and the prediction of their financial needs through AI? How do AI models' lack of empathy, and of intuitive and moral reasoning influence their predictive and prescriptive potentials for addressing poverty and hunger among smallholder farmers and what is the impact of location-specific factors? 	<ul style="list-style-type: none"> How do the digital and non-digital competences of farmers in developing countries affect international scaling decisions to actualize AI affordances? What location-specific factors affect the creation and scaling of a local data ecosystem to train an AI application for poverty eradication? How do the MNE's local relationships influence the development of a local data ecosystem, to maximize AI's predictive and prescriptive potential for improving smallholder farmers' livelihoods? To what extent and how do developed-country and developing-country MNEs differ in scaling AI solutions for poverty eradication? 	<ul style="list-style-type: none"> How do foreign MNEs collect the necessary volume of location-specific high-quality data to train their AI model(s), in order to realize its affordances for local farmers in developing countries? To what extent are multiple local data ecosystems formed in different locations and how are they coordinated by the digital MNE? How do MNEs actualize AI's predictive and prescriptive potential so as to augment farmers' local assets and leverages the advantages of (partial) replication?
Cloud computing and prosperity	<ul style="list-style-type: none"> What are the innovation-related advantages and disadvantages for an MNE of storing and processing the data on an international cloud or edge computing network? What are the implications for CO₂ emissions of different configurations of international computing continuum infrastructures? 	<ul style="list-style-type: none"> How do local regulations on data protection and digital sovereignty influence MNEs' location decision of their computing continuum infrastructure? Which factors on a hyper-local scale influence the actualization of edge computing's affordances for innovation? How do MNE's digital and knowledge management capabilities affect the location choice for storing and processing the data the MNE owns or controls? 	<ul style="list-style-type: none"> What implications do different international computing continuum configurations have for the realization of edge and cloud computing's affordances and the neutralization of their constraints for data-driven innovation? Which kind of geographical footprint is more effective in neutralizing edge and cloud computing's constraints and actualizing their affordances for data-driven innovation? How does the MNE manage, in its location choice, the hyper-local scale of edge and the national/ regional level of the cloud, and what are implications for innovation?

For the latter, it may be valuable to test different blockchain solutions (cf. Rossi et al., 2019).

With regard to contextual factors and actualization, an interesting area of research is contributing to the IB body of work on GVC governance (e.g., Ambos et al., 2021, Benito et al., 2019, Kano 2018, Strange and Humphrey 2019), i.e., the “organization and control of GVCs” (McWilliam et al., 2020, p.1). As Saberi et al. (2019), p. 2120 put it, “blockchains are, potentially, a disruptive technology for the [...] general management of supply chains”; even more so if these supply chains are global. At the same time, recent studies on GVCs propose new, more participative forms of governance for addressing sustainable development (Soundararajan et al., 2021). Hence, realizing blockchain's potential to attain climate change goals is likely to require changes in GVC governance, with different contextual factors playing a role.

If we look at **contextual factors**, a location-specific dimension that is worthy of investigation is the institutional context of the countries in which the GVC is embedded, and a relevant question is how a GVC's multiple institutional embeddedness affects the actualization, by the MNE, of the opportunities afforded by smart contracts for climate action. Scholars could also investigate how resources, capabilities and commitment on blockchain and on climate action along the GVC influence the governance mechanisms adopted by the MNE to trace the CO₂ emissions with blockchain. Another interesting question is how the size

and degree of fragmentation of a GVC influences the MNE's governance decisions, to actualize blockchain's affordances for climate action. Also the role played by existing trust-control dynamics along the GVC deserves further investigation. The influence of MNE-specific factors represents another promising research area, especially related to the relative influence of the MNE's digital and climate-induced FSAs on the governance mechanisms it adopts to realize blockchain's potential to tackle climate change.

As to **actualization**, we encourage further studies to illuminate the form GVC governance takes to actualize blockchain's affordances for climate action and to what extent such actualization entails novel GVC governance mechanisms, as well as new roles and responsibilities for the actors involved. More specifically, future research should explore how MNEs govern the integration between the blockchain and the climate action dimensions along the GVC. Indeed, the actualization of blockchain's affordances hinges on fostering and coordinating suppliers' engagement in reducing CO₂ emissions *and* in adopting a novel technology like blockchain, and both can be rather challenging depending on the suppliers' resources and capabilities. Another promising research avenue is exploring how MNEs (can) ensure that quality data on CO₂ emissions are shared on the blockchain by all GVC relevant partners. It should be investigated particularly what role traditional control and enforcement mechanisms, such as codes of conduct, standards and third-party verification (Fransen et al., 2019; McWilliam et al., 2020; Strange & Humphrey, 2019), play in this context and how other novel, digitally-enabled mechanisms, e.g., data collection through IoT, can be deployed. It would also be worthwhile to look at "smart contract governance" (Saberli et al., 2019) and particularly at how the MNE designs the rules and agreements that underlie the smart contracts on climate action along the GVC.

4.2. AI and poverty: Promising research avenues on international scaling

Adopting the affordance perspective for AI in relation to poverty eradication offers relevant research avenues for IB scholars as well. A key research area consists of investigating the interplay between the **affordances** and **constraints** a digital MNE may have to handle when it deploys AI to tackle poverty and food insecurity in developing countries. In particular, further studies could explore how the quality and quantity of local data influence the detection of problems smallholder farmers face, the optimization of their decisions and the prediction of their financial needs through AI in different contexts. Experimental designs are particularly valuable to address these questions. We also encourage scholarly inquiry on when and how the lack of "intuitive and creative thinking, holistic vision, ethical and moral reasoning, emotional intelligence, compassion and empathy" (Marjanovic et al., 2021, p. 400) currently exhibited by AI models 'neutralizes' their predictive and prescriptive potentials for addressing poverty and hunger among smallholder farmers, and whether this effect is amplified by location-specific factors.

For contextual factors and actualization, we encourage further research to connect to the nascent debate, in IB literature, on digital MNEs' international "scaling" (Tippmann et al., 2023). Recent IB studies, on the one hand, contend that digitalization enables MNEs to scale internationally at an unprecedented speed and with no or marginal local adaptation but, on the other hand, they point at a set of challenges digital MNEs may face which hamper the mere replication of their business model, arguing that local adaptation is easier for digital solutions (Birkinshaw, 2022; Mihailova, 2023; Stallkamp et al., 2022; Tippmann et al., 2022, 2023). Except for Tatarinov et al. (2022), extant IB research views the replication-adaptation dilemma from a mere value capture perspective (Tippmann et al., 2023) and with scant attention for the specificities of individual digital technologies. Yet, we posit that, to realize the affordances and neutralize the constraints of an AI solution for poverty, a key actualization decision consists of disentangling the replication-adaptation dilemma.

A set of **contextual factors** are likely to influence this decision and represent promising lines of inquiry. First, further studies should explore how the digital and non-digital competences of farmers in developing countries affect international scaling decisions to actualize AI affordances. It would also be worthwhile to uncover the location-specific factors that affect the creation and scaling of the local data ecosystem to train the AI application for poverty eradication. A relevant MNE-specific research question concerns how the MNE's local relationships influence the development of a local data ecosystem which maximizes the AI application's predictive and prescriptive potential for improving smallholder farmers' livelihoods. Finally, as practitioners have underlined the importance of fostering the rise of "leadership and ownership of AI innovation" and "home-grown AI activities" in developing countries, for example in Africa (Gwagwa et al., 2021), it might be interesting to examine whether and how developed-country MNEs and developing-country ventures and MNEs differ in scaling AI solutions for poverty eradication.

With respect to **actualization**, a promising avenue for IB scholars is investigating how digital MNEs tackle the replication-adaptation dilemma in order to actualize the affordances and minimize the constraints of AI solutions for poverty eradication. In the illustrative example we provided a set of arguments supporting the need to locally adapt an AI solution for smallholder farmers, and it would be worthwhile to explore the process and mechanisms of such local adaptation. Specifically, scholars should investigate how foreign MNEs collect the necessary volume of location-specific high-quality data to train their AI model, in order to realize its affordances for local farmers in developing countries. Also exploring the extent to which multiple local data ecosystems are developed in different locations and how they are coordinated by the digital MNE might be valuable, as it would advance the discussion on the role of ecosystems in international scaling (cf. Tatarinov et al., 2022). Moreover, further research could investigate how MNEs (can) actualize AI's predictive and prescriptive potential in such a way that, on the one hand, it effectively augments local farmers' capabilities and does not disrupt local informal institutions and social and natural ecosystems and, on the other hand, leverages the advantages of (partial) replication. For this line of inquiry, we suggest the design of experiments with farmers embedded in different institutional contexts, who make decisions using AI applications designed by the MNEs.

4.3. Computing continuum and innovation: Promising research avenues on location choice

Adopting an affordance perspective to edge and cloud computing for prosperity offers interesting research directions. Stemming from the different **affordances** and **constraints** exhibited by the two technologies, a promising line of inquiry consists of comparatively examining the innovation-related advantages and disadvantages for an MNE of storing and processing the data on an international cloud or edge computing network. Further studies could also investigate the CO₂ emissions produced by different configurations of international computing continuum infrastructures. Studies focusing on the actualization of edge and cloud computing's affordances and on the contextual factors that affect it would add to the research area on location choice, within the body of work on digitalization in IB. Indeed, as highlighted previously, to realize cloud and edge computing's affordances and to neutralize their constraints, in order to unlock data-driven innovation internationally, key decisions the MNE has to make is *where* to store, process and analyze the massive volume of data it owns or controls. This decision is important for IB research because previous studies have emphasized the intangible nature of digital resources (Nambisan & Luo, 2021), inferring that "the concept of place shifts from physical, territorial attributes to digital, information flow-based characteristics" (Banalieva & Dhanaraj, 2019, p. 1382). However, some IB scholars have also acknowledged that the physical and geographical dimensions may still play a role (Autio et al., 2021; Birkinshaw, 2022; Monaghan et al., 2020; Verbeke &

Hutzschenreuter, 2021).

Considering **contextual factors** leads to new relevant questions. To start with, interesting insights may emerge from exploring how local regulations on data protection and digital sovereignty influence MNEs' location decision of their computing continuum infrastructure and to what extent MNEs should "include a regional component into [their] strategy" (Verbeke & Asmussen, 2016), for example in the EU. It would also be worthwhile to examine which factors on a hyper-local scale influence the actualization of edge computing's affordances for innovation. Another area of investigation regards the MNE's FSAs that influence the actualization of edge and cloud computing affordances. It would be valuable for example to examine whether and how the MNE's digital as well as knowledge management capabilities affect the location choice for storing and processing the data the MNE owns or controls.

With regards to **actualization**, scholars could explore location choice by accounting for different dimensions of space that are key for the realization of edge and cloud computing affordances for innovation. Indeed, with cloud and edge computing the location choice MNEs have to make is "hybrid", because the digital (i.e., data and applications) and physical (i.e., data centers, smart devices and products) levels are intertwined. In addition, the location choice regarding the computing continuum connects in an unprecedented way the hyper-local, national and international scale. Considering in particular the digital data flow, scholars should examine MNEs' choice of storing and processing data on the edge and/or on the cloud and, more widely, their configuration of computing continuum, and assess what implications these decisions have on the realization of edge and cloud computing's affordances and the neutralization of their constraints for innovation. Looking at the physical, geographical dimension, it would be worthwhile to examine which kind of geographical footprint is more effective in neutralizing edge and cloud computing's constraints and actualizing their affordances. How the MNE manages, in its location selection, the hyper-local scale of edge and the national or regional level of the cloud is another interesting question. Relatedly, and connecting to IB literature on knowledge management, a valuable question consists of examining how these location choices influence an MNE's "ability to integrate and recombine knowledge across borders" (Cano-Kollmann et al., 2016, p. 259) for data-driven innovation. For example, in the case of an MNE's smart home products, further studies could illuminate what the implications are for knowledge creation of keeping the storage and processing of sensitive data at the edge under the customer's control, while transferring non-sensitive data to the cloud for the MNE to pool it and analyze it with data produced in other locations (Premsankar et al., 2018; Satyanarayanan, 2017; Siemens Energy, 2021).

5. Concluding remarks

This article aimed to connect the dots between IB, digitalization and sustainable development by leveraging the affordance perspective, widely established in IS research but hardly discussed in the IB literature thus far. We exposed, both conceptually and through three illustrative examples, that the four core components of this approach, i.e., affordances, constraints, contextual factors and actualization, help uncover the distinctive opportunities and shortcomings that a digital technology brings to MNEs; the actions MNEs might undertake to realize the former and curtail the latter in order to contribute to the SDGs; and the role of location- and firm-specific factors in this context. Building on these examples, we indicate future research directions for IB scholars through three bundles, each one including a different digital technology, a sustainable development dimension and an IB theory area. However, as each of these lines of inquiry are multifaceted, multiple other foci can be adopted by future studies by, for example, considering other digital technologies such as IoT (Baiyere et al., 2020), different combinations of digital technology and sustainable development dimensions like AI and the planet (e.g., Cowsls et al., 2021), and further IB theory areas, e.g., headquarter-subsidiary relationships (cf. Liou and Rao-Nicholson 2021).

Our perspective article was, therefore, not aimed at providing a comprehensive, in-depth analysis of all possible facets of the phenomenon, but rather at offering IB scholars a new approach, which can guide them when investigating digitalization and sustainable development, by accounting for their complexity. We also underline the importance of turning to other disciplines, particularly to IS research, to gain a fine-grained understanding of the mechanisms underlying the wide digitalization phenomenon.

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