Digital transformation and localizing the Sustainable Development Goals (SDGs)

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ABSTRACT

This paper examines how digital transformation can impact the localization and achievement of the Sustainable Development Goals (SDGs). We collect data on the progress made towards SDGs, existing e-governance and big data initiatives, as well as the state of localization in seven countries from different parts of the world. We find that localization allows governments to effectively tailor sustainable development strategies at the local level, which can be boosted with digital transformation. Localization requires local governments' effective planning by ensuring that budgetary allocations reflect the priorities of local communities. Our main recommendations are that adequate data are necessary to identify and follow-up with decision makers, which requires a review of institutional competence in dealing with information and data and the use of digital transformation for this purpose. Appropriate funding for development programs and projects and effective application at the local level are also important. This requires policy makers to direct and encourage investments in the 'The Digital Network Architecture' (DNA) infrastructure and human capital. A key limitation lies in its sample of countries used with their own cultural and population features. However, our findings provide a good basis to analyse further case studies with more heterogeneous compositions as well as other practices of digital transformation.

1. Introduction

The adoption of the Sustainable Development Goals (SDGs) in 2015 signaled a commitment from world leaders to pursue a more sustainable path towards inclusive and equitable growth. Known also as Agenda 2030, 17 SDGs cover a broad range of issues related to development and include 169 targets and 304 indicators. SDGs build on various advancements made in sustainable development efforts over the past three decades. SDGs build on the Millennium Development Goals (MDGs), which were the first example of global goals and were operational from 2000 until 2015. Similarly, SDGs continue and scale up the ambition of Agenda 21(A21) adopted in Rio de Janeiro in 1992 at the Earth Summit; where senior leaders of governments recognised that most of the environmental and development challenges had their roots in local activities. This eventuated in their understanding the rationale for supporting local authority action on sustainable development, by including Chapter 28 of A21 (LA21) as a special mandate describes the important role of local authorities in facing these challenges. Localizing SDGs is the process of adjusting strategies, monitoring, and evaluation to subnational contexts to enable local and regional governments support the achievement of the SDGs from the bottom up.

One of the most important characteristics of the 2030 Agenda is its universality. The global goals aim to be of relevance to all community levels, from global to local. Localization of global goals and sustainability efforts have played an important role in the advancement of sustainable development around the world. This is because it aims to engage local stakeholders in the processes that affect local, national and global development. In the global efforts towards sustainable development in general, and in the process of localizing these efforts in particular, technology and innovation have been playing an increasingly important role over the past several decades.

The major databases are recently becoming the new oil; the new form of wealth that fuels the age of information and digital economy (Mohieldin, 2019). While oil drives its value from scarcity, data brings its value availability with the superior ability to deal with and employ (Mohieldin, 2018). Countries should invest in acquiring the data by all possible conventional ways in addition whatever could be obtained by new innovative methods. The world is currently in the Fourth Industrial Revolution (Baller et al., 2016). Innovations in information technology (IT) and digital devices have led the world towards a new emerging

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paradigm of digital transformation, which presents a strategy-oriented changes in infrastructure and processes in modern socities based on current information and communication technologies (ICT) (Pihir, 2018). Accordingly, we expect the economic sectors and systems[2] to be completely changed at the global level to launch the complete picture of 'Globalization 4.0'. Definitely, data collected in form of algorithms has no competitive advantage as such, skills are what transforms the algorithms into valuable tools and thus create the competitive advantage for the data. Countries -especially the developing countries-should be prepared with updated infrastructures, institutions as well as skills and most importantly with streamlined mentalities. Such redesign allows countries to get use of the new opportunities, while avoiding the risk of disruptions (Schwab, 2018).

The 2030 Agenda for sustainable development presents the concept of data-driven governance and highlights the challenge to "increase significantly the availability of high-quality, timely, reliable and disaggregated data by 2030". Digital transformation is defined as "the profound transformation of business and organizational activities, processes, competencies and models to fully leverage the changes and opportunities of a mix of digital technologies and their accelerating impact across society in a strategic and prioritized way, with present and future shifts in mind" (i-SCOOP.eu, 2016). The current study explores the potential role of digital transformation in localizing SDGs. The study focuses on e-Government and Big Data as two tools of digital transformation.

E-Government is the digital transformation of government bodies, where most of administrative transactions are conducted electronically, to improve governemt performance, boost coordination, and faster service delivery for the citizens (Rombach and Steffens, 2009). Many local units/cities have moved to the new paradigm of e-Government in their Web-based services and information technology management, which reverses the traditional bureaucratic paradigm (Ho, 2002). E-Government allows for a better delivery of government services to citizens, improves interactions with business and industry, citizen empowerment through access to information, or more efficient government management. The resulting benefits can be less corruption, increased transparency, greater convenience, revenue growth and/or cost reductions (WB, 2015).

While, big data is a massive volume of both structured and unstructured data collected from a many sources including emails, call logs, mobile-banking transactions, online user-generated social media, online searches, satellite images, mobile devices, applications etc.

The new 2018 Global Digital suite of reports from We Are Social and Hootsuite[3] reveals that there are now half of the world's population (more than 4 billion) around the world using the internet[4]. In 2013, 4.4 Zettabytes of data existed in the global digital universe, it is doubling in size every two years and expected to reach 44 zettabytes by 2020.[5]

Digital transformation holds a potential to support SDGs, where the captured information is analysed by computational techniques to unveil trends and patterns and turned to be actionable dynamic information on human behaviours, environment and experiences[6]. Such data hold a potential for policymakers to establish the proper development programs, monitor progress, and dynamic improvement. That creates new opportunities for the SDGs fulfillment with lower transaction costs. digital transformation supports local governments efforts to build sustainable and resilient communities through inclusive data collection. Both E-government and big data highlight the five key dimension of SDG 16; effectiveness, inclusion, openness, trustworthiness, and

accountability. There are a number of best practice digital transformation cases that can be used as benchmarks for local governments worldwide.

This article attempts to analyze the potential impact of digital transformation on the localization of SDGs in different places of the world. Two main points are developed throughout the analysis. First, sustainable development through localization takes the advantages of both centralized and decentralized modes of governance. The framework of localization includes elements of national security and full alignment of smaller entities with national policies and development agendas while simultaneously providing local communities with better service delivery and effective policy management and the local level to enable better understanding of priorities for these local communities. Second, technological and digital solutions can establish virtual decentralization that provides governments with effective tools to localize sustainable development by diffusing ownership of the SDGs to promote better service delivery, thereby localizing the SDGs. As importantly, to successfully localise the SDGs, local governments must first consider raising sustainable revenue streams and ensure consistent expenditure in functions that reflect the priorities of local communities.

This paper begins with an introduction to the two conventional modes of governance, namely centralization and decentralization as a pretext to the concept of localization. This is followed by a discussion on the methodology where we outline the main criteria around our choice of countries. We draw on country case studies from Cambodia, Colombia, Egypt, Ghana, Kenya, the Philippines and Tunisia.

2. Centralization, decentralization, and localization

The end of the Millennium Development Goals (MDGs) marked the start of the era of the 2030 Agenda, comprised of 17 Sustainable Development Goals (SDGs). From 2000–2015, the MDGs stimulated a global campaign to eliminate various dimensions of poverty. They were mainstreamed into strategies and plans on the national and sub-national level, but efforts were uneven and many countries missed a number of MDGs targets. During the last three years of the MDGs period, efforts were channeled for accelerating progress. Acceleration was expected to expedite the completion of the MDGs and benefit the SDGs implementation phase. Many lessons were learned from the experience of 16 countries and the Pacific Islands sub-region with acceleration efforts (UNDP, 2016). The main lesson was on the delivery at the local level. Acceleration needs subnational interventions, especially for countries with decentralized governance structures. Local governance mechanisms need to be strengthened to avoid bottlenecks in service provision, which happen very often at this level (UNDP, 2016). The SDGs were articulated based on these lessons and stood out from their predecessors in several ways. First, while only developing countries were concerned by the MDGs, the SDGs provide a more universal approach to development. They apply to all UN member states, got rid of the "developing" versus "developed" dichotomy. Second, the scale and the content of the SDGs expand beyond those of the MDGs and are more ambitious. While the MDGs were focused on reducing poverty, the SDGs' themes reflect the synergies between economy, environment and society. Third, the debate on an adequate governance model, on centralization versus decentralization, may not have helped with the full achievement and effectiveness of the MDGs. For this reason, in the era of the SDGs, it is important to move beyond this discussion and acknowledge the comparative advantage that the center can offer.

Over the years, academics and policy makers have confirmed that centralization is not the right path for development. Their hierarchical and bureaucratic nature failed in developing countries (Wunsch, 1991). Shifting the governance model from a centralized to localized approach includes decentralizing governance to move closer to people, for a number of reasons. First, there is a political imperative arguing that local communities will push for autonomous local institutions (World Bank, 2001). Allowing communities at the local and regional levels to

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[2] Education, health, production, energy, communication..ect

[3] https://wearesocial.com/blog/2018/01/global-digital-report-2018

[4] Africa has seen the fastest growth rates, with the number of internet users across the continent increasing by more than 20 percent year-on-year.

[5] https://wearesocial.com/blog/2018/01/global-digital-report-2018

[6] large socioeconomic datasets

be involved in decision making brings policies closer to problems and individuals, paving the way for partnerships to address issues of collective implications. Second, the economic imperative argues that reducing governments' roles will enable small and medium enterprises to unlock new investments and come up with new innovations that will drive sustainable development. Third, the service delivery imperative suggests that local institutions are better qualified to understand the needs of people, hence allowing better public service delivery by prioritizing expenditures (World Bank, 2001). Decentralization implies improved accountability and addressing issues associated with corruption at the central level. Unlike decentralization, the concept of localization is not administrative as such, but instead combines the benefits of both centralization and decentralization. Localization does not compromise the benefits of centralization but aligns local communities with national development strategies and ensures national security. It also includes advantages of a decentralized mode of governance such as tailoring priorities to the needs of local communities and promoting accountability and transparency at the local level. We believe that localization is a "system-wide" goal for sustainable development for several reasons. Localization helps with inclusion, accountability, and acceptance by the target population. It ensures that decisions are taken closer to the communities served as they reflect their needs and the goals. It is associated with accountability requested and supported by local communities, increasing chances of sustainability in the development process. In a localized concept, decision makers understand local issues, speak the local community's language and have a solid grasp of the local context. Therborn (2017) argues that the distribution of local services is a direct manifestation of local power. Local community life is structured by the accessibility and availability of services. Localizing the development agenda builds resilient communities by allowing them to learn from their own experiences and needs through a dynamic feedback loop, especially in service delivery. Crisis management is a good example, where local entities build experience from previous region or community-specific crises. Localization also offers an opportunity to enhance and support international development programs by allowing international actors to solidify local efforts and effectively scale and prevent marginalization. It also improves the cost efficiency and effectiveness of development programs. For instance, localization helps reduce the cost of implementation, staffing, and management throughout all implementation stages, thereby ensuring sustainability. Localization also ensures less program waste and duplication, respects diversity, culture, traditions which enhances local innovation and effectiveness. Fig. 1 outlines the overall benefits of localization.

Different countries deal with local communities differently. As mentioned by Rajan (2019), the role of communities at the local level has been long ignored. Governments and markets took center stage while what mattered, community and local authorities, were left aside. Communities, he argues, are left relatively powerless to face the full and irregular impact of technological change. While the increasing roles of the markets and the state eroded the importance of local communities, local institutions are a valuable and homogeneous means for ensuring that government and markets behave. Community ties can be more efficient than markets or government alone, as they bring back power to the people. Giving power back to communities works because of the confidence that members of this community will stay mutually committed. "Inclusive localism", as Rajan calls it, gives a greater say to communities in economic and social matters. For instance, when giving local communities more power in the provision of schooling, this can not only help in building capabilities but also in instilling citizenship. Power should be spread out to local communities in order to rebuild a sense of local responsibility and autonomy. In addition, as demonstrated by Lowman (2017), there a number of functions that can be attributed to local authorities such as education, health, transport and waste management. For this reason, resources and effective institutions are needed at the local level.

Katz and Nowak (2018) advocated changing the traditional view of putting the local level at the periphery. The way cities and local counties are administered must mirror their distinct role as leaders and networks of institutions who share the responsibility to co-govern daily life and co-produce the economy. This will allow them to educate, plan and regulate tax with their hard power, but also to convene diverse networks of actors from within the community who are at the center stage of service delivery.

Cities also offer the ability to raise significant amounts of civic, private and public capital and channel these resources to advanced problem solving. Financing at the local level can also be an effective means to spur inclusion and innovation, and to connect to national and global instruments to finance the future (Katz and Nowak, 2018).

Haryana, one of the 29 states in India, is a prime example of this. Populated by over 25 million people, it accounts to 3.6 % of India's GDP and has a high agricultural productivity (Prasad, 2018). Haryana's 2018/19 budget included just over 6 billion USD towards achieving the SDGs (Prasad, 2018). The state has prepared a Haryana-specific Vision 2030 identifying fundamental SDG targets. This Vision is also aligned with India's national development plan. Integrating the SDGs into the budgetary process at the community-level is an efficient way to localize the SDGs. It takes into account the priorities of the local community and, consequently, enables optimal distribution of funding across the different Goals. Furthermore, it improves public service delivery and promotes good governance by encouraging transparency and accountability of local governments. Two other cities are also trying to localize the global agenda. Helsinki and New York City have decided to present their voluntary local reviews to the United Nations, as part of the efforts

Fig. 1. Localization as a system goal for sustainable development.
Source: Developed by the authors.

to achieve the SDGs. While Agenda 2030 is an intergovernmental agreement, these cities recognize that the success of the SDGs relies greatly on implementation at the local level and that pressing global issues will increasingly be solved at the local level.[7]

3. Methodology

This study examines several case studies of employing e-government and big data: Cambodia, Colombia, Egypt, Ghana, Kenya, the Philippines and Tunisia. Countries were chosen based on five criteria: *level of development, region, level of decentralization, internet penetration, and e-government development*. We used a number of indicators such as GDP per capita, the Administrative Decentralization Index (ADI), internet penetration percentage, and the e-Government Development Index (EGDI).

Cases are analyzed in terms of their SDGs-related progress, existing e-governance and big data initiatives. Progress and challenges were compared to determine the extent to which digital transformation has been successful, and what potential lies in the existing structures relating to local SDGs achievement (Table 1).

Cambodia, Egypt, Ghana, Kenya, the Philippines, and Tunisia fall in the category of Lower-Middle Income (LMI) countries while Colombia falls in the Upper-Middle Income (UMI) countries[8], according to the classification of the World Bank. This study mainly focuses on LMI countries because they are projected to require as much as $900-944 billion annually to achieve SDGs (Schmidt-Traub, 2015). Thus, it is crucial to understand the challenges facing such economies such as centralization of development or inefficient decentralization and how virtual decentralization can be achieved by digital transformation to bypass such challenges to achieve the SDGs. We study these cases to explore whether digital transformation could be a promising avenue towards localizing SDGs in centralized countries.

Internet access has been recognized by the United Nations as a basic human right and a target on internet access has been included into MDGs. To make adequate use and benefit of digital transformation, internet access should be relatively established and wide-spread as a prerequisite infrastructural requirement. Internet Penetration is used for the percentage of total population that uses the Internet. All our sample countries have have a percentage above 25 % except for Cambodia (11.1 %). Internet penetration rates in lower income countries average 10–20 %, which highlights the need of expanding DNA infrastructure before employing digital transformation for achieving any global or national development goals.

We adapt the World Bank (2015) definition of e-government that refers to "government agencies' use of information technologies (such as Wide Area Networks, the Internet, and mobile computing) that can transform relations with citizen". We use the E-Government Development Index (EGDI) published by UN E-Government Survey 2018, that is a weighted average of normalized scores of e-government dimensions: the scope and quality of online services (OSI), the status of the development of telecommunication infrastructure (TII) and the inherent human capital (HCI). EGDI takes values between the range of 0–1 and ranks the 193 UN countries to EGDI subgroups (Very-High, High, Middle, and Low). Our sample of countries falls under 'High' and 'Middle' categories.

Cases are analyzed in terms of their SDGs-related progress, existing e-governance and Big Data initiatives, as application for digital transformation. Progress and challenges were compared to determine the extent to which digital transformation has been successful, and what potential lies in the existing structures in relation to the local SDGs achievement.

4. Country case studies

4.1. Colombia

Colombia has a high level of decentralization. Colombia ranks very high on the ADI index (#42) and has been chosen to highlight the importance of having robust local institutions for the localization of SDGs.

The country has demonstrated its commitment to the SDGs and the 2030 development agenda by launching its 2014–2018 National Development Plan. This plan aims to kickstart ambitious reforms in three pillars: peace, equity and education by promoting robust co-operation and coordination between all stakeholders at the local level. This will help the country strengthen local capacity and institutions in public finance management to improve service delivery and allow local municipalities to thrive (Mohieldin, 2017a).

57 % of the population in Colombia have internet access. The country ranks 55 in terms of technological readiness (Economist Intelligence Unit, 2018). The country has developed a strong reputation for the use of big data and digital transformation to achieve the SDGs. A large portion of households in Colombia rely heavily on agricultural production as a source of income. However, amidst the backdrop of global warming, farmers have been struggling to make calendar-based decisions on what and when to plant. A public sector initiative led by The International Centre for Tropical Research (CIAT) recently tested an innovative tool supporting Colombian rice farmers using big data (World Bank Group, 2015). The technique involves merging both harvest and weather datasets to examine the correlation between climate factors and yield variability, thereby forecasting potential favorable and unfavorable conditions for cropping in certain areas (World Bank Group, 2015). This tool collects complex datasets and converts them into accessible and meaningful information for farmers on an Android application, enabling them to make data-driven decisions on agricultural production. The technique relies heavily on machine learning like random forest and clustering techniques to support analysis. This initiative tackles a number of different SDGs such as SDG *13*, associated with combatting climate change, in addition to SDGs *1 and 2* related to poverty reduction and zero hunger. This example also highlights how the presence of local authorities gives governments a head start in terms of collecting big data. Actions at the local level helped tailor the product to the profile of agricultural households.

4.2. Ghana

Ghana has a medium level of decentralization. The country ranks 81 in the ADI rankings. Although Article 240 of the 1992 Constitution mentions that "Ghana shall have a system of local government and administration which shall, as far as practicable, be decentralized"[9], the country still has a long way to go to achieve full decentralization.

Ghana has shown country ownership and participation with a long-term vision that includes all stakeholders (Ministry of Environment Science and Technology of the Republic of Ghana, 2012). A report by the Ghanaian government published in 2012 suggests that Ghana is implementing a bottom-up approach to the development agenda, meaning that the government is moving towards a strategy of localizing

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[7] Helsinki Joins New York in Commitment to Review Local Progress Toward Global Sustainable Development Goals (2018) https://www.hel.fi/uutiset/en/kaupunginkanslia/helsinki-joins-new-york-in-commitment-to-review-local-progress-towards-global-sustainable-development-goals

[8] For the current 2018 fiscal year, low-income economies are defined as those with a GNI per capita, calculated using the World Bank Atlas method, of $1,005 or less in 2016; lower middle-income economies are those with a GNI per capita between $1,006 and $3,955; upper middle-income economies are those with a GNI per capita between $3,956 and $12,235; high-income economies are those with a GNI per capita of $12,236 or more. (World Bank, 2018).

[9] Constitution of the Republic of Ghana (1992). https://www.judicial.gov.gh/index.php/decentralization-and-local-government

Table 1
Selected Countries' Characteristics.
Sources: Ivanyna and Shah (2014); Internet Live Stats (2016); World Bank (2016); United Nations (2018).

Country	Development GDP Per Capita (USD, current)	Region	ADI Ranking	Internet Penetration	EGDI level
Cambodia	1,384.42 (LMI)	APAC	86	11.1 %	Middle
Colombia	6,301.59 (UMI)	Latin America	42	56.9 %	High
Egypt	2,412.73 (LMI)	MENA	85	33 %	Middle
Kenya	1,507.81 (LMI)	Africa	105	45 %	Middle
Ghana	1,641.49 (LMI)	Africa	81	28.4 %	High
The Philippines	2,988.95 (LMI)	APAC	33	43.55	High
Tunisia	3,490.83 (LMI)	MENA	87	48.1 %	High

sustainable development.

In Ghana, 28.4 % of the population have internet access. It is the only African country that streamlined its institutional policy frameworks to capitalize on ICT innovations, with intensive investing in improving online services delivery (UN E-Government Survey, 2018). The country has showcased a significant commitment towards the implementation of the SDGs.

A joint initiative launched by the MasterCard Foundation and the International Finance Corporation used big data tools to promote coverage of financial services to disenfranchised populations in Sub-Saharan Africa (International Finance Corporation, 2019). The innovation uses almost two terabytes of big data provided by mobile network operators to forecast and predict potential users of digital financial services (Harten, 2019). The research uses machine learning techniques to model the most important variables predicting these users at the local level using data from mobile network operators. There was an uptake of digital financial services by 70,000 (Harten, 2019). This case is important because it is led by a private sector entity which makes the case for enhanced public-private ties and collaboration in the development sphere. This case explicitly shows how big data can be used to identify potential clients based on information collected from local residents, helping financial services companies tailor products accordingly to maximize market share and promote economic inclusion at the local level. This effort helps achieve SDGs *1 and 2*, in addition to SDG *10* by reducing inequality within and across local communities.

4.3. Cambodia

Cambodia is number 86 in the ADI ranking, which shows that the country still has high levels of centralization (Ivanyna and Shah, 2014). The UN has emphasized the importance of further decentralization, or devolution, in the country. Outdated and inconsistent data in governmental reports addressing key development issues risks undermining the achievement of the SDGs in the country. The government does not cooperate with local organizations and institutions to collect and analyze data related to citizens and services (UNICEF, 2016).

Deviating away from centralized planning and implementation is required for the country to achieve the SDGs. Currently, data, service and resource distribution, transparency and accountability at both national and sub-national levels are problematic (UNICEF, 2016). Decentralization and information sharing need to improve, especially in the light of the recent attempts to consolidate power at the national level, the lack of local administrative capacity and funding, and the lack of public support and political awareness at the village-level (Open Development Cambodia, 2015). The country is currently prioritizing its National Strategic Development Plan 2014-18 (Open Development Cambodia, 2018). Despite moderate progress on the SDGs and their localization in areas such as child mortality and HIV reduction, many barriers still remain in other areas such as nutrition, education, sanitation, and domestic violence (Handley, 2018). Poverty in rural areas also remains very high.

The concept of e-governance is very new in the country, despite recent efforts to engage with citizens through online platforms (Chheang, 2016). With an internet penetration rate of 11.1 % (Internet Live Stats, 2016), Cambodia's readiness for digital transformation is less developed than most countries. 70 % of the population lives in rural areas, making the issue of access to internet-based services acute. However, as smartphone usage increases significantly each year, including in rural areas (Open Institute, 2016), connectivity seems to be an area of high potential for citizen outreach and virtual decentralization. The country established its National ICTs Development Authority in 2000. It designs ICT policy and promotes digital transformation for all public and private institutions. The country also launched the Government Administrative Information System the same year. Since then, it generated four key flagship programs: an electronic approval system, real estate registration, resident registration, and vehicle registration. However, the majority of data produced by e-governance programs is not publicly released or takes years to be processed and disclosed. In 2003, the government identified ICTs as a key tool for social and economic development (Pho et al., 2015). Since then, the country has invested in internet connectivity for rural areas and private sector development of ICTs. The government also enacted policies focusing on improvement of ICT education in public schools, and trained IT workers on digital security. In 2015, the country announced a new ICTs policy emphasizing the importance of ICTs in bottom-up empowerment and in improving good governance. Furthermore, administrative knowledge of IT remains low: only half of government staff have even basic technology skills, and there is a lack of coordination across ministries (Pho et al., 2015).

Despite all of these limitations, there is a great potential for Cambodia to follow up on the digital transformation goals it has already put in place, to increase public trust and cooperation with civil society, reduce poverty and rural inequalities with better and more reliable data, increase quality of education, especially in ICTs, integration into global economy. digital transformation would apparently hold potential of success for a number SDGs *1, 4, 8, 9, 10, 11, 16 and 17*.

4.4. Egypt

Egypt ranks just above Cambodia in the ADI rankings, with a score of 85. This demonstrates that the country is not very decentralized. The 2014 Constitution outlines the country's administrative units (governorates, cities, and villages), and the legal personality that they enjoy. Each local unit is to elect a council to ensure oversight over authorities. This council has the power to retract confidence from the leadership of the local unit (Barsoum, 2018). However, practical progress on decentralization has been slow.

The country has demonstrated its commitment to the 2030 Agenda by launching Egypt's Vision 2030, a plan to outlining different SDG strategies and ways to implement them. Additionally, the government has made the Ministry of Planning, Monitoring and Administrative Reform responsible for monitoring and reporting on progress toward

SDG objectives (UNDP Egypt, 2015). However, despite government recognition of the need for decentralization, policies still lack co-ordination and related public inclusion and there is a lack of training and data at the municipal level (ElMassah, 2016, 2018a, 2018b). Local bureaucracies remain undeveloped, and local autonomy is consequently limited. Moreover, corruption and problems with transparency have hindered local political participation (El Hag, 2014).

Despite the country's commitment to SDGs, the main challenges they face relate to sexual health and education (SDGs 3 and 4), water scarcity and agriculture in the face of climate change (ElMassah and Omran, 2014) (SDGs 6 and 13), technological innovations (SDG 9), gender equality (SDG 5), and labor precarity (SDG 8) (UNDP Egypt, 2015).

The country ranks low (#69) in terms of technological readiness (Economist Intelligence Unit, 2018). It also has a low internet penetration rate of 33 %. Egypt's EGDI was "medium" in 2016 after it was dropped out of the "high-EGDI" group of countries.

The official government online portal was launched in 2004 and currently focuses on four main domains: institutional development, governmental services, enterprise resource planning, and establishing and integrating national datasets (Gebba and Zakaria, 2015). These programs aim to provide comprehensive, accurate, and updated information to support decision-making processes in the public and private sector in general and foster long term planning in particular (Gebba and Zakaria, 2015; p. 15). Through the Government Services Development Program, the government attempts to speed up the process of service delivery through digitalization (Essawi, 2012). The country is automating and speeding up a large number of its service provision processes, updating and expanding public and private data, and raising awareness on the availability of essential resources and services by advertising local government provider locations. The system has greatly improved e-participation and citizen engagement (Zaied et al., 2017).

However, data communicated is generally national and individual, while capacities related to infrastructure and data of local and regional e-governments are limited. Virtual decentralization and IT capacity-building at local levels are essential to push the country forward. Data collection and improved analysis and publication platforms should be supported by more cooperation with the private sector and CSOs. This can help the government in implementing its ICT projects in under-served areas (ibid). The success of current e-governance policies in improving individual participation shows a high potential to engage with citizens at a local level, reduce negative impacts of political and economic crises (SDG 16), help identify proper job opportunities (SDG 8), build trust in and engagement with local government and civil societies institutions (SDG 17), reduce gender inequalities by producing evidences (SDG 5) and support education (SDG 4). More results could be achieved with capacity-building and consultations with local actors, especially in the light of lack of trust in the central government (Ho, 2002).

4.5. Kenya

Kenya has a low level of decentralization with a rank of 105 in ADI (Ivanyna and Shah, 2014), indicating that it remains highly centralized. In 2010, county governments were given the responsibility of delivering basic services, but the transfer of power did not appropriate enough funds nor capacity-building measures for this to actually take place (Mohieldin and Ijjasz-Vasquez, 2017). In addition, infrastructure at the local level is too weak to effectively create adequate social and economic opportunities for all citizens (Mohieldin, 2017). The provision of services and resources (notably, water and sanitation, housing, education, and health) has not been effectively implemented by these authorities as most control, monitoring, and implementation take place at the national level (Ndii, 2010).

In 2008, Kenya adopted a long-term development program, also

known as Kenya Vision 2030, which "aims to transform Kenya into a newly industrializing, middle-income country providing a high quality of life to. dall its citizens by 2030 in a clean and secure environment" (Kenyan National Economic and Social Council, 2007). Since then, all 17 SDGs have been integrated into Vision 2030.

45 % of Kenya's population have access to the internet. The country ranks 67 in terms of technological readiness (Economist Intelligence Unit, 2018). Kenya's Vision 2030 identifies digital transformation as a critical enabler to achieve its development targets. The government has been implementing a wide array of e-governance initiatives to increase reach and engagement, improve the quality and dissemination of public data, and distribute services and resources (Kenya Engineer, 2017).

In 2011, the Kenya Open Data Initiative (KODI), with support from the World Bank, made government data, such as information about national health, education, infrastructure, and census surveys, widely available to the public. Since then, many measures have been passed to ensure accessibility, especially to those with low digital literacy. Additionally, the initiative aims to create a discussion based on this data by organizing public fora (UN, 2016). Established in 2013, the Kenyan ICT Authority, a state corporation under the Ministry of Information Communication and Technology focused on "enforcing ICT standards in Government and enhancing the supervision of its electronic communication", also promotes ICT literacy, capacity, innovation and enterprise.

To achieve Kenya's objectives of SDGs localization, e-government and big data can play a big role. The Kenyan government's commitment to increasing the presence and quality of e-governance has provided a conducive environment for the use and analysis of data for progressive political purposes. At the same time, civil society has produced multiple platforms and initiatives to promote SDG-related outcomes, such the Ushahidi platform and the Institute for Social Accountability. These platforms encourage citizen participation and engagement with both county and national governments (Salome, 2016). Generally, these initiatives have accelerated digital transformation, with the potential to increase information for quality resource distribution that would reduce poverty (SDG 1), eliminate hunger (SDG 2), improve health conditions (SDG 3), provide suitable quantity and quality of education (SDGs 4), as well as providing clean water and sanitation at the local level (SDG 6), The initiative also improves collaboration between ministries, and data is accessible for all stakeholders such as civil society actors and private business (SDG 17), and clear goals for nationwide needs and goals related to infrastructure and sustainable cities can be set (SDGs 9,11). Civil society actors and private business can also innovate and develop better ways of improving well-being and sustainability (SDG 9, 11, 12).

However, a large amount of the data collected is not stored in nor transferred to systems that allow effective political analysis (CIPESA, 2015). Furthermore, there is a lack of legislation protecting citizens' online privacy and ensuring private institutions' transparency on data collection. While the Kenyan government has invested millions of dollars into e-governance efforts, many Kenyans are unaware of the platforms or do not have access to networks or computers (Salome, 2015).

4.6. Philippines

The Philippines is highly decentralized, with a rank of 33 in the ADI ranking. It fares the best among all seven country case studies. The Philippines pioneered the decentralization front in East Asia. Its local governance reforms started before the broader wave of decentralization of the 90 s and the 2000s. (World Bank and Asian Development Bank, 2005; World Bank, 2005; Matsuda (2011). Although its decentralization efforts were initially spurred by a crisis, these reforms took time and were not negotiated nor implemented quickly (Smoke, 2015a).

The Philippines has achieved considerable progress in implementing the SDGs. The recent Voluntary National Review (VNR) report submitted by the government in 2016 outlines lessons learned from the

MDGs such as good governance and sustained commitment from all stakeholders, and improved capacity to manage and communicate financing plans (The Government of the Philippines, 2016). Under President Duterte, the government crafted the ten-point socioeconomic agenda laying out the importance of institutions, governance, competition and social protection programs to promote inclusive development (ibid). The government also launched the AmBisyon Natin 2040 vision which is a set of goals that serve as the country's long-term vision and is closely linked to the SDGs (The Government of the Philippines, 2016). The government encourages ownership and localization of the 2030 Agenda through a number of initiatives such as the OpenRoads initiative, investing in safe and sustainable infrastructure for local communities, among others. For example, the government is effectively targeting SDG *9* which seeks to build infrastructure projects that foster innovation and industrialization, as well as SDG *11*, which focuses on developing sustainable and inclusive cities through investing in safe and sustainable infrastructure in the local communities through increased operations (such as lighting, transportation, etc.).

43.55 % of the population in the Philippines have internet access. The country ranks 55 in terms of technological readiness (Economist Intelligence Unit, 2018).

The country has witnessed many initiatives that highlight the potential of big data to achieve the SDGs. The OpenRoads initiative combines crowd-sourced geo-coded video and image data obtained from mobile phones with road data in an attempt to track the state of road networks and national investment projects (World Bank Group, 2016). Big data in this case addresses a number of challenges. First, with localization stimulating a large number of local projects, it becomes difficult for policymakers to priorities and supply operational road networks. Furthermore, many large-scale highway networks tend to be inefficient in linking communities together because of the poor state of last-mile local roads, which make up 85 % of roads in the Philippines (World Bank Group, 2016). The multi-media portal tracks national infrastructure projects that aim to develop last-mile road networks by leveraging the abundance of data on public infrastructure (SDG 9) through crowd-sourcing (World Bank Group, 2016). This occurs by combining data from different agencies within the Filipino government. This enables all stakeholders—including citizens—to comment on all local road projects in all locations. It also allows them to track the lifecycle of infrastructure projects using a mobile video application using track-mapping of photos or videos, which are then geo-processed into project information (World Bank Group, 2016). This allows increased collaboration across stakeholders to find innovative development solutions.

4.7. Tunisia

Tunisia has a very low level of decentralization, ranking 87 on the ADI ranking (Ivanyna and Shah, 2014). On paper, Tunisia's municipal and regional authorities' decision-making mechanisms exist, albeit performing mostly administrative duties. However, in reality, most local authorities were selected by the central state and reported to the Ministry of the Interior (Yerkes and Muasher, 2018). A new constitution was written in 2014, with a focus on decentralization. However, despite this stated goal, a clear framework for implementing decentralization has not materialized. Less than 50 % of Tunisia's municipalities are able to independently finance themselves. There is a lack of coordination between local and national health officials, and 65 % of Tunisians are unsatisfied with the provision of basic services such as water and electricity (Miller and Chace-Donahue, 2017). Marginalization of groups in southern regions, especially with youth unemployment, has led to increasing investment-related demands, and perceptions of corruption have limited the extent of public engagement with the political process (Miller and Chace-Donahue, 2017).

The Tunisian government has advertised its support for full SDGs implementation, and has specifically noted the need to raise awareness

and communication on SDGs to the public, improve governance at all levels, and promote innovation to improve the quality of labor in the country (Salem, 2017). Most recently, Tunisia's focus has been concentrated on good health and wellbeing (SDGs 3) specifically on access to medicines and enhanced knowledge sharing of diseases, increasing investments in health systems in rural areas, and ensuring access to quality education (SDG 4). This includes raising awareness and changing curricula based on shifting demands of the labor market and ensuring equal access to IT skills (Lakhal, 2017). However, a structural challenge remains for localization with the creation of 86 new municipalities (out of 350 total) and that are so far not fully operational. The challenge of staffing and budgeting them will be difficult in the short term, which might hinder efforts to localize the SDGs (Yerkes and Muasher, 2018).

Tunisia has a high rate of internet penetration of 48.1 %. Following the People's Revolution in 2011, the new Tunisian government attempted to strengthen pre-existing e-government initiatives, which began in 2005 (Sellami, 2012). E-government services in Tunisia aim not only to offer "one-stop shop" solutions for citizens but also to engage people to take part in policy discussions. One example is the e-consultation on vocational training policy on the website of the National Agency for Employment and Self-Employment, which provides an opportunity for people to ask questions and make suggestions around professional education (Bouchnak, 2013).

The government has collaborated with the OECD's Open Government Project, which supports countries in designing and enacting reforms using big data in collaboration with public and civil society. Analysis usage of available public data has been called for by civil society groups, such as the Tunisian e-government Society, whose objective is to raise awareness on political and administrative functions and usages of IT platforms and information to build sustainable cities and communities. In 2017, for example, they organized the Big Data Hackathon in which participants competed to make the best use of big data to encourage start-ups, educational institutions, and others to innovate on available data (Tunisian e-Government Society, 2017).

After the massive success of Tunisia's e-government initiatives, and the recognition that there is much progress to be made in both implementing and localizing SDGs and in effectively decentralizing governance, the government has committed to using e-governance infrastructure and innovation for digital transfromation to improve data collection, analysis, and usage.

Fig. 2 presents a board that summarizes our thorough analysis of the case studies in terms of the existing digital transformation initiatives and their local SDGs-related potential.

5. Concluding remarks and policy implications

We draw several ***findings*** from our case studies analysis. ***First***, our findings contribute to a relatively new approach of thinking around sustainable development. By localizing the SDGs, governments are effectively tailoring sustainable development strategies at the local level. The concept of localization uses the advantages of both decentralization and centralization as modes of governance. In addition, it does not compromise the benefits of centralization like fully aligning local communities to national policies and promoting national security. It also draws advantages from decentralization like better public service delivery through transparency and accountability. This not only encourages ownership of the SDGs at all levels of society, but it also is the most practical approach to achieving the SDGs and the 2030 Agenda. Localization also diffuses ownership of SDGs across all levels of the population, which highlights inclusive development. By that, localization is a more robust mode of governance and is the most pragmatic means of achieving the SDGs. The debate on centralization versus decentralization hindered the full achievement of the MDGs, and, in the era of the SDGs, we need to move beyond that debate by giving the space for the comparative advantage that the center can offer, which we
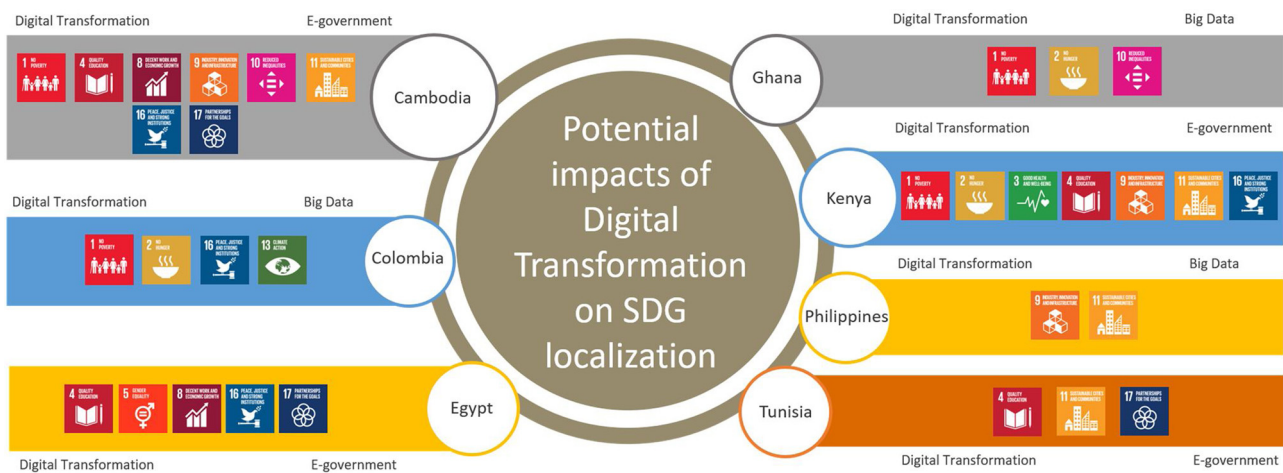
Fig. 2. Potential Impact of digital transformation on localizing the SDGs.
Source: Developed by the authors.

believe should be the concept of localization. The ***second*** finding is that digital transformation boosts the likelihood of localizing SDGs. Big Data and e-government can facilitate the effective implementation of sustainable development through the localization of the SDGs. Over the last decade, or the era of Globalization 4.0, we have seen immense progress in terms of technological solutions. These solutions can improve living standards across the local and global communities. Many cases focus on digital data to detect, monitor, evaluate and achieve sustainable development at the local level. This finding is relevant to variations in regions, level of development, and level of decentralization, internet penetration and e-government development. Nevertheless, countries with more decentralization, such as Colombia, have the upper hand in using digital transformation to promote inclusive development. Several best practice cases of e-government and big data already exist and can be used as benchmarks for local governments worldwide. These cases explore the potential of these methods, yet it is still too early to judge full and complete results. Knowledge and peer-to-peer experience exchange would help multiply global impact. Digital transformation could then be used for monitoring and reporting the sucess of SDGs at each local level. ***Third***, localizing the SDGs requires local governments' effective planning by ensuring that budgetary allocations reflect the priorities of local communities. If the efforts are not reflected in the budget, these efforts do not exist and hence, will not be realized. As outlined in the Freire and Garzon (2014), finding the adequate level of budgetary resources is decided by both revenues and expenditure. Determining revenue for local governments in developing countries tends to be a function of both central government transfers and arbitrary levies from different sources. To effectively localise SDGs, reforms should target a fair raise of tax revenues, meet local requirements and establish an easily administrable and stable revenue stream (see Appendix A for a list of potential revenue sources for local governments) (Freire and Garzon, 2014). Data systems and big data solutions can help in this regard and can be coupled with institutional capacity at the local level. This allows local governments to release potential revenue sources to support local economic development. In addition, guaranteeing an effective expenditure management system requires measurable milestones to monitor performance against set targets. Spending control is also necessary to ensure optimal resource allocation across all targets. Objectives targeting the requirements and priorities of local communities should also be set (see Appendix B for a list of potential expenses for local governments to consider) (Morrell and Kopanyi, 2014). That said, local governments must ensure fiscal discipline, allocative efficiency and operational efficiency. The latter two respectively guarantee consistency of budgets with strategic priorities and the provision of decent quality public

services (Morrell and Kopanyi, 2014). Haryana, one of the 29 states in India, is a prime example of this. Populated by over 25 million people, it accounts to 3.6 % of India's GDP and has a high agricultural productivity (Prasad, 2018). Haryana's 2018/19 budget included just over 6 billion USD towards achieving the SDGs (Prasad, 2018). The state has prepared a Haryana-specific Vision 2030 identifying fundamental SDG targets. This Vision is also aligned with India's national development plan. Integrating the SDGs into the budgetary process at the community-level is an efficient way to localize the SDGs. It takes into account the priorities of the local community and, consequently, enables optimal distribution of funding across the different Goals. Furthermore, it improves public service delivery and promotes good governance by encouraging transparency and accountability of local governments. ***Finally***, development experiences have taught us that three conditions are necessary: adequate data to identify and follow-up with decision makers, appropriate funding for development programs and projects, and effective application at the local level.

The main ***policy implications*** of our study are that: public and administrative makers in the developing countries should direct/encourage investments in the 'The Digital Network Architecture' (DNA) infrastructure. DNA enhances digital transformation and therefore accelerates the localization of SDGs by collecting big data in a Dynamic, cost effective & inclusive way. DNA return on investment is expected to expand, as the digital divide narrows over time (Goel and Saunoris, 2016a, 2016b). Similarly, governments ought to invest in human capital to build the skills needed to develop and improve the data collection systems and application as well as skills needed to translate/analyze the collected data at the local level for decision makers & policy designers. UN E-government Survey (2018) pointed out to some cities already provide information about services, as well as downloadable forms for their requests, but that still requires in-person submission and process triggering, which make responsiveness and quality of email usage by municipalities, when interacting with citizens, are far from expected levels (UN 2018- E-gov survey).

Furthermore, developing countries need to review their institutional competence in dealing with information and data; collection, preservation, analysis, deliberation, disclosure and standards of confidentiality as well as the privacy protection along the lines of recent initiatives and legslations to reduce the risk of infringement of individual privacy; the UN has recently developed a guidance note on protecting privacy and the use of big data in an ethical manner (UNDP, 2017), as well as the EU General Data Protection Regulation launched in 2018[10]. Moreover, local budgeting should be aligned with the SDGs and priorities of local communities - based on local sustainable revenue. In the same context, local governments are advised to get use of digital

transformation for revenue data collection. Undoubtedly, if the developing countries do not adapt the technology and the fitting human capital and skills for digital transformation, they will lose in the course of progress through the current era of Globalization 4.0, and would have no vestige of the oldest but the traces and ruins (Mohieldin, 2019). A key limitation faced by this study lies in its sample of countries used with their own cultural and population features. However, our findings give insights that pave the way and provide a good basis to analyze further case studies and ongoing operations around the world with more heterogeneous compositions, and also with other homogeneous settings different from the one used in this study. As importantly, other practices of digital transformation could be explored to check for their significance in localizing SDGs. It also offers a foundation for future work to include greater elements of social inclusion and service delivery outcomes, and develop a measurable indicator on how we assess the impacts of digital transformation on the local SDGs outcomes and its reflection on the Sustainable Wellbeing Index (SWI) (Costanza et al., 2016) that connects with inclusion and service delivery at the local level.

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Appendix A

List of potential revenue sources for local governments, as listed in Freire and Garzon (2014):

- Property tax (rates) on land and/or buildings
- Tax on the transfer of immovable property
- Tax on motor vehicles
- Local sales tax and/or tax on sale of local products (or surcharge)
- Tax on local businesses and services
- Tax on electricity consumption (surcharge)
- Tax on nonmotorized vehicles
- Tax on tourism, hotels, restaurants, and entertainment
- Tolls on roads, bridges, etc., within the limits of the local government
- Charges for public works and public utilities such as waste collection, drainage, sewerage and water supply
- Charges for markets and rents for market stalls
- Chanrges for the use of bus stations and taxi parks
- Fees for approval of building plans and erection and reerection of buildings
- Fees for fairs, agriculturals shows, cattle fairs, industrial exhibitions, tournaments, and other public events
- Fees for licensing of businesses, professions, and vocations
- Fees for other licenses or permits and penalties or fines for violations
- Fees for advertisement
- Fees on sales of animals in cattle markets
- Fees for registration and certification of births, marriages, and deaths
- Fees for education and health facilities established or maintained by the local government
- Fees for other specific services rendered by the local government
- Rent from land, buildings, equipment, machinery and vehicles
- Surpluses from local commercial enterprises
- Interest on bank deposits or other funds

Appendix B

List of potential functions for expenditure, as listed in Morrell and Kopanyi (2014):

- Delegated Functions
  - Preschool education, wages, operating, repair and maintenance, capital investment
  - Primary and secondary school
  - Healthcare
  - Social assistance and poverty alleviation
  - Public order and civil protection
  - Other
- Own Expenditures
  - Infrastructure and public services
  - Environment protection
  - Social, cultural, recreational expenditures
  - Local economic development
  - Social housing
  - Urban development
  - Civil security
  - Transfer to sublocal government entities
  - Subsidies, grants, equit, in-kind
  - Loan repayment
  - Interest charges
  - Guarantees

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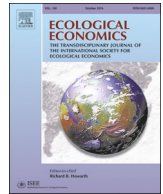
Update

Ecological Economics

Corrigendum

Corrigendum to "Digital transformation and localizing the Sustainable Development Goals (SDGs)" [Ecol. Econ. 169 (2020) 106490]

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The authors would like to apologise for any inconvenience caused.