

Review

Systematic literature review of the role of e-commerce in providing pathways to sustainability for poverty alleviation in Sub-Saharan Africa

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Abstract

Poverty elimination by 2030 is the major initiative of the United Nations Sustainable Development Goals. However, poverty in Sub-Saharan Africa is rising. There is an absence of structural reform for transformational change across the region. E-commerce is an enabler of small and large businesses in developed economies. Community-led initiatives for poverty alleviation may benefit from the transactional capabilities of e-commerce for direct trade with suppliers and consumers. Well-structured small and medium-size enterprises (SMEs) can foster local innovation and entrepreneurship, and collaboration between SMEs can enhance product development and marketing strategies. This review aims to discover formal research into the application of e-commerce in sustainable development models for poverty alleviation in Sub-Saharan Africa, and the extent of innovation, entrepreneurship, and collaboration among SMEs. The review found an absence of formal research into theories and practical strategies for sustainability innovations across the low-income spectrum. Organizational structures have not been developed to stimulate outreach, to foster innovation and entrepreneurship, or to embrace technology. Further, there is limited discussion on the importance of collaboration for the sharing of knowledge and joint business activities, but there is acknowledgement that SMEs can provide spatially diversified sustainable development. This article proposes a framework for the implementation and management of networks of SMEs focused on the sustainable development of low-income communities.

Keywords Poverty · Sustainability · Sustainable development · Innovation · Technology · E-commerce · Entrepreneurship · Sub-Saharan Africa · Social media · Social networks · Collaboration

1 Introduction

Global efforts to eliminate poverty by 2030 under the United Nations Sustainable Development Goals [1] have been mitigated by increases in armed conflict, climate change, and the emergence of the COVID19 pandemic during 2020 [2]. It was estimated that an additional 100 million people may fall into poverty during 2020 due to COVID19 and a further 132 million by 2030 because of climate change [2]. However, prior to the pandemic, the rate of poverty reduction had slowed, and the World Bank [2] observed that Sub-Saharan Africa (S-SA) was a major contributor to this slowing. The number of people falling below the extreme poverty line of US\$1.90 per day was increasing because of population growth in the region [2].

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While there are differing approaches to forecasting poverty rates, there is a consensus that the elimination of poverty in S-SA Africa by 2030 is not achievable [2–5]. Lakner et al. [3] studied the relative impact of economic growth and inequality on poverty projections from 2019 to 2030. They concluded that a 1% decrease in Gini for each country reduced poverty by more than a 1% increase in GDP did. Economic inequalities across S-SA are high in comparison to other global regions and economic growth in isolation will not lower poverty [6]. Remedies to reduce inequality include the creation of better paid jobs, property ownership, removal of gender inequality, and the redistributions of taxes to improve schools and health services [3]. The nature of economic development varies across the region and the effects of foreign aid programs (FAP), foreign direct investment (FDI), and trade do not necessarily result in a reduction of poverty [7]. FDI in industries, such as mining, the banking sector, and telecommunications may not result in broad transformational change for the region [7–9]. Further, FDI and FAPs may operate in weak institutional environments and the impact on poverty may not be readily accounted for [8]. Anetor et al. [7] observed a positive, but inconsistent, correlation between trade and poverty reduction across the region.

Small medium enterprises (SMEs) have the potential to create many jobs over diverse sectors with greater geographic diversity [10–12]. However, there are challenges to the success of SMEs including lack of funding, poor management, skills deficits, absence of mentoring, inadequate infrastructure, and low demand for locally produced products and services [10, 12–15]. Corruption is also a significant factor in the operational structure and performance of SMEs in S-SA [16, 17]. Microfinance has played a role in the elevation of people out of poverty but there is limited evidence that it leads to the sustainability of SMEs [18]. The success of SMEs is highly dependent on skill levels and innovations of the entrepreneurs, and technology adoption [19]. While 65% of university graduates across S-SA are unemployed [20], the propensity for innovation and technology adoption is low [20]. Technology transfers have great potential to alleviate poverty despite not living up to full potential [21]. The issues surrounding failures to fully capitalize on the transferred technology relate to the process of the transfer, local support issues, poor “socio-cultural entrenchment,” and lack of adequate marketing strategies [21]. However, viable local business strategies may be established when drawing upon the immense body of intellectual capital available in Africa [20]. It is feasible to establish innovation or technology clusters that are linked and can share resources through collaborative networks to collectively develop locally and regionally relevant products from the core technology [22, 23]. This initiative is replicable, generalizable, and offers great potential for community-led programs for sustainability and poverty alleviation. Sashi [24] proposes the encapsulation of microfinance with strategic and market advice to allow entrepreneurs to make and sell products. This is an income enhancing activity and aligns with technology transfer programs [21, 22] and export-led initiatives [16, 22, 25].

Urquhart et al. [26] contend that while information and communications technology (ICT) may help to alleviate poverty, just how this can be done has yet to be fully developed. Urquhart et al. [26] frame social capital and knowledge within information technology to conceptualize interventions for poverty reduction. This framework suggests what Peffers et al. [27] describe as a systematic and iterative approach to the development of artifacts to address a problem, in this case poverty alleviation. However, viable theoretical constructs have not emerged to define a way forward for sustainable development programs for poverty reduction [26, 28–30]. Diga et al. [31] state that ICT policy interventions in Africa promote a techno-centric approach that places emphasis on economic outcomes and neglects other aspects of wellbeing, and they call for a more “contested, discursive policy environment.” Access to information then becomes essential for any meaningful public policy discourse. The dissemination of information is recursive within the ICT framework through different levels of media (radio, television, and social media) to inform and engage the community in such discourse. Gebremichael and Jackson [32] introduce the concept of “information poverty” to add to the complex nature of poverty and to identify a digital divide that is emerging as a delineator of poverty.

Laudon and Traver [33] define e-commerce as “digitally enabled transactions” for the purposes of transferring value and that e-commerce is part of a broader e-business definition that also includes transactions where no value is exchanged. E-commerce conjures thoughts of exchanges over the Internet, but this is not necessarily the case. Khavul and Bruton [28] describe how telecommunications and mobile payments have reduced transaction costs in making and receiving payments.

The focus of this systematic literature review (SLR) is to inform formal research into the roles of e-commerce, innovation, entrepreneurship, and collaboration in the development of sustainable models for community-led initiatives for poverty alleviation. This objective is encapsulated in the following research questions:

Research Question 1—Does electronic commerce provide pathways for sustainable development of low-income communities to alleviate poverty in Sub-Saharan Africa?

Research Question 2—What roles do entrepreneurship and innovation play in sustainable development in low-income communities in Sub-Saharan Africa?

Research Question 3—Does social media help guide sustainable development in low-income communities in Sub-Saharan Africa?

The significance of this research is in the development of a systematic approach to SME development in S-SA. SMEs hold the best hope for widespread economic, social, and environmental programs. These programs require a readily deployable financial, intellectual, legal, and technological framework within which local innovation and entrepreneurship can flourish. Each program can generate continuous real-time data to inform policy makers and investors on the progress of each SME, with measures of the impact on social wellbeing of the communities they serve. The significance of this research also lies in the idea that the digital divide can be closed through the actions of these communities rather than rely on the push strategies of government policies. Another benefit is that these communities become enumeration areas that are continuously reporting household information and obviate the need for expensive census and survey data collection in the future.

This SLR draws upon information systems research to propose a new approach to SME development that engages with regional, national, and global economies through e-commerce. This platform is inherently computational and data intensive. Hence, the contribution to theory arises out of data analytics and the real-time insights into generalizability of sustainable development programs and the wellbeing of all communities, not just poor communities. This SLR follows the guidelines prescribed by PRISMA 2020 [34]. Accordingly, the following sections cover methodology, search, results, discussion of results and contributions, conclusions, and future research.

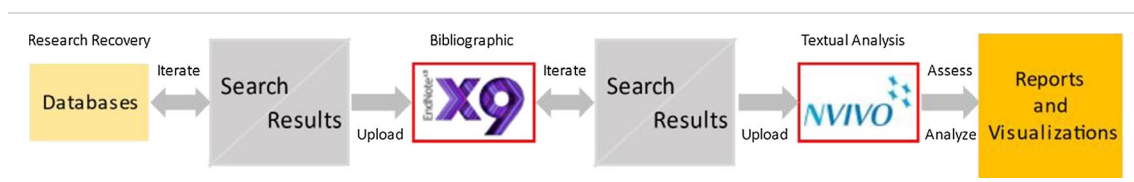
2 Methodology

The search for relevant articles was framed within the search process illustrated in Fig. 1. An iterative process is used to optimize the database search criteria to obtain a comprehensive collection of the most relevant and credible research articles. Articles are systematically recovered from the research repositories, each within proprietary query definitions. The combination of the bibliographic capabilities of EndNote and the textual analysis capabilities of NVivo facilitate meta-analysis and good record keeping at each iteration. Multiple tools, including Excel, Tableau, and custom code may be used for the visualization of the search outcomes depending on requirements. Excel is the main tool used in this SLR for visualizing search outcomes.

2.1 Search words and phrases

This SLR aligns with the terminology used in the United Nations Sustainable Development Goals [1]. While the terminology used by the United Nations is well-defined, observations in the professional literature indicate ambiguity. The following discussion addresses this ambiguity so that the search outcomes more precisely align with the research questions.

Poverty. Haughton and Khandker [35] define poverty in terms of wellbeing, inequality, and vulnerability. Wellbeing is expressed as levels for consumption of commodities, health, education, freedom, self-esteem, access to



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Fig. 1 Search Process

services, and transport above which a person, family, or a community can equitably function in the broader society. Inequality measures the distribution of incomes across the population as shown by the Gini Index (GNI). Vulnerability is the “risk of falling into poverty.” The people in this group are vulnerable to a significant event that may erode or eliminate their income earning potential. Poverty is multi-dimensional, difficult to define, and it varies across regions, and across countries. It is not to be confused with standard-of-living which is a broader measure usually related to per capita income and is subject to interpretation against measures of inequality [35]. However, poverty is more simply stated as the ability to purchase commodities [35] and is quantified as \$1.90 per day for workers and their families [36].

Sub-Saharan Africa. This is the list of countries in Africa defined by the Library of Congress [37] that lay south of the Sahara Desert. This SLR is focused on this list of countries, but broader areas of research that are applicable to this region may simply refer to *developing countries*.

Sustainable development and sustainability. Waas et al. [38] note that these terms are often used interchangeably. They also observed that research scholars often associated sustainable development with economic growth while sustainability also embraces social and environmental issues. Sustainable development is a process through which sustainability can be achieved [38]. Di Fabio [39] state that sustainability creates a balance between current and future aims [39], and hence is an outcome of sustainable development. Sustainability reflects resilience while maintaining dynamism for changing social needs. Because of the lack of consensus on the definitions for sustainable development and sustainability these terms are used interchangeably in the search for research articles. Otherwise, in this SLR, where the context permits, sustainable development refers to all actions and outcomes of initiatives that successfully transition to sustainability.

Information and communications technology or information and communications and technology. ICT, ICTs, or IT are terms commonly used to describe structural (such as telecommunications networks, data centers, Internet, and the Web), operational, and transactional aspects of information systems [40].

E-commerce or ecommerce or electronic commerce. These terms relate to “digitally enabled transactions” for the purposes of transferring value [33]. E-commerce falls under the umbrella of ICT and in this SLR both terms are used to search for the presence of electronic processing. In this SLR, e-commerce, where the context permits, refers to electronic commerce, ecommerce, or ICT.

Innovation. Refers to the propensity for solutions that improve wellbeing. The objective is to discover research that illuminates innovative solutions for potential generalization geographically and culturally. Innovation is usually a product of *entrepreneurship* and in this SLR a search for innovation may reveal entrepreneurship and vice versa.

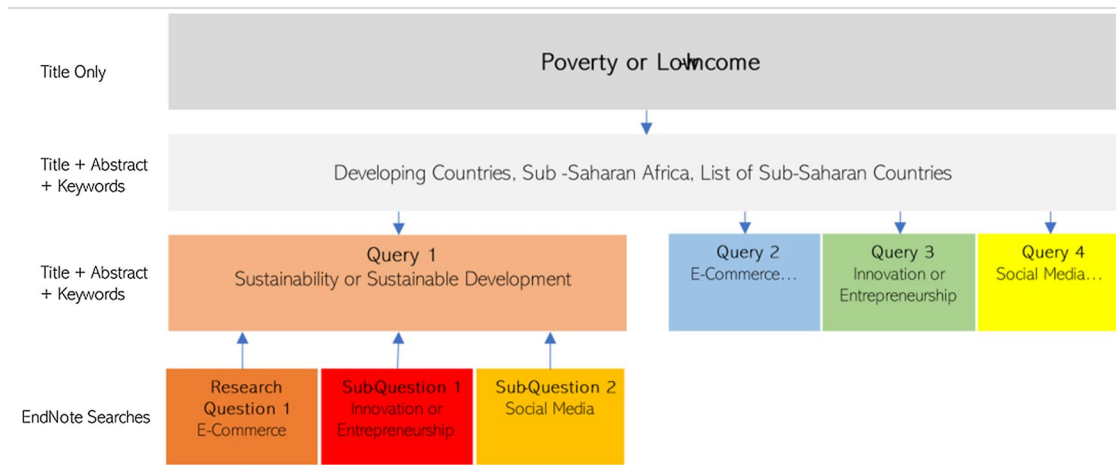
Social media. Social media is the substrate for the delivery of a wide range of information and communication services including social networking and the formation of special interest groups. The detection of the presence of social media may be indicative of collaboration, cooperatives, and working groups in sustainable development projects within communities and between communities. The absence of social media may be indicative of a digital divide and the lack of reach of ICT infrastructure and services to low-income communities.

These terms inform the construction of the key words and phrases used in the following search process. The objective is to search for articles that relate to research on poverty (or low-income) in Sub-Saharan Africa (or developing countries, or any Sub-Saharan African country) that accord with the concepts of sustainability (or sustainable development). The outcomes of this meta-search can then be searched for the specific requirements of the research questions.

2.2 Search process

Online databases, including Scopus, Proquest, Web of Science, ScienceDirect, and Sage, were investigated systematically with trial searches. Scopus and Proquest consistently yielded the most articles across all research questions. The search inclusion criteria required articles to be peer reviewed, published in journals or conference proceedings, English language, and published during or after 2000.

Figure 2 illustrates the hierarchy of the searches. Four queries were made on each of the Scopus and Proquest databases. Query 1 established the set of articles from which articles for each research question were drawn. Queries 2, 3,



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Fig. 2 Search Structure

Table 1 Database Queries

Query #	Title only		Title, abstract, and keywords		Title, abstract, and keywords
Query 1					
	Poverty	AND	Developing countries	AND	Sustainability
OR	Low-income	OR	Sub-Saharan Africa	OR	Sustainable development
		OR	(List of S-SA countries)		
Query 2					
	Poverty	AND	Developing countries	AND	Ecommerce
OR	Low-income	OR	Sub-Saharan Africa	OR	E-commerce
		OR	(List of S-SA countries)	OR	Electronic commerce
				OR	ICT
Query 3					
	Poverty	AND	Developing countries	AND	Entrepreneurship
OR	Low-income	OR	Sub-Saharan Africa	OR	Innovation
		OR	(List of S-SA countries)		
Query 4					
	Poverty	AND	developing countries	AND	Social media
OR	Low-income	OR	Sub-Saharan Africa	OR	Social networks
		OR	(List of S-SA countries)	OR	Collaboration
				OR	Social groups
				OR	Cooperatives

and 4 extract articles that do not have a requirement of sustainability or sustainable development in the search criteria. These queries are used only to highlight the differences between the respective outcomes from Query 1.

Table 1 shows the Boolean structure for each of the four queries referred to in Fig. 2. The mandatory inclusive search terms are shown horizontally (AND operator) with search word options shown vertically (OR operator).

This search process was applied systematically to the selected databases to recover articles that are relevant to the research questions. However, there are limitations that may have a material impact on the outcomes, these are discussed as follows.

Table 2 Database Query Results

For query #	Number of articles		
	Proquest	Scopus	Consolidation in endnote*
1	363	430	682
2	36	52	73
3	161	166	272
4	137	164	247

*Most duplicates are removed.

Table 3 Final Selection of Articles for Each Research Question

EndNote Search Criteria and Results for each Research Question	Query 1	Query 2	Query 3	Query 4
<i>Research Question 1 – Appendix A Table 1</i>				
commerce OR electronic commerce OR ICT	4	77		
<i>Research Question 2 – Appendix A Table 2</i>				
Entrepreneur* OR innovation	24		272	
<i>Research Question 3 – Appendix A Table 3</i>				
social media OR social network* OR collaboration OR social group* OR cooperative*)	9			247

*denotes a character that can be replaced by another character or string of characters in the search criteria, e.g., the characters "e-" preceding "commerce" allow for "e-commerce"

2.3 Limitations of the methodology

This SLR seeks to discover research literature on the roles of e-commerce, innovation, entrepreneurship, and social media in S-SA within the constraints of poverty or low-income, and sustainability or sustainable development. This is a narrow perspective that may preclude significant current activities in sustainable development. The databases chosen for the recovery of research articles were chosen purposively. Other databases may have contained publications that may have captured additional perspectives on the research questions. The searches were limited to peer-reviewed articles presented for publication in journals or in conference proceedings. This excludes research notes, book chapters, institutional reports (World Bank, International Monetary Fund, Organization of Economic Cooperation and Development, United Nations, National Statistics Offices), dissertations, aid agency reports, and reports by various government and private sector organizations. The term *e-commerce* is widely used in business and information systems contexts but is not necessarily a term that is widely used by consumers. Further, the research community is more likely to use a general term such as *ICT* without targeting e-commerce specifically. *ICT* discovers everything related to information, communication, and technology. E-commerce may be buried in terms like sales, purchases, merchant payments, or mobile money, and they may not be discoverable under the methodology of this SLR [41]. The following summarizes the results of the searches and lists relevant articles for each of the research questions.

3 Search results

The literature search was conducted in two phases. The first phase searched the Scopus and Proquest databases with Queries 1—4 structured in accordance with Table 1. Table 2 records the number of research articles returned for each query on each database. Eight files were created in readiness for uploading to Endnote.

The second phase of the literature search involved the uploading of the 8 query files from the first phase to Endnote to create 4 consolidated library files as shown in Table 2. The Endnote upload and consolidation process

eliminated many duplicates. The consolidated Query 1 library in EndNote was then searched using the queries shown in Table 3 and by manual selection to eliminate any undetected duplicates and off-topic articles. EndNote also searches for the PDF of the full text for each article and attaches it to the article record in Endnote. This was not always successful, and the remaining PDFs were extracted manually from the journals. The results of Queries 2, 3, and 4 are included in Table 3 to highlight the restriction of adding *sustainability* of *sustainable development* in the Query 1 search criteria.

The Table 3 Query 1 articles with attached PDFs for each research question were uploaded to NVivo for further analysis. NVivo was used to study the prevalence of the Table 3 search words in each article and to eliminate any articles that did not contribute appreciably to the research questions. Appendix A Tables 6, 7, 8 list the articles returned from the Table 3 Query 1 searches and refined using NVivo. The Query 1 consolidated library was also searched with keywords such as *agent-based*, *big data*, *data analytics*, *socio-technical*, *machine learning*, *artificial intelligence*, and *design science research* to retrieve any research articles on potential theoretical and evidence-based frameworks supporting the research questions. The results of these queries are shown in Appendix A Table 9. The following is an assessment of the quality of these articles in terms of their potential contribution to the research questions.

4 Assessment

Each of the files for the research questions were analyzed using NVivo. The purpose of this step was to provide a very high-level assessment of the frequency of occurrences and contextual significance of the search words and phrases in the articles to give a broad view of the quality and relevance of their content to the research questions. Other textual searches were performed to test for the presence of omitted relevant keywords/phrases. Figure 3 summarizes the search results across all articles for all research questions across. As an example, Fig. 3 shows there were a total of 948 occurrences of the search word *innovation* in a total of 19 articles. The keywords/phrases for Research

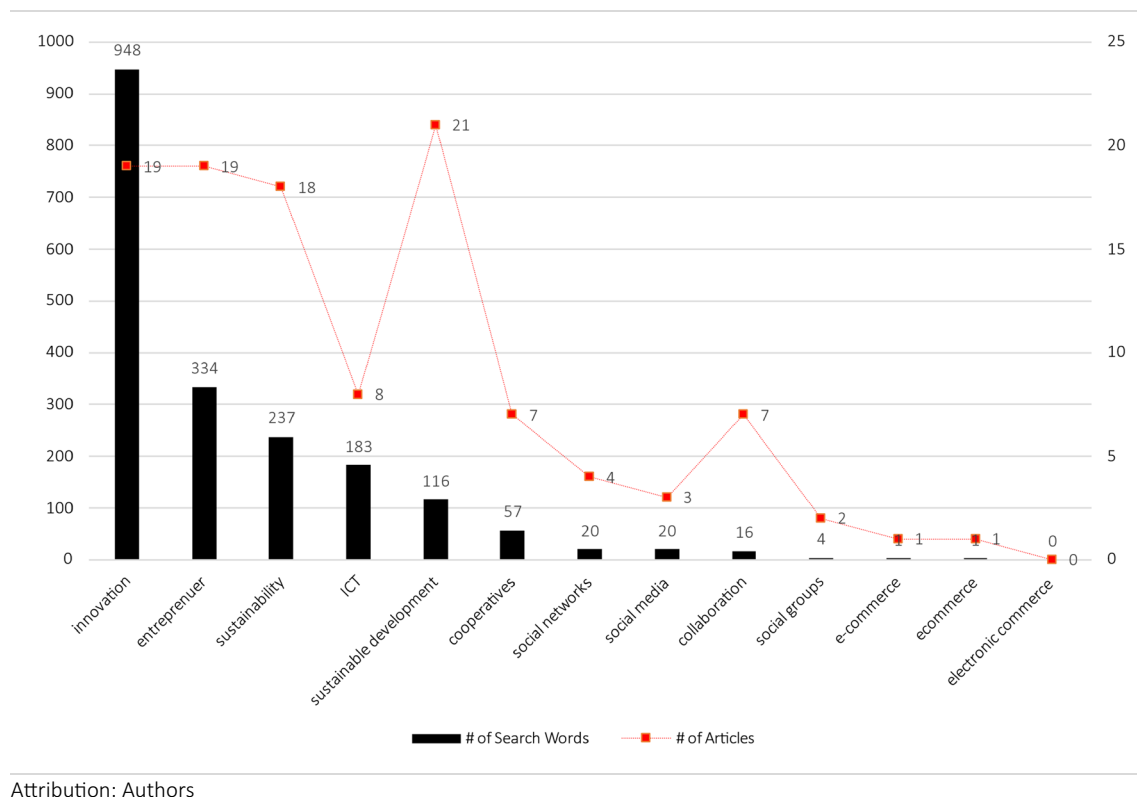
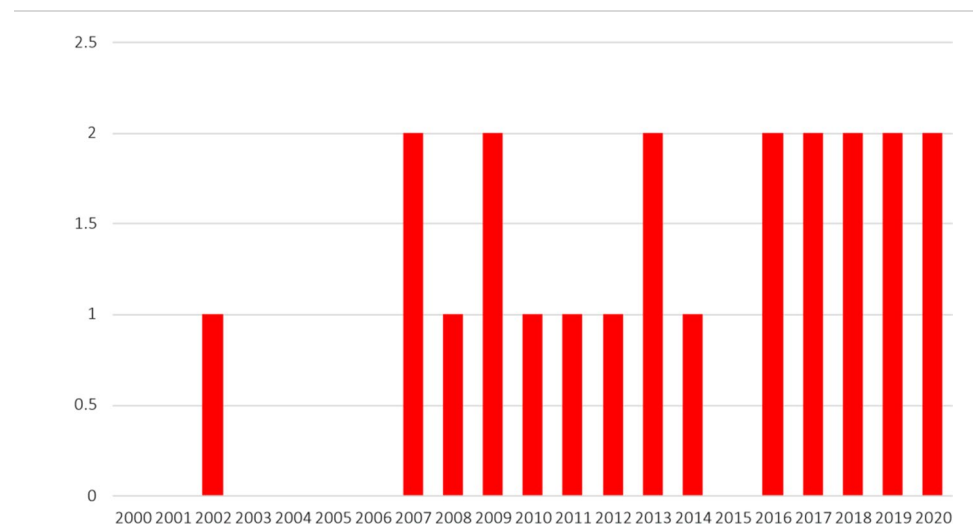


Fig. 3 Distribution of Search Words/Phrases in All Research Articles

Fig. 4 Year of Publishing of All Articles

Attribution: Authors

Question 1 are not well represented. 183 references to *ICTs* appeared in a total of 8 articles of which only 4 were selected for review. This may indicate a research gap or the presence of a lack of access to the Internet in low-income communities. There are almost zero references to *electronic commerce*, *ecommerce*, or *e-commerce*, the primary focus of Research Question 1.

The sources of the articles were examined for diversity. Were articles drawn from a narrow journalistic point of view, and are the journals credible? Appendix B Table 1 lists 19 journals and 3 conference proceedings from which the final list of 23 articles were recovered. The chronology of the final set of articles shown in Fig. 4 indicates only a moderate interest in this research area over the past decade. There is considerable diversity in the sources of articles. The reasons for this were not researched. The proliferation of journals is taken as a positive indicator of intellectual diversity but there is a potential research gap in the literature within the search criteria. The impact factors were not available for all journals and no conclusions were reached under any merit classification.

5 Analysis

The literature search process was sensitive to any evidence of structural form and organizational management of poverty alleviation initiatives. Such structures are a necessary precursor to the implementation of e-commerce strategies and to the collection and dissemination of information on the social, economic, and environmental outcomes of the initiatives. There is no current systematic approach to sustainable development for poverty alleviation in S-SA [26, 28–30]. The following discussion identifies broad structural issues across S-SA with examples of initiatives to address aspects of these structural deficiencies. There is an absence of a coordinated effort to develop cross-border trade and community-wide sustainable programs for the region.

5.1 Research question 1

Appendix A Table 6 lists 4 articles that discuss poverty, sustainable development, and ICT in a variety of contexts that address Research Question 1. ICT related topics in these articles covered areas such as information/knowledge/education, infrastructure, Internet accessibility, and social networks. However, apart from acknowledging that poverty was a serious problem facing millions of people and that ICT could play a pivotal role in its alleviation, the results did not form a consensus on a systematic approach to how ICT could be effectively deployed to meet this challenge. Further, Appendix A Fig. 9 highlights the almost complete absence of e-commerce from the research discourse. ICTs include numerous manifestations of information and communications technologies and systems. ICTs are often referred to as a top-down paradigm driven by policy initiatives to extend reach into society. It is the boundary of this

reach that is often referred to as the digital divide. For ICTs to be relevant to sustainable development they must be transactional as well as informational. Each of these presents additional “divides.” Negash [42] introduce the concepts of the information divide which denies access to relevant information, the skills divide which relates to learning, and the economic divide which limits employment and business development.

How can information motivate innovation and entrepreneurship in communities that are profoundly poor, and survival is a daily struggle? How can the transactional capability lead to a more sustainable existence? Access to the bewildering world behind an Internet connection is not osmotic for these communities. In a domestication of ICT study in urban slums in Nairobi, Kenya, Wamuyu [43] learned that few households had access the Internet. To connect to the Internet a computer or smart phone or other mobility device is required, and there must be an affordable public Internet access point. The most common Internet access point for low-income communities is the mobile telephone service. Other Internet access points are combinations of shared and dedicated wireless and cable connected services, but these need substantial physical infrastructure within the service area. Even if access to the public Internet service is free, a computer or smartphone may not be affordable. Further, the lack of ICT skills and digital literacy will limit the usefulness of Internet access. Wamuyu [43] also noted that many children from low-income areas attended schools without Internet access. Michael-Onuoha et al. [44] contend that libraries can provide a range of services including ICT skills development, mobile information services, consulting, and agricultural information services to contribute to sustainable development and poverty alleviation. Negash [42] also approaches ICT in sustainable development of low-income communities from an educational perspective. However, no insights were gained into any sustainable development programs within urban low-income areas that utilized e-commerce or any other Internet service driving economic development.

Skuse and Cousins [45] similarly discuss the cost of access to telecommunications services in a low-income rural area in South Africa. Rural areas have various levels of coverage and there are provisions for communities to build and operate their own local networks. Skuse and Cousins [45] observed that the cost of access and the inability of poor people to participate in small telecommunications enterprises may worsen the poverty crisis. The cost of access and the use of the Internet as a service is beyond the reach of the rural poor in most instances. There are exceptions if they receive remittances from family members who have migrated to urban areas [45]. Skuse and Cousins [45] suggest welfare payments to lift qualifying households out of poverty and briefly refer to initiatives under the sustainable livelihoods approach (SLA) [46]; but there was no mention of any substantive poverty alleviation initiatives where ICTs were an enabler of

Table 4 Summary of Research Themes

SMEs	Importance of small business in employment generation and poverty alleviation
Local Partnerships	Discussion on local business ecosystems and the importance of developing local partnerships to help gain local acceptance of new products and development initiatives
Corporate Social Responsibility (CSR)	Alignment of core business activities to better serve poor communities
Microfinance	Effectiveness of microfinance. The impact of opportunist intermediaries and the actual cost of money
Housing Innovations	Concepts of lean housing construction techniques for low-income families and rapid deployment of building projects
Women Entrepreneurs	Role of women social entrepreneurs in education, economic growth, and empowerment of vulnerable people
Law Reform	The need to address legal structures that reflect local business and cultural needs
Foreign Venture Capital	Investment in locally developed technical innovations
Research and Development	Research and development of products that are more affordable and meet the needs of low-income markets
Bridging the Skills Gap	Focuses on the gap between vocational training and the skills required of entrepreneurs. Example of failure
Vulcanizing	An innovation to solar power a compressor to inflate tires at the roadside
Education	Role of libraries in Nigeria to bridge the knowledge gap for ICTs
Sanitation	Discusses the need for management of sanitation facilities in low-income communities. An interesting introduction of socio-technical transition theory (STTT)
Socio-Technical Transitions	Discussion on the application of sociotechnical transition theory in the transition to sustainability of low-income communities
Transportation	Low-cost transportation for low-income communities

economic development. An informal review of more contemporary literature and media reports since 2007 indicates that rural telecommunications coverage and Internet access in South Africa is still problematic.

5.2 Research question 2

Appendix A Table 7 lists 16 articles on entrepreneurship and innovation that address Research Question 2. These articles cover a diverse range of subject matter summarized in Table 4. The articles offer insights to the importance of innovation at a local level and provide examples of projects that appear to have been successful. Appendix A Fig. 10 shows the distribution of the search words and phrases in this reference set.

Research Question 2 was framed around the thinking that community-led entrepreneurial innovations may lead to sustainability and empowerment. Abisuga-Oyekunle et al. [10] investigated whether SMEs are a good strategy for widespread job creation. They concluded that, despite structural problems, including access to electricity, difficult establishment procedures, long business development cycles, and limited funding, SMEs can contribute to developmental change in S-SA. Abisuga-Oyekunle et al. [10] note that SMEs are better positioned to take advantage of local capacity, are not so capital intensive, create more jobs, and promote independence with local decision making. However, the lack of access to equity and debt financing for SMEs is a major impediment to growth and many SMEs fail in the early stages. They also state that the diversity of SMEs in different market sectors can potentially withstand competition from larger international entities. This requires a high level of integration and collaboration among countries in S-SA where the lack of public infrastructure, different trade rules, the lack of a uniform stable currency, and other factors present significant operational and transactional difficulties [10].

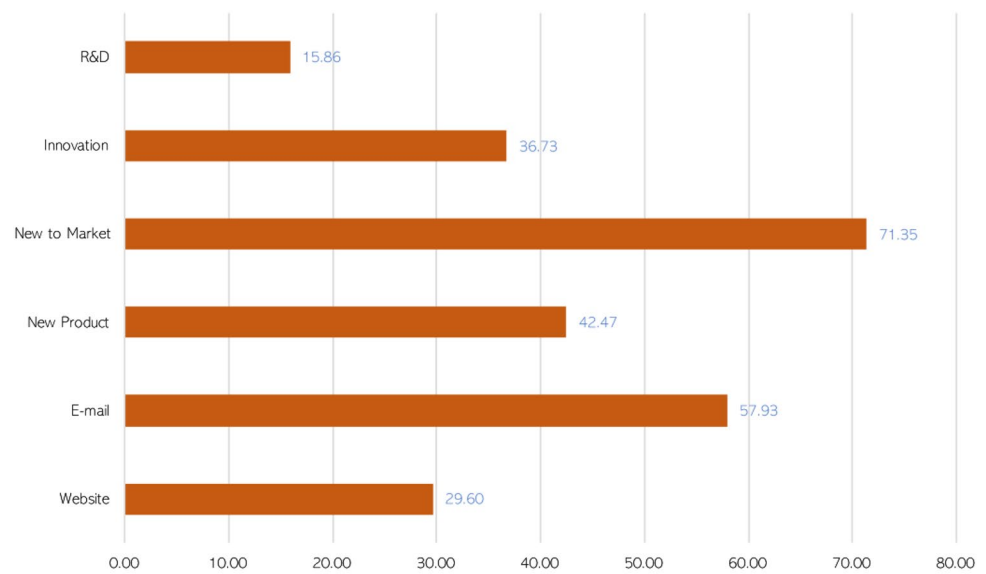
One such integrative effort was the introduction of the "Organisation pour l'harmonisation en Afrique du droit des affaires" (OHADA), a western style legal framework that was introduced in West and Central Africa following the financial collapse of the CFA currency in 1993. It was meant to facilitate a consistent regional investment environment in West and Central Africa and to attract foreign investment [47]. OHADA purports to provide a uniform legal environment promoting regional integration and development but it has only been adopted by francophone countries. English-speaking countries in the region (Ghana, Nigeria, Sierra Leone, and Liberia) preferred common law [47]. The imposition of OHADA may not be optimum for local business environments because there are significant gaps between the official law and the practices of local firms in the region [47]. The laws should be changed to allow for the more efficient conduct of micro, small, and medium enterprises in low-income communities and the needs of sustainable development initiatives for poverty alleviation [47]. Hence, a cultural boundary limiting legal integration and a uniform approach to sustainable development is still heavily influenced by colonialism at a time when the African Union is actively engaged in the removal of colonial footprints from the African continent [48]. Several regional efforts including the Economic Community of West African States (ECOWAS), the Economic Community of Central African States (ECCAS), the East African Community (EAC), the South African Development Community (SADC), and other market and inter-government bodies have been formed to address integration issues. The African Union aims for greater unity and cooperation between its 55 member states [48].

Abisuga-Oyekunle et al. [10] also comment on problems confronting policy decisions on poverty alleviation because of a lack of reliable household data. Regime instability, corruption, insufficient capacity, and inadequate public infrastructure exacerbates access to reliable and current data. Reliable Internet services make data collection much easier than traditional survey processes. Self-reporting, automated reporting, remote sensing, and other techniques can provide large volumes of data with near real-time analysis and reporting.

Abisuga-Oyekunle et al. [10] undertook an analysis of World Bank statistics on innovation and technology use in 27 S-SA countries. Figure 5 presents a summary of this analysis. Of the firms surveyed across the 27 S-SA countries within the 2013–2017 survey period, only 15.86% were engaged in research and development (R&D) and only 36.73% had developed an innovative process. 42.47% of firms surveyed had introduced a new product or service and 72.35% of which were new market entrants with the new product. Only 29.6% of the firms surveyed had a website and 57.93% communicated with customers using email. While this survey used data from the period 2013–2017, the presence of e-commerce in market valuable transactions appears minimal.

Sustainability enhancing innovations can be instrumental in resolving poverty and its environmental impacts [28]. A key factor in the assimilation of innovations into communities is influenced by the extent of social networks and business ecosystems, the internal hierarchy of networks, and other internal and external ties [28]. Kaplinsky et al. [49] observed that research and development activities in low-income countries have not resulted in innovative products and services for "bottom of the pyramid" markets. Innovations must be designed and marketed to address the specific requirements

Fig. 5 Summary of Percentage of S-SA Firms Engagement in Innovation and Technology



Note: This analysis is for 27 S-SA countries with year of reporting ranging from 2013 to 2017
Attribution: Adapted from Table 3: Abisuga-Oyekunle et al. [10]

of these communities, and that a one-design-fits-all approach is unlikely to get significant traction [28, 50]. In developing countries, the tendency is to assume a homogeneous need across the low-income spectrum. However, low-income markets share the same heterogeneity characteristics as developed markets and for products to be accepted by consumers, corporations need to undertake similar levels of market research and adjust their business practices, product configurations, and marketing strategies accordingly [28]. Khavul and Bruton [28] draw upon three examples to illustrate this claim: (1) fuel efficient stoves, (2) safe drinking water, and (3) electricity. While each of these examples had obvious benefit for consumers, the uptake was not what was hoped for, primarily because there was a lack of understanding of the nuances of the market. Poverty in developing countries is an intrinsic part of the markets, and corporations expecting to enter these markets must engage at multiple levels [28]. Kaplinsky et al. [49] contend that innovation in emerging countries such as India and China can lead to products for markets in low-income countries that are less expensive, easier to use, and require less supportive infrastructure. This is supported by the appearance of inexpensive and often low-quality products from India and China in low-income countries [50]. Researchers and business managers need to reach into behavioral science to gain further insights into decision processes within these communities, and to address “deeply entrenched behavior” [28].

Innovations that are generalizable across S-SA are the main interest of this research. One such example is the mobile payments service introduced in Kenya in [28]. Mobile payments are now widespread across S-SA [51] and have been adopted in India [52]. Digital banking enables the settlement of payments via mobile phones over telecommunication networks. This is the simplest and most readily available e-commerce capability. Consumers can settle payments with merchants and transfer funds between family and colleagues at lower costs, especially for low value transactions. Bongomin et al. [53], while not addressing poverty, concluded there was a “positive relationship between mobile money usage and financial inclusion”, and the importance of social networks on this relationship in Uganda.

Other innovations in S-SA are hard to find. The following examples are dependent on policy initiatives for small business and funding from various sources. They also lack structural support (research and development, management, advocacy, and market positioning) to transition innovations into sustainability. Matthews et al. [54] provide an example of an innovation that they claim could create millions of jobs for Africans, reduce crime rates, use renewable energy, and “save the planet”. A solar-powered roadside vulcanizing machine (air compressor) is proposed. This is an ambitious goal reflective of the poor state of roads across S-SA and the low level of roadworthiness of vehicles. van Welie et al. [55] use ideas within socio-technical transition theory to examine how sanitation services in Kenya can be established as viable small businesses and their transition to sustainability. They used a systematic approach to identify segments in the value

chain including collection and conveyance, processing, and disposal. While acknowledging innovations in the treatment segment with economically viable products such as animal fertilizer and biogas, the provision of well-maintained non-sewered sanitation services is undeveloped and requires innovation to complete a viable value chain [55]. There are backlogs and delays in providing affordable low-income housing in South Africa [56]. Innovative lean construction techniques can eliminate time wastage and improve profits compared with conventional construction [56]. A lean construction framework incorporating innovative financing, construction, subsidies, and institutional arrangements to address the chronic shortage of housing in South Africa is proposed [56]. This framework can lead to the development of a housing sector with skills and technological development [56]. Michael-Onuoha et al. [44] believes that libraries in Nigeria can contribute to sustainable development and poverty alleviation. The libraries can provide a range of services including ICT skills development, mobile information services, consulting, and agricultural information services. Economic growth in low-income countries can lead to the demand for new products and services and multi-national enterprises (MNEs) who contribute to the development of these markets will reap large benefits [49]. Ramos-Mejia et al. [57] attempt to place sustainable development initiatives for poverty alleviation into a framework that can then be examined under socio-technical transition theory (STTT). They discuss the challenges confronting the sustainability of poverty alleviating innovations in low-income countries where supportive political and commercial infrastructure may be weak or non-existent and offer suggestions for future research. To highlight these challenges, Okon [58] observed the outcomes of two initiatives in the Niger delta region in Nigeria. Two successive programs aimed to empower women and to educate and train youth in vocational skills failed because there was no diffusion of innovation. According to Okon [58] these failures suffered from top-down imperatives rather than a lateral engagement of the beneficiaries in the objectives, conduct, and outcomes of the programs.

Policies that create an environment for technology initiatives to thrive can be the catalyst to attract foreign venture capital [59]. Foreign venture capital investments can build local competencies and foster sustainable innovations much faster than other forms of funding [59]. Venture capital investors bring technical, management and marketing competencies to product development for local and potentially global markets [59]. However, the experiences with microfinance have been less encouraging. Arp et al. [18] undertook two studies to investigate the performance of formal microfinance, informal moneylenders, and trade finance. These studies were driven by the debate over the effectiveness of microfinance in terms of the impact on poverty and sustainability under the United Nations Sustainable Development Goals. Their findings concluded that microfinance does not result in sustainability for borrowers in low-income communities. The administrative processes for formal lending, despite lower interest rates, were a deterrent to borrowers whereas the ease of borrowing from moneylenders, despite increased costs, was more attractive. Alternatively, trade finance had the perception of being interest free because cash was not directly involved. Equipment, fertilizer, and seeds were exchanged for offtake arrangements for the farm output [18]. Trade financiers also became more integrated with rural communities and were able to contribute advice and other support and were more trusted than formal or informal moneylenders [18]. In this context, trade financiers perform a similar role as venture capitalist, albeit at a local level and rarely to stimulate innovation [18]. Tanzanian women were met with new experiences of prejudice and inequality when applying for and managing microcredit [60]. Many were able to cope with the “oppressive” burdens of repayment regimes, but others were trapped in a cycle of working and repayments, and not advancing to the level of self-determination [60].

Social entrepreneurship is a combination of people, resources, and innovation that may be directed to solving social problems including poverty alleviation [61]. Social entrepreneurs are leaders in their community. They marshal resources and take actions for the benefit of the community. Foy Connor and Bent-Goodley [61] discuss the role of women entrepreneurs working to address educational needs of women and girls in low-income communities, to empower people with disabilities, and to develop ways for women to become engaged in income-earning activities. Foy Connor and Bent-Goodley [61] acknowledge that this type of entrepreneurship is not generalizable, but when combined with other initiatives the social entrepreneur can play an important role in sustainable development. There are complex qualitative issues surrounding women in entrepreneurial roles [60]. The process of self-determination and elevation as business owners creates tensions with their traditional roles of subservient inequality. Women dealt with this through discussion and renegotiation of their relationship contracts or through compartmentalization of their entrepreneurial life from their traditional life [60].

Corporate social responsibility (CSR) may contribute to economic development in low-income communities [62]. Corporations may integrate local participation in areas such as manufacturing and distribution into their core business strategy, rather than taking a philanthropic approach to the poor [62]. Philanthropy is counter to corporate profits whereas business strategies that contribute financial benefits from engaging local capital and resources may have a direct impact on profits. Bai and McMartin [62] briefly discuss how social impact credits could be earned through the alignment of business strategies with social need, albeit with accountability challenges.

5.3 Research question 3

Appendix A Table 8 lists 3 articles on social media, social networks, and collaboration for Research Question 3. This research question was formulated on the premise that for community-led businesses to create generalizable sustainability models, collaborative networks providing access to a wide range of resources and advocacy services were essential. Social media with a large inventory of applications and services for collaboration, sharing of problems and ideas, socialization, commerce, and a say in the shaping of communities and the broader society. There is limited evidence in the formal research of the systemic use of social and collaborative networks in sustainability initiatives in S-SA. Appendix A Fig. 11 shows the distribution of search words and phrases in this reference set.

Reed [63] focuses on the poverty-environment-sustainable development nexus. Reed [63] believes that global corporatization has exacerbated protections for the environment and has accelerated the clearing of forests for other pursuits. Reed [63] states that, among other institutional reforms for environmental sustainability in low-income countries, poor communities should be granted more control over natural resources and the environment. This can only be achieved through greater collaboration between all stakeholders with civil society having a greater voice in the outcomes.

Brown et al. [64] observed a successful example of collaboration in Ethiopia between the Humbo community, government and non-government organizations, and external participants bringing advice and money to a reforestation project. The Humbo project was inspired out of the 1984 famine in Ethiopia which drew attention to the almost complete degradation of the Ethiopian forests and the resulting devastation of the communities that relied upon them [64]. The project directly engaged with the communities through the establishment of cooperatives to manage revenues earned from carbon credits. The cooperatives are responsible for the development of community assets such as grain milling and other agribusiness projects [64]. According to World Vision Australia, one of the project's sponsors, the project has been a huge success in generating income through the sale of carbon credits to the World Bank, the sequestration of carbon, and investment in local infrastructure [65].

Capability enhancement at the community level is essential for any gains in poverty alleviation [66]. Capability deprivation refers to the inability to effect changes to enhance the wellbeing of the community because of lack of social support, illiteracy, basic education, health care systems, and real property [66]. Mabogunje [66] describes a project which commenced in the Nigerian city of Ijebu-Ode in 1998. The objective of this project was to address capability deprivation to guide initiatives for poverty alleviation. The project used a consultative process to engage the whole community in the design and implementation of the poverty alleviation plan. This lateral approach helped to coalesce local knowledge, to identify skills, and to stimulate innovation. Mabogunje [66] states that after 7 years employment increased, poverty reduced, skill levels improved, and cooperatives had been established in agribusiness. However, the program required considerable financial support from government programs, microfinance, and project management. Therefore, the question of sustainability could not be answered. Mabogunje [66] also state that micro-finance was management intensive and could not singularly reduce poverty. Default rates had grown significantly. Other issues related to accountability of the cooperatives that had been formed, and there was limited capacity to access further funds for growth [66]. The project is still in operation (<https://www.idipr.org.ng/>).

The next section discusses ideas for the development of a formal structure for SMEs to provide a consistent organizational framework for diverse initiatives that can be generalized across spatial, demographic, and cultural domains. This framework is intrinsically computational and forms the basis of a data-driven approach to social, economic, and environmental sustainability.

6 Potential SME framework

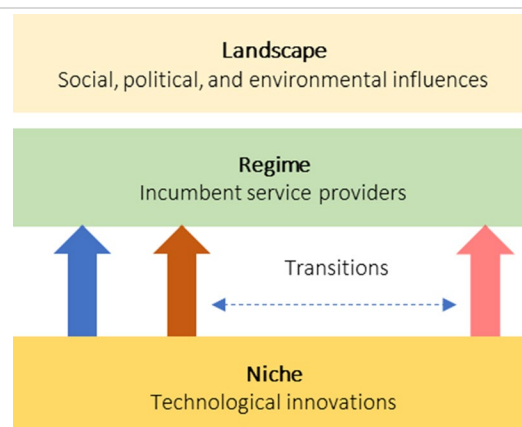
This SLR did not directly reveal any significant recognition of the role of e-commerce in sustainable development of low-income communities in S-SA. The importance of ICT is acknowledged but e-commerce as a sub-element of ICT does not gain any prominence. There is a sense that ICTs are a policy push concept that is further illustrated by the existence of the digital divide. The digital divide separates households and SMEs in low-income communities from the informational and transactional capabilities of the Internet. Innovation and entrepreneurial initiatives arise from observing role models and the proliferation of ideas of others. The digital divide creates a chasm that puts this out of reach. This chasm can be narrowed if there is a contemporaneous “pull” strategy from within the low-income communities. However, there is an absence of formal research into theories and practical strategies that may be applied to gain widespread proliferation of sustainability innovations across the low-income spectrum [28, 67]. The organizational structures within communities have not been developed to stimulate outreach, to foster innovation and entrepreneurship, or to embrace technology. Further, there is an absence of formal discussion on the importance of collaborative networks that can contribute to the sharing of ideas, joint marketing initiatives including brand development, and the transactional benefits of e-commerce. The theory and its practical derivations must transcend spatial, demographic, and cultural boundaries for universal application. Low-income communities have unique social structures that need to be understood and incorporated into sustainable development initiatives [28].

There are research opportunities engaging socio-technical transition theory [57], complexity theory with agent-based modelling [68], design science research [27], and other management and organizational theories to create frameworks for sustainability transitions from poverty to empowerment [69]. There are also several emerging data analytics and machine learning techniques that may also be useful [70–72] for progress monitoring and forecasting. The following discussion draws upon research articles referred to in Appendix A Tables 6, 7, 8, 9, additional articles from the Query 2, Query 3, and Query 4 searches (Fig. 2), and other research articles. A brief synopsis of a potential SME framework follows.

6.1 Socio-technical transition theory

The multi-level perspective (MLP) of STTT (Geels) [73] may be used to illustrate sustainable development and sustainability transitions for poverty alleviation [57]. The MLP is defined at three levels as depicted in Fig. 6.

- Landscape—this level embodies the social, political, demographic, and cultural dimensions of influence in a region or country.
- Regime—this level is where incumbent sustainable systems reside. It is characterized by the regulatory environment, politics, business, advocacy (lobby, industry associations) groups, and the infrastructure of society.
- Niche—this is where technical innovations or sustainable developments are conceived, grow, and strive to transition to sustainability at the regime level.



Attribution: Adapted from Geels (2002) [76]

Fig. 6 Multiple-Level Perspectives of STTT for Poverty Alleviation

The literature on STTT provides analytical accounts of technological transitions with explanations of how various technological innovations merged to force regime change [57]. One example is the impact of renewable energy systems (solar and wind) on fossil fuel power generation systems. However, Ramos-Mejia et al. [57] noted challenges in applying STTT to poverty alleviation in developing countries where there is often a lack of institutional support and where complex social structures prevail. The landscape has a mix of characteristics including security, social structures, and political integrity which differentiate it from that of developed countries [57]. Similarly, socio-technical regimes also suffer from uncertainty of industry structures (formal private and government firms, and informal entities), the absence of protective laws, and corruption [57]. Ramos-Mejia et al. [57] note that culture, lifestyle, rural and urban challenges, gender, and class makes it difficult to apply the MLP to sustainability transitions in developing countries and calls upon researchers to undertake further research to resolve this or to develop new frameworks.

The MLP can be used as a computational framework for the study of potential poverty alleviation strategies. This is made possible through the availability of data that more precisely describes the landscape, regime, and niche levels together with new and advanced data collection techniques enabled by the Internet, smart mobility devices, and remote sensing technologies. No country or region is perfectly homogeneous. The MLP can be used to describe and forecast conditions at a micro level, and the likelihood of community-based projects reaching sustainability in the future. The following briefly describes techniques that enhance operational management and to provide a data-intensive knowledge-based approach to increasingly improve the reliability of sustainability forecasts.

6.2 Design science research methodology

Wieringa [74] describes design science research to be an approach which first involves the conceptualization of a solution to a research question. The design of an artifact which addresses this conceptual solution can then be constructed and implemented as an experiment. The design undergoes continuous iterative evaluation and refinement until the artifact performs to a defined level of quality [27].

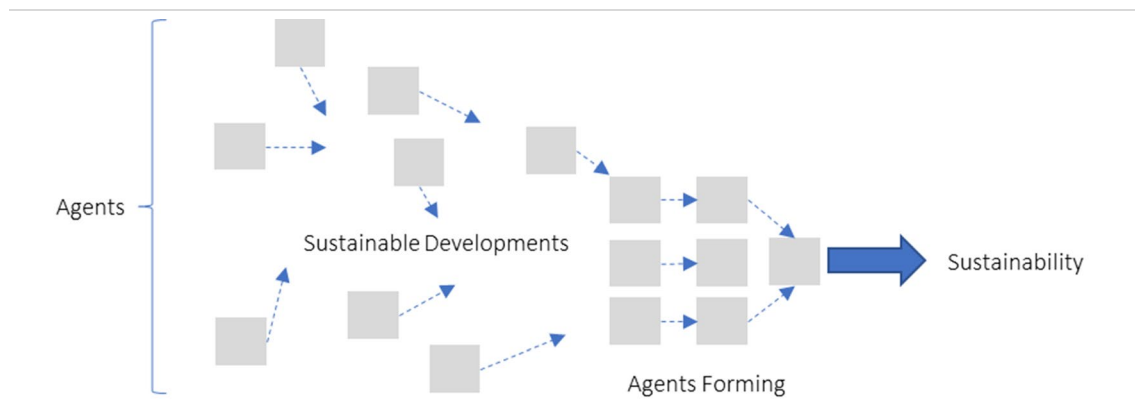
Table 5 illustrates an adaptation of the Peffers et al. [27] six-step design science research methodology (DSRM) to describe a theoretical and practical approach to the systematic design, development and refinement of an artifact that may be used in sustainable development projects for poverty alleviation. The DSRM artifact of Peffers et al. [27] is enhanced to include social, economic, and environmental elements to form a social construct for a community-based SME. DSRM is intrinsically computational and serves to provide structure for SME projects and can generate large volumes of data to inform management strategies to facilitate and nurture sustainable innovations. For example, research in indoor farming to mitigate climate change effects and water and land usage should proceed under a collaborative shared-knowledge approach. The DSRM is an Internet edge instantiation with full informational and transactional capabilities accessing local, regional, and global markets. It will typically include production management, business management, sales, marketing, and reporting elements.

6.3 Agent-based modelling

ABM is a theory that applies studies of interactions at the relational level within social groups or networks (agents) to predict their impact on higher level systems [75] (pathways to sustainability). ABM has potential application in modeling trajectories for sustainable development projects and their likelihood of attaining sustainability. ABM recognizes

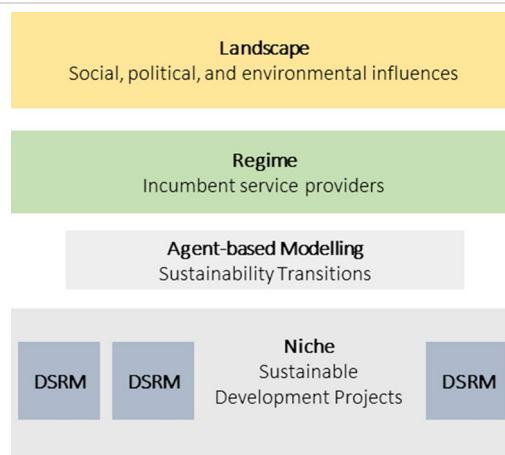
Table 5 DSRM for Sustainable Development

Design phase	Description	
1	Problem recognition	Failings of current efforts to reduce poverty
2	Idea for a resolution	Solution based on community empowerment, financial capital, intellectual capital, and technology
3	Design of trial solution	Design of a community-led sustainable development project
4	Implementation of the trial	To measure model performance and to collect data
5	Evaluation	Evaluate the data and refine the model
6	Summarize outcomes	Summarize the achievements and outcomes against measures for poverty reduction and sustainable development



Attribution: Authors

Fig. 7 ABM and Sustainability Transitions



Attribution: Adapted from Geels (2002) [76]

Fig. 8 Integration of DSRM and ABM into MLP

a physical agent (person, social group, object, community) or a conceptual agent (contract, poverty measure) to represent sustainable development initiatives across complex multiple spatial, demographic, and cultural dimensions.

Figure 7 is an illustration of the ABM concepts within which collaborating agents interact and align towards sustainability.

There are challenges to the selection of an agent in low-income community sustainable development. Well-defined communities of households (say 150) could be selected as agents. However, Khavul and Bruton [28] draw attention to the importance of understanding the nature of the social structures within community groups to determine how receptive individuals within the community are to new innovations or products. They observed that the fabric of social networks is maintained through strong family ties, external connections, and the attitudes of local leaders [28]. This implies a level of homogeneity that may not exist in other communities. The homogenous nature of communities could lead to widespread acceptance of innovation or not. Macy and Willer [75] also draw upon emergence theory to suggest that homogeneity could lead to more powerful outcomes for the collective acceptance of innovation than that observed at the individual level of acceptance. However, in sustainable development for poverty alleviation, the concept of emergence is complex and is difficult to quantify as a measure of social wellbeing. Instead, an SME that contributes to the social, economic, and environmental imperatives of sustainability of the same community could be nominated as the agent. The SME would

report on the number of jobs created and the total payroll, its investment in social infrastructure such as water supply and sanitation, and its investment in environmental remediation such as waste management as a proxy for social wellbeing.

The MLP/DRSM structure can support both approaches to learn more precisely how a community is developing. Data on household incomes, school attendance rates for boys and girls, health clinic visits, small business activities, frequencies of social gatherings, home ownership, transportation, and other metrics can contribute to the learned models for social wellbeing.

ABM is not that useful for single agents but can be applied to the trajectories of collectives of agents (communities) towards sustainability. Trajectories of multiple instantiations of collaborating SMEs can be modeled using rules-based ABM to provide insights into the sustainability of similar sustainable development projects leading to more informed managerial and policy decisions. Agents are “niches” for poverty alleviation and ABM provides a computational overlay that derives its inputs from the DSRM artifact and presents a near real-time view of the path to sustainability.

6.4 MLP computational model

Figure 8 depicts how the DSRM, and ABM fit within the MLP. In this diagram, each DSRM defines the methodology for the design, development, and operationalizing of the sustainable development project. ABM models the pathways to sustainability in the regime. ABM may also be useful in directing sustainability transitions into well-functioning institutions at the regime level and avoid areas of corruption, conflict, ambiguity, and insecurity, and therefore address the issues raised by Ramos-Mejia et al. [57].

The MLP is a computational framework along with DSRM and ABM which are both inherently computational. Each niche is computational because each development project is quantifiable. The regime level can be quantified in terms of institutional support, public infrastructure, and business structures. The landscape can also be quantified in terms of human development, political transparency, national security, and the environment. The MLP can generate high volumes of data which can be combined with other data sources (remote sensing data, survey data) and be analyzed to provide near real-time visualizations of sustainable development initiatives, and to progressively improve the predictive quality of the model.

6.5 Data analytics and machine learning

Data analytics is simply the processing of data to gain useful insights to support decision making. The processing of data is straightforward, and tools range from simple spreadsheets to more sophisticated big data toolkits depending on the source, type, and volume of data. Survey data such as from census collection is static because it is a snapshot in time. Big data is characterized by volume, velocity, and variety [76]. Data is collected from a variety of sensors and often streamed at high velocity and high volume. Big data analytics can process data in near real time with predictive and prescriptive outputs, and a variety of visualizations. Blumenstock et al. [70] combined mobile phone metadata with survey data from Rwanda to predict poverty, wealth, social connections, travel patterns, and other expenditures. Njuguna and McSharry [71] successfully combined mobile phone data, night light data (illumination levels at night), and population data to predict regions of poverty. Xie et al. [72] trained a convolutional neural network (CNN) using night light data and reported poverty prediction results approaching that of survey data. Accurate census and survey data is not readily available in S-SA [70–72] but night light data is available from the National Oceanic and Atmospheric Administration [77].

Big data analytics and machine learning (ML) is emerging as a field of research that can contribute to the monitoring and prediction of the impacts of sustainable development initiatives on poverty alleviation. Sustainable development projects in low-income communities can be established with new methods for data collection. This data, together with remote sensing data, can provide almost real-time supervision of these projects.

7 Theoretical contributions

There is a complete absence of theory that addresses sustainable development for poverty alleviation [26, 28–30]. Further, this SLR did not inform the research questions with any evidence of a systematic approach to the application of e-commerce that has so successfully inspired and catapulted small, medium, and large businesses in developed countries into global markets. In the absence of any developmental theory from which practical solutions could be derived and implemented, this SLR instead proposes an adaptation of the MLP of STTT [57] and of the DSRM [27] to establish a

framework that encapsulates the social, political, and commercial environment of a country or region, and proposes a formal structure for the implementation of SMEs. The MLP of STTT has been used to explain the historical transition of multiple instantiations of a single socio-technical initiative into sustainability, and the DSRM is an information systems methodology for the systematic development of a technical artifact. For the MLP and DSRM to be useful in studying the future likelihood of any initiative becoming sustainable, it must support multiple complex social phenomena, be computational, and it must be immediately responsive to changes in the societal dynamic. The MLP/DSRM construct forms the basis for the systematic implementation of SMEs that provide support for a wide range of business support systems, including e-commerce, and contributes to originality in developmental theory for sustainable development in low-income countries.

The first part of the proposed MLP construct hypothesizes a sensitive quantitative assessment of the probability of successful transitions into sustainability of any sustainable development initiative. Each of the landscape, regime, and niche levels is assigned a probability that it can support such initiatives. A weak or corrupt political environment at the landscape level negatively impacts the probability of successful outcomes, whereas positive policy initiatives and investor support at the niche level will increase the probability of successful outcomes. The initial probabilities can be determined from any available survey data such as census data, living standards surveys, business data, remote sensing data, mobile phone metadata, weather data, health reports, education levels, and other sources. With improved data collection methods, the MLP can continuously evolve to accurately reflect regional and community environments. Location specific data such as crime rates, terrorism activities, or climate change effects on certain agribusiness initiatives can be easily incorporated. This construct is data intensive and can provide highly detailed and focused visualizations of countries, regions, and communities to inform policy decisions on poverty alleviation initiatives. This first part of the proposed construct is effectively a purposeful socio-geographic representation of the conditions that directly influence the likelihood of successful transitions to sustainability.

The niche level of the MLP is where the sustainable development initiatives are conceived and encouraged into sustainability at the regime level. At this level there are many initiatives (SMEs) operating in diverse business sectors. It is proposed that these entities be structured in accordance with the modified DSRM, with each entity providing a wide range of information that can be monitored and analyzed remotely. These SMEs are rules-constrained and must contribute measurable social, economic, and environmental benefits to its associated community. The transition to sustainability of a single SME can be observed, as can collectives of SMEs that are in the same business sector, spatial sector, or any other common dimension that can be identified for each entity. This is a highly structured approach but any niche structure that meets the required data generation requirements can also be recognized and supported under this model. The path to sustainability for communities of similar SME operations can be modeled by ABM, with directional targets for each of the pre-determined social, economic, and environmental goals being provided by ML. Each entity will report progress against the social, economic, and environmental goals, and will provide information to the ABM for directional correction and reporting purposes.

8 Managerial and policy implications

The main outcome of this SLR is confirmation that large numbers of SMEs can engage in highly diverse activities over a broader demographic [10–12] than larger location-centric businesses. Large commercial operations play a significant role in the overall economy, but SMEs are central to strategies for low-income community development and poverty alleviation. This implies a stronger managerial and policy focus on the development of frameworks for the systematic development of community-based SMEs that can be generalized across spatial and cultural boundaries. For SMEs to achieve success across multiple industry sectors (agribusiness, manufacturing, construction, retail, services), organizational structures must be put in place that facilitate funding, business management, job creation, marketing (including brand development), access to information (farming techniques, production quality management), and performance reporting. E-commerce enables SMEs to access regional, national, and international markets for the supply and purchase of goods and services.

For instance, in Ghana there are about 3000 small pond aquaculture businesses that collectively produce about 57,000MT of tilapia and catfish per annum [78]. There are significant management, funding, quality control, and competitive issues burdening the growth of this industry at a time when marine fisheries are declining rapidly. Hasselberg et al. [78] advocate for greater investment in the supply chains for small fisheries, and for policy makers to act to safeguard the interests of small fisheries to address the declining marine fish stocks, and to investigate seasonal availability which has

a significant impact on the consumer price for fish. This requires combined private and public sector involvement and a new breed of investors that are interested in the long-term success of land-based aquaculture in Ghana.

The management implications are significant. There is the need to conduct intensive trials of the MLP/DSRM structure proposed above and to evaluate this structure with a project like the small fisheries in Ghana. This will provide valuable insights into the generalizability of small fisheries across the region. This is a construct that is a diversification of manufacturing in a time when centralized manufacturing has offered benefits of economies of scale and logistical efficiencies. However, this diversification is essential to the spatial uniformity of sustainable social, economic, and environmental benefits. The application of the MLP/DSRM structure to small farms in the cocoa sector in Ghana also holds promise, as does the remediation of vast areas of land decimated by illegal gold mining with the ecological benefits of bamboo production for sustainable housing, or to the development of indoor farming that vastly reduces water consumption, land use, and chemicals in the food chain in the face of climate change across the region.

The management of large collectives of similar industries is simplified under the highly data intensive MLP/DRSM construct. Instead of centralizing the manufacture, it allows for the centralization of the *management of manufacture* including production, quality control, supply chains, marketing, and payments (e-commerce). The MLP/DRSM construct can be augmented, for example, with emerging ML techniques to uniformly apply adjusted feeding regimes for all fisheries to optimize growth and product quality. The threats of disease are also mitigated with diversification. When the early onset of disease is detected, mitigation techniques can be immediately implemented to prevent the spread of the disease. This geographic diversification also supports production diversification to eliminate the seasonality effects that currently influence product availability, and in the production of different fish species. Production scheduling means that there is always a constant supply of product with minimal price variability. Quality control from the fisheries to the consumer can be assisted with block chain technology that records the certifications of all supply chain participants. In the fisheries example, the block chain allows for the immediate tracing of a defective product back to the fishery that produced it and facilitates rapid action to mitigate the spread of illness from human consumption.

From a policy perspective, initiatives to help facilitate social, economic, and environmental development can be continuously monitored and reported for their effectiveness. Such initiatives may include infrastructure (roads, energy, water, telecommunications) or more focused support for SMEs including tax incentives, grant funding, employment incentives, training programs, health, and education services.

9 Conclusions

The outcome of this literature review is the premise of each of the research questions was not well supported by the available literature and there is considerable scope for research over a wide range of social, economic, and environmental disciplines. The literature supported the need for entrepreneurship and innovation in SMEs and the development of collaborative networks, but there was no clarity on how ICT or e-commerce could be embedded into SME ecosystems. A common institutional approach is to provide structural support for ICT in terms of access to telecommunications and online government services. What is lacking is the metaphorical last mile where community projects draw upon high-performance infrastructure and thrive independently with minimal external governance other than what is required under law.

In S-SA, sustainable development projects to address poverty include agribusiness, manufacturing, construction, health, education, and other services. ICT is persuasive across all business activities in design, production, operations, and business support services such as website development (with e-commerce capabilities), marketing support, software development for special applications, mobile applications, media production, and digital production services. It would be difficult to conceive of any sustainable development program that does not extend the reach of the Internet to every business and community in developing countries, and eventually to individuals. However, while the literature was sparse in examples of successful diffusion of innovation in S-SA, mobile payments was reported as major socio-technical innovation. Mobile payment services facilitate lower cost transactions between individuals and for the payment of merchant services. Separate reports indicate this has become ubiquitous across S-SA, often exceeding bank transactions. Payment systems are an integral part of e-commerce and mobile payments will contribute to the development of low-cost methods for settling SME e-commerce transactions in S-SA.

The literature search did not reveal any systematic theoretical or practical frameworks for poverty alleviation. Socio-technical transition theory was the subject of one article but the applicability of the MLP was drawn into question because of structural problems in developing countries. However, in the presence of increased access to data and advanced data

analytics techniques it is proposed that the MLP be adapted as a computational framework for the design, implementation, operations, and monitoring of sustainable development initiatives. DSRM provides structure for the SME and informs the contribution to the social, economic, and environmental wellbeing of the community it serves. It also informs ABM which visualizes the trajectories of sustainable developments towards sustainability. Data analytics and machine learning may also be used to predict population growth and migration, climate change effects, the diffusion effects of sustainable development initiatives, and other factors that contribute to social wellbeing.

10 Future research

A potential SME framework has been introduced. Future research will involve the development of economic models for potential community-level SME projects (e.g., agribusiness, manufacturing, construction, or services) using this framework. These models should reveal an understanding of the diffusion of benefits to local communities as well as the regional generalizability of specific models. At a community level this could indicate the level of job creation, investment in social and environmental infrastructure, and potential benefits through collaboration with other communities. At a macro level, modeling should reveal insights to regional benefits of SMEs operating in the same industry, and macro-economic impacts regionally and nationally. This information can be used to guide policy initiatives in business development, skills training, tariff structures, tax programs, and other support programs. Data generation models will evaluate the viability of accessing big data for highly nuanced data analytics of trends in the social wellbeing of households and communities. Climate change models could also be applied to agribusiness SMEs to determine future mitigation strategies. A study into the use of mobile money services may provide valuable insights into the current usage of these services and the propensity for additional services arising from large scale SME deployments.

Author contributions D.C. wrote the manuscript text. All authors reviewed the manuscript text. All authors read and approved the final manuscript.

Availability of data and material All database search results are available in Endnote library format.

Declarations

Competing interests The authors declare no competing interests.

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Appendix

Appendix A - Lists of research articles

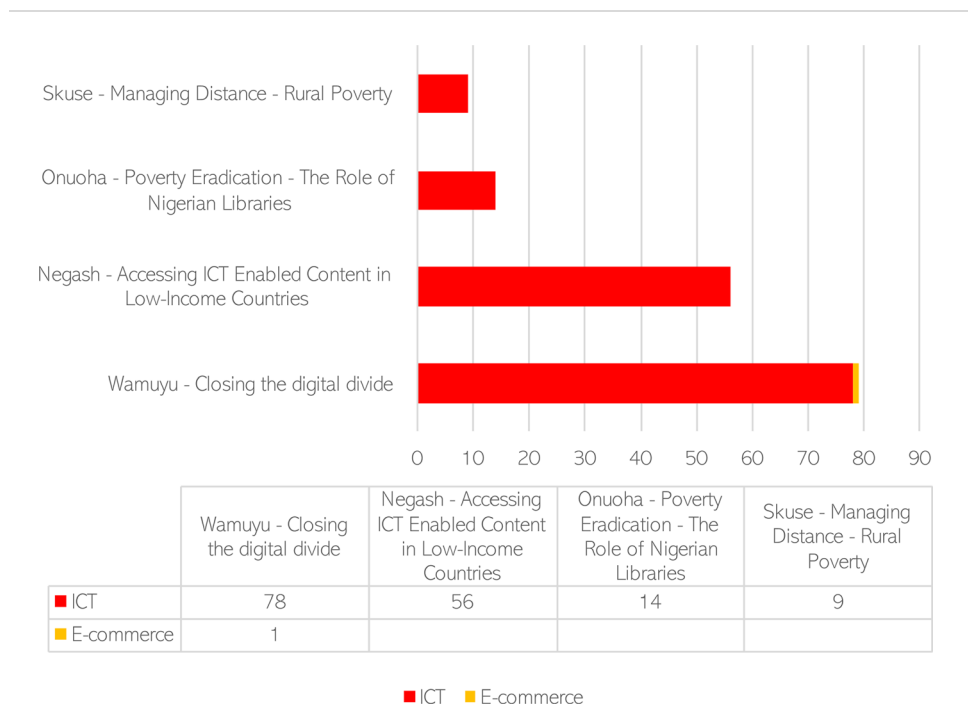
Research question 1

See Table 6, Fig. 9.

Table 6 Research Question 1 Articles Retrieved

Article Name	
1	Michael-Onuoha, H. C., Nkiko, C., & Omorodion, O. (2020). Poverty eradication: The role of Nigerian libraries towards the achievement of the sustainable development goals (SDGs). <i>Library Philosophy and Practice</i> , 1(13). https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=8003&context=libphilprac
2	Negash, S. (2010). Accessing ICT enabled content in low-income countries: Think big, start small, and scale up. <i>International Journal of Information and Communication Technology Education</i> , 6(4), 49–60. https://doi.org/10.4018/jicte.2010100105
3	Skuse, A., & Cousins, T. (2007). Managing Distance: Rural poverty and the promise of communication in post-apartheid South Africa. <i>Journal of Asian and African Studies</i> , 42(2), 185–207. https://doi.org/10.1177%2F0021909607074867
4	Wamuyu, P. K. (2017). Closing the digital divide in low-income urban communities: A domestication approach. <i>Interdisciplinary Journal of e-Skills and Lifelong Learning</i> , 13, 117–142. https://doi.org/10.28945/3885

Fig. 9 Occurrences of Search Words/Phrases



Attribution: Authors

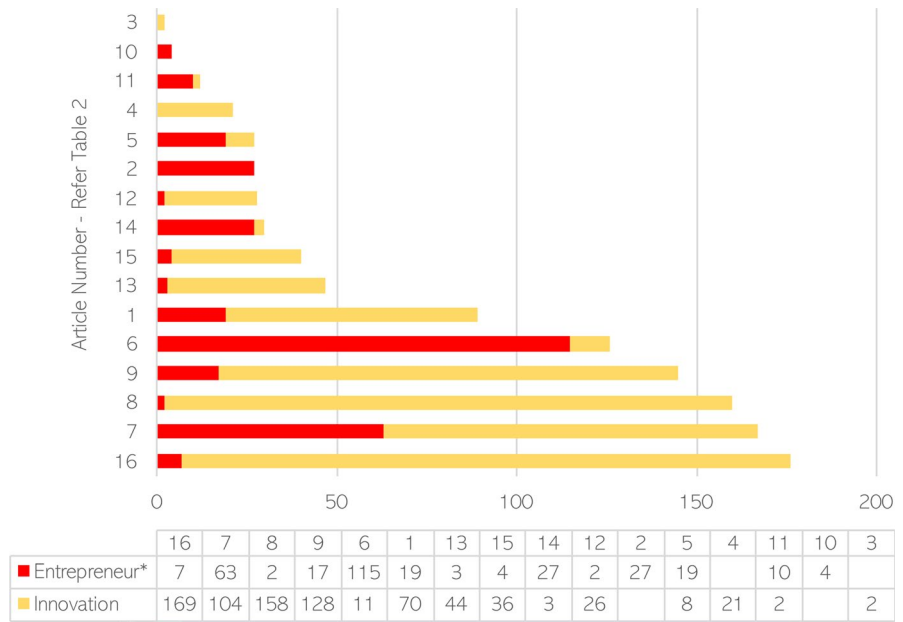
Research question 2

See Table 7, Fig. 10

Table 7 Research Question 2 Articles Retrieved**Article Name**

- 1 Abisuga-Oyekunle, O. A., Patra, S. K., & Muchie, M. (2020). SMEs in sustainable development: Their role in poverty reduction and employment generation in Sub-Saharan Africa. *African Journal of Science, Technology, Innovation and Development*, 12(4), 405–419. <https://doi.org/10.1080/20421338.2019.1656428>
- 2 Arp, F., Ardisa, A., & Ardisa, A. (2017). Microfinance for poverty alleviation: Do transnational initiatives overlook fundamental questions of competition and intermediation? *Transnational Corporations*, 24(3), 103. https://unctad.org/system/files/official-document/diaei_a2017d4a8_en.pdf
- 3 Bai, Z., & McMartin, K. (2009). *Corporate social responsibility: A new perspective for alleviating poverty while maximizing profits*. Paper presented at the TIC-STH'09: 2009 IEEE Toronto International Conference—Science and Technology for Humanity. <https://ieeexplore.ieee.org/document/5444386>
- 4 Chakwizira, J. (2019). Low-income housing backlogs and deficits "Blues" in South Africa. What solutions can a lean construction approach proffer? *Journal of Settlements and Spatial Planning*, 10(2), 71–88. <https://dx.doi.org/10.24193/JSSP.2019.2.01>
- 5 Deschamps, I. (2013). Assessing the Organisation pour l'Harmonisation en Afrique du Droit des Affaires's Contributions to poverty reduction in Africa: A grounded outlook. *Law and Development Review*, 6(2), S111-153. <https://dx.doi.org/10.1515/ldr-2013-0022>
- 6 Foy Connor, R., & Bent-Goodley, T. B. (2016). Zanzibari social entrepreneurs and poverty alleviation strategies: Understanding efforts to build local community sustainability. *Journal of Community Practice*, 24(3), 302–318. <https://doi.org/10.1080/10705422.2016.1201784>
- 7 Hain, D. S., & Jurowetzki, R. (2018). Local competence building and international venture capital in low-income countries. *Journal of Small Business and Enterprise Development*, 25(3), 447–482. <https://doi.org/10.1108/JSBED-03-2017-0092>
- 8 Kaplinsky, R., Chataway, J., Clark, N., Hanlin, R., Kale, D., Muraguri, L., & Wamae, W. (2009). Below the radar: what does innovation in emerging economies have to offer other low-income economies? *The International Journal of Technology Management & Sustainable Development*, 8(3), 177. <https://doi.org/10.1386/ijtm.8.3.177/1>
- 9 Khavul, S., & Bruton, G. D. (2013). Harnessing innovation for change: Sustainability and poverty in developing countries. *Journal of Management Studies*, 50(2), 285. <https://doi.org/10.1111/j.1467-6486.2012.01067.x>
- 10 Matthews, V. O., Atayero, A. A., & Popoola, S. I. (2016). *Development of a solar photovoltaic vulcanizing machine towards extreme poverty eradication in Africa*. Paper presented at the Lecture Notes in Engineering and Computer Science. <https://pdfs.semanticscholar.org/aac9/456e0a6e9e2c5b2f4641504a8711484db3f4.pdf>
- 11 Michael-Onuoha, H. C., Nkiko, C., & Omorodion, O. (2020). Poverty eradication: The role of Nigerian libraries towards the achievement of the sustainable development goals (SDGs). *Library Philosophy and Practice*, 1–13. <https://digitalcommons.unl.edu/cgi/viewcontent.cgi?article=8003&context=libphilprac>
- 12 Okon, G. B. (2014). Diffusion of innovation patterns among poverty alleviation agencies and sustainable development challenges in the Niger delta region: The Rivers state experience. *Review of European Studies*, 6(2), 40–44. <https://doi.org/10.5539/res.v6n2p40>
- 13 Ramos-Mejía, M., Franco-García, M. L., & Jauregui-Becker, J. M. (2018). Sustainability transitions in the developing world: Challenges of socio-technical transformations unfolding in contexts of poverty. *Environmental Science and Policy*, 84, 217–223. <https://doi.org/10.1016/j.envsci.2017.03.010>
- 14 Sigalla, R. J., & Carney, S. (2012). Poverty reduction through entrepreneurship: Microcredit, learning and ambivalence amongst women in urban Tanzania. *International Journal of Educational Development*, 32(4), 546–554. <https://doi.org/10.1016/j.ijedudev.2012.02.011>
- 15 Van den waeyenberg, S., & Hens, L. (2008). Crossing the bridge to poverty, with low-cost cars. *The Journal of Consumer Marketing*, 25(7), 439–445. <https://www.deepdyve.com/lp/emerald-publishing/crossing-the-bridge-to-poverty-with-low-cost-cars-CaZ0rfu0Ld>
- 16 van Welie, M. J., Truffer, B., & Yap, X. S. (2019). Towards sustainable urban basic services in low-income countries: A technological innovation system analysis of sanitation value chains in Nairobi. *Environmental Innovation and Societal Transitions*, 33, 196–214. <https://doi.org/10.1016/j.eist.2019.06.002>

Fig. 10 Occurrences of Search Words/Phrases



Attribution: Authors

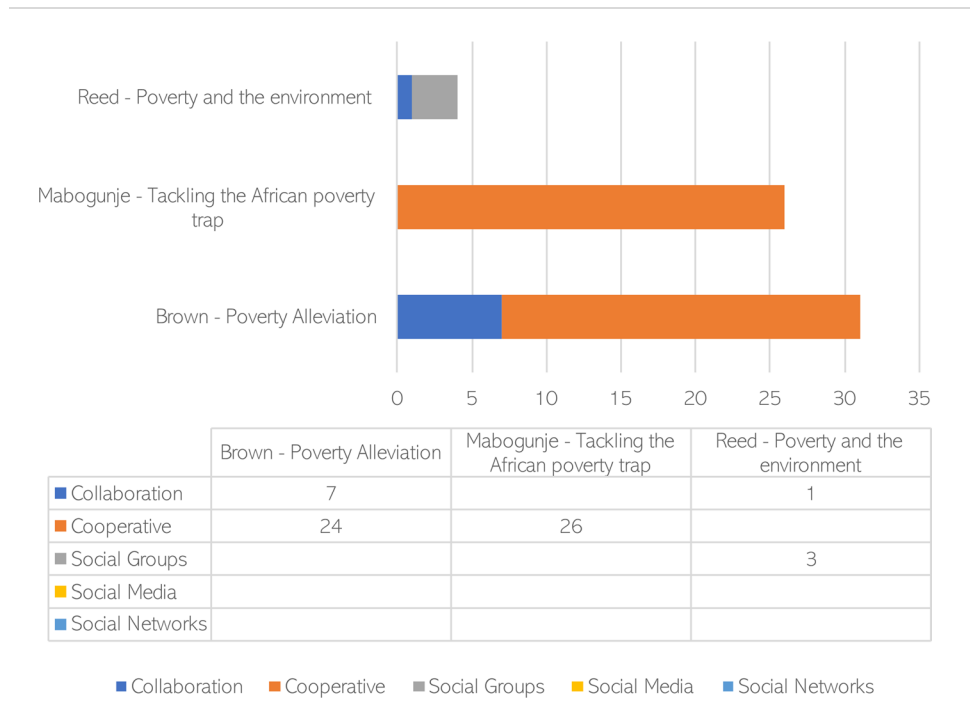
Research question 3

See Table 8, Fig. 11

Table 8 Research Question 3 Articles Retrieved

Article Name
1 Brown, D. R., Dettmann, P., Rinaudo, T., Tefera, H., & Tofu, A. (2011). Poverty Alleviation and Environmental Restoration Using the Clean Development Mechanism: A Case Study from Humbo, Ethiopia. <i>Environmental Management</i> , 48(2), 322–333. https://doi.org/10.1007/s00267-010-9590-3
2 Mabogunje, A. L. (2007). Tackling the African "poverty trap": The Ijebu-Ode experiment. <i>Proceedings of the National Academy of Sciences of the United States of America</i> , 104(43), 16,781. https://doi.org/10.1073/pnas.0704765104
3 Reed, D. (2002). Poverty and the environment: Can sustainable development survive globalization? <i>Natural Resources Forum</i> , 26(3), 176–184. https://doi.org/10.1111/0165-0203.00019

Fig. 11 Occurrences of Search Words/Phrases



Attribution: Authors

Other queries

See Table 9

Table 9 Research Articles Retrieved from Other Queries

Article Names
1 Martin, D. P. (2019). Knowledge transfer models and poverty alleviation in developing countries: critical approaches and foresight. <i>Third World Quarterly</i> , 40(7), 1209–1226. https://dx.doi.org/10.1080/01436597.2019.1597340
2 Panseira, M., & Martinez, F. (2017). Innovation for development and poverty reduction: an integrative literature review. <i>The Journal of Management Development</i> , 36(1), 2–13. https://dx.doi.org/10.1108/JMD-02-2015-0013
3 Ramos-Mejía, M., Franco-García, M. L., & Jauregui-Becker, J. M. (2018). Sustainability transitions in the developing world: Challenges of socio-technical transformations unfolding in contexts of poverty. <i>Environmental Science and Policy</i> , 84, 217–223. https://doi.org/10.1016/j.envsci.2017.03.010
4 Schreinemachers, P., Berger, T., & Aune, J. B. (2007). Simulating soil fertility and poverty dynamics in Uganda: A bio-economic multi-agent systems approach. <i>Ecological Economics</i> , 64(2), 387–401. https://doi.org/10.1016/j.ecolecon.2007.07.018
5 Xie, M., Jean, N., Burke, M., Lobell, D., & Ermon, S. (2016). <i>Transfer learning from deep features for remote sensing and poverty mapping</i> . Paper presented at the 30th AAAI Conference on Artificial Intelligence, AAAI 2016. https://arxiv.org/abs/1510.00098v2

Appendix B – List of journals/publications

See Table 10

Table 10 List of Journals/Publications Containing All Research Articles Retrieved

Journal/Publication Name	Type	# Articles	Impact
1 African Journal of Science, Technology, Innovation and Development	Journal	1	0.560
2 Environmental Innovation and Societal Transitions	Journal	1	8.400
3 Environmental Management	Journal	1	2.561
4 Environmental Science and Policy	Journal	1	5.160
5 IEEE Toronto International Conference—Science and Technology for Humanity, 2009	Conference	1	N/A
6 Interdisciplinary Journal of e-Skills and Lifelong Learning	Journal	1	N/A
7 International Journal of Educational Development	Journal	1	N/A
8 International Journal of Information and Communication Technology Education	Journal	1	N/A
9 Journal of Asian and African Studies	Journal	1	0.684
10 Journal of Community Practice	Journal	1	0.730
11 Journal of Management Studies	Journal	1	5.839
12 Journal of Settlements and Spatial Planning	Journal	1	0.240
13 Journal of Small Business and Enterprise Development	Journal	1	N/A
14 Law and Development Review	Journal	1	0.58
15 Lecture Notes in Engineering and Computer Science Lecture Notes in Engineering and Computer Science	Conference	1	N/A
16 Library Philosophy and Practice	Journal	2	0.250
17 Natural Resources Forum	Journal	1	1.292
18 Proceedings of the National Academy of Sciences of the United States of America	Conference	1	9.412
19 Review of European Studies	Journal	1	0.790
20 The International Journal of Technology Management & Sustainable Development	Journal	1	0.320
21 Third World Quarterly	Journal	1	2.156
22 Transnational Corporations	Journal	1	0.910

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