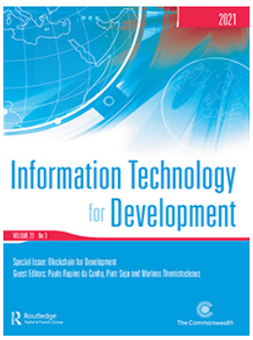

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Factors affecting digital technology adoption by small-scale farmers in agriculture value chains (AVCs) in South Africa

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ABSTRACT

Digital technologies enable small-scale farmers to reduce some constraints to participate in Agriculture Value Chains (AVCs). Small-scale farmers face significant challenges and barriers to adopting digital technology. This study contributes to the literature on digital development in three ways: present the economic, political, and social factors affecting digital adoption in the AVCs; highlight the implications for governance and institutional challenges;adds knowledge to the analytical value of the Choice Frameworkto study digital technology adoption. This paper after identifying more than 100 papers and articles, uses a Systematic Literature Review (SLR) aligned with Cooper's [(2010). *Research synthesis and meta-analysis: A step-by-step approach* (5th ed.). Sage] approach to examine 52 articles published from 2014 to 2019, ultimately selecting the most relevant 36 studies. The study uses the Choice Framework that operationalizes the Capabilities Approach (CA) as a theoretical window for this research. Papers were classified into four different categories: economic; political; social factors; institutional/governance. The findings show: - the role of the state in governance and institutional support is critical to facilitate the collaboration and participation of different actors;- the importance to develop a comprehensive localized developmental implementation framework that can support the adoption of digital solutions to support small-scale farmers. Limitations for this study are highlighted and areas for further research are suggested.

KEYWORDS

Digital; technology adoption; value chain; small-scale; farmers; inclusive

1. Introduction

The 2030 Agenda for Sustainable Development adopted at the United Nations (UN) in September 2015, sets out 17 Sustainable Development Goals (SDGs) across the social, economic, and environmental dimensions (SDSN, 2015). The development of small-scale agriculture contributes to sustainable food security and influences three dimensions of the SDGs namely, ending poverty (SDG1), zero hunger (SDG2) and sustainable consumption and production (SDG12) (FAO, 2015). In 2013, the African Union (AU) adopted Agenda 2063 with Goal 5 intended to modernize agriculture for increased productivity (AUC & AUDA-NEPAD, 2020). South Africa's National Development Plan (NDP) launched in 2012 foresees agriculture to have the potential to create new jobs by expanding irrigated agriculture, cultivating underutilized land, and facilitating commercial production (NAHF, 2017). The goal is to develop the weak Agriculture Value Chains (AVCs) of small-scale farmers and assist them to graduate into commercial farming (AUC & AUDA-NEPAD, 2020).

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Caroline Khene is the accepting Associate Editor for this paper

Agriculture is critical in alleviating poverty and a common approach for agriculture development is through commercial AVCs (ITU, 2016). AVCs must comply with national and international rules where digital data of food products and related processing phases enhance marketing (Corallo et al., 2018). Digital technologies such as internet applications and mobile phones are changing the nature of communication (Boateng et al., 2017) and Stugeon (2017) suggests that the "New Digital Economy" creates opportunities for digital-driven solutions to numerous agricultural development problems. There has been much progress with regards to identifying the opportunities of digital use in agriculture (FAO & ITU, 2017). The use of digital technology integrated into aspects of agriculture development, improves efficiency within the AVCs and food production (Heeks, 2018).

However, challenges may limit gains as the digital divide in agriculture is also characterized by ineffective knowledge exchange, management of information content as well as limited human and institutional capacity (Mago & Mago, 2015). Many promising examples of positive digital impacts on small-scale agriculture development have often not scaled up (Deichmann et al., 2016) and new government policies could address inequality and social exclusion by reducing structural roadblocks to drive inclusive innovation (Foster & Heeks, 2015). A strong political will is needed to develop small-scale agriculture that involves family farmers, rural women, indigenous communities, youth, and other vulnerable or marginalized people in rural areas (FAO, 2015). Both the ICT and Agricultural sector policymakers need to support this new technology revolution using the context of digital development as many social implications have been ignored.

Digital development is described by Heeks (2016) as socio-technical systems where digital technology and society are interrelated as they shape each other. Heeks (2016) further describes these socio-technical systems as of an economic, political, and social nature that are involved in the design, use, and governance of digital development. Discussions about digital technology adoption by small-scale farmers in AVCs should relate to the role of digital technology adoption in global AVCs to exploring the role of digital technology adoption at the farmer level. To start this discussion, there is a need to capture the economic, political, and social factors affecting these socio-technical systems. This reinforces the requirement to understand, the current state of research identifying knowledge gaps, similarities, and differences between the components of AVCs.

Considering the above, the aim of this article is to answer two questions. The first question is "What are the economic, political, and social factors that affect the adoption of digital technology in AVCs of small-scale farmers?" The answer to this question involves the identification, realization, and assessment of benefits or challenges that these factors can bring about for the development of small-scale farmers when adopting digital technology in their AVCs. The outcome of this review presents a foundation for further research when asking the second question "What are the implications for governance and institutional challenges that affect policy considerations for the adoption of digital technology in AVCs of small-scale farmers?"

The section on governance and institutional implications will separately discuss overlapping issues to guide researchers and industry experts in organizing, conceptualizing, and conducting their research on the digital transformation in AVCs of small-scale farmers for the future. The task of implementing and verifying digital transformation in these AVCs is not only essential for small-scale farmers to manage and function better but is also functional and essential for a typical SME supply chain that adopts digital technology.

This study analyzes and synthesizes past knowledge to identify important bases for further development. By addressing this, a new and theorized understanding of factors affecting digital technology adoption in AVCs of small-scale farmers is made. This can help digital development academics and practitioners in organizing, conceptualizing, and conducting their research on digital technology adoption in AVCs by small-scale farmers for the future. This study aims to contribute to the literature on digital development in three ways. First, to present the economic, political, and social factors affecting digital adoption in the AVCs of small-scale farmers. Secondly, to highlight the implications for governance and institutional challenges that affect policy considerations. Finally, the

paper adds knowledge to the analytical value of the Choice Framework as a theoretical window to study digital technology adoption in the AVCs of small-scale farmers.

This article is organized by discussing in Section 2 the concept of a digital AVC framework, its importance to the development of small-scale farmers and the barriers that hinder the use of digital technology by them. Section 3 presents the Choice Framework as the theoretical and conceptual window used when analyzing the data in this SLR. Section 4 describes Cooper's (2010) approach as the research methodology, formulate the problem, search the literature, gather information from studies, and evaluate the quality of studies. In Section 5 the outcomes of the studies are analyzed and integrated by highlighting the economic, political, and social factors that affect digital technology adoption in AVCs of small-scale farmers. Section 6 highlights institutional and governance implications when developing government policy. Section 7 discusses the need for farmer-centered participation and collaboration as well as the contribution of the study to the theoretical framework. Finally, Section 8 looks at limitations plus areas for further research and Section 9 gives some concluding remarks.

2. The concept of a digital Agricultural Value Chain (AVC)

The concept of a Value Chain (VC) involves the sequential linkages through which raw materials and resources are converted into products for a market. An Agricultural Value Chain (AVC) is thus the set of actors and activities that bring agricultural produce from production to final consumption where at each stage, value is added to the product (ADBG, 2013). To explore new opportunities for digital transformation in VCs, Sealey (2018) suggests Porter's VC as a framework to separate business activities across primary and supporting activities. Primary activities relate to the production, marketing, and sales of a product while support activities are there to support the primary activities. Digital solutions to numerous agricultural problems can assist a country to meet its agricultural goals more effectively. In South Africa, the agriculture sector sees drivers of change as new digital technologies that unlock opportunities and experiences for consumers based on digital capabilities in AVCs (Ungerer et al., 2018).

Table 1 lists the value drivers that drive value in digital AVCs to become productive, efficient, inclusive, sustainable, transparent and resilient. The three value drivers are operational excellence, supply chain orchestration, and transparency.

Digital innovation plays a key role in improving agricultural production and the value chain such as post-harvest, transport, and storage (Corallo et al., 2018). Food traceability systems using digital platforms have become key risk management tools to contain food safety problems and promote consumer confidence (FAO & ITU, 2016). Digital-enabled marketing helps to increase intra-company efficiency and competitiveness in markets (Corallo et al., 2018). Figure 1 gives a schematic

Table 1. Value drivers driving value in Agriculture Value Chains.

Value drivers	Productive, efficient, inclusive, sustainable, transparent, resilient VCs
Operational excellence	Yields improved and less water/land/energy/pesticide used per ton of food. The outcome is that demand for food is sustainably met, and food is affordable
	Less food waste along with the VC
	Efficient capital markets and insurance
Supply chain orchestration	Food security improved
	Greater local production and frictionless markets for non-local production
	More efficient first and last-mile delivery
	Greater disintermediation
	The emergence of higher value-added intermediaries
	Buyers and sellers better connected
Transparency	Transparent and traceable supply chains
	Connected VC that collects data in real-time for actionable insights

Source: Adapted from Lee et al. (2017).

representation of a digital agriculture value chain vertical integration and the available digital technology services.

Digital technologies increase knowledge through new ways of providing extension services (Deichmann et al., 2016), and according to FAO (2015) improve AVC access for small-scale farmers. Agriculture is increasingly becoming knowledge-intensive and providing such knowledge can be challenging as information must be tailored to local conditions (NAHF, 2017). In agriculture, digital tools can improve access to commercial markets by positively influencing the ability to access information and overcoming spatial barriers by connecting farmers and buyers (Krone & Dannenberg, 2018).

AVCs must comply with national and international rules where data of food products and related processing phases enhance marketing (Corallo et al., 2018). The way food moves down the VC is the fundamental connection between people and the planet (FAO, 2015). Thus, next why the future of agriculture development in South Africa is dependent on digital adoption in AVCs of small-scale farmers is discussed.

2.1. The importance of a digital AVC for small-scale farmers in South Africa

South Africa's development of small-scale agriculture is focused on rectifying the past unjust land ownership policies experienced under Colonialist and Apartheid rule (DAFF, 2016). South African agriculture can be classed as a dual system with mostly white well-developed capital-intensive large-scale farmers on the one side and mostly black less-developed smallholder and subsistence farmers that lack resources on the other side (Thamaga-Chitja & Morojele, 2014). Unequal development continued after the end of Apartheid, with large-scale subsidized white farmers, supermarket chains, and agribusiness competing against unsubsidized black peasant farmers (DAFF, 2016).

The importance of information cannot be highlighted enough to address the challenges facing the small-scale agriculture sector in South Africa (SDSN, 2015). Agricultural information and knowledge need to reach small-scale farmers (DAFF, 2016) where many lack the knowledge about the nature of digital adoption in AVCs (Heeks, 2018).

Table 2 describes the benefits of new technologies across different players involved in a digital AVC such as farmers, consumers, the environment, and new players. The new players can be business opportunities for SMEs, new technology in AVCs, and development of start-ups. Digital tools can empower small-scale farmers to better understand their costs, improve decision-making and facilitate the flow of agricultural knowledge across AVCs for better financial access (Campion, 2018).

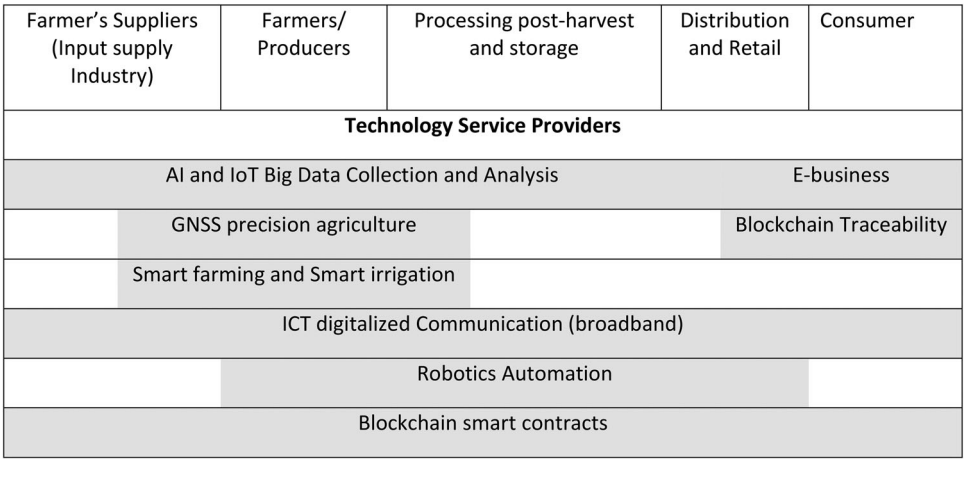

Figure 1. Digital AVC vertical integration and available technology services. Source: Adapted from Pesce et al. (2019).

Small-scale farmers can use digital connectivity and digital tools to overcome development constraints (Graham, 2019) but sometimes fail to appreciate the scale and scope of reforms needed (Juma, 2019). Small-scale farmers in South Africa often lack economies of scale and production prospects are negatively influenced by insufficient access to farming land, access to credit, technology, and other resources (Malan, 2018). Government and other stakeholders should promote digital adoption to improve agricultural production and promote food security (Mago & Mago, 2015). The Fourth Industrial Revolution (4IR) creates new opportunities to address challenges small-scale farmers face and proposes new ways to manufacture, grow, market, and distribute food in South Africa (Malan, 2018). Digital development can improve farmers' capabilities and livelihoods where research has shown a link between digital development, small-scale farmers' livelihoods, and poverty reduction (Mago & Mago, 2015).

The inability of the government to implement digital adoption programs for small-scale farmers stems from a lack of skills in ministries of agriculture and that of extension services to small-scale agricultural development that has been largely inadequate (Action Aid International Briefing, 2011). Since the study is also interested in factors affecting the adoption of digital technology by small-scale farmers in AVCs, it is important to identify barriers that inhibit the use of digital technology by small-scale farmers.

2.2. The barriers that hinder the use of digital technology by small-scale farmers

Low-capacity usage of digital technology by small-scale farmers and a lack of digital technology infrastructure in rural areas is a major problem (Munyua, 2007). Inadequate digital technology skills among researchers and shortage of electricity infrastructure for disseminating agricultural information among farmers are a key hurdle (Musa et al., 2013).

In Sudan's Gezira State some of the challenges of digital technology adoption by small-scale farmers are low education levels, low income, cultural inertia as well as the scarcity of relevant localized content in local languages. Similarly, Nmadu et al. (2013) identified language, poverty, and illiteracy as major barriers for small-scale farmers in Nigeria to use digital technology to secure marketing information. A study of small-scale farmers in Kenya founded that they have inadequate information due to lack of infrastructure, low literacy levels, lack of suitable information services, and lack of technical competencies (Odini, 2014). At a conference hosted by the International Fund for Agricultural Development (IFAD), a paper presented by Samii (2008) presented the lack of access to relevant information and digital technology infrastructure by small-scale farmers, leads to a lack of access to key players such as processors, traders, and consumers in the agriculture value chain as a challenge.

Research has shown that over time as technology changes, the perception of farmers towards the adoption of new technology changes. Studies in the United States of America during 2011 and 2007 have revealed that farmers did not adopt profitable farming technology due to high cost, time constraints and satisfaction with the current practice. These results could have been influenced due to them being unfamiliar and highlighted the importance of education in encouraging adoption (Gillespie et al., 2007; Paudel et al., 2011). A similar study in 2020 indicated that profit was the most important and environmental benefits next. Findings also

Table 2. Benefits of new technologies across different players.

Farmers	Increased production, reduced production cost, supported decision making and improved livestock health
Consumers	Real-time data and production information, the better quality of products
Public properties	Accurate farm and field evaluation
Environment	Reduce water consumption due to soil moisture, better environmental, energy, and climate care
New players	New business opportunities for SMEs, New technology players in the Agri-food VC, and Start-up's development

Source: Pesce et al. (2019).

revealed that educated and experienced farmers were the most likely to adopt technologies for profit reasons, while younger farmers are more likely to look at environmental benefits (Paudel et al., 2020). The studies show that time has to a certain degree impacted the perception of farmers towards adopting new technology. For example, during the two studies in 2007 and 2011 farmers might have perceived cost as a major factor for not adopting new technology. Their perception has changed in 2020, where they see a need for adopting new technology to increase profits and because of environmental benefits.

The above studies showed numerous barriers influencing digital adoption by small-scale agriculture that are outside the control of the farmers. Given the low incomes of most small-scale farmers, it is difficult, if not impossible, to buy digital technology of their own accord. As a result, this limits the usage of digital technology for their productivity and economical sustainability. What this suggests is that, for digital technology to be used successfully in small-scale agriculture, they need to be supported by the government and other developmental organizations in the agriculture sector.

Digital development is used more and more by the poor, to increase their capacity (capabilities) to achieve more functionings. The impact of digital development can be measured through one of three lenses that conceptualize development as economic, livelihood, or capability (Heeks, 2016). Heeks (2016) further argues the importance to understand the socio-technical systems involved in the design, use, and governance of digital development that is of an economic, political, and social nature.

Thus, to increase the functionings of small-scale farmers to utilize digital technology as a development tool in their processes and strategies, there is a need to identify the social, political, and economic factors that affect their capabilities. Since this study is interested in investigating the factors that affect the capabilities of small-scale farmers to increase their functionings, it employs Dorothea Kleine's (2010) Choice framework (CF) that operationalizes the Capabilities Approach (CA). In the next section, this paper will discuss theoretical underpinnings and the conceptual framework within which the research was conducted and analyzed.

3. Theoretical framework and conceptual discussions

The framework for any research is to include the belief about reality (ontology), the knowledge that exists and use in our research (epistemology), the data gathered, analyzed, and processed to create new knowledge (Tuli, 2005). This section discusses theoretical underpinnings and the conceptual framework used when this research was conducted and analyzed. Sen (1985) argues that when analyzing or developing vulnerable small-scale farmers, the freedom for them to choose and achieve certain functionings should be the most important. The Capabilities Approach (CA) is used to understand how the political, social, and economic factors affect digital technology adoption by small-scale farmers in Agriculture Value Chains (AVCs). This would guide us in identifying the governance and institutions needed for small-scale farmers to make better choices to enhance their capabilities to create more functionings.

The Choice Framework (CF) can be applied as a guide to do a systemic and holistic analysis as was done in the case of telecenters in rural Chile. Development is not conceptualized as economic growth, but as individual freedom (Kleine, 2010). The framework distinguishes between different dimensions of individual capabilities that link to a set of outcome indicators that could be measured according to the digital impact (Gigler, 2004). This study identifies the factors that affect digital technology usage by small-scale farmers in AVCs using the CF. This framework suggests capabilities to be the interaction of assets, which through using certain structures and processes can achieve certain functionings. These are the actual strategies adopted to achieve livelihood outcomes.

Given this, the CA is first further explained and then the CF is discussed as an analytical framework for this study. The CF is applied to examine factors affecting digital technology opportunities for

small-scale farmers using a systematic literature review (SLR). In general, within the context of Cooper's (2010) approach to the proposed SLR and analysis, the study is expected to provide the social, political, and economic factors that influence digital adoption by small-scale farmers in AVCs together with implications for governance and institutions.

3.1. Capabilities Approach (CA) explained

The capability approach can evaluate or look at the state of well-being of individuals or communities. It can be used for the evaluation and design of policies to eradicate poverty or inequality that start from the base of assessment of an individual level (Robeyns, 2005). The CA describes functionings as the operations performed daily by small-scale farmers to survive and how an individual farmer can convert physical resources into a functioning. Capabilities are thus the opportunities farmers possess or develop to achieve desired functionings (Alkire, 2005).

Sen (1985) argues for the use of well-being freedom and agency freedom such as individuals' abilities, skills, and choice (agency) in combination with their capabilities (opportunities) to achieve certain functionings. The CA defines development as the freedom to exercise one's choice in choosing the life one wants to live. Individual agency is the backbone of the capability approach and is embedded in socio-cultural conditions (Zheng, 2007). Through digital adoption and education, capabilities can be increased as can the freedom of choice which in turn can lead to an increase in economic freedom and income disposal freedom (Sen, 1999).

Conversion factors are the degree to which a person can transform a resource into a function. The three different types of conversion factors identified are personal, social, and environmental factors. Personal conversion factors are internal to a person and can include sex, literacy level, health, and intelligence. Social conversion factors stem from the society that one lives in and the people one relates to. Examples of social conversion factors are public policies, social structures, discriminating practices, gender roles, cultural hierarchies within society that direct and influence power relations. Environmental conversion factors are the physical or built environments where people live, that include the climate, infrastructure, institutions, and public goods (Robeyns, 2005).

Small-scale farmers have different freedoms to convert resources influenced by their social and environmental conversion factors as well as what resources or structural opportunities they have access to. A small-scale farmer is said to have a capability or opportunity when they can convert their resources into functionings. Successful small-scale farmers relate to having a large and varied capability set with many opportunities and have both the capacity and freedom to convert them (Sen, 1999).

Through the critical engagement of Sen's CA, questions arise about the applicability of the CA to guide empirical data collection and analysis. Social capital leads to collective capital and it is argued that the CA has too much emphasis on individual choice (Stewart & Deneulin, 2002). The social capital of communities is increased using digital technologies where newly collective capabilities are created through collective action (Andersson et al., 2012). The CA can be complemented by incorporating theoretical and conceptual thinking that emphasizes the collective and society.

To summarize, the CA was conceptualized due to Sen's concerns against analyzing poverty and inequality eradication in terms of utilities or resources. He emphasized the freedom for individuals to choose the life they want to live and articulated an approach that included the focus on individual freedom. Well-being freedom, together with agency freedom is used to transform capabilities and opportunities into functionings that allow people effective freedom. Social practices may restrict people's capability sets or privileges some group's capabilities at the expense of other groups. After explaining the CA as the conceptual approach, the Choice Framework (CF) is now presented as the theoretical framework on digital technology adoption that operationalizes Sen's CA in this study.

3.2. The Choice Framework (CF)

Since this study is interested in investigating the factors affecting digital technology adoption by small-scale farmers in AVCs it employs Dorothea Kleine's (2010) CF that operationalizes CA. This framework is used to do a systemic and holistic analysis of the social, political, and economic factors that affect digital technology adoption by small-scale farmers in AVCs. To identify the specific contribution digital technologies, make to specific development goals has proved to be extremely difficult (Kleine, 2010).

The CF shown in Figure 2 looks at digital development systemically and holistically rather than trying to conceptualize digital development impacts within a linear economistic view of development. The four key concepts of Kleine's CF are structure, agency, dimensions of choice, and development outcomes. The development outcomes are achieved functionings rather than capabilities. Kleine sees a key development outcome as the choice people exercise to achieve these functionings. She also lists secondary outcomes such as easier communication, increased knowledge, access to markets, business ideas, increased income, more voice, time saved, and higher job satisfaction.

At one end of the framework is structure and agency where the structure is made up of institutions and organizations, discourses, policies and programs, laws, and informal laws as well as access to digital technologies. Access to digital technologies includes its availability, affordability, and the skills needed to use digital technologies. Agency comprises different types of resources that include educational, psychological, information, financial, cultural, social, natural, material, health, and geographical resources. In the CF age, gender and ethnicity are conceptualized as personal characteristics or personal conversion factors. Figure 2 reflects the systemic and pervasive impact of digital adoption on development when applying the CF. Effects are aggregated and their systemic interrelatedness plus co-causality are demonstrated.

The CF offers a way to operationalize Sen's capability approach which is an alternative to the economic growth-focused conceptualizations of development. Sen's approach is of particular interest to the digital development research community, as digital technologies have enormous potential to give individuals a greater sense of choice (Kleine, 2010). Having dealt with conceptual discussions on the theoretical framework, the next section describes the research methodology, formulates the problem, outlines the search of the literature to gather information from studies, and evaluates the quality of studies.

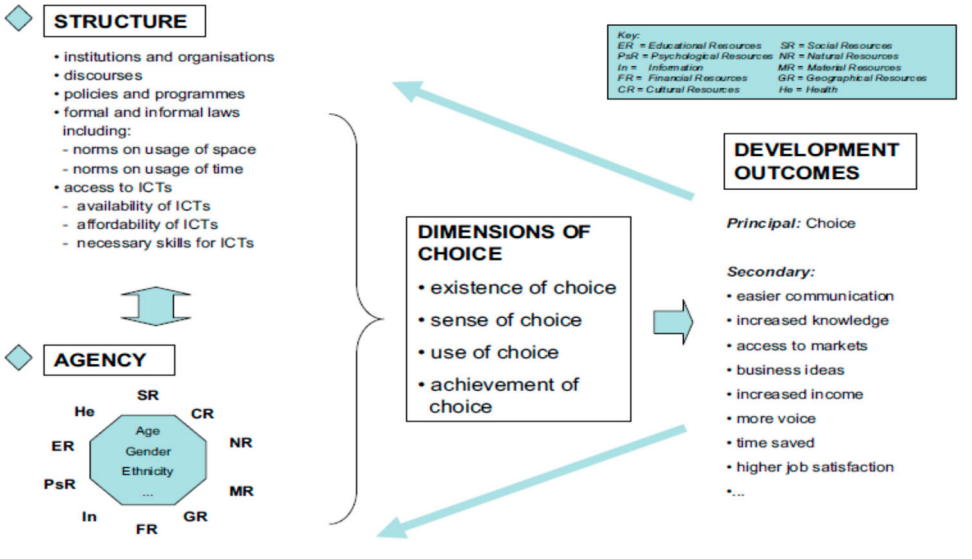

Figure 2. A schematic representation of the Choice Framework. Source: Kleine (2010).

4. Research methodology

A Systematic Literature Review (SLR) is an essential feature of any academic project making a systematic collection and analysis of prior, relevant literature. It creates a firm foundation for advancing knowledge to identify, select, and appraise all the significant studies previously published and identify knowledge gaps for further research (Webster & Watson, 2002). This SLR will contribute through identifying, evaluating, and interpreting all available research relevant to the questions for this study. Figure 3 gives a schematic presentation of the steps for research synthesis when adopting an SLR approach according to Cooper (2010) and includes the following: formulating the problem; searching and gathering information from the literature; evaluating the quality of studies; analyzing and integrating the outcomes of studies; interpreting the evidence and presenting the results.

4.1. Formulating the problem

With a broader aspiration of developing a conceptual developmental framework to guide and support digital technology adoption in AVCs of small-scale farmers, the aim of this work is to make the first approach to analyze and identify the factors affecting the adoption of digital technology in existing AVCs. The SLR approach adopted in this study is to answer the proposed research questions: Firstly, "What are the economic, political and social factors that affect the adoption of digital technology in AVCs of small-scale farmers?" and secondly, "What are the implications for governance and institutional challenges that affect policy considerations for the adoption of digital technology in AVCs of small-scale farmers?"

The research encompasses all the aspects and dimensions that the concept embraces to identify and review digital technology adoption in AVCs of small-scale farmers. It is to understand the economic, political, and social factors that influence the institutions involved in the design, use, and governance of digital AVCs.

4.2. Searching the literature to gather information

Due to the lack of precise keywords defining the topic, a sort was done through academic and industrial journals by reviewing their titles, abstracts, and manuscripts in the traditional and electronic library systems. Since digital technology adoption in AVCs of small-scale farmers is a recent

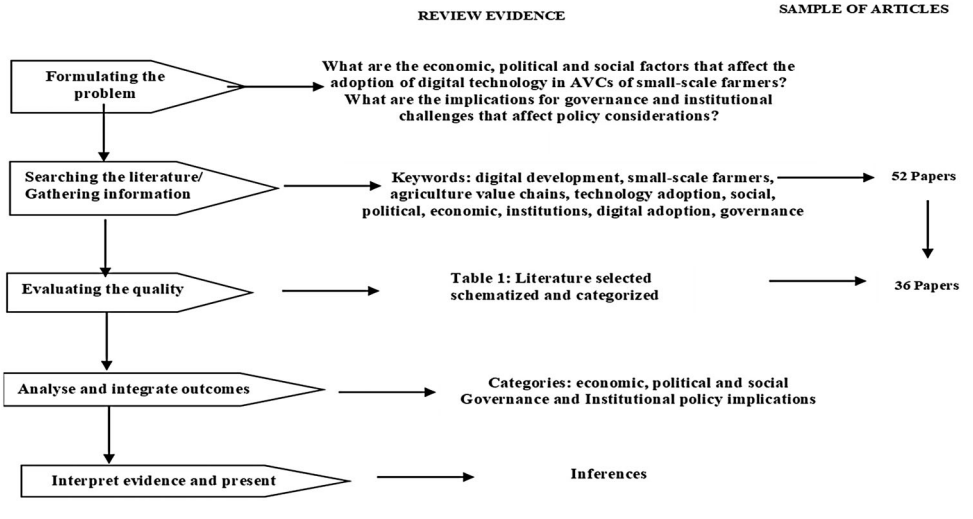

Figure 3. Adoption of the Systematic Literature Review (SLR). Source: Adapted from Cooper(2010).

phenomenon that has emerged within only a few years, related publication channels are still scattered. In my view, the dominant method in identifying the most relevant papers today is to focus on online databases rather than reviewing library collections.

This research targeted literature published and related to the topic on the following major online databases for the past six years (2014–2019): Scopus, Google Scholar, Nexus (NRF), Wiley Online Library, JSTOR, and Science Direct (Elsevier). The keywords were not predetermined before the search, but they have gradually emerged during the extensive reading process that took place while drafting this study. The following criteria were applied in the search and selection of papers on these databases.

- "digital development" AND "small-scale farmers" OR "agriculture value chains"
- "technology adoption" AND "small-scale farmers" OR "agriculture value chains"
- "agriculture value chains" AND "small-scale farmers" OR "social factors"
- "agriculture value chains" AND "small-scale farmers" OR "political factors"
- "agriculture value chains" AND "small-scale farmers" OR "economic factors"
- "institutions" AND "agriculture value chains" OR "digital adoption"
- "governance" AND "agriculture value chains" OR "small-scale farmers"

Other more specific search strategies were attempted to obtain systematic and exhaustive results. The study also employed guidelines on digital technology adoption in AVCs related to development in low-income countries to retrieve papers used by International Organizations such as FAO, ITU, World Bank, CIAT, GTZ, USAID, IDRC, etc.

Our SLR led us to identify 52 papers out of 127 papers that were relevant to the analysis. Out of the 127 papers identified, 67 papers were identified by searching online databases and 60 additional papers were identified through other sources. In Figure 4 our Prisma flow diagram illustrates the decisions made after scanning through the published titles and their abstracts. Fifty-two relevant articles were selected for further review and 75 were excluded. After the first two criteria were applied to filter the output, the remaining journal publications that were available were all

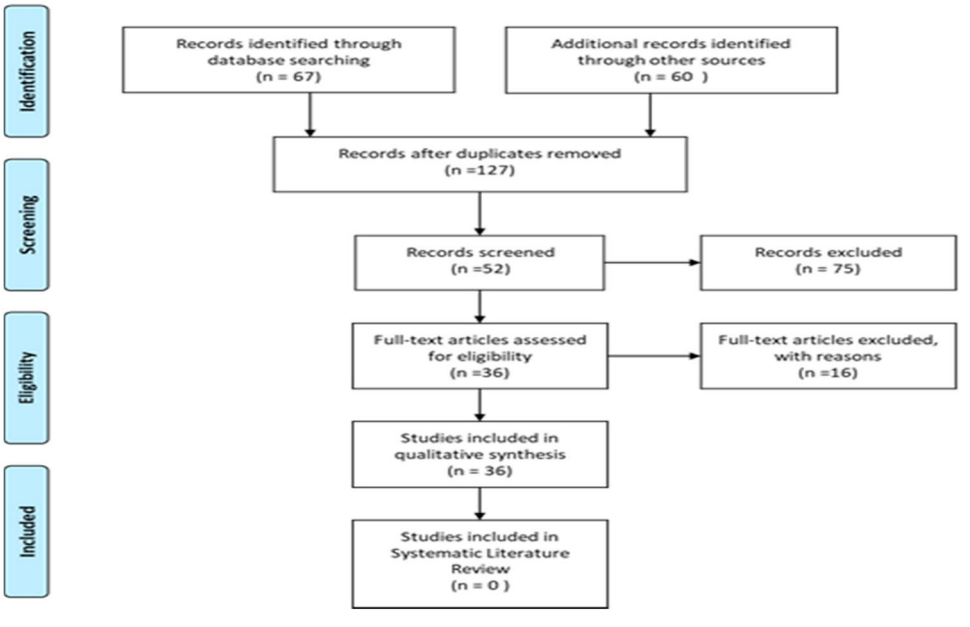

Figure 4. Prisma flow diagram illustrating the decisions made. Source: Adapted from Moher et al. (2009).

Table 3. List of materials accessed.

Materials used	Number of materials	References
Peer-reviewed journal articles	19	Awuor et al. (2016), Bayer (2018), Boateng et al. (2017), Bukht and Heeks (2018), Constantinides et al. (2018), Corallo et al. (2018), Deichmann and Mishra (2019), Deichmann et al. (2016), El Bilali and Allahyari (2018), Foster and Heeks (2015), Gaiha and Mathur (2018), Gillespie et al. (2007), GSMA (2018), Habiyaremye et al. (2019), Heeks (2018), Heeks (2016), Mattern and Ramirez (2017), OECD (2019), Paudel et al. (2020)
Reports/grey literature	8	Begashaw et al. (2019), EIP-AGRI (2017), FAO and AUC (2018), FAO, et al. (2018), Jackson and Weinberg (2016), Juma (2019), Odini (2014), UN (2019)
Webpages	9	FAO (2013), Graham (2019), ITU (2016), Lee et al. (2017), Malan (2018), Maru et al. (2018), Rose and Chilvers (2018), Thamaga-Chitja and Morojele (2014), Tuli (2005)

considered. However, a total of 36 papers were sampled and selected for more detailed analysis with each of the papers identified providing certain elements and different points of view to address the aim of this work.

The challenges that were addressed by the review were specified in the form of questions before beginning the review work. The study selection criteria flowed directly from the clear, unambiguous, and structured review questions.

Papers older than six years were excluded as technology adoption into AVCs of small-scale farmers came into existence only recently. However, because of the limited number of relevant peer-reviewed literature, grey literature was also included. After the inclusion and exclusion exercise, a total of 37 relevant artifacts were identified. They include 19 journal articles, 8 reports [grey literature], and 9 web pages as listed in Table 3.

In reporting these review findings, the information retrieved from the literature was grouped into themes that correspond to answering the research questions. Therefore, how the quality of studies was evaluated and categorized is explained next.

4.3. Evaluating the quality and categorizing the studies

The next step involved evaluating the quality of studies and categorizing relevant studies to gain insight into factors affecting the adoption of digital technology in AVCs of small-scale farmers. The purpose of this SLR was to identify and determine the factors affecting the adoption of digital technology in AVCs of small-scale farmers. Accordingly, this research captures the trends in literature about digital technology adoption in AVCs of small-scale farmers by examining published academic articles and industrial reports. Such information was processed and summarized considering the nature of digital technology adoption in AVCs of small-scale farmers.

It is quite a challenge to confine studies into specific categories to ensure that these papers are sufficiently investigated based on the year of publication, subject, objective or method. However, an exception was made for industry publications due to the limited output generated, based on search criteria from academia. As a first step, papers were classified into four categories. The first three categories were economic, political, and social factors. The fourth category looked at governance and institutional implications. The objective was to understand how the actions of people with digital technology create an inter-relation between agency and structure as proposed by the theoretical window used by this study. The reason is to better understand and identify factors within the economic, political, and social interlocking systems that affect the design, use and governance of digital technology adoption in AVCs of small-scale farmers. At this point, the literature selected was schematized and categorized to find consistencies and common patterns as shown in Table 4 using a systematic approach.

Beyond the fact that all methodological approaches have their limitations, this SLR follows the structured procedures that provide a systematic approach and thus ensure objectivity. The validity

Table 4. Literature selected schematized and categorized by a systematic approach.

	Factors affecting digital adoption in AVCs of small-scale farmers			
Articles	Economic factors	Political factors	Social factors	Governance and institutional policy implications
Awuor et al. (2016)			x	x
Bayer (2018)			x	
Begashaw et al. (2019)	x	x		x
Boateng et al. (2017)	x			
Bukht and Heeks (2018)	x	x		x
Constantinides et al. (2018)	x		x	
Corallo et al. (2018)	x			
Deichmann and Mishra (2019)			x	x
Deichmann et al. (2016)	x			
El Bilali and Allahyari (2018)	x		x	
EIP-AGRI (2017)	x		x	x
FAO (2013)	x		x	x
FAO and AUC (2018)	x			
FAO et al. (2018)	X	X	X	
Foster and Heeks (2015)			x	x
Gaiha and Mathur (2018)				
Graham (2019)	x			x
GSMA (2018)	x		x	
Habiyaremye et al. (2019)		x		x
Heeks (2018)				
Heeks (2016).				x
Horner and Alford (2019)	x	x		x
Jackson and Weinberg (2016)	x			
Joiner and Okeleke (2019)	x		x	
Kanoktanaporn et al. (2019)		x		x
Loukos and Javed (2018)	x		x	
Maru et al. (2018)			x	
Mattern and Ramirez (2017)	x			
Matto (2018)			x	
OECD (2019)	x			
Ospina and Heeks (2016)			x	
Quinones et al. (2017)				
Sealey (2018)	x			
UN (2019)				
Vroegindewey and Hodbod (2018)			x	
Wisdom et al. (2018)	x		x	

condition was attained by following the formal recommended steps for an SLR by Cooper (2010), while reliability was addressed by having all the formal procedures conducted by myself. The next step analyzes and integrates the outcomes of studies, interprets the evidence, and presents the results, to find consistencies and common patterns. This would help to determine categories to review and determine the factors affecting the adoption of digital technology in AVCs of small-scale farmers.

4.4. Analyzing and integrating the outcomes of studies

4.4.1. Economic category

The first group of papers identified the economic category that influenced digital technology adoption in AVCs by small-scale farmers. The contribution of the authors within this line is that they analyze the whole value chain as an economic unit, with a common business goal. A group of authors focuses on the influence of the mobile industry in providing digital technology solutions. In this line, the GSMA Agri-tech brings together and supports the mobile industry, agricultural sector stakeholders, innovators, and investors. The program improves and scales impactful commercially viable digital solutions for small-scale farmers. In Ghana, opportunities in AVC digitization were

implemented to foster sustainable and scalable mobile services to improve livelihoods (Loukos & Javed, 2018).

In a similar line of analysis Wisdom et al. (2018) plus Mattern and Ramirez (2017) argue that digital technology is opening new avenues for agricultural actors to access capital and other financial services which have historically been limited. In agriculture, e-Money can be a good fit for applying a digital solution to the chronic challenge of financial exclusion (Jackson & Weinberg, 2016). Certain authors show how digital technologies can support trade in global AVCs, concerning market access, traceability, and trade facilitation (El Bilali & Allahyari, 2018; OECD, 2019).

Begashaw et al. (2019) propose that African small-scale farmers need to adopt new production strategies that will increase income and make farming more appealing to the next generation. This could include precision agriculture as a food production model in food processing, distribution, and consumption (El Bilali & Allahyari, 2018). Joiner and Okeleke (2019) examined the market opportunity in agriculture e-commerce and found key trends, business models, and recommendations for stakeholders to maximize the opportunity.

Finally, within the economic category, papers were found that focus directly on competitiveness at an economic level. A few authors concluded that digital solutions could address a wide range of gaps and inefficiencies in AVCs such as information sharing and analytics, access to markets, access to finance as well as tracking and traceability (El Bilali & Allahyari, 2018; FAO, 2013; FAO & ITU, 2017; GSMA, 2018; OECD, 2019). Returns on agricultural research and digital technology involve impact on crop and livestock, economic growth, natural resource management, nutrition, poverty reduction, and food security (Gaiha & Mathur, 2018). The Connected Farmer Alliance (CFA) creates solutions to supply chain efficiencies, linking farmers to commercial markets while facilitating productivity improvements (OECD, 2019).

4.4.2. Political category

The second group of papers identified political factors that influenced digital technology adoption in AVCs of small-scale farmers. This is a perspective that is centered on how governments interact with the digital adoption of the AVCs. Horner and Alford (2019) argue that although private global firms played a defining role in the governance of global value chains (GVCs), the state still has a role to play in the broader institutional context shaping GVCs.

In a similar line, Habiyaremye et al. (2019) discuss the three domains in which the state plays a pivotal role in spurring inclusive rural transformation. This includes promoting agricultural innovation, supporting rural capacity building, and the provision of pro-poor innovations for rural social development. Joiner and Okeleke (2019) analyze what the role of governments is to support farmers' operational functions by creating an enabling regulatory environment to get donors and investors to invest in viable services that recognize local market conditions.

4.4.3. Social category

The third group of papers identified social factors that influenced digital technology adoption in AVCs of small-scale farmers to become sustainable. The value is derived for beneficiaries from more socially and environmentally sustainable activities. This implies that AVCs are producing value for society in social and environmental aspects, in addition to the creation of economic value. In line with this, Vroegindewey and Hodbod (2018) developed a framework and assessment approach that synthesizes knowledge from the social-ecological systems (SES), supply chain management, and value chain development literature. They argue that in conceptualizing resilience in AVCs, consideration should be given to the resilience of the social-ecological system and food systems. Ospina and Heeks (2016) developed RABIT (Resilience Assessment Benchmarking and Impact Toolkit) to benchmark the role of digital adoption in developing the resilience of small-scale farmers. Ospina et al. (2016) believe digital adoption can play an important role in impacting rural resilience for agricultural livelihoods against external stressors.

Furthermore, Awuor et al. (2016) propose that to meet the need for information for small-scale farmers, two strategies, namely community participation, and the collaborative approach need to be applied. Bayer (2018) similarly argues that digital solutions are more likely to succeed if farmers see them as relevant and trustworthy. This view is further supported by Wisdom et al. (2018) who motivate that the key to designing Digital Financial Services (DFS) is to understand what farmers value, for the products to have strong uptake and commercial success. Bayer (2018) further investigates the use of ICT for agriculture to empower rural women and youth to close the digital gender divide articulated by the 2030 Sustainable Development Goals (SDGs) agenda.

4.4.4. Governance and institutional policy implications category

The fourth group of papers looks at the importance of understanding the multidisciplinary nature of actors to build institutions, and governance rules to make sure digital technology is deployed to empower small-scale farmers. El Bilali and Allahyari (2018) investigate the broader institutional support needed on which the success of digital technology interventions depends. In line with this, Constantinides et al. (2018) investigate governance rules to allow digital platform participants to generate value for one another. Rose and Chilvers (2018) propose the need for a comprehensive development framework to assist in digital technology adoption in AVCs of small-scale farmers.

There is a need to explore the implications and identify positive and negative scenarios for society in general (Stugeon, 2017). Digital information, as one of the fuels of the new economy, needs to be better protected and governed to avoid advantaging rich over poor in the global economy (Graham, 2019). Thus, the following frameworks are investigated to understand the actors and governance factors that influence digital technology adoption in AVCs of small-scale farmers.

On a regional continental level, Kanoktanaporn et al. (2019) proposed "The Agricultural Transformation Framework (ATF)" as an Asian Productivity Organization (APO) initiative. The framework suggests a holistic approach to building the capacity of member countries to adopt modern technologies and best practices for farm-level transformation. They argue that governments should create public goods related to smart agricultural technologies that benefit most players, especially small-scale farmers.

Similarly, the European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI) (2017) goal is to accelerate the innovation process in the agricultural sector by bringing research and practice closer together in innovation projects. They propose Digital Innovation Hubs (DIHs) to facilitate access to markets by fostering connections between competence centers, the farming sector, IT suppliers, digital technology experts, and investors (EIP-AGRI, 2017).

Awuor et al. (2016) developed an integrated framework for digital adoption based on stakeholders' interests. They integrate information required by farmers from the diverse to a single information access point to provide timely, relevant, and accurate information to farmers. The Resilience Alliance's assessment framework and value chain analysis techniques can be integrated to outline an adaptable participatory approach for assessing the resilience of AVCs (Vroegindewey & Hodbod, 2018).

Deichmann et al. (2016) review the recent literature on corresponding digital technology impacts in the rural sector. They introduce a concise framework for describing the benefits of new digital technologies. Similarly, FAO and AUC (2018) present a framework for the Sustainable Agricultural Mechanization for Africa (SAMA). The framework outlines 10 priority elements that are mainstreamed into the agricultural development agenda for the continent.

5. Interpreting the evidence and presenting the results

Earlier in Section 2, an AVC was defined as a sequential process that converts raw materials and resources into products for the market. This allows a set of actors and activities to bring a basic agricultural product from production in the field to final consumption. To assess digital technology adoption in AVCs, it is important to understand the characteristics of agriculture produce, the

different farmer and customer segments, and the potential operational functions of a digital service. These factors underpin the cost structure of the service which, along with reliable revenue streams, impact the sustainability and scalability of a digital business (Joiner & Okeleke, 2019).

The digital economy is economic output derived solely or primarily from digital technologies based on digital goods or services (Bukht & Heeks, 2018). It has a focus on the activities of enterprises in telecommunications, digital services, software and IT consulting, hardware manufacture, information services, platform economy, gig economy, and sharing economy (Boateng et al., 2017). The digital economy thus consists of value creation digital information that enhances, replaces, or complements economic transactions in an ever-increasing amount of economic value creation processes (Graham, 2019).

Increased digital technology adoption in AVCs could help governments to increase the scale of transformation of small-scale farmers by connecting them to opportunities and benefits. The most important question in understanding who benefits relates to who controls, owns, and can access these new modes of economic production (Graham, 2019). Thus, platform governance must provide appropriate structures and incentives for value-creation and balancing openness and control among different stakeholders (Constantinides et al., 2018).

As an enabler digital technology may look good in the short term while delaying solving the real underlying problems (Deichmann & Mishra, 2019). There is a need to understand more about the motivations and implications across the range of actors (Constantinides et al., 2018). Thus, digital development requires a multidisciplinary approach to understand the increasing complexity caused by different stakeholder constituencies with different worldviews (Jokonya, 2016). Deichmann and Mishra (2019) argue that for us to make sure digital technology is deployed to empower the poor, the focus should be on strengthening the business environment, improving skills development, and holding the public sector accountable.

Digital technologies can transform agriculture where many promising examples of positive impacts have not often scaled as expected (Deichmann et al., 2016). Therefore, it is important to understand the multidisciplinary nature of actors to build institutions and governance rules to make sure digital technology is deployed to empower the poor. This justifies the need to understand the different economic, political and social factors affecting digital adoption in AVCs of small-scale farmers, which is discussed next.

5.1. Economic Factors affecting the adoption of digital technology in AVCs

Digital technology interventions can lead to positive economic outcomes such as reducing costs as well as increasing productivity and profitability. Connecting small-scale producers to markets can reduce transaction costs in their AVCs (El Bilali & Allahyari, 2018; Joiner & Okeleke, 2019). These digital interventions address a wide range of gaps and inefficiencies such as information sharing and analytics, access to markets, access to finance plus tracking and traceability (El Bilali & Allahyari, 2018; FAO, 2013; FAO & ITU, 2017; GSMA, 2018; OECD, 2019). Food traceability systems and digital technology tools have become very important for risk management to support compliance with food safety regulations (FAO, 2013; FAO & ITU, 2017; OECD, 2019). They track food through a supply chain for downstream consumers to pinpoint origination (Deichmann et al., 2016; El Bilali & Allahyari, 2018; FAO, 2013). AI and blockchain are digital technologies that assist to support compliance with traceability regulations for exports (OECD, 2019).

Digital payments are the entry point of any digital intervention in AVCs (GSMA, 2018) where the three barriers to achieving a holistic approach are providing financial services, improving the efficiency of financial transactions, and improving market opportunities (Jackson & Weinberg, 2016; Mattern & Ramirez, 2017). Small-scale farmers have historically contended with limited access to capital and other financial services. Digital technology is opening new avenues for financial service providers to apply a digital lens to the chronic challenge of financial exclusion (Wisdom et al., 2018). Digital technology adoption can provide better access to payments, credit,

or collateral management (FAO, 2013; Joiner & Okeleke, 2019) as it facilitates fast and secure payments for products, inputs, agricultural subsidies, and remittances (Deichmann et al., 2016). Digital innovation can shape financial services by offering more tailored products to small-scale farmers to meet their distinct needs and capabilities (Deichmann et al., 2016; FAO, 2013; Joiner & Okeleke, 2019).

Digital technology intervention enables efficient logistics to optimize supply chain management, enhance coordination of transportation, and improve capacity utilization (Deichmann et al., 2016). Digital marketplaces create solutions to supply chain efficiencies by strengthening external market linkages for buying or selling various inputs, goods, and services (FAO, 2013; Maru et al., 2018; OECD, 2019).

Digital technologies can increase knowledge through new ways of providing extension services for small-scale farmers (Deichmann et al., 2016; Joiner & Okeleke, 2019). Precision agriculture can integrate many ICTs in food production and down the value chain such as food processing, distribution, and consumption (El Bilali & Allahyari, 2018). Digital technology enhances farm productivity as it facilitates the adoption of improved inputs, weather forecasts, and encourages agricultural investment decisions (Deichmann et al., 2016).

5.2. Political Factors affecting the adoption of digital technology in AVCs

In GVCs, the state, in its four roles as facilitator, regulator, producer, and the buyer, can have a key influence in AVCs of small-scale farmers related to each role (Horner & Alford, 2019). The three domains where the state can play a pivotal role in spurring inclusive rural transformation are promoting agricultural innovation, supporting rural capacity building, and the provision of pro-poor innovations for rural social development (Habiyaremye et al., 2019).

It is important to understand how the state matters in GVCs as it does not act in an institutional vacuum. In the past, the state has assumed the role of facilitator, while recently it has become visible as a regulator. On the other hand, the role of the producer has been neglected and the state plays a hidden role as buyer (Horner & Alford, 2019). The state operates at different levels and enacts different strategies which can have positive or negative outcomes within a country that create inequality (Habiyaremye et al., 2019). The role of the state as a facilitator can assist AVCs with the challenges of the global economy; as regulators, put in measures that restrict the activities of firms within GVCs. As producer have state-owned firms which compete for market share with other firms and as buyer purchase the output of small-scale farmers using public procurement. These distinct VCs' roles may be shaped by economic, social, or environmental requirements (Horner & Alford, 2019).

The government should have a strong commitment to invest in smart agriculture and create public goods related to smart agricultural technologies that benefit most players, especially small-scale farmers (Kanoktanaporn et al., 2019). The state can harness innovation policy to enhance agricultural production methods and intervene by promoting capacity building for inclusive transformation and by ensuring the provision of pro-poor social innovations (Habiyaremye et al., 2019).

5.3. Social Factors affecting the adoption of digital technology in AVCs

In Africa, demographic pressures and climate change make it almost impossible for smallholder farmers to have a livelihood. On the other hand, urbanization and economic growth are creating new markets for fresh and processed foods in the region. Overcoming the challenges of rural poverty and vulnerability requires transforming small-scale farms from subsistence operations into profitable, commercial-oriented businesses, as well as strengthening their links to growing food markets (Begashaw et al., 2019).

Resilient AVCs can be promoted through digitalization that would increase transparency while improving the communication of information, automation of processes, and documents (OECD,

2019). Digital technology interventions lead to positive sustainable environmental outcomes. These interventions increase the more efficient use of resources and inputs. They further reduce a negative environmental footprint, greenhouse gas emissions, and food losses to wastage (El Bilali & Allahyari, 2018).

Digital technology generates significant social value for investors, donors, businesses, governments, and other stakeholders around the key targets of the UN Sustainability Development Goals (SDGs) (Joiner & Okeleke, 2019). Social impacts of digital technology interventions include increasing transparency of food supply chains and making access to information easier for all food chain actors. The interventions further assist with food safety and foster networking among food chain actors that empower small-scale farmers by enhancing their connectivity (El Bilali & Allahyari, 2018). Digital adoption has the potential to improve rural households' food security, income, the value of assets through enhanced management practices and interventions through greater opportunities (Deichmann et al., 2016). They improve the livelihoods of farmers, boosts productivity, reduces wastage, and drives digital and financial inclusion in rural areas (Joiner & Okeleke, 2019).

Major barriers that contribute to social factors affecting digital adoption by small-scale farmers include the lack of digital technology training, awareness, poor infrastructure, and the high cost. To plan and implement sustainable digital AVCs models for small-scale farmers it is important to provide access for women and the youth. Digital innovations empower women and young farmers through better access to information about how to improve agricultural production and connect them to finance opportunities and markets (Bayer, 2018).

6. Governance and institutional implications for policy development

Digital technology adoption is touching upon all aspects of AVCs of small-scale farmers and emerging worldwide are the governance and institutional support needed to transform small-scale farmers to adopt digital technology in their AVCs. Digital technologies can empower small-scale farmers to transform their VCs into collaborative digital models with higher flexibility, agility, and sustainability. Selecting the most suitable digital technological solutions and reaping the maximum benefits requires collaboration as local silo-based approaches often fail.

I believe that to start a comprehensive approach to the digital technology implementation process in AVCs of small-scale is to identify the governance and institutional policy arrangements needed to guide digital adoption to reach its goal. This will enable small-scale farmers not only to grasp the untapped potential of their existing capability, but also to achieve higher productivity and create greater sustainability.

The right skill sets, processes, and tools must be in place for digital adoption to make AVCs of small-scale farmers stronger, more agile, efficient, and effective. To achieve these objectives, digital adoption policies must work on initiatives that will prepare them for the digital era. It is with this in mind that this section discusses the governance and institutional factors affecting digital technology adoption in AVCs of small-scale farmers.

6.1. Governance implications

Global Value Chains (GVCs) are shaped differently because not all states have the same power and capacity to establish and enact their various functions concerning GVCs. It is increasingly apparent that states do not just shape GVCs, but that their policy options are themselves shaped by GVCs (Horner & Alford, 2019).

To build resilience in AVCs it is important to identify the resilience of system components and the resilience of governing institutions. Thus, it is important to have the right application of the principles, assessment, or measurement approach and scope of participation (Vroegindewey & Hodbod, 2018). In today's global political economy, the centrality of the state and the relational dynamic between powerful private and public actors in GVCs should be recognized and explored

even further. This can provide crucial insights into how states, in combination with private actors, can and should govern GVCs (Horner & Alford, 2019). Governments must support farmer operational functions and create an enabling regulatory environment while donors and investors need to invest in viable services and recognize local market conditions (Joiner & Okeleke, 2019).

Digital technology adoption by small-scale farmers is influenced by data governance conditions plus the availability and quality of IT infrastructure (EIP-AGRI, 2017). GVCs are widely understood as comprising linkages between different actors. Practitioners and researchers must understand the power that some firms can exert on the actions and capabilities of small-scale farmers and trading partners (Horner & Alford, 2019). Integrated value chain models go beyond just connecting value chain actors as there is more information flow and control throughout the value chain (Jackson & Weinberg, 2016).

The state must play a pivotal role in supporting local capacity building and bridging knowledge gaps between innovation producers and rural communities to facilitate local absorption of external digital solutions (Habiyaremye et al., 2019). The state should support public- and private-sector institutions in conducting R&D and encourage private investment in affordable, low-cost technologies and services. Furthermore, it should facilitate information and data sharing, with adequate safeguards and protection of intellectual property rights through experiments and the launch of pilot programs before scaling up (Kanoktanaporn et al., 2019).

6.2. Institutional implications

Information sharing allows for the communication and receipt of information and knowledge between two or more actors. Information analytics conducts data analysis and communicates results to either external customers, partners or for internal reporting and efficiency (FAO, 2013). Digital platforms can be defined as a set of digital resources that include services and content to enable value-creating interactions between external producers, consumers, and third-party actors (Constantinides et al., 2018). These platforms are no longer defined by local institutional environments but allow them to combine knowledge across sectors (Quinones et al., 2017).

The European Innovation Partnership Agricultural Productivity and Sustainability (EIP-AGRI) (2017) argue that DIHs as an institution can play a key role in supporting the digital transformation in AVCs of small-scale farmers. These hubs can also promote cross-border, sub-regional, and regional collaboration where digital rural infrastructure must be improved, and agricultural support services strengthened. This will reduce costs and increase profitability by expanding the supply and effective demand (FAO, 2018).

The success of digital technology interventions depends on broader institutional support to facilitate political empowerment, human capital development, and address income inequality (El Bilali & Allahyari, 2018). According to EIP-AGRI (2017) institutions such as Digital Innovation Hubs (DIHs) intend to facilitate access to markets by fostering connections between competence centers to support the small-scale farming sector, IT suppliers, digital technology experts, and investors. The six "building blocks" of an ideal are competence centers, advisers/innovation brokers, start-ups, entrepreneurs, SMEs, public/private investors, regional/national authorities, and the farming community (EIP-AGRI, 2017).

The digital transformation of the global food system provides new ways of engaging and involves new actors participating in international AVCs. It is important to understand your trading partners as digital trade platforms allow the entry of new actors in AVCs (OECD, 2019). All stakeholders who participate in agriculture must formulate the digital AVC institutional model. Stakeholders in this context are farmers, government, research institutions, international organizations, and financial institutions (Awuor et al., 2016).

For agricultural transformation to be inclusive and conducive to growth, a coordinated strategy is necessary to address all the issues simultaneously. Strategies in other sectors need to align with strategies in agriculture, and appropriate infrastructure can be linked to these sectors. This strategy could

provide an effective means of reducing rural poverty and promoting economic growth (Begashaw et al., 2019). Thus, next is the need for farmer-centered participation and collaboration to address the institutional and governance issues when developing policy to adopt digital technology in AVCs of small-scale farmers is discussed.

7. Discussion: the need for farmer-centered participation and collaboration when developing policy

This study is part of a broader project to construct a comprehensive framework that is systemic, inclusive, and socially responsible to guide the adoption of digital innovation to facilitate sustainable small-scale agriculture development in South Africa. To understand this phenomenon, this study was conducted with two objectives. The first was to identify and understand the factors affecting digital adoption in AVCs of small-scale farmers, using a systematic literature review. The second objective of the study was to explore the governance and institutional implications that need to be considered when developing policy to support digital adoption in AVCs of small-scale farmers. These build on earlier literature that is more general and applying this to small-scale farmers in South Africa. To address this objective, the literature is examined using keywords such as digital development, technology adoption, agriculture value chains, small-scale farmers, institutions, governance, social factors, political factors, and economic factors.

When adopting digital technology, a country's policies and its broader regulatory environment must be considered (Bayer, 2018). The study suggests the importance of the role of the state, the participation of the farmers, and the need for collaboration when developing solutions for digital technology adoption into AVCs of small-scale farmers.

The central goal is to improve the enabling policy environment to enhance investment capital into climate-smart-agriculture enterprises and projects (FAO, 2013, 2018). This should include canvassing international fora to develop a common understanding of the principles of digital technologies for sustainable production and innovation. Further to this, the development of digital platforms and programs should promote good policy practices for digital adoption in agriculture by identifying a gap for action (FAO et al., 2018).

Agricultural policy in agrarian African countries should make domestic agriculture more competitive, both domestically and globally, with the rest of the world, especially in terms of quality (Begashaw et al., 2019). The government should create an enabling environment for the growth of the digital services industry and scale-out the establishment of rural telecenters (Matto, 2018). Policies must ensure that effective procedures are in place by removing legal and regulatory constraints. There should be direct support to companies providing digital technology services support to small-scale farmers (FAO, 2018).

Government policy can enhance the widespread adoption of appropriate technologies for agriculture, the environment, and risk management. Policy issues on digital technology in agriculture should increase productivity growth and improve the sustainable use of land, water, and biodiversity resources (FAO et al., 2018). They should create awareness among smallholder farmers on the opportunities that digital technology adoption offers, such as timely access to agricultural information from credible sources (Matto, 2018).

Currently, there is a need to strive for more socially-just distributive outcomes due to the highly uneven outcomes and considerable income inequality within countries (Horner & Alford, 2019). To develop an integrated, inclusive, and equitable global food system, countries should promote policies and practices that provide opportunities to small-scale farmers, rural families, women, and young people in the agro-processing industry (Begashaw et al., 2019). Innovations in digital AVCs can make agriculture more attractive to the youth who are well placed to benefit from the opportunities. They are more open to new technologies as the more complex

digital technology requires more training and qualified extension support to ensure successful outcomes (Bayer, 2018).

From experience, this study agrees with Bayer (2018) that digital solutions are more likely to succeed if small-scale farmers see them as relevant and trustworthy. Thus, there is a need for the establishment of DIHs that are problem-oriented, with farmer needs as the key driver, to be serviced by advisors and innovation brokers to connect people. Thus, next follows a discussion on the need for collaboration and participation among small-scale farmers when developing policy to facilitate uptake of digital technology solutions.

7.1. Collaboration and participation

The key to designing digital AVCs solutions is to understand what farmers value, for the products to have strong uptake and commercial success (Wisdom et al., 2018). Meeting farmers' information needs relies on two strategic approaches: the community participation approach and the collaborative approach (Awuor et al., 2016).

In the community participation approach, the farmers need to be made part of the process of designing and developing these digital technology solutions. Government support coupled with greater participation of local community members in the planning and implementation of innovative projects proved to produce a greater potential for success (Habiyaremye et al., 2019). The collaborative approach requires that since farmers' information needs are vast and cannot be provided by one source, there is a need to ensure that all the information providers share a common goal of providing the information within their jurisdiction promptly (Awuor et al., 2016). The choice of digital technology adoption in AVCs depends on the local market and how it balances these considerations to build trust and increase user loyalty (Joiner & Okeleke, 2019).

Awuor et al. (2016) propose enhancing cooperation among the stakeholders to complement each other and ensure that the individual interests are met. Business models must fit local market conditions to maximize the digital AVC's business opportunity that requires scalable and sustainable business models (Joiner & Okeleke, 2019). Agriculture stakeholders should foster collaboration and knowledge sharing while promoting the creation and adaptation of content in local languages and contexts to ensure equitable and timely access to agricultural knowledge by resource-poor farmers (FAO et al., 2018). For meaningful improvement to occur, digital AVCs need to reach critical mass, otherwise, digital liquidity would be small and temporary (Jackson & Weinberg, 2016). Agriculture stakeholders need to support inclusive, efficient, affordable, and sustainable digital technology services by promoting public–private partnerships in cooperation with cooperatives, farmer organizations, academia, and research institutions (FAO et al., 2018).

To reduce uncertainty and justify investment into information analytics processes arrangements for data-sharing can be made among AVCs partners. In the beginning, data-sharing should be a core component of business models to drive collaboration and maximize the benefits and value of data collection and analysis (FAO, 2013). In-depth research allows digital AVCs implementers to assess the barriers to improved procurement performance and the competitiveness of farmers and buyers, as well as the potential of digital AVCs in addressing some of these limitations (GSMA, 2018).

Opinions and insights of this review can be used by academics and practitioners for applying digital technology adoption in AVCs of small-scale farmers. Hence, researchers and practitioners can extend this area of research by upgrading and transforming the AVCs of small-scale farmers into digital AVCs. Based on the review and findings of this study, the next section recommends future research around the implementation of digital technology adoption in AVCs. All other aspects of digital adoption in AVCs of small-scale should also be examined that could lead to the development of a localized implementation framework.

7.2. Contribution of the study to the theoretical framework

This paper is situated in the field of digital development and investigates how digital technology adoption can foster the development of the small-scale agriculture sector in South Africa. Digital technology intervention's role for development is not always clear and is often challenged by critical issues associated with social change improvement. By using the Capabilities Approach (CA) as the theoretical foundation, the systematic nature of the development process is recognized, and Kleine's Choice Framework (CF) is used as the evaluation framework for this study. The CF that operationalizes the CA was used as a multidimensional theoretical window to examine academic journals and industrial reports from online databases.

Aspects of structure can be illustrated with examples found within the research findings. For example, political factors that create a structural barrier are the non-existence of appropriate policies and programs to facilitate awareness and training to encourage the use of digital technology among small-scale farmers. Furthermore, the inadequate laws and informal laws that regulate the affordability of purchasing and accessing digital technology led to the high cost. This creates structural impediments in terms of access to digital technology. Low awareness of the potential of digital technology use to improve the sustainability of small-scale farmers because of insufficient government policies or programs is also a structural barrier. Implementing policies and programs to establish rural digital technology hubs to act as extension services to small-scale farmers can be an example of a structure that could facilitate the use of digital technology in the small-scale agriculture sector.

Similarly, there are many types of agency resources that can affect a small-scale farmer's level of digital technology adoption, and subsequently, the influence it has on their degree of empowerment. For example, the lack of infrastructure resources can create a hindrance for small-scale farmers to use digital technology. There are also other limitations of various other resources that include insufficient financial resources and a low level of literacy that is coupled with a lack of training. Variations of development outcome can have different outcomes among participants who share similar structure and agency resources.

The CA has shown that when developing small-scale farmers, the structure (political, social, and economic factors) that exists could influence the choices of small-scale farmers that can lead to certain development outcomes. The development outcomes can make small-scale farmers' agency better, which can again lead to better utilization of structure. The utilization of structure can also influence a small-scale farmer's agency. How structure and agency interact can produce choices, and such choices can lead to further development outcomes.

For development outcomes to be achieved, there must first exist the possibility of a choice for small-scale farmers. Secondly, they must have a sense of the availability of that choice. Thirdly, they must make use of the option to choose and finally achieve an outcome. When small-scale farmers choose to use or not to use digital technology, it would make them achieve the primary outcome which is the "achievement of choice". These dimensions of choice have an impact on the nature and extent of development outcomes.

Having secondary development outcomes like easier communication and increased knowledge can lead to others such as better access to markets, business ideas and increased income. Thus, to achieve development outcomes can increase the capabilities of resources under agency. If small-scale farmers can increase the achieving of functionings such as easier communication using digital technology, they can impact their resources within agency and thus increase their potential functionings. Just as some development outcomes influenced agency resources so too, they have the potential to influence structure.

8. Limitations plus areas for further research

This SLR identifies economic, political, and social factors affecting the adoption of digital technology in existing digital AVCs of small-scale farmers using the Choice Framework as a theoretical lens. The

study tried to understand the factors involved in the design and use of institutions that can assist with the governance of digital adoption in AVCs of small-scale farmers. It further highlights the governance and institutional implications for policy to support these digital AVCs to become more resilient against economic stresses or disasters. It summarizes prior research on digital technology adoption in AVCs of small-scale farmers, critically consolidates, and examines the contributions of past research. However, this paper has several limitations that include:

- A systematic literature review methodology has been used in this paper where databases are searched separately before the analysis. A different approach could have been used for collating these documents found in databases.
- The theoretical lens used needs more detailed development as there may be additional dimensions that should be considered, and other concepts and relationships needed in such a multidimensional framework.
- Literature in this review is based mainly on findings from academic journals or industrial reports and academic journals. Had the category of literature been expanded, it could have enhanced this review's findings.
- Findings are based on the search of databases using keywords. This is sensitive as slightly different input studies could have given significantly different results.
- The period for this review spanned the last 6 years (2014–2019). This is demonstrative of the related literature on digital technology adoption in AVCs for small-scale farmers. Expanding the period of the review could have made it more comprehensive as it still may not be exhaustive.

Not forgetting the limitations, the following future research trends on digital adoption in AVCs of small-scale farmers are based on an elaborate literature review as well as the past working experience of authors. Based on the findings of the present study and experience gained in working with digital technology adoption projects in AVCs of small-scale farmers several research questions are suggested. They can address some of the challenges in developing a comprehensive localized implementation framework for digital adoption in AVCs of small-scale farmers. Some key questions that could be addressed in the research agenda for digital adoption in AVCs of small-scale farmers include:

- To identify the best practices together with agricultural knowledge and information needs using baseline studies, surveys, and needs assessment.
- Market research focusing on standards, requirements, and certification to identify the pathway of information flow through the AVCs of small-scale farmers. Furthermore, understanding what the most effective way is of reaching small-scale farmers with timely agricultural information and knowledge.
- Investigating the role of public–private partnerships in promoting digital technology adoption through institutional building and infrastructure development.
- Understanding how the participation of women and youth in initiatives on digital technology adoption in AVCs of small-scale agriculture could be improved.
- To strengthen training and capacity building and identifying the minimum literacy level required by small-scale farmers to use available digital technology in AVCs.
- Understand the gaps that exist in the available digital technology policies to support small-scale farmers and how they can be improved. Ways to get the voices of small-scale farmers heard at the policymaking.

9. Concluding remarks

This study used an SLR to address two research questions that deal with digital adoption in AVCs of small-scale farmers, a topic of great interest to both practitioners and researchers. The results of this

study answer the questions such as what are the economic, political, and social factors that affect digital technology adoption in AVCs of small-scale farmers, as well as the implications for governance and institutional challenges for policy considerations.

The contributions of this study to the ICT4D research field are three-fold. Firstly, the study extends the existing literature on economic, political, and social factors that affect digital technology adoption in AVCs of small-scale farmers. Secondly, this study gives a more comprehensive understanding of institutional and governance implications for policy development. Thirdly the study also uses the Choice Framework as a theoretical lens when doing this SLR.

Digital technologies can enable small-scale farmers to reduce some constraints to participate in AVCs. Upstream it creates new access to agricultural extension and advisory services while downstream it reduces coordination costs and creates value addition opportunities (OECD, 2019). Mobile operators and other mobile money providers can adopt mobile money services and use partnerships to leverage assets and minimize liabilities (Joiner & Okeleke, 2019). What is learned through this SLR is that digital technology solutions targeted at small-scale farmers face significant challenges in maintaining viability. Digital technology services that target small-scale farmers in informal and disaggregated supply chains are sometimes not utilized fully and do not scale up to the extent expected.

With advances in digital adoption in AVCs, concerns about small-scale farmers have heightened. However, little has been done to understand the relative importance of these concerns and the factors affecting them. This study addresses this gap by exploring economic, political, and social factors affecting digital technology adoption in AVCs of small-scale farmers. This is done concerning governance and institutional implications for policy considerations. The results show that the role of the state in governance and institutional implications is more complex than previously thought. Given the complexity, small-scale farmers only rely on digital technology adoption once they trust it.

This work has reinforced previous findings that collaboration and participation of small-scale farmers are important in developing policy for digital technology adoption in AVCs. To prevent digital harm, stakeholders should collaborate when developing digital policy to promote digital inclusion and digital sustainability (Heeks, 2018; UN, 2019). The paper further argues that digital solutions to support small-scale farmers should be aligned to local conditions and centered around the needs of small-scale farmers. To deal with these challenges and negative impacts it is important to understand the local barriers and develop country-specific solutions. Hence, it is important to construct a comprehensive localized developmental implementation framework that can support the adoption of digital solutions into AVCs. This framework should be able to integrate AVCs globally, regionally, and nationally.

Digital technology can only address some of the barriers faced by farmers and although there are many promising examples of positive impacts, it often has not scaled up to the extent expected. The study also provides some insights into the factors influencing these concerns and future studies may examine these. Further research is needed to construct a comprehensive developmental framework that can be verified in a typical AVC of South Africa.

This encourages further research for the construction of a more complete theoretical framework dealing with digital technology adoption in AVCs of small-scale farmers. Thus, this work can serve as an aide to future digital development researchers in directing and focusing their work. To that intent, suggestions are provided for several future research directions that appear to have major gaps and require more examination. Those include investigating best practices; addressing challenges of markets standards, certification, and requirements; the role of public–private partnerships; participation of women and youth; strengthening training and capacity; and addressing the gaps that exist in available digital technology adoption policies in AVCs of small-scale farmers.

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No potential conflict of interest was reported by the author(s).

Notes on contributor

Hermanus Jacobus Smidt is studying towards a PhD in Information Systems. The PhD study seeks to review existing frameworks to understand the patterns of economic, political, and social transformation that may be associated with the digital development of small-scale farmers in South Africa. This paper is part of the study that aims to construct a more comprehensive framework that is systemic, inclusive, and socially responsible for responsible digital innovation to facilitate sustainable agriculture development in South Africa.

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