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The Principles of Digital Transformation for Development (DX4D): Systematic Literature Review and Future Research Agenda

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Abstract

Given the growing salience of digital transformation within international development, this paper presents the results of a systematic literature review on "digital-transformation-for-development" (DX4D). Using a variety of different search terms, a corpus of 75 papers was analysed.

This paper presents general features of the literature and the research designs used. The main analysis consists of 13 principles that can be used as a starting point to guide a better understanding and operationalisation of digital-transformation-for-development research and consulting. The paper ends with a brief outline of future DX4D research priorities.

A. Introduction

Gathering pace at the start of the 2020s, "digital transformation" has become something of a buzz term within international development. International development actors have created digital transformation reports and briefings (e.g. DIAL 2020, OECD 2021) and set up digital transformation labs and projects (e.g. JICA 2022, GIZ 2023). Governments and inter-governmental bodies in the global South have created digital transformation strategies and policies (e.g. AU 2020, UNPA 2020, VMPI 2021, Mintel 2022).

These practical actions have also seen a reflection in growing literature. While there have been a number of general reviews of literature on digital transformation (e.g. Hanelt et al 2021, Nadkarni & Prügl 2021, Vial 2021), there have as yet been very few reviews of digital-transformation-for-development (DX4D) literature. Those found were very specific – e.g. on digital transformation in Latin American universities (de Pirela et al 2022) or on barriers to digital transformation in developing countries (Haryanti et al 2023) – and no general reviews.

This gap set the objective for this current paper: to undertake a systematic review of literature on digital-transformation-for-development to date. The original intention was a characterisation of main themes within the literature and identification of a future research agenda. However, as the review progressed, what mainly emerged was a set of DX4D principles: guidelines for defining and understanding digital-transformation-for-development. It is these that form the main content presented below, preceded by a description of the review methodology followed, and by an overview of some potential priorities for future DX4D research.

B. Methodology

The approach used was a systematic literature review: a structured approach to searching, analysing and synthesising literature on a particular topic (Okoli & Schabram 2010). In this instance, we sought to analyse the meaning, nature and status of digital transformation as understood in literature focused on developing countries. A systematic literature review involves several distinct and iterative steps, and is guided by a review protocol which outlines the inclusion criteria, the search strategies, screening procedures, and the methods for data extraction, synthesis, and reporting (Gates 2002, Xiao & Watson 2019). These elements are described below.

B1. Literature Search Strategy

Google Scholar was the only search engine used to extract literature because it is open access, aggregates the most significant amount of academic literature across a wide range of disciplines, and accommodates the use of search strings using AND and OR Boolean operators (Khabsa & Giles 2014). The review was undertaken in April 2023 and used six search strings to generate a broad range of papers around the research topic. The review also adopted some exclusion criteria to manage the large number of papers generated

through Google Scholar search. Table 1 presents the search strings and exclusion criteria used in this review.

Table 1: Search Strings Used to Extract Literature from Google Scholar

Search String	A. allintitle:"developing countries"[1] "digital transformation" or allintitle:"developing country" "digital transformation" B. allintitle:"global south" "digital transformation" C. allintitle:"Africa" "digital transformation" D. allintitle:"Latin America" "digital transformation" E. allintitle:"Asia" "digital transformation" F. "digital transformation" "developing countries"
Exclude	Patents, citations, non-English papers, not open access, organisational reports[2], not full-text, repeated papers, student assignments and off-topic papers.

In identifying papers to include in this review through Google Scholar, there were more papers from search string C (Africa) which meant the analysis of papers would be skewed towards digital transformation in Africa. Therefore, search strings for developing countries/country, the global south, Latin America and Asia (A, B, D and E) were first used, then only as many papers found in Latin America (D) and Asia (E) were included from the Africa (C) search string. Finally, search string F was used but selecting only from the first twelve pages of results (120 items) in order to maintain some balance of sources from the different search strings, and to have a manageable number of overall sources for analysis. Table 2 provides more details on the inclusion and exclusion criteria adopted.

Given the approach taken, it is not claimed that the literature reviewed here is a comprehensive set of all material on digital-transformation-for-development. Instead, these 75 items are seen as a representative sample, sufficient in number and diversity of origin to provide an appropriate foundation for analysis.

[1] The included papers are largely restricted to coverage of low- and middle-income countries in Latin America, Africa and Asia. However, a few papers included countries outside these regions described by authors from those countries as "developing countries", such as those from Eastern Europe on the OECD Development Assistance Committee list of ODA recipients.

[2] Organisational reports were excluded because they are the subject of a separate analysis

Table 2: Detailed Summary of Inclusion and Exclusion Strategy

	Search Strings	**Exclusion Criteria**	**Number Excluded**	**Number Included**
A1&2=31	allintitle:"developing countries" "digital transformation" or allintitle:"developing country" "digital transformation"	Not open access – 4 Not in English – 1 Abstract only – 2 Paper removed by authors – 2 Student assignment – 1 Repeated item – 3	13	18
B=8	allintitle:"global south" "digital transformation"	Not full-text – 2 Repeated item – 1	3	5
C=78 but used 17	allintitle:"Africa" "digital transformation"	Not open access – 1 Abstract only – 1 Student assignment – 1 Organisational report – 2 Repeated item – 2	7	10
D=21	allintitle:"Latin America" "digital transformation"	Not full text – 7 Abstract only – 2 Not in English – 2 Organisational report – 3	14	7
E=16	allintitle:"Asia" "digital transformation"	Not open access – 7 Unavailable file – 1 Abstract only – 1 Not in English – 1 Student assignment – 1 Organisational report – 2	13	3
F=3,470 but used 120	"digital transformation" "developing countries"	Not open access – 12 Student assignment – 3 Repeated item – 23 Topic not DX4D – 45	88	32
Total				**75**

A literature review categorisation schema was developed to guide data extraction from the 75 papers included in the review. This was iteratively developed between authors Ezeomah and Heeks based initially on co-coding of eight items, and then co-coding of a further ten items. The final schema consisted of five main category domains: paper descriptors (e.g. details of authorship and research design); digital transformation analysis (particularly definition and operationalisation of digital transformation); digital transformation impact analysis (particularly the outcomes of transformation); advice analysis (recommendations for organisations, governments and researchers); and other quotations. Fuller details of the 31 sub-categories and their coding values are given in the Appendix table.

In the analysis that follows, the nature of the literature is first reviewed, followed by analysis of emergent principles for digital-transformation-for-development research and consulting, and a short overview of future DX4D research priorities.

C. Characterising the Literature

C1. General Features

The earliest literature item appearing was published in 2017 and, as Figure 1 shows, there has been rapid growth in literature on digital-transformation-for-development in recent years. Two-thirds of the items were journal papers, with the rest divided between conference proceedings papers and other items such as book chapters and institute reports. Of the journal papers, just under one-sixth were in journals ranked in the first quartile by the Scimago ranking system; meaning just 11% of papers in total were refereed in highest-quality journals.

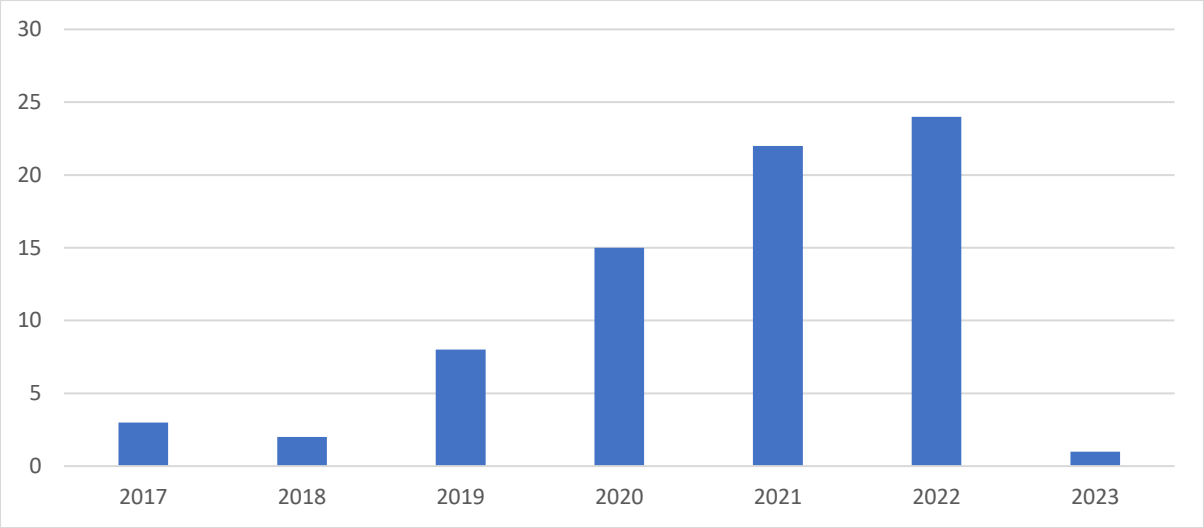


Figure 1: Year of Publication of Digital-Transformation-for-Development Literature

Based on the location of the corresponding author, low- and middle-income country scholarship is quite well-represented with two-thirds of authors coming from countries on the OECD list of official development assistance recipients. There remain gaps, however. Only two papers came from a low-income country author (Uganda, Togo), and geographically, there was little or no work emanating from North and South America, Oceania, the Caribbean, South and West Asia, and East Africa. In terms of the geographical focus of the papers, roughly one-third sought to cover continental or wider scale but beyond this, again, low-income countries were relatively under-represented: only five papers had this as a specific focus. There were ten papers on Latin America but otherwise the authorship lacunae were mirrored with Oceania, the Caribbean, South and West Asia, and East Africa barely covered if at all in region- or country-specific papers.

Disciplinary background of the corresponding authors was quite narrow and skewed. Half came from business and management with a particular emphasis on information systems; and around one-fifth came from economics. Another fifth came from various science and engineering domains though only three from computing. Only one paper was led by an author from development studies, and likewise only one from politics; both of which are disciplines that can readily inform digital transformation research.

C2. Research Design

A little under half of the papers used some form of primary data-gathering: split roughly evenly into those relying on interviews alone, on interviews alongside some other method such as a focus group or participant observation, and on surveys. About one-third of the papers using interviews talked with fewer than 10 people or did not specify the number of interviewees, and only four papers were based on primary data and published in the highest-ranked journals. Thus, while research in the field is quite well supported by primary data, there could be an argument for a greater quality or rigour in such work.

That argument is strengthened by the fact that two-thirds of the papers made no explicit use of a theory or conceptual framework. Of those that did make such use, only nine – so, 12% – clearly structured the empirical findings of the paper around the theory. For most of the others, a theory was mentioned in the early part of the paper but then did not appear in findings or conclusions. Theories mentioned were of many different types: stakeholder theory and variants of the technology acceptance model were the only ones to be mentioned more than once. Equally notable was that none of the theories was a theory of transformation, let alone digital transformation and, indeed, (digital) transformation as a concept did not appear within the theories.

While there has been a general dearth of theorisation about digital transformation (Markus & Rowe 2021, Vial 2021), there are inductive thematic models being built from literature or expert review (Mergel et al 2019, Nadkarni & Prügl 2021) alongside maturity models that incorporate digital transformation (e.g. Gollhardt et al 2020, Kääriäinen et al 2020). Just two such models were found, both in later papers, that provided three simple stages of digital transformation (access, proficiency, benefits in Haryanti et al 2023; and foundation, adoption, acceleration in Kim et al 2022). In addition, there are cognate models that could readily be drawn upon such as theories of organisational transformation (Edwards 2010) and of transformational leadership (Yammarino & Dubinsky 1994). None of the conceptualisation was drawn from development studies or even from related fields like geography and economics. Yet development paradigms and their related theorisation often contain within them notions of economic or social transformation (Castles 2001, Pieterse 2010) that could frame analysis of digitalisation.

Around 70% of papers focused on economic development, of which half looked at broad issues like business and the economy, one quarter looked at specific sectors such as construction or banking, and one quarter combined an economic focus with other development issues such as public sector development. 20% of the papers analysed a social development issue of which the majority looked at education. The remaining papers dealt almost entirely with digital transformation in government and public administration.

Beyond the strong skew towards economic development, at least from this literature sample, some gaps were notable given the mismatch to their importance in the global South. Only four papers discussed agriculture of which only one included food security, and none took rural development as their theme. Only three papers discussed digital transformation and health. Only one looked at the intersection of digital transformation and

environmental development. No papers specifically analysed digital transformation in services. None looked specifically at primary sector activities such as mining and forestry. None looked specifically at poverty or at gender inequality. None looked specifically at water and energy. None looked at implications for governance and politics beyond public administration. In terms of the SDGs, then, SDG 4 and some aspects of SDGs 8 and 9 were relatively well-represented. But there was little or nothing relating to the intersection of digital transformation with all of the remaining 14 goals.

D. What is Digital Transformation for Development?

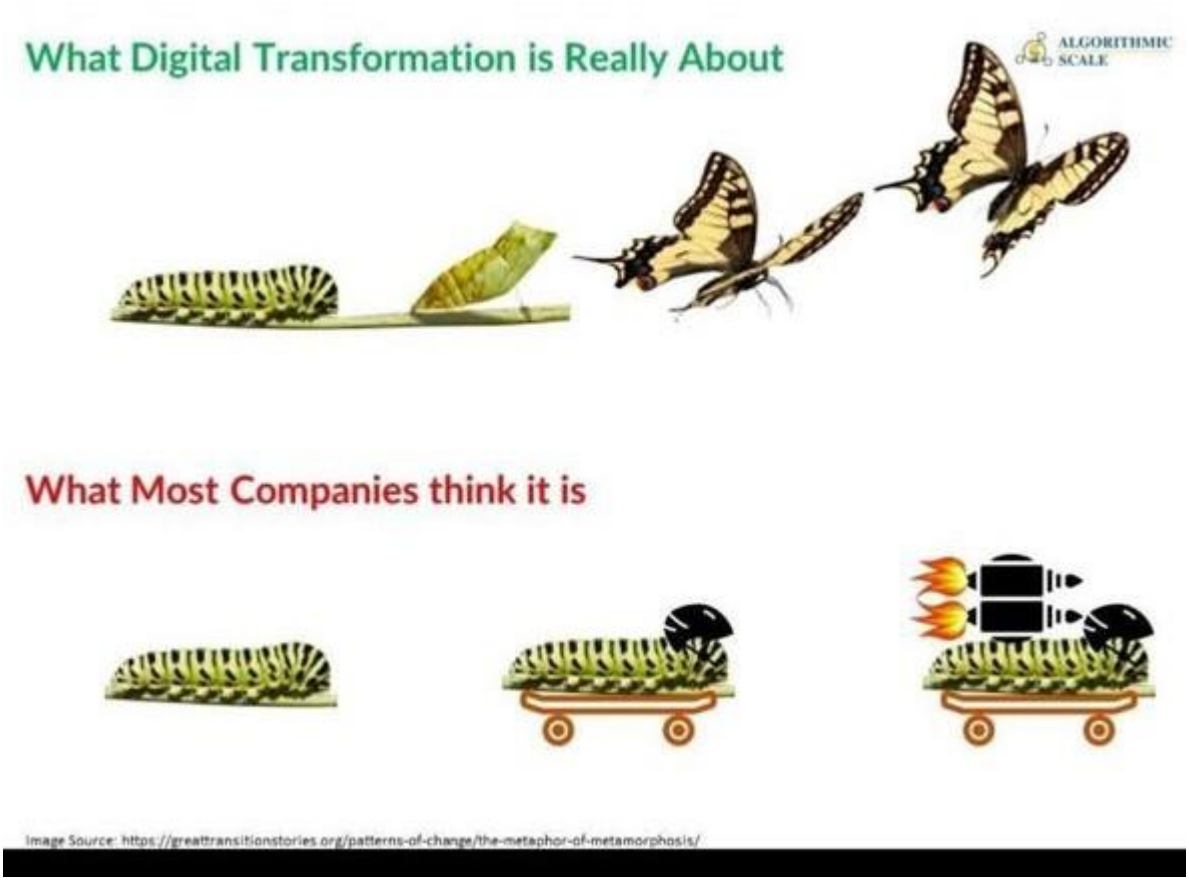
D1. Defining Digital Transformation

Just over half (40) of the papers did not give any definition of digital transformation and, of the remainder, 11 (c.30%) gave multiple definitions that were not integrated, prioritised or in some other way focused. In two-thirds of the papers, therefore, it was not possible to know exactly what they were talking about, despite the focal topic of the paper being digital transformation.

PRINCIPLE 1: DX4D should incorporate a (single) definition of digital transformation.

Analysing the content of the definitions when provided, about one-third of descriptors clearly represented a transformative degree of change, using terms such as “disruption”, “fundamental change”, “radical change” or, circularly, defining digital transformation as “transformation” using digital technology. Another one-third were not obviously transformative; for example, speaking of the extent of change only as “changes”, “effects” or “adjustments” or not actually discussing change. The remainder fell between these two poles, either mixing transformative and non-transformative descriptors in parallel definitions, or using mid-range terms such as “enhancement”, “shift of activity” or “create new processes”. Yet, despite widespread thinking to the contrary (neatly summarised in the bottom half of Figure 2), DX4D is not about incremental alterations to existing systems but – per the top half of Figure 2 – about significant disruption.

PRINCIPLE 2: the extent of change envisaged and incorporated in DX4D must be transformative; involving significant systemic disruption.



Source: Vlemincx (2022)

Figure 2: Differing Perspectives on Digital Transformation

D2. What is Transformed?

What is, or needs to be, transformed for digital-transformation-for-development to be brought about? Of course, there needs to be a transformation of digital systems, with the introduction of disruptive applications and platforms. But is that sufficient? Roughly two-thirds of papers made some statement about this but almost all of them focused on parallel changes in one or both of two things as illustrated in the following quote: "True digital transformation lies not just in the documented technological innovation it promises, but in deploying digital infrastructure, addressing challenges with internet connectivity, ensuring widespread access to computing devices, and building human capital and skills" (Mhlongo & Dlamini 2022). There need to be changes in the underlying technological infrastructure including telecommunications, cloud, cybersecurity, data analytics and the like. And there need to be changes in the underlying human infrastructure of skills and knowledge, including digital literacy.

While digital transformation cannot occur without more widespread access to these hard and soft resources, they are understood here as "foundations" (Alam et al 2020, Kusmiarto et al 2021) or "enablers" (Pereira et al 2020, Lamid et al 2021): a role no different from that they are seen to play for ICT4D generally (Heeks 2018). They are seen as part of "e-readiness" (Manda & Backhouse 2017, Kagoya 2020) and hence as components of "digital"

more than aspects of "transformation". Five papers – sometimes alongside other issues – focus on a need for change in transformation of organisational or wider processes, and of institutional factors such as culture. These come closer to the notion not of precursors but of change that must occur alongside digitalisation to deliver transformation.

Finally, 12 of the papers – so just under one-sixth – identified that, alongside technological change, what digital transformation requires is parallel structural changes. This requirement is clear from the general literature on digital transformation (Kraus et al 2021, Vial 2021): "structural and institutional changes will be necessary and required if desired expectations and results of disruptive technologies are to be realized" (Hanson et al 2020). Some identified this at the level of the organisation: "While value creation may definitely result from digital transformation, to optimally reap its benefits would require several structural changes throughout the business organization" (Radzi et al 2021). Others identify transformation as involving broader societal change: "The realization of their transformative potentiality requires not only further innovation and widespread adoption of digital technologies but also the reconfiguration of the social structures in which they operate … multi-dimensional societal change processes that are prompted by actions that we located in economic, organizational, political, social and cultural environments" (Ndemo & Weiss 2017). It is to this issue of level that we turn next.

PRINCIPLE 3: although it necessarily involves technological changes to digital data and systems, digital transformation for development involves and requires broader, parallel transformative changes in structural relations, development processes, formal/informal institutions, and resource distributions.

In relation to the ***level*** of what is transformed, there were no definitions or analyses of change at the micro-level of individual people or households. More than half of the papers that provided a definition saw the change as organisational-level and business-oriented e.g. "changes in the ways of working, functions and services offered by the adoption of digital technologies in a company or in the operational framework of the company" (Conde & Wasiq 2021); "the upfront implementation of the latest technologies to enhance business" (Ofosu-Ampong 2021). Half of the remainder equally understood digital transformation to operate at the level of the organisation: "the process by which a Higher Education Institution breaks the management paradigms of the past and reinvent them through a creative disruption, supported by the utilization of digital technology" (Serna Gómez et al 2021); "encompasses the working systems, organisational systems, organisational culture, individual participation and much more" (Nahayo & Rutikanga 2020). While this meso-level understanding of digital transformation is perfectly legitimate, six papers included macro-level societal transformation as at least part of their definition: "the economic and societal effects of digitisation … and digitalisation" (Hicks 2021); "the changes and opportunities of a mix of digital technologies and their accelerating impact across society" (i-SCOOP.eu 2016 cited in El-Massah & Mohieldin 2020).

Looking beyond definitions, at the way in which digital transformation was operationalised within papers, a little over one-third of papers (29) only considered an intra-organisational scope of transformation. But a similar number (26) – while still locating the process of digital transformation within organisations – recognised how aggregation of meso-level

changes impacts the macro-level of society, for example, leading “old sectors and industries [*to*] gradually be replaced by the new industries" (Aly 2022) and “changing the way that businesses operate, the way economies function and the way that societies interact” (Ciuriak & Ptashkina 2019). A further 14 papers operationalised digital transformation solely at the societal level and linked it to delivery of broad development goals: “less corruption, increased transparency, greater convenience, revenue growth and/or cost reductions” (El-Massah & Mohieldin 2020) in the case of public sector DX, “empowering lives, transforming businesses, and increasing engagement, equitability, and wellbeing” (Kazim 2021) more generally.

PRINCIPLE 4: digital transformation impacts both organisations and societies, and macro-scale, societal transformation must be incorporated into the understanding of DX4D.

Linked to this, from the definitions and from the wider discussion within the paper, digital transformation is positioned in two different ways vis-à-vis the agency of individual and organisational actors. For most papers (45, i.e. 60%) and especially those that were organisational case studies, digital transformation is a proactive activity; something which actors undertake and which then produces results:

- “digital transformation describes a broad, long, and unified process of internal changes” (Lola & Bakeev 2020)
- “digital transformation can be the approach by which enterprises drive changes in their business models and ecosystems” (Radzi et al 2021)

For seven papers, action is reactive to digital transformation; something which happens broadly, which is experienced by the focal actors, and which must be responded to. In these papers, the focus is less on the process of transformation (something emphasised in the proactive-oriented papers), and more on the impact of transformation. Organisations generally, for example, are seen to need to respond to “the unintended side effects of digital transformation” (Pereira et al 2020) or higher education institutions specifically need to address the “technology-related unemployment in emerging countries” that ensues from digital transformation (Goulart et al 2022).

In a quarter of papers – which might be described as “proactive-reactive” – digital transformation is something done within organisations but in response to some wider phenomenon. Where explicit, and not surprisingly given the timing of the literature review, this was almost always related to Covid-19 and particularly linked to education; for example, noting "the influence of the COVID-19 pandemic in motivating digital transformation in the education sector in South Africa" (Mhlanga & Moloi 2020) and “the pandemic … causing schools and universities to hastily begin the transformation of teaching practices” (Becirovic & Dervic 2022). Expanding on this, some papers taking the proactive perspective are implicitly proactive-reactive because the need for digital transformation comes by implication from external factors such as the need to compete with other businesses in a market place.

This relationship and the overall view within the literature can be drawn from the characterisation in Ndemo & Weiss (2017), "making connections from micro-level actions to meso-level environments and macro-level societal outcomes". Proactive views look at the

micro-level: at the actions of individuals within organisations. Reactive views look at the macro-level: at the broader changes taking place in society. This is very similar to the differentiation between imminent and immanent development: the former being the willed, intentional actions of individuals and organisations – digital transformation *for* development (DX4D); the latter being the broad societal changes that emerge over time – digital transformation *of* development (DXoD) (Hickey & Mohan 2005, Murphy & Carmody 2015).

PRINCIPLE 5: digital-transformation-for-development derives from the micro-level, proactive actions of individuals but both creates and responds to macro-level societal changes deriving from digitalisation: digital-transformation-of-development.

D3. The "For Development" Part of DX4D

If digital-transformation-for-development involves societal-level change, how exactly does the "for-development" aspect manifest itself?

None of the definitions made any direct reference to the particular circumstances of low- and middle-income countries. This is understandable: what could be incorporated that would not be a sweeping generalisation or even stereotype? Only one definition made an explicit reference to development; summarising other Western literature that it said "often presented [*digital transformation*] in terms of a new technological revolution, a change of development paradigm" (Ganichev & Koshovets 2019). It associated this with emergence of the "fourth industrial revolution" rather than with the more widely-cited paradigms of international development (Heeks et al 2022).

Though rarely explicit, the underlying development paradigm could be interpreted from the changes that papers saw digital transformation – or digital technologies generally in some instances – as facilitating. Mirroring the business orientation of many definitions, a large tranche of the literature saw digital's developmental purpose being to support the development of business and markets:

- "a necessary process through which global modern trends of doing business and strengthening competitiveness can be achieved" (Melovic et al 2020)
- to "bring new value and market opportunities … redefine new business models … and as a result, facilitate the value creation for businesses" (Bui 2021)
- "to boost efficiency, innovation, profitability and productivity" (Aly 2022)

The same worldview could be seen even when referring to digital transformation in public sector organisations: "a major driver of efficiency, productivity and innovation for optimizing limited resources, creation of new business models" (Lamid et al 2021); "It is therefore essential that higher education … is reconsidered to address job market demands" (Goulart et al 2022). In total, 47 (roughly two-thirds) of the papers adhered to this neoliberal development paradigm; giving primacy to markets, competitiveness, profit and other market values.

A small number of papers – seven (c.10%) – saw digital as being a key to addressing inequalities in society: "a tool for tackling the country's human development challenges such as poverty, unemployment and socio-economic inequality" (Manda & Backhouse 2018), which could also be seen with central attention to issues such as "inclusiveness"

(Quayson et al 2020) or "forms of exclusion" (Mhlongo & Dlamini 2022). These were discussed in relation to livelihoods, poverty, health and education, and could thus – as the first quote makes explicit – be seen to align with a human development paradigm.

A further 15 papers were also techno-centric in their understanding of change but without a clear conformity to either market or pro-equity logics: e.g. "the transformation of society into a modern and smart society driven by advanced technology, skills, innovation and responsive policy" (Manda & Dhaou 2019). A number of these were education-related and talked just in general terms, for example, of digital's purpose being "to transform traditional teaching and learning" (Mhlanga et al 2022). These we associated with a modernisation development paradigm that gives primacy to use of advanced technologies to enable "developing" countries to "catch up" with "developed" countries.

Three papers were much more negative in their assessment of the current situation, and focused on power and inequality between nations: "Power has been seen as the dominant ethical concern with a causal effect on other concerns such as dependency, data management and ownership, privacy, digital divide, indebtedness, and innovation stifling" (Wakunuma 2019) with "a new architecture of the technological center (leadership) and technological periphery (dependence)" (Ganichev & Koshovets 2019). As the reference to dependency suggests, these can be linked to a structuralist view of development; one that sees the global South needing to find ways to break away from dependence on, and exploitation via, digital technologies supplied by the West and China.

Only one paper considered the current environmental emergency and the need to transform to a sustainable development paradigm; seeing contributions but also challenges to this from digital (Hicks 2021). And one paper gave priority to a decolonial development paradigm: "Eurocentric paradigms for technology continue to dominate in Africa yet can impede digital transformation by perpetuating senses of inferiority in societies that have endured colonialism and apartheid" (Magoro & Bidwell 2022). None adopted a post-development paradigm.

As can be seen, and as shown by analysis of the transformations that different development paradigms seek (Heeks et al 2022), the different paradigms lead in very different directions. Yet only the one paper mentioned the term development paradigm and none explicitly identified a paradigm from the widely-used categorisation which was applied above.

PRINCIPLE 6: transformation of digital ecosystems is not the goal of digital-transformation-for-development; development – understood as the transformation of societies – is. Digital-transformation-for-development should be explicit about the developmental transformation that it is seeking to bring about, or wishes to emerge.

While a few gave illustrations – such as social media, mobile technologies, cloud, platforms, big data analytics, internet of things, blockchain, robotics and artificial intelligence – all definitions were ultimately comprehensive in referring generically to "digital technologies", "digitalisation" or similar terms. Likewise, most papers without a definition were generic in references to the technologies of transformation.

Putting the digital and the developmental together, we looked for the new development models that digital transformation was enabling. While there were a few non-descript phrasings – "digital agriculture" (CEPAL 2020) or "digital government" (Lamid et al 2021) or "digital learning" (Cerda Suarez et al 2021) – there was no sense from these of a new model. A number of papers referred to "Industry 4.0" but this was just a branded collection of the same technologies listed above. As yet, then, there has not been identification of "Development 4.0" models: ways in which the potentially-transformative affordances of digital technologies – automation, connection, equalisation, illumination, innovation and universalisation (Heeks 2018) – can be used to reinvent traditional approaches to delivery of the SDGs.

PRINCIPLE 7: digital-transformation-for-development overall is not associated with any specific digital technology, but it could be associated with new "Development 4.0" models.

D4. The Impact of DX4D

Where are we in relation to digital-transformation-for-development? At least according to the surveyed literature, it is an emerging phenomenon in the global South, with more than 70% of papers describing digital transformation in terms such as "in the early or developing stages" (Ozumba et al 2022), "in progress" (Winasis et al 2020) or "still in its infancy" (Bui 2021). One sixth of papers implicitly saw digital transformation as having occurred but these were generally case studies of what were presumed to be transformative applications such as gig economy platforms or e-commerce platforms. Even if these were transformative – and the papers did not overtly describe them as such or demonstrate how they met the threshold of transformation – then this can be compatible with the "emerging phenomenon" view given transformation in one application or organisation may run in parallel with lack of transformation elsewhere in a country.

Even the emerging phenomenon view could be seen as overstating the extent of transformation since papers often failed to differentiate the progress of digitalisation generally with the specific attainment of digital transformation, and their focus was often on the barriers to, and strategies needed to fully implement, digital transformation – a topic discussed below. A few papers (9 of 75) were thus even more subdued and saw digital transformation as something yet to occur in the global South: "digital transformation is missing" (Kagoya 2020). Overall, then, digital transformation in the global South is seen as just being at a formative stage.

PRINCIPLE 8: even allowing for islands of significant digitalisation – which may or may not be transformative – digital-transformation-for-development is a future more than present phenomenon.

Because of this, in discussing the impact of digital transformation in the global South, the majority of papers speak hypothetically e.g. that digital transformation "may" or "can" or "should" or "will" deliver particular outcomes. In doing this, a number extrapolate from experiences in the global North, from current experience with more incremental digitalisation, or from the initial experiences of a very few organisations that are regarded as having digitally transformed.

In attributing the cause of these impacts, well over 80% of papers were techno-centric; despite – as noted above – a number identifying that digital transformation requires change in more than just digital systems. They talked about "the impact and change digital technologies can or already have realized" (Ndemo & Weiss 2017) and at times were even more technologically deterministic in discussing, "integration of digital technology into business that results in, sometimes fundamental, changes in business operation and delivery of value to customers" (Micic 2017) and "the changes that digital technology causes" (Hai et al 2021). Only 12 papers took "a socio-technical perspective" (Manda & Dhaou 2019) that acknowledged – consistent with the holistic understanding of what needs to be transformed for digital transformation to occur – that impacts of digital transformation emerge from a mix of technological and social causes: "not [*just*] the new technologies themselves, but changes in the way of thinking and business strategies" (Nosova et al 2021), or that the "combination of smart technology and smart human resources makes organisations effectively achieve their objectives and goals" (Nahayo & Rutikanga 2020).

PRINCIPLE 9: the impact of digital-transformation-for-development emerges not deterministically from technology alone but from a mix of social and technological factors.

The DX4D literature in general is not just techno-centric but also techno-optimistic; seeing the impacts associated with digital transformation as overwhelming positive. 60% of papers were solely positive. In some cases, the impacts were described in generic terms: "transparency, accountability and efficiency" (Ndemo & Weiss 2017); "opportunities for innovation, creativity, learning and development" (Nahayo & Rutikanga, 2020). In other cases, the benefits were sector specific; for example: "enrich and make the educational process efficient" (Argüelles-Cruz et al 2021); "improved market transparency … enhanced farm productivity … and more efficient logistics" (Xie et al 2021); "a significant increase in production quality and reduction in costs by eliminating waste … and improving efficiency" (Beyaz & Yildirim 2019).

Only two papers were solely negative in their judgement of DX4D impacts while the remainder were, overall, much more positive than not but included some greater or lesser reference to potential negative impacts. For instance, it was recognised that the intense level of digitalisation required for digital transformation would be likely to exacerbate existing challenges associated with digital including environmental ("increasing consumption or energy levels … increases in CO_2 emissions": Hicks 2021) and employment-related ("massive job losses": Manda & Backhouse 2017).

However, in the minority of papers that did discuss negative impacts, the main one identified was a rise in inequality, with DX4D seen to produce both winners and losers. This was most often expressed in digital divide terms; seeing digital transformation per se as beneficial but only for those who could participate in it. Others, lacking "digital skills, capabilities and infrastructure" (Fu 2020) who could enact only much more limited levels of digitalisation would not realise those benefits, and so relative inequality would increase. This was sometimes linked to individuals such as those on low incomes as compared to those on higher incomes (Mhlanga & Moloi 2020); most often to organisations such as "SMEs" vis-à-vis large enterprises (Hai et al 2021), "small farms" relative to "large farms"

(Xie et al 2021) or "universities in rural areas" in contrast to those that were urban-based (Mhlanga et al 2022); sometimes to groups such as "rural and under-resourced communities" (Mhlongo & Dlamini 2022); and in a couple of instances to "developing countries" overall in comparison to high-income countries (Manda & Dhaou 2019, Fu 2020).

In four papers, the rise in inequality was expressed in more systemic terms around labour market changes in the skill composition of work. These argued that digital transformation for development would lead to a relatively greater requirement for higher-skilled workers while lower-skilled workers would find their jobs automated out of existence; thus increasing inequality between these two groups (Fereidouni & Kawa 2019, Aly 2022, Pawar 2022, Rhee et al 2022). Finally, five papers came close to the ideas of adverse digital incorporation, arguing that inequalities would increase between entities that were incorporated into digital transformation. In four, the perspective was explicitly or implicitly based on dependency theory, contrasting the "economic domination [*and*] imperial control" of the "technological centre" based in higher-income countries that uses its "oligopolistic digital power" to extract rents from the process of digital transformation at the expense of the "technological periphery" in lower-income countries (Ciuriak & Ptashkina 2019, Ganichev & Koshovets 2019, Wakunuma 2019, Pereira et al 2020). In three, the inequalities were discussed in relation to individuals vs. powerful actors: citizens losing power to surveillance states, or workers ceding power and labour value to platform capital (Ciuriak & Ptashkina 2019, Wakunuma 2019, Zhu 2022).

PRINCIPLE 10: there must be recognition of both positive and negative impacts associated with DX4D because, without this, there can be no understanding of, or attempt to mitigate DX4D's downsides.

D5. Taking Action on DX4D

The credible consensus from the literature is that digital-transformation-for-development is still at a relatively formative stage, that impacts are only just emerging, and that one reason for this is that it faces a series of barriers. More than three-quarters of the papers identified one or more barriers. Of these papers, around half identified issues with technical infrastructure: "a lack of high-quality and affordable infrastructure (including access to reliable electricity)" (Gaglio et al 2022); "limited internet access and connectivity, and use of mobile services is driven by voice rather than data consumption" (Conde & Wasiq 2021). A similar number identified human capabilities as a barrier: "absence of knowledgeable and qualified personnel" (Rassool & Dissanayake 2019), "both leaders and staff lack digital thinking, knowledge, and skills" (Hai et al 2021).

Building on the last quote, about one-third mentioned issues with leadership: "inadequate top management support" (Kagoya 2020) "lack of holistic vision … lack of leadership support" (Marks et al 2021). A similar proportion discussed informal institutional barriers: "the resistance for any change regarding the DT in their organizations from both … managers and employees" (Bui 2021), "The main barrier for the digital transformation in HEIs is … the conservative culture" (Serna Gómez et al 2021). Other barriers discussed by a few papers include finance ("challenges include the implementation cost": Quayson et al 2020, "poor access to financing": Gaglio et al 2022), policy ("the lack of specific public

policies": CEPAL 2020, "lack of policy and regulations": Alam et al 2020), and data ("insufficiency of data": Radzi et al 2021).

A number of sources (Limani et al 2018, Alam et al 2020, Kagoya 2020, Lola & Bakeev 2020, Marks et al 2021, Haryanti et al 2023) provided a collective perspective that lists many or all of these barriers: technical infrastructure, human capabilities, leadership, culture/resistance, finance, policy, data. What is notable, however, is that these are the same factors identified for decades; for example, as barriers to ICT4D (Heeks 2018). While the scale of the barriers might be greater if DX4D is trying to change more than ICT4D did, the nature of the barriers does not appear to be.

Very few papers discussed traditional barriers but specifically in light of what is different about DX4D. For example, the relative absence not simply of leadership but of "transformative leadership" that can motivate and direct transformational change in global South societies (Hanson et al 2020). And seven papers talked about structural barriers; for example, the difficulty of "concurrent reconfiguration … across multiple environments … economic … organizational … political … economic" (Ndemo & Weiss 2017) that are required for digital transformation of a society; or in relation to organisational-level digital transformation, the problem that "organisational structure is not flexible" (Limani et al 2018), that organisational structures are too "fragmented" (Manda & Backhouse 2018) and "compartmentalised" (Imran & Okai-Ugbaje 2022), or that structures are rooted in "legacy business models" (Marks et al 2021) or wider "legacy systems" (Rusu et al 2020). While structural barriers are discussed in relation to ICT4D (Chipidza & Leidner 2019), they have a specific relevance to DX4D given that structural change is a particular feature of digital transformation.

PRINCIPLE 11: alongside traditional ICT4D barriers, DX4D faces barriers of a specific size and nature due to the scope of transformation that it entails.

What, then, should be done to help accelerate the slow pace of digital-transformation-for-development? About one third of papers make recommendations for organisations, and just under a half provide government policy recommendations. More than one-quarter of papers provided neither. There is an argument that organisations are not ultimately agents, it is individuals within organisations. This is something well-recognised within wider digital transformation research and practice (e.g. Gartner 2022, McCarthy et al 2022) and yet clearly acknowledged by only one paper in the set reviewed (Bui 2021).

Intra-organisational recommendations are largely concerned with addressing the barriers just identified. In particular, organisations are advised to develop staff capabilities (e.g. Aghimien et al 2020), to change staff culture in order to reduce resistance to change (e.g. Bui 2021), and to strengthen both leadership (e.g. Hai et al 2021) and data infrastructure (e.g. El-Massah & Mohieldin 2020). Alongside these, individual instances were found of recommendations to improve organisational technical financing or infrastructure. Relatively limited detail was provided on what organisations should do and – echoing a point found in relation to barriers – most of the recommendations could be applied to digitalisation generally. They rarely take into account the specifics of digital transformation. They even more rarely take into account the specifics of digital-transformation-for-development,

either in the sense of attunment to specificities of particular global South contexts, or in the sense of the particular needs of transformation to achieve development goals. The need to adopt a strategic plan for digital transformation and to align that with wider organisational strategy was recognised (e.g. Conde & Wasiq 2021, Marks et al 2021). But, again, that has been a recommendation for digitalisation and ICT4D generally for decades (e.g. Henderson & Venkatraman 1989, Prakash & De' 2007).

Much the same was true of government policy recommendations, in terms of addressing identified barriers to DX4D, though generally with a bit more detail and broader range of ideas about policy content. For example:

- For infrastructure development, not merely that governments should increase investment but also help reduce user costs (Kagoya 2020), ensure interoperability of systems (Ganichev & Koshovets 2019), and adopt open technologies (Ciuriak & Ptashkina 2019).
- For capability development, not merely that governments should build the national base of digital skills training but also encourage in- or return migration of skilled individuals (Ciuriak & Ptashkina 2019).
- For finance, not merely that governments themselves should spend more but also find ways to increase international private and donor investment (Rhee et al 2022), open up channels for local private sector investment (CEPAL 2020), and subsidise individual and organisational adoption of digital tech (Khalil et al 2022).

Recommendations ranged from those that saw a relatively strong role for state intervention (e.g. CEPAL 2020) to those from the neo-liberal stable recommending, "the government should minimize interference in business operations and follow the principles of fair competition in market economy" (Chen & Hao 2022).

Yet again, though, these policies are not recognisably different from those recommended for ICT4D. There were only two (partial) exceptions. A number of policies were recommended to deal with the negative impacts associated with DX4D. Some are extrapolations from ICT4D: digital inclusion policies to address growing inequality (e.g. Manda & Backhouse 2017, Lola & Bakeev 2020) and data privacy and security policies to address growing data breaches (e.g. Rassool & Dissanayake 2019, Lu et al 2022). A couple of papers were somewhat more DX4D-specific in recommending policies on retraining and workers' rights to address the labour market turbulence emerging from digital transformation (Manda & Dhaou 2019, Zhu 2022). And two papers implicitly argued that use of digital cannot be transformative unless the dependency on foreign tech firms is reduced; hence, requiring policy to build local digital innovation capabilities (Ganichev & Koshovets 2019, CEPAL 2020). These were exceptions, however, reflecting a more general rule like that for organisational recommendations: that recommendations focused on the digital component of DX4D, but hardly at all on the transformation or the for-development parts.

PRINCIPLE 12: implications or recommendations for DX4D practice should be provided wherever feasible, taking into account the specificities of digital-transformation-for-development.

A notable skew within the recommendations for both organisations and national governments is that 85% of the recommendations related to the content of strategy or policy. Only a small minority attended to strategy-/policy-making process or structure. Yet, given the preponderance of content advice and notwithstanding the lacunae mentioned above, the "menu" of content may be relatively well known. Process and structure recommendations may be more valuable. Three recommendations arose that were common to both organisations and governments though – a continuing refrain – they neither apply solely to DX4D nor were they presented with DX4D-specific substance. First, adopt an open and participative process that incorporates the key DX4D stakeholders identified above; a corollary of this being the need for collaborative strategy/policy structures that included these stakeholders (e.g. Aayale & Seffar 2021, Romanova & Kuzmin 2021). Second, develop some indicators of digital transformation for development so that progress can be monitored, and outcomes of the time and money invested can be evaluated (e.g. Beyaz & Yildirim 2019, Aayale & Seffar 2021). Third, customise strategy and policy to local realities rather than following one-size-fits-all exemplars (Manda & Dhaou 2019).

Alongside the lack of attention to process and structure, there was recognition of a broad range of stakeholders being involved, seeing that digital transformation for development needs "government … to partner with leading businesses, start-ups, civil society, academia, and international organizations to co-design and pilot new approaches" (Manda & Dhaou 2019:251) and that "future research should investigate … government, industry, higher education and civil society partnerships" (Manda & Backhouse 2017:10). Yet the recommendations focused on actions by private businesses or other individual organisations in the case of studies on digital transformation in education or the private sector, or on the wider role for the state.

There was thus something of a "missing middle" with no recommendations made for civil society organisations, community-based organisations, or other types of local non-government organisations. Likewise, there was barely any consideration of the role of international organisations. Only one paper (Zhu 2022 – a paper presented at a UN meeting) explicitly discussed recommendations for them and only in relation to labour market initiatives. Yet the necessity of a role in DX4D for international organisations is clear from both the history of ICT4D and from the role of international organisations in dealing with individual and potentially-transformative digital technologies such as data or artificial intelligence (Heeks 2018, GPSDD 2023, UNDP 2023).

PRINCIPLE 13: DX4D recommendations will need to cover not just the content of organisational (private, public, NGO and international agency) strategy and government policy but also their underlying processes and structures.

E. Future Research

The research agenda proposed below derives from the literature review as lacunae identified in the analysis above, and from the roughly-half of papers that explicitly discussed future research directions (noting the latter were often quite sector- or country- or technology-specific in their suggestions). Beyond general calls for more research on digital-transformation-for-development, a starting point is that DX4D research to date has over-emphasised the "digital", at the expense of "transformation" and "for development".

STEERING BETWEEN HYPE AND CONTINUITY IN RESEARCHING THE "X"
The heavy lean of current literature towards optimism and techno-centrism suggests that research has been a little too taken up with the hype of digital transformation when it is clear that DX4D is still at best an emerging phenomenon. While it needs to avoid the hype, future research must equally ensure it is not simply researching standard ICT4D or digital development. Research can therefore aim for the window of relevance: better reflecting the realities of digital transformation today but also how it will emerge over the next, say, three to five years. If it is not to simply be digital research, then the future agenda must attend to the transformational elements: for example, researching the structural changes that run in parallel to digital change, and researching issues like structural barriers and transformative leadership. Where specific technologies are the focus – and artificial intelligence is rising sharply up the DX4D agenda at the time of writing – then the focus will be singularly on their transformative, as opposed to business-as-usual, potential.

BROADENING THE "4D" COMPONENT OF RESEARCH
In a straightforward sense, the 4D element of DX4D may be better addressed in future research by filling some of the gaps in terms of authorship and geographical focus: Oceania, the Caribbean, South and West Asia, and East Africa. Likewise by filling some of the disciplinary gaps with a greater proportion of research drawn from development studies or cognate disciplines that might help ensure that research specifically incorporates features of development as a historical and political process, and the particular contexts and global positionality of global South countries.

Reflecting the origins of digital transformation as a concept, DX4D literature to date has had a major concentration on business, on economic growth and on neoliberalism. Future research can fill the voids left by this focus. The role of digital transformation for a broader range of stakeholders needs to be further researched: civil society organisations, international development agencies, and perhaps public service organisations, though these were relatively well-covered. The role of digital transformation must be researched not just vis-à-vis economic development but also in relation to social and political development and, particularly, environmental development. Under-researched sectors – agriculture, mining, forestry, services – need to be better represented. How does digital transformation relate to the 14 Sustainable Development Goals (all except 4, 8 and 9) that were largely absent from literature to date? How, therefore, will digital transformation impact major goals including poverty alleviation, gender inequality and environmental sustainability?

Digital transformation for development has to date mainly been researched at the organisational level. This leaves two directions for future agenda. Moving down to the

micro-level, how do individuals experience and participate in digital transformation for development? How do their capabilities and their positionalities impact DX4D?

Moving out to the macro-level, how are societies and economies and polities and environments in the global South being affected, and how will they be affected by digital transformation? Taking the big picture, how is digital transformation delivering – and how could digital transformation deliver – the transformative aims of the different development paradigms? And organically, is the relentless march of digital creating anything like its own development models and paradigm: a "Development 4.0" that may come to shape the post-2030 transformative development agenda?

In particular, future research can much better inform us about the politics and geo-politics of digital transformation for development. Captured by the well-worn question, "*Cui bono*?", at the broad level, who is benefitting from DX4D and who is not? How are the (dis)benefits of digital transformation for development being distributed, and who is facilitating that distribution? Whose interests are being advanced by the current DX4D discourse?

PROVIDING BETTER DX4D ROUTEMAPS

The kind of papers reviewed here are intended to add to knowledge generally, and should not necessarily be expected to offer practical recommendations. However, calls for more recommendations for policy and practice were the second most-common element of future research found in the literature. In addition, the limitations of recommendations found in the literature so far do suggest a disconnect between research and practice that future research can usefully address. The agenda would include providing research-based guidance for a slew of stakeholders on how to improve DX4D outcomes: local policy-makers at regional, national and sub-national levels; organisational strategists in local private, public and civil society organisations; organisational strategists working in international development agencies; and strategists working in organisations with a particular DX4D role such as local tech firms, multinational tech firms, and universities.

Basing guidance on DX4D research, rather than more generic formulations such as private sector DX guides from the global North, will ensure that recommendations are DX4D-specific. Addressing a further identified gap, research can be undertaken to enable recommendations to relate not just to the content of DX4D policy or strategy, but also to the structures and processes through which those policies or strategies are made. One approach could be collaborative action research that aims to share good practices and lessons between similar development stakeholders. This could create communities of practice: of DX4D policy-makers in different global South countries, of DX4D strategists in different international development agencies, of DX4D consultants, and so on.

HIGHER-QUALITY DX4D RESEARCH

The final agenda is generic, and relates to research design: the single largest area of explicit future research recommendations in the literature. DX4D research will potentially be more rigorous, more credible and hence possibly more influential if it is based around primary data from a sufficient set of sources; triangulated by involving different stakeholders and/or a mix of quantitative and qualitative methods; and analysed using an explicit framework

that is socio-technical in overall perspective and specifically-relevant to digital, to transformation, and to development.

F. Conclusions and Next Steps

The thirteen emergent principles – summarised below in Box 1 – should not be seen as definitive and final but as a starting point for interrogation of DX4D. They are intended particularly for use in DX4D research and consulting though could also be modified for analysis of DX4D strategy, policy, and practice. Alongside the four research gaps identified above, they can also form the basis for a future DX4D research agenda.

Box 1: The 13 Principles for DX4D Research and Consulting

PRINCIPLE 1: DX4D should incorporate a (single) definition of digital transformation.

PRINCIPLE 2: the extent of change envisaged and incorporated in DX4D must be transformative; involving significant systemic disruption.

PRINCIPLE 3: although it necessarily involves technological changes to digital data and systems, digital transformation for development involves and requires broader, parallel transformative changes in structural relations, development processes, formal/informal institutions, and resource distributions.

PRINCIPLE 4: digital transformation impacts both organisations and societies, and macro-scale, societal transformation must be incorporated into the understanding of DX4D.

PRINCIPLE 5: digital-transformation-<u>for</u>-development derives from the micro-level, proactive actions of individuals but both creates and responds to macro-level societal changes deriving from digitalisation: digital-transformation-<u>of</u>-development.

PRINCIPLE 6: transformation of digital ecosystems is not the goal of digital-transformation-for-development; development – understood as the transformation of societies – is. Digital-transformation-for-development should be explicit about the developmental transformation that it is seeking to bring about, or wishes to emerge.

PRINCIPLE 7: digital-transformation-for-development overall is not associated with any specific digital technology, but it could be associated with new "Development 4.0" models.

PRINCIPLE 8: even allowing for islands of significant digitalisation – which may or may not be transformative – digital-transformation-for-development is a future more than present phenomenon.

PRINCIPLE 9: the impact of digital-transformation-for-development emerges not deterministically from technology alone but from a mix of social and technological factors.

PRINCIPLE 10: there must be recognition of both positive and negative impacts associated with DX4D because, without this, there can be no understanding of, or attempt to mitigate DX4D's downsides.

PRINCIPLE 11: alongside traditional ICT4D barriers, DX4D faces barriers of a specific size and nature due to the scope of transformation that it entails.

PRINCIPLE 12: implications or recommendations for DX4D practice should be provided wherever feasible, taking into account the specificities of digital-transformation-for-development.

PRINCIPLE 13: DX4D recommendations will need to cover not just the content of organisational (private, public, NGO and international agency) strategy and government policy but also their underlying processes and structures.

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References

* = items included in systematic literature review

*Aayale, J. & Seffar, M. (2021). A step towards an inclusive digital transformation of the public administration in a developing country: Evidence From Morocco. *Journal of Public Administration and Governance*, 11(2), 331356-331356.

*Aghimien, D., Aigbavboa, C., Meno, T. & Ikuabe, M. (2021). Unravelling the risks of construction digitalisation in developing countries. *Construction Innovation*, 21(3), 456-475.

*Alam, M.Z., Hu, W. & Uddin, A. (2020). Digital transformation in healthcare services sector of Bangladesh: current status, challenges and future direction. *Journal on Innovation and Sustainability RISUS*, 11(1), 30-38.

*Aly, H. (2022). Digital transformation, development and productivity in developing countries: is artificial intelligence a curse or a blessing?. *Review of Economics and Political Science*, 7(4), 238-256.

*Argüelles-Cruz, A.J., García-Peñalvo, F.J. & Ramírez-Montoya, M.S. (2021). Education in Latin America: Toward the digital transformation in universities. In *Radical Solutions for Digital Transformation in Latin American Universities*, D. Burgos & J.W. Branch (eds) (pp. 93-108). Springer, Singapore.

AU. (2020). *The Digital Transformation Strategy for Africa (2020-2030)*. African Union, Addis Ababa.

*Becirovic, S. & Dervic, M. (2022). Students' perspectives of digital transformation of higher education in Bosnia and Herzegovina. *The Electronic Journal of Information Systems in Developing Countries*, e12243.

*Beyaz, H.F. & Yıldırım, N. (2019). A multi-criteria decision-making model for digital transformation in manufacturing: a case study from automotive supplier industry. In *Proceedings of the International Symposium for Production Research 2019*, N.M. Durakbasa & M.G. Gençyılmaz (eds) (pp. 217-232). Springer, Cham.

*Bui, M.L. (2021). A journey of digital transformation of small and medium-sized enterprises in Vietnam: Insights from multiple cases. *The Journal of Asian Finance, Economics and Business*, 8(10), 77-85.

Castles, S. (2001). Studying social transformation. *International Political Science Review*, *22*(1), 13-32.

*CEPAL. (2020). *Food Systems and COVID-19 in Latin America and the Caribbean: The Opportunity for Digital Transformation*. CEPAL, Santiago, Chile.

*Cerda Suarez, L.M., Nuñez-Valdes, K. & Quiros y Alpera, S. (2021). A systemic perspective for understanding digital transformation in higher education: Overview and subregional context in Latin America as evidence. *Sustainability*, 13(23), 12956.

*Chen, P. & Hao, Y. (2022). Digital transformation and corporate environmental performance: The moderating role of board characteristics. *Corporate Social Responsibility and Environmental Management*, 29(5), 1757-1767.

Chipidza, W. & Leidner, D. (2019). A review of the ICT-enabled development literature: Towards a power parity theory of ICT4D. *The Journal of Strategic Information Systems*, 28(2), 145-174.

*Ciuriak, D. & Ptashkina, M. (2019). *Leveraging the Digital Transformation for Development: A Global South Strategy for the Data-Driven Economy*, CIGI Policy Brief no. 148, Centre for International Governance Innovation, Waterloo, ON.

*Conde, M.A. & Wasiq, S. (2021). Digital transformation of business challenges and issues in developing countries. *Journal of Information Systems and Digital Technologies*, 3(1), 65-73.

*de Pirela, N.G., Añez, A.E.P., Hinestroza, M.G., Sánchez, M.S., Vásquez, P.J.I., Villamar, C.A.M. & Carpio-Cevallos, C. (2022). The digital transformation of universities in Latin America, changes in the teaching-learning process after the pandemic. *Journal of Positive Psychology and Wellbeing*, 6(1), 3933-3942.

DIAL. (2020). *Accelerating National Digital Transformation*. Digital Impact Alliance, Washington, DC.

Edwards, M. (2010). *Organizational Transformation for Sustainability: An Integral Metatheory*. Routledge, New York, NY.

*El-Massah, S. & Mohieldin, M. (2020). Digital transformation and localizing the sustainable development goals (SDGs). *Ecological Economics*, 169, 106490.

*Fereidouni, M.A. & Kawa, A. (2019). Dark side of digital transformation in tourism. In *Asian Conference on Intelligent Information and Database Systems*, N.T. Nguyen, F.L. Gaol, T.-P. Hong & B. Trawiński (eds) (pp. 510-518). Springer, Cham.

*Fu, X. (2020). Digital transformation of global value chains and sustainable post-pandemic recovery. *Transnational Corporations Journal*, 27(2).

*Gaglio, C., Kraemer-Mbula, E. & Lorenz, E. (2022). The effects of digital transformation on innovation and productivity: Firm-level evidence of South African manufacturing micro and small enterprises. *Technological Forecasting and Social Change*, 182, 121785.

*Ganichev, N.A. & Koshovets, O.B. (2019). Integrating Russia into the global project of digital transformation: Opportunities, problems and risks. *Studies on Russian Economic Development*, 30(6), 627-636.

Gartner. (2002). *5 Leadership Characteristics for CIOs to Succeed as a Digital Transformation Leader*. Gartner, Stamford, CT.

Gates, S. (2002). Review of methodology of quantitative reviews using meta-analysis in ecology. *Journal of Animal Ecology*, *71*(4), 547-557.

GIZ. (2023). *Digital Transformation for Sustainable Development*. Deutsche Gesellschaft für Internationale Zusammenarbeit, Eschborn.

Gollhardt, T., Halsbenning, S., Hermann, A., Karsakova, A. & Becker, J. (2020). Development of a digital transformation maturity model for IT companies. In *2020 IEEE 22nd Conference on Business Informatics (CBI)* (Vol. 1, pp. 94-103). IEEE, New York, NY.

*Goulart, V.G., Liboni, L.B. & Cezarino, L.O. (2022). Balancing skills in the digital transformation era: The future of jobs and the role of higher education. *Industry and Higher Education*, 36(2), 118-127.

GPSDD. (2023). *Better Data. Better Decisions. Better Lives*. Global Partnership for Sustainable Development Data. https://www.data4sdgs.org/

*Hai, T.N., Van, Q.N. & Thi Tuyet, M.N. (2021). Digital transformation: Opportunities and challenges for leaders in the emerging countries in response to COVID-19 pandemic. *Emerging Science Journal*, 5, 21-36.

Hanelt, A., Bohnsack, R., Marz, D. & Antunes Marante, C. (2021). A systematic review of the literature on digital transformation: Insights and implications for strategy and organizational change. *Journal of Management Studies*, *58*(5), 1159-1197.

*Hanson, K.T., Shaw, T.M., Puplampu, K.P. & Arthur, P. (2020). Digital transformation: A connected and "disrupted" Africa. In *Disruptive Technologies, Innovation and Development in Africa*, P. Arthur, K.T. Hanson & K.P. Puplampu (eds) (pp. 295-305). Palgrave Macmillan, Cham.

*Haryanti, T., Rakhmawati, N.A. & Subriadi, A.P. (2023). A comparative analysis review of digital transformation stage in developing countries. *Journal of Industrial Engineering and Management*, 16(1), 150-167.

Heeks, R. (2018). *Information and Communication Technology for Development (ICT4D)*. Routledge, Abingdon, UK.

Heeks, R., Ezeomah, B., Iazzolino, G., Krishnan, A., Pritchard, R. & Zhou, Q. (2022). Development transformation as the goal for digital transformation, *ICT4D blog*, 13 Dec. https://ict4dblog.wordpress.com/2022/12/13/development-transformation-as-the-goal-for-digital-transformation/

Henderson, J.C. & Venkatraman, N. (1989). *Strategic Alignment: A Process Model for Integrating Information Technology and Business Strategies*. Center for Information Systems Research, MIT, Cambridge, MA.

Hickey, S. & Mohan, G. (2005). Relocating participation within a radical politics of development. *Development and Change*, 36(2), 237-262.

*Hicks, J. (2021). *Environmental Challenges of Digital Transformation in Developing Countries*. K4D Helpdesk Report. Institute of Development Studies, Brighton, UK.

i-SCOOP. (2016). *Digital Transformation: Online Guide To Digital Business Transformation*. i-SCOOP. https://www.i-scoop.eu/digital-transformation/

*Imran, A. & Okai-Ugbaje, S. (2022). Complexities and challenges of multi-stakeholder involvement in digital transformation in the Global South: The machine-readable passport project in Bangladesh. In *Innovation Practices for Digital Transformation in the Global South*, J. Abdelnour-Nocera, E.O. Makori, J.A. Robles-Flores & C. Bitso (eds) (pp. 16-33). Springer, Cham.

JICA. (2022). *Digital Transformation (DX) Lab*. Japan International Cooperation Agency, Tokyo.

Kääriäinen, J., Pussinen, P., Saari, L., & Kuusisto, O. (2020). Applying the positioning phase of the digital transformation model in practice for SMEs: Toward systematic development of digitalization. *International Journal of Information Systems and Project Management*, 8(4), 24-43.

*Kagoya, S. (2020). The use of digital transformation to address education challenges caused by COVID-19 in developing countries. *Social Sciences*, 9(6), 233-240

*Kazim, F.A. (2021). Digital transformation in communities of Africa. *International Journal of Digital Strategy, Governance, and Business Transformation*, 11(1), 1-23.

Khabsa, M. & Giles, C.L. (2014). The number of scholarly documents on the public web. *PloS one*, 9(5), e93949.

*Khalil, A., Abdelli, M.E.A. & Mogaji, E. (2022). Do digital technologies influence the relationship between the COVID-19 crisis and SMEs' resilience in developing countries?. *Journal of Open Innovation: Technology, Market, and Complexity*, 8(2), 100.

*Kim, J. Y., Park, J. & Jun, S. (2022). *Digital Transformation Landscape in Asia and the Pacific*. ESCAP Working Paper Series, UN-ESCAP, Bangkok.

Kraus, S., Jones, P., Kailer, N., Weinmann, A., Chaparro-Banegas, N. & Roig-Tierno, N. (2021). Digital transformation: An overview of the current state of the art of research. *Sage Open*, 11(3).

*Kusmiarto, K., Aditya, T., Djurdjani, D. & Subaryono, S. (2021). Digital transformation of land services in Indonesia: a readiness assessment. *Land*, 10(2), p.120

*Lamid, L.I., Ibrahim, I.A., Abdullahi, K.I. & Abdullahi, U.G. (2021). A framework for digital government transformation performance assessment and toolkit for developing countries. In *14th International Conference on Theory and Practice of Electronic Governance*, E. Loukis, M.A. Macadar & M. Meyerhoff Nielsen (eds) (pp. 203-215). ACM, New York, NY.

*Limani, Y., Stapleton, L. & Groumpos, P.P. (2018). The challenges of digital transformation in post-conflict transition regions: digital technology adoption in Kosovo. *IFAC-PapersOnLine*, 51(30), 186-191.

*Lola, I. & Bakeev, M. (2020). *Digital Transformation In Manufacturing: Drivers, Barriers, And Benefits*, Higher School of Economics Research Paper No. WP BRP 107. HSE University, Moscow.

*Lu, C.H., Chen, Y.H. & Jan, P.T. (2022). The privacy trap of digital transformation: The existence and the implication. *Journal of Internet Technology*, 23(1), 63-71.

*Magoro, K.D. & Bidwell, N.J. (2022). Land, letšema and leola: Digital transformation on a rural community's own terms. In *Innovation Practices for Digital Transformation in the Global South*, J. Abdelnour-Nocera, E.O. Makori, J.A. Robles-Flores & C. Bitso (eds) (pp. 59-78). Springer, Cham.

*Manda, M.I. & Backhouse, J. (2017). Digital transformation for inclusive growth in South Africa: challenges and opportunities in the 4th industrial revolution. Paper presented at *2nd African Conference on Information Science and Technology*, Cape Town, South Africa, 10-11 Jul.

*Manda, M.I. & Backhouse, J. (2018). Inclusive digital transformation in South Africa: An institutional perspective. In *Proceedings of the 11th International Conference on Theory and Practice of Electronic Governance*, A. Kankanhalli, A. Ojo & D. Soares (eds) (pp. 464-470). ACM, New York, NY.

*Manda, M.I. & Dhaou, S.B. (2019). Responding to the challenges and opportunities in the 4th Industrial revolution in developing countries. In *Proceedings of the 12th International Conference on Theory and Practice of Electronic Governance*, S.B. Dhaou, L. Carter & M. Gregory (eds) (pp. 244-253). ACM, New York, NY.

*Marks, A., Al-Ali, M., Atassi, R., Elkishk, A.A. & Rezgui, Y. (2021). Digital transformation in higher education: maturity and challenges post COVID-19. In *International Conference on Information Technology & Systems*, Á. Rocha, C. Ferrás, P.C. López-López & T. Guarda (eds) (pp. 53-70). Springer, Cham.

Markus, M.L. & Rowe, F. (2021). Theories of digital transformation: A progress report. *Journal of the Association for Information Systems*, 22(2), 273-280.

McCarthy, P., Sammon, D. & Alhassan, I. (2022). Digital transformation leadership characteristics: A literature analysis. *Journal of Decision Systems*, 32(1), 79-109.

*Melovic, B., Jocovic, M., Dabic, M., Vulic, T.B. & Dudic, B. (2020). The impact of digital transformation and digital marketing on the brand promotion, positioning and electronic business in Montenegro. *Technology in Society*, 63, 101425.

Mergel, I., Edelmann, N. & Haug, N. (2019). Defining digital transformation: Results from expert interviews. *Government Information Quarterly*, 36(4), 101385.

*Mhlanga, D., Denhere, V. & Moloi, T. (2022). COVID-19 and the key digital transformation lessons for higher education institutions in South Africa. *Education Sciences*, 12(7), 464.

*Mhlanga, D. & Moloi, T. (2020). COVID-19 and the digital transformation of education: What are we learning on 4IR in South Africa?. *Education Sciences*, 10(7), 180.

*Mhlongo, S. & Dlamini, R. (2022). Digital inequities and societal context: Digital transformation as a conduit to achieve social and epistemic justice. In *Innovation Practices for Digital Transformation in the Global South*, J. Abdelnour-Nocera, E.O. Makori, J.A. Robles-Flores & C. Bitso (eds) (pp. 1-15). Springer, Cham.

*Micic, L. (2017). Digital transformation and its influence on GDP. *Economics*, 5(2), 135-147.

Mintel. (2022). *Digital Transformation Agenda 2022-2025*. Ministry for Telecommunications and Information Society, Quito.

Murphy, J.T. & Carmody, P. (2015). *Africa's Information Revolution*. John Wiley, Chichester, UK.

Nadkarni, S. & Prügl, R. (2021). Digital transformation: A review, synthesis and opportunities for future research. *Management Review Quarterly*, 71, 233-341.

*Nahayo, O. & Rutikanga, J.P. (2020). The output of digital transformation on human resource development in developing countries: Case of Rwanda. *International Journal of Innovation, Creativity and Change*, 13(7), 712-729.

*Ndemo, B. & Weiss, T. (2017). Making sense of Africa's emerging digital transformation and its many futures. *Africa Journal of Management*, 3(3-4), 328-347.

*Nosova, S., Norkina, A., Makar, S. & Fadeicheva, G. (2021). Digital transformation as a new paradigm of economic policy. *Procedia Computer Science*, 190, 657-665.

OECD. (2021). *Development Co-operation Report 2021: Shaping a Just Digital Transformation*. OECD, Paris.

*Ofosu-Ampong, K. (2021). Determinants, barriers and strategies of digital transformation adoption in a developing country Covid-19 era. *Journal of Digital Science*, 3(2), 67-83.

Okoli, C. & Schabram, K. (2015). A guide to conducting a systematic literature review of information systems research. *Sprouts: Working Papers on Information Systems*, 10(26).

*Ozumba, A., Olaniyi, T. & Mohammed, S. (2022). Adoption of big data technologies for the digital transformation of public agencies in the Global South. *International Journal of Sustainable Energy*, 10(1).

*Pawar, P.S. (2022). A comparative study of digital transformation among the emerging economies in Asia and Africa during 2001-2020. *WVSU Research Journal*, 11(1), 18-35.

*Pereira, G.V., Estevez, E., Cardona, D., Chesñevar, C., Collazzo-Yelpo, P., Cunha, M.A., Diniz, E.H., Ferraresi, A.A., Fischer, F.M., Cardinelle Oliveira Garcia, F. & Joia, L.A. (2020). South American

expert roundtable: Increasing adaptive governance capacity for coping with unintended side effects of digital transformation. *Sustainability*, 12(2), 718.

Pieterse, J. N. (2010). *Development Theory*. Sage, London.

Prakash, A. & De', R. (2007). Importance of development context in ICT4D projects: A study of computerization of land records in India. *Information Technology & People*, 20(3), 262-281.

*Quayson, M., Bai, C. & Osei, V. (2020). Digital inclusion for resilient post-COVID-19 supply chains: Smallholder farmer perspectives. *IEEE Engineering Management Review*, 48(3), 104-110.

*Radzi, M.S.R., Tajudin, M.M., Musa, N.C. & Rose, R.M. (2021). The importance of governance in digital transformation: A case study of e-CRM implementation in a Malaysian petrochemicals company. *International Journal of Early Childhood Special Education*, 13(1).

*Rassool, M.R. & Dissanayake, D.R. (2019). Digital transformation for small & medium enterprises (SMEs): With special focus on Sri Lankan context as an emerging economy. *International Journal of Business and Management Review*, 7(4), 59-76.

*Rhee, T., Wood, J. & Kim, J. (2022). Digital transformation as a demographic and economic integrated policy for Southeast Asian developing countries. *Sustainability*, 14(5), 2857.

*Romanova, O.A. & Kuzmin, E. (2021). Industrial policy: A new reality in the context of digital transformation of the economy. In *Digital Transformation in Industry*, V. Kumar, J. Rezaei, V. Akberdina & E. Kuzmin (eds) (pp. 13-23). Springer, Cham.

*Rusu, L., Balasuriya, P.B. & Bah, O. (2020). Cultural barriers in digital transformation in a public organization: A case study of a Sri-Lankan organization. In *European, Mediterranean, and Middle Eastern Conference on Information Systems*, M. Themistocleous & M. Papadaki (eds) (pp. 640-656). Springer, Cham.

*Serna Gómez, J.H., Díaz-Piraquive, F.N., Muriel-Perea, Y.D.J. & Díaz Peláez, A. (2021). Advances, opportunities, and challenges in the digital transformation of HEIs in Latin America. In *Radical Solutions for Digital Transformation in Latin American Universities*, D. Burgos & J.W. Branch (eds) (pp.55-75). Springer, Cham.

UNDP. (2023). *SDG AI Lab*. United Nations Development Programme. https://sdgailab.org/

UNPA. (2020). *NDPIII Digital Transformation Programme*, Uganda National Planning Authority, Kampala.

Vial, G. (2021). Understanding digital transformation: A review and a research agenda. In: *Managing Digital Transformation*, A. Hinterhuber, T. Vescovi & F. Chechinato (eds) (pp.13-66). Routledge, Abingdon, UK.

Vlemincx, E. (2022). What digital transformation is really about. *LinkedIn*. https://www.linkedin.com/posts/evevlemincx_what-digital-transformation-is-really-all-activity-7003396620490792961-B5L5/

VMPI. (2021). *National Digital Transformation Program to 2025*. Vietnam Ministry of Planning and Investment, Hanoi.

*Wakunuma, K. (2019). Power as an ethical concern in the Global South's digital transformation: Power or empowerment?, *TATuP – Journal for Technology Assessment in Theory and Practice*, 28(2).

*Winasis, S., Riyanto, S. & Ariyanto, E. (2020). Digital transformation in the Indonesian banking industry: Impact on employee engagement. *International Journal of Innovation, Creativity and Change*, 12(4), 528-543.

Xiao, Y. & Watson, M. (2019). Guidance on conducting a systematic literature review. *Journal of Planning Education and Research*, 39(1), 93-112.

*Xie, L., Luo, B. & Zhong, W. (2021). How are smallholder farmers involved in digital agriculture in developing countries: A case study from China. *Land*, 10(3), 245.

Yammarino, F.J. & Dubinsky, A.J. (1994). Transformational leadership theory: Using levels of analysis to determine boundary conditions. *Personnel Psychology*, 47(4), 787-811.

*Zhu, X. (2022). Implications of digital transformation on employment in developing countries. Paper prepared for *UNDESA EGM on Creating Full and Productive Employment and Decent Work for All*, 27-30 Jun.

Bibliography

*Anim-Yeboah, S., Apau, R. & Preko, M. (2022). Drones in the digital transformation of healthcare delivery in Africa. In *Digital Innovations, Business and Society in Africa*, R. Boateng, S.L. Boateng, T. Anning-Dorson & L.O. Babatope (eds) (pp. 31-56). Springer, Cham.

*Azu, N.P. & Nwauko, P.A. (2021). Evaluating the effect of digital transformation on improvement of service trade in West Africa. *Foreign Trade Review*, 56(4), 430-453.

*Chauke, T.A. & Ngoepe, M. (2022). End-to-end digital transformation for document flow at a professional council in South Africa. *Global Knowledge, Memory and Communication*, (ahead-of-print).

*Guzmán, J.M.A., Abdelnour-Nocera, J., Parra-Agudelo, L. & Barriga-Isaza, P. (2022). From staging to social protagonism: Digital transformation within the Experimental Theater of Cali. In *Innovation Practices for Digital Transformation in the Global South*, J. Abdelnour-Nocera, E.O. Makori, J.A. Robles-Flores & C. Bitso (eds) (pp. 165-182). Springer, Cham.

*Kuntsman, A. & Arenkov, I.A. (2019). Method for assessing effectiveness of company digital transformation: Integrated approach. *IBIMA Business Review*, 2019, 334457.

*Madichie, N.O., Bolat, E. & Taura, N. (2021). Digital transformation in West Africa: A two country, two-sector analysis. *Journal of Enterprising Communities: People and Places in the Global Economy*, 15(2), 246-257.

*Marcelo, A.B. (2020). A practical approach to digital transformation: a guide to health institutions in developing countries. In *Leveraging Data Science for Global Health*, L.A. Celi, M.S. Majumder, P. Ordóñez, J.S. Osorio, K.E. Paik & M. Somai (eds) (pp. 307-314). Springer, Cham.

*Orbegozo, J.M.G., Ccoscco, N.C.H. & Portocarrero, E.J.P. (2022). COVID-19: Territorial impact of digital transformation on accessibility to the educational system in Latin America in a context of COVID-19. *Journal of Positive School Psychology*, 6(5), 229-240.

*Romero, M.Á.M. (2022). Digital transformation and COVID 19: Contrasts in Latin America. *Journal of Positive School Psychology*, 6(2), 5592-5600.

*Sodokin, K., Koriko, M., Lawson, D.H. & Couchoro, M.K. (2022). Digital transformation, banking stability, and financial inclusion in Sub-Saharan Africa. *Strategic Change*, 31(6), 623-637.

*Udomdech, P., Papadonikolaki, E. & Davies, A. (2021). Digital transformation in developing countries: A study into BIM adoption in Thai design and engineering SMEs. *International Journal of Structural and Construction Engineering*, 15(8), 367-374.

*Umar, A. (2022). A digital transformation lab for developing countries and small to medium enterprises. In *2022 IEEE European Technology and Engineering Management Summit (E-TEMS)* (pp. 160-165). IEEE, New York, NY.

*Yang, C. (2022). Cross-border expansion of digital platforms and transformation of the trade and distribution networks of imported fresh fruits from Southeast Asia to China. *Global Networks*, 22(4), 716-734.

Appendix: Literature Review Categorisation Schema

Main Category	Sub-Categories	Values	Comment
A. Paper Descriptors	Main Author Geography	Country and continent of correspondence	Based on details of corresponding author (or first author where unclear)
	Main Author Discipline	Business and Management, Economics, Other Social Sciences, Science and Engineering, Arts & Humanities	Based on details of corresponding author (or first author where unclear)
	Year of Publication		
	Source Type	Journal paper, Book chapter, Conference paper, Institutional paper (e.g. working paper)	
	Scimago Rank	Q1, Q2, Q3, Q4, Unlisted	For journal papers only
	Geographical Focus	As per main author geography	Allowing for aggregations for multi-country focus
	Foundation of Research Data	Primary research, Secondary research	Primary to include interviews, surveys, focus groups and observation
	Use of Theory?	Yes, No	Included if a named theory or conceptual framework is used in some way to inform the establishment or findings of paper
	Theory/Conceptual Framework Used	Actor-Network Theory, Institutional Theory, Unified Theory of Acceptance and Use of Technology, etc.	Developed inductively from papers
	Theory Usage	Structures findings; Some analytical use in findings; Sensitising framework not mentioned in findings or conclusions	
	Transformation-Specificity of Theory?	Yes, No	Whether (digital) transformation is specifically identified within the theory
B. Digital Transformation Analysis	Digital Transformation Defined?	Yes, No	Is there an explicit definition of digital transformation
	Sector Transformed	Economic (general), Economic (specific), Social, Environmental, Political, General / Multi-sectoral	Reference to sector(s) within definition or operationalisation of digital transformation
	Digital Transformation Definition	Definition quote(s)	
	Nature of Transformation	Extent, scope and developmentalism of definition	Analysis of wording of definition

	Type of Digital Technology Involved	All digital / ICTs, Specific technologies: AI, drones, digital platforms, etc	Analysis of wording of definition
	Which Development Paradigm?	Modernisation, Structuralist, Neoliberal, Human development, Sustainable development, Post-development, Decolonial	Interpretation of paradigm of development the paper is adhering to, or assuming
	Digital Transformation Agency	Proactive, Reactive, Proactive-Reactive	Whether digital transformation as defined and operationalised is something undertaken proactively, or as a reaction to wider challenges
	Key Digital Transformation Actors	State, Private Sector, Civil Society/NGOs, Public Sector Organisations, Organisations (general), International Agencies	Who are seen as the key actors involved in digital transformation
	Extent of Current Digital Transformation	Absent, Emergent, Spectrum of extent, Has happened	Is digital transformation seen as something which has already occurred, or not yet
C. Digital Transformation Impact Analysis	What is Transformed	Organisational level, Societal level, Mid level (e.g. sector)	Based on specific examples given of digital transformation
	New Development Model Examples	Fintech-based, AI-based, Big data-/datafication-based, Industry 4.0, etc.	Based on specific examples given of new digitally-enabled development models
	Parallel Transformations	Structures, Skills, Tech infrastructure, Processes, Institutions, etc.	Parallel changes described as being part of digital transformation in order to achieve outcomes
	Impact Perspective	Positive, Largely positive, Both, Largely negative, Negative	Descriptors attached to the impacts associated with digital transformation
	Inequality	Digital divide, Systemic re employment, Adverse digital incorporation, etc	Indication within paper of some group benefitting for some reason digital transformation, while another does not
	Causes of Transformational Impact	Technology as cause, Social forces as cause, Socio-technical forces as cause	What is seen to be the driving force or main cause of the impacts of transformation
	Key Barriers to Transformation	Digital infrastructure, Digital capabilities, Leadership, Cultural resistance, Finance, Structures, etc	Inductive categorisation of what are seen as main barriers to DX4D
D. Advice Analysis	Organisational Strategy Recommendations?	Capability development, Strategic planning, Leadership, Address culture, etc.	Inductive categorisation of what, if anything, the paper recommends organisations should do about DX4D
	National Policy Recommendations?	Digital infrastructure development, Capability	Inductive categorisation of what, if anything, the paper recommends national

		development, Financing, Harm reduction, etc.	governments should do about DX4D
	Research Gaps	Recommendations for policy/strategy, Analysis of impacts, Research design, Implementation processes, etc.	Inductive categorisation of any knowledge gaps or areas for future research about DX4D identified in the paper
E. Other	Quotes	Quotations	Any other quotes of interest