



# A framework to develop technopreneurs in digital agriculture value chains in South Africa



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**Background:** The coronavirus epidemic together with Industry 4 has created several disruptors that transformed workplaces and markets. This also highlighted the need to rethink and find alternative approaches to secure future work for unemployed graduates and youth. Digital technology adoption in agriculture value chains (AVCs) creates opportunities for the development of technopreneurs that can help to address this issue of unemployment.

**Objectives:** This study aimed to understand how an institutional framework can support the inclusive development of technopreneurs in digital AVCs. This should align to government policies and the opportunities created by Industry 4.0.

**Method:** A systematic literature review (SLR) assessed numerous frameworks that aligns with government policies and strategies associated with digital for development (D4D). The final outcome is a framework that lists the institutions to support the development of technopreneurs in digital AVCs in South Africa.

**Results:** Provincial digital innovation hubs and district agro-food sustainable knowledge hubs are suggested for implementation. The adoption of digital technology in AVCs is encouraged by these institutions that create future work and enterprise creation opportunities for unemployed graduates and youth.

**Conclusion:** An alternative conceptualisation of the emergence of technopreneurs is envisioned in order to address the research question. This will assist to better understand the institutional arrangement needed to support the development of technopreneurs in AVCs.

**Contribution:** This research adds to D4D literature as such a framework does not exist in South Africa. In the future, this will assist practitioners and academics in better organising, conceptualising and carrying out their investigations.

**Keywords:** technopreneur; entrepreneur; innovation; incubation; value chains; inclusive; digital hubs.

## Introduction

The effect of the coronavirus disease 2019 (COVID-19) on unemployment for university graduates and youth produced devastating life-altering disruptions. They face an uncertain future with bleak career prospects (Fleming, 2021; Partington, 2021; Polakovic, 2020). In South Africa, young generations' lack of economic activity started with the financial crisis, worsened by the COVID-19 pandemic, a failing education system and the current climate crisis (Fleming, 2021). The cumulative impact shows that youth and graduate unemployment has hit a 5-year high (Partington, 2021).

Academic institutions need to do more to transform these graduates and youth or they will struggle for decades to become employed (Fleming, 2021; Polakovic, 2020). Thus, questions arise about how graduates and youth can be better supported with employment. There is a need for academia and industry to work together to deal with this challenge of graduate and youth unemployment.

Industry 4.0, also referred to as the fourth industrial revolution, was sparked by technology and came after the industrial revolutions caused by computing and computerised automation (Industry 3.0), electric power (Industry 2.0) and water and steam power (Industry 1.0). It encourages the production, dissemination and use of tangible reality by merging robots, the Internet of Things, social media, sensors, big data, cloud computing and artificial intelligence (Fuchs, 2018). Industry 4.0 uses modern digital technology to integrate industry and logistics processes using the Internet

to merge the real with the virtual world (Fonseca, 2018). Linked smart systems assist production in real-time decision-making by sensing, predicting and interacting with the actual world. This reduces stoppages during manufacturing to be more productive, energy efficient and sustainable by reducing costs (Sirimanne, 2022).

In today's global agricultural markets, big agricultural conglomerates compete with small farmers. Without commercialisation, small-scale farmers would stagnate because of the difficulties created by modernisation using digital technologies. They need to increase their output but lack the requisite production technology. To increase their output, farmers require both new and alternative production techniques. Small-scale farmers should embrace an agripreneurship model supported by technopreneurship and entrepreneurs to start building their agriculture value chains (AVCs) as a collective (IED, 2020).

Industry 4.0 connects people and machines to work together to form digital manufacturing networks that share and analyse data along an entire value chain (Fonseca, 2018). Industry 4.0 technology increases productivity and can impact inequalities positively or negatively. It is crucial to harness Industry 4.0 for inclusive development in the digital economy of developing countries (Sirimanne, 2022). The use of technology determines the fundamentals of Industry 4.0 development in any society. Every economy will become underdeveloped if a technology acquisition as well as competency strategy is not prioritised in planning (Adeoti, 2019).

Industry 4.0 suggests new business models with faster operations and delivery times of products to markets. Consumer involvement in product customisation fosters stronger consumer loyalty (Fonseca, 2018). Graduate and young people's skills must adjust to Industry 4.0's shifting organisational structures and business models. For graduate and young talent to reach their full potential at all levels, it is crucial to comprehend the key competencies for Industry 4.0 according to global comparisons (Bowles, 2016). It is important to stay focused and increase training to build the skills of graduates and youth so that they can better use opportunities and address the issue of post-covid unemployment.

The goal of agricultural entrepreneurship practiced by technopreneurs and agripreneurs is to use digital technology to significantly expand trade and trade-related commercial activity in order to provide superior quality and value. A strong digital footprint is essential, and digital marketing aids in this process. Agricultural businesses cannot compete against large farming firms using agripreneurship if they lack even a basic online presence (IED, 2020). Governments must influence the private sector to promote the implementation of Industry 4.0 through investments and financing (Sirimanne, 2022). Successful implementation of Industry 4.0 requires strong leadership, the right competencies and the removal of barriers.

This will lead to significant job creation or job losses for low-skill employees (Fonseca, 2018).

The development of technopreneurs often associated with university graduates and youth provides a way and guidance to achieve the Industry 4.0 vision of inclusive development (Siregar, 2019). Technopreneurs play a critical role in building the economy through technological innovations by creating new businesses or enhancing the resilience of existing businesses. New vigour and motivation are given to the economy, which leads to long-term expansion, equitable wealth and substantially increases international standing (Adeoti, 2019). Thus, the next section describes the problem and aim for this study.

### Aim and problem statement

According to Fuchs (2018), operations related to Industry 4.0 are a significant part of broader initiatives to transform human civilisations into socially intelligent, interacting machines. The primary force behind these innovations has been business, which has shaped research and innovation strategies that are geared towards industrial output. He cautions us to consider Industry 4.0 with suspicion and criticises it for being governed by capitalist technical means. He argues that it fails to consider social interests as in the case of digital transformation (Fuchs, 2018).

The development of graduate and youth capabilities is the subject of extensive doomsday predictions and unfavourable hype during digital technology disruption, created by Industry 4.0. Technology changes markets and workplaces and career ladders vanish as borders between jobs or professions get fuzzier. The lifespan of skills is dramatically decreasing and graduates and young people change careers and jobs more frequently. In many industries where organisational structures and business models change, the tiers of Industry 4.0 positions vanish. The global talent recruiting competition in Industry 4.0 has changed to involve distributed and contracted knowledge (Bowles, 2016).

Governments and related institutions should cooperate with university graduates and youth as the future leaders to develop and implement Industry 4.0 technology. This can be done through multistakeholder mechanisms to institutionalise youth participation (Sirimanne, 2022). The introduction has highlighted that the COVID-19 pandemic has required the need for us to find a human-centred approach to secure future work for graduates and youth. Industry 4.0 has also created several technology disruptors that transform workplaces and markets. Human capabilities supported by institutes require new skills to innovate and create a more inclusive society.

To solve these challenges, the specific circumstances of graduate and youth experiences must be understood as each situation may be unique and different when planning recovery. Governments must create policy initiatives and interventions to improve the situation (Fleming, 2021).

There is a need to close the deep digital divides that exist (Partington, 2021). Innovation is a part of agripreneurship and entrepreneurship, which are essential for AVCs to flourish. Rural centres need to be enhanced and promote entrepreneurship within AVCs and train unemployed graduates, youth and farmers on how to become technopreneurs and agripreneurs (IED, 2020). Digital technology adoption in AVCs creates opportunities for the development of technopreneurs.

The aim of the study is to investigate and offer an institutional framework that fosters the growth of technopreneurs in digital AVCs. Ultimately, it aligns to government policies in South Africa that can alter the underdevelopment of graduates and youth using inclusive Industry 4.0 development.

### Research gap

Most literature on entrepreneurial development mainly focuses on the training and practical experience for university graduates and youth to become employable. Literature fails to emphasise the need for entrepreneurial training to develop unemployed graduates and youth to become not only job seekers but also job producers.

The mental well-being of unemployed graduates and youth is subjected to anxiety and depression that threatens to delay their recovery. They can use a human rights approach to education to make their voices heard. They must organise and assert their interest to create decent and productive employment (Partington, 2021).

A broad institutional framework is needed to identify aspects and benefits within the digital economy that supports the development of technopreneurs in digital AVCs. Such an institutional framework can facilitate the

participation of university graduates and youth in existing or new agri-tech spaces that focus on responsible innovation.

## Research methods and design

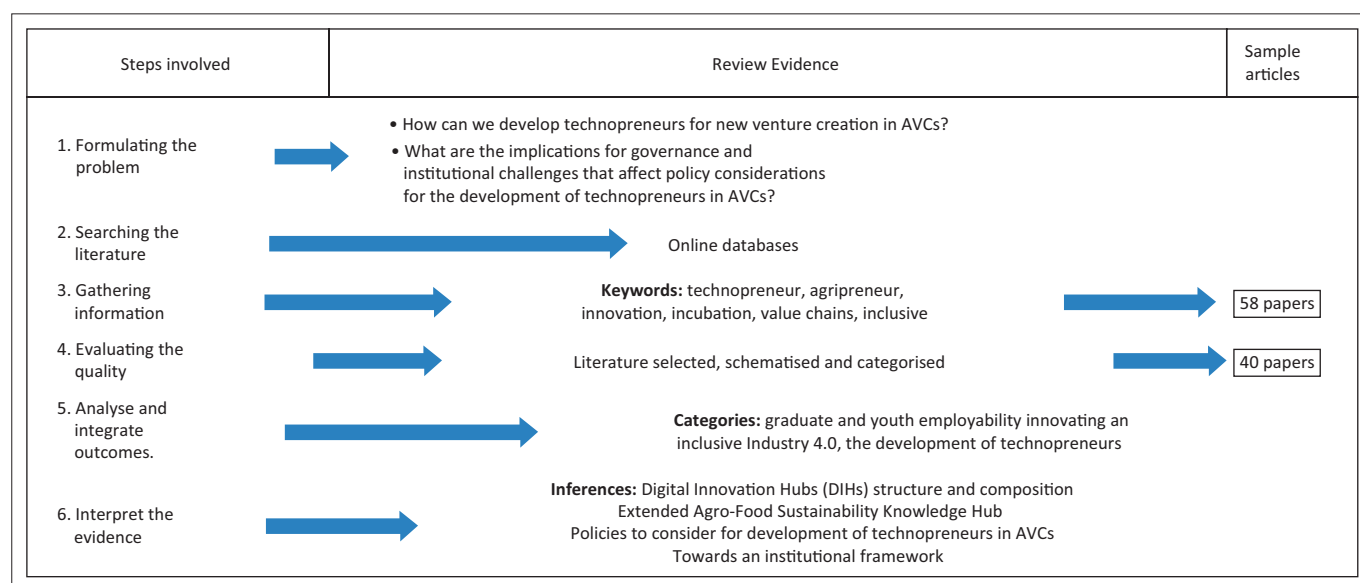
The initial gathering and analysis of pertinent material is a crucial component of any academic research undertaking. A systematic literature review (SLR) forms a firm base to produce new knowledge. Literature is identified, assessed and chosen to establish the knowledge gaps that need to be researched further (Webster & Watson, 2002).

This SLR used Cooper (2010), shown in Figure 1, as a guide to identify, evaluate and interpret the relevant research that can answer the research questions that guide this study. In order to gather data, this approach first formulates the problem that will be the basis for the literature search. After evaluating the quality, the outcomes are integrated and analysed until finally the evidence is interpreted and the results presented.

### Problem formulation

This article's goal is to propose an institutional structure for Industry 4.0 that will guide and support the growth of technopreneurs in digital AVCs. This work responds to the two research questions put forward. Firstly, 'How can we develop technopreneurs, for new venture creation in digital AVCs?' and secondly, 'What are the implications for governance and institutional challenges that affect policy considerations for the development of technopreneurs in digital AVCs?'

In this study, all the features and elements of the development of technopreneurs are embraced by the concept of digital AVCs implementation. It tries to understand and identify best practices of how practitioners and researchers can be assisted by such a framework to address the massive unemployment rate among people with degrees and youth



Source: Adapted from Cooper, H. (2010). *Research synthesis and meta-analysis: A step-by-step approach* (5th ed.). Sage  
AVC, agriculture value chains.

FIGURE 1: Systematic literature review steps.

in South Africa. The ultimate objective is to mitigate the current unemployment crisis caused by measures of national lockdown brought about by the COVID-19 pandemic.

### Searching the literature to gather information

As there are clear-cut keywords that define the topic, abstracts and titles were reviewed to sort academic manuscripts and industrial journals in library systems. As the development of technopreneurs in digital AVCs is a recent phenomenon, related publications channels are still disorganised. Searching online databases is today the dominant procedure to identify relevant articles rather than reviewing library collections. Internet searches were conducted using the following databases: (1) JSTOR, (2) Google Scholar, (3) Nexus (NRF), (4) Scopus, (5) Science Direct (Elsevier) and (6) Wiley Online Library.

The key phrases were not prearranged but slowly emerged throughout this comprehensive reading process while documenting this study. Among the search methods utilised were Boolean logic, parenthesis, phrase seeking, truncation and field searching.

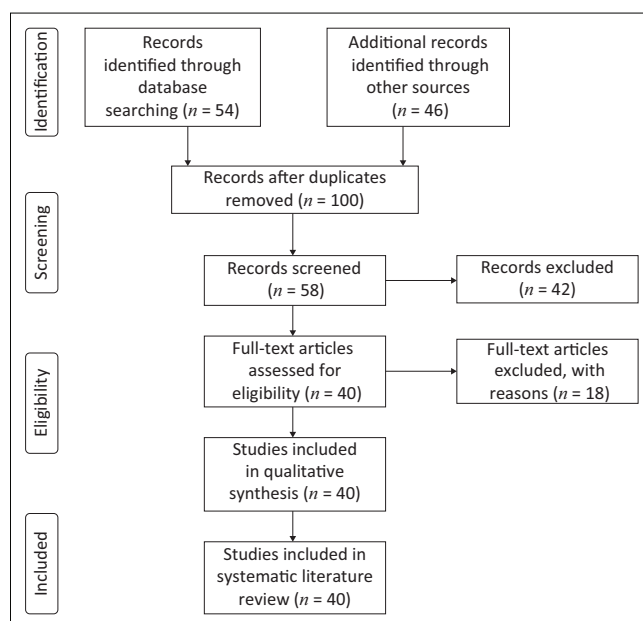
While searching and selecting articles the following criteria were applied: (1) 'technopreneur' and 'innovation' or 'incubation'; (2) 'entrepreneur' and 'innovation' or 'incubation'; (3) 'entrepreneur' and 'value chains' or 'incubation'; (4) 'value chains' and 'innovation' or 'incubation'; (5) 'technopreneur' and 'value chains' or 'incubation'; (6) 'inclusive' and 'technopreneur' or 'entrepreneur'; (7) 'inclusive' and 'value chains' or 'incubation'; (8) 'inclusive' and 'value chains' or 'innovation'.

The research identified 100 studies that included 54 online databases and 46 through other sources. After duplicates were removed 100 studies remained. After screening the 100 studies, only 58 were considered for analysis and a further 42 were excluded. After reviewing titles and abstracts, decisions were taken, as shown in Figure 2 of the Prisma flow diagram. The studies selected show different opinions and addressed several concepts related to the study.

### Gathering information from the studies

Multiple sources were searched to make the SLR as extensive as possible. The following keywords were used to search and select the articles covered in this study: 'technopreneur', 'innovation', 'incubation', 'value chains' and 'inclusive'.

The study also retrieved articles that interrogate the development of unemployed graduates and youth as technopreneurs from global institutions such as the Food and Agriculture Organization (FAO) of the United Nations, International Telecommunication Union (ITU), World Economic Forum (WEF), etc. This study analysed and identified concepts that could impact and assist with the design of an institutional framework for implementing technopreneur development for unemployed graduates and youth in digital AVCs. Thus, information from



Source: Adapted from Moher, D., Liberati, A., Tetzlaff, J., & Altman, D.G. (2009). Preferred reporting items for systematic reviews and meta-analyses: The PRISMA statement, The PRISMA Group. *PLoS Medicine*, 6(7), e1000097. <https://doi.org/10.1371/journal.pmed1000097>

FIGURE 2: PRISMA flow diagram for this study.

existing research was summarised after being processed to establish the contribution the conceptual content can make to an inclusive society. Next, is a discussion of how articles were evaluated and categorised.

### Assessing the studies' quality

Next, studies' quality was assessed, and applicable literature was categorised to get a better understanding of technopreneur development within an inclusive digital economy. The objective of this SLR was to identify and design an institutional framework to support the technopreneur development within digital AVCs. It was difficult to limit studies to classifications and ensure the studies were investigated sufficiently because of the nature of technopreneurs' development.

After the given criteria were applied, the remaining publications were put through a more detailed quality examination using design-based quality checks. Decisions regarding suitability were informed by these checks. The studies are chosen and provided concepts and different opinions to answer the research questions.

Articles were placed into four classes such as 'graduate and youth employability', 'innovating an inclusive Industry 4.0' and 'the development of technopreneurs'. The objective was to understand how an institutional framework to develop technopreneurs can assist in addressing graduate and youth unemployment. This can give a better understanding of how to identify institutions that affect technopreneur development in digital AVCs.

Although all methods have their limitations, a systematic approach with structured procedures was followed for

this SLR to ensure objectivity. Cooper's (2010) formal recommendations for an SLR were followed for the study to be valid. For the study to be reliable, all the recommended formal procedures were carried out. The next step finds consistencies and common patterns to help in the design of an institutional framework to support technopreneur development in digital AVCs.

## Ethical considerations

This research was performed in accordance with the ethical and professional guidelines of the University of the Western under Ethics reference number: HS 20/3/32. This study ensured that the highest ethical standards were adhered to for conducting the research have been acquired. The research, among other things, ensured factual accuracy and prevented data from being fabricated, falsified, suppressed or misinterpreted. This is accomplished by properly citing concepts and data sources. The origins for every knowledge, ideas and technique employed in this study were also properly recognised.

Appropriate epistemological orientation and purpose were identified. The various publications and search biases that may influence the findings were systematically reflected upon. There was a constant reflection to make sure that our subjective position did not influence the findings. Purposeful informed selective inclusivity guided critical decisions. Transparency to maximise ethical impact is used to communicate the findings. Careful attention is given to making missing perspectives visible.

## Results

Overall findings analysis, reporting, evaluation, integration and presentation are discussed in the section that follows. Key results include the following areas such as 'graduate and youth employability', 'innovating an inclusive Industry 4.0' and 'the development of technopreneurs'. An understanding is first needed of graduate and youth employability in South Africa. This will form the basis of our discussion on why we need new skills to innovate every business model, strategy and practice to achieve inclusive Industry 4.0 development. We define what is a technopreneur and aligned this to innovative-driven policies for an inclusive Industry 4.0. This would assist us with the design of an institutional framework to support the development of technopreneurs in digital AVCs.

### Graduate and youth employability

Employability refers to an individual being able to get employed, stay employed or get other employment if the need arises. This relies on the understanding, expertise, attitudes plus capability to get and keep fulfilling work (Rudhumbu et al., 2016). Constant technological advances demand specialised labour (Mayra, 2012). This drives students to universities to obtain a university qualification to improve their employability prospects in the labour market (Archer & Chetty, 2013; Mayra, 2012).

The rise of smart technology and internet use had affected employment and allowed organisations to function outside traditional boundaries. This uncertainty creates opportunities as well as challenges (Rudhumbu et al., 2016). The number of vacant positions has decreased as a result of the global COVID-19 pandemic. Several businesses are also dissatisfied with many university graduates' ability to contribute effectively (Sarkar et al., 2016).

Human capabilities need to transform as the digital economy is going through continuous disruptive change (Bowles, 2016). There is pressure on universities because of the belief that human capital development will lead to national growth and prosperity (Mayra, 2012). To reduce the high unemployment rate, universities must deliver graduates that accommodate the demands of the job market (Archer & Chetty, 2013).

A tertiary institution's success is measured by the ability of the qualifications to get students employed in a forever changing globalised knowledge economy (Archer & Chetty, 2013). Gaining an education without increasing relevant knowledge and skills do not increase employability (Cai, 2012). To address this challenge, tertiary institutions should synchronise the academic and work environments (Mayra, 2012).

There is a need to produce graduates to be employment creators and not only job seekers. Entrepreneurship education empowers students with the necessary expertise and capabilities to become self-supporting through establishing profitable ventures (Chukwudi & Nwosu, 2018). Enterprise development learning programmes must be integrated into the curriculum to assist students to put skills into practice (Archer & Chetty, 2013). When repositioning entrepreneurship teaching methods, more emphasis must be on practical real-life situations than on theory. Industry practical work must be relevant to their discipline and have the latest and modern equipment (Chukwudi & Nwosu, 2018).

Human capital development should be a priority, as this is critical to the development of technopreneurs (Adeoti, 2019). Entrepreneurship study centres that promote commercialised research and provide an adequate enabling environment should be established across universities (Chukwudi & Nwosu, 2018). Academic schools can provide guidance, working closely with successful technopreneurs (Archer & Chetty, 2013).

Industries increasingly use computer-based automation such as big data, intelligent machines, the internet, and artificial intelligence to connect people (Siregar, 2019). Enormous amounts of doom and negative hype exist around the creation of employment in this digital age of Industry 4.0. Digital disruptions give rise to workforces with turbulent futures as technology transforms workplaces. The relevance of certain skills is shortened as occupations

disappear and jobs need to be changed more regularly (Bowles, 2016). Thus, next, we try and understand what is meant by an 'Inclusive Industry 4.0' society.

### Innovating an inclusive Industry 4.0

Science and technology had advanced Industry 4.0 resulting in a lot of opportunities for graduates and youth. There is a need to respond to the future of talent development while considering how COVID-19 had reshaped the way we work (Gupta et al., 2015). Industry 4.0 has created a new age of entrepreneurship that is today the lifeblood of economies, valued for their contributions and encouraged to innovate to compete globally (Siregar, 2019). Stimulating opportunities for the poorest may need us to rearrange existing power relations and go beyond a technocratic approach. Without understanding the specific context, graduates and youth may be prevented from utilising opportunities (Gupta et al., 2015). Inclusive entrepreneurship education is significant for graduates and youth to attain adequate skilled manpower for national development in the fight to eradicate poverty (Akpama, Eneji & Ogar).

Inclusive development focuses on reducing inequalities and developing the most marginalised in society. Equal opportunities are built in areas of exclusion using local indigenous knowledge together with modern knowledge. Innovation hubs are used to generate investment and employment opportunities (Gupta et al., 2015). Development programmes produce entrepreneurs through entrepreneurial awareness, capacity building and mentoring. Entrepreneurs receive knowledge and become motivated to innovate new ideas. An incubation activity at the end of the programme produces new independent entrepreneurs (Hati et al., 2018).

Industry 4.0 will negatively impact governments that are slow to utilise rapid technological developments. Redistributing social benefits and education opportunities sometimes is not enough for the most marginalised (Siregar, 2019). Competitive advantage lies in seizing opportunities and enabling relationships with partners. There is a need to build network platforms as this disruption is changing structures and the design of the workforce from traditional hierarchies to flatter services. Production is streamlined using robotics, automation and cloud technologies to replace routine skilled workers (Bowles, 2016).

Technopreneurs have an enviable role in the national development and economic competitiveness of modern economies. Technopreneurs develop digital platforms for economies that are knowledge driven and innovation focused. The development of technopreneurs has grown to be a significant strategic strategy to value production and crisis resolving. Encouraging the rise of technopreneurs could boost economic growth and global competitiveness (Adeoti, 2019). Thus, how the development of technopreneurs can facilitate graduate and youth employability is discussed next.

### The development of technopreneurs

In both business and society, technology is a key factor in defining creative processes. A company can operate more productively thanks to technology, which also reduces the possibility of fraud. Business growth is facilitated by record keeping of activities and transactions effectively. It presents an approach for business process automation to facilitate quick connections with customers and efficient satisfaction of customers (Gaur & Sharma, 2020). A large amount of money has been invested in technology by nations that exhibit consistent economic growth and competitiveness (Adeoti, 2019).

The use of digital technologies is crucial in one of the most significant changes brought on by the globalisation of trade and commerce. New businesses that foster continual innovation and the development of sophisticated skills were born as a result (Abbas, 2018; Gaur & Sharma, 2020). Technopreneur development is built upon science and technology with a strong link to innovative entrepreneurship (Fowosire et al., 2017). Technopreneurs integrate entrepreneurship with technology to create an economic society based on technological knowledge. A businessperson who uses technology artistry to launch a traditional company is called a technopreneur (Abbas, 2018; Gaur & Sharma, 2020).

Technopreneurs revolutionise prevailing economic orders by introducing new product concepts and services in the market using technology (Debsin, 2021). Organisational creativity is when innovation is mainstreamed to find digital technology solutions to important corporate challenges. Technopreneurs care for and understand that the development of science and technology is dynamic, creative, innovative and takes new paths that have not been explored (Siregar, 2019).

A technopreneur uses technology in business operations to accomplish objectives. They have an essential part in the growth and development of the economy that is dependent on the latest technology (Gaur & Sharma, 2020). The concept of technopreneurship enables aspiring entrepreneurs' greater success as in a post-COVID-19 world the demand by people for technology solutions is rising (Debsin, 2021).

New technologies do not emerge by themselves but must be supported to become profitable. New technologies depend on human beings, that contemplate, educate and use prior knowledge along with fresh information to solve uncomplicated tasks and those that appeared unimaginable (Adeoti, 2019). Technopreneurs innovate new unique technologies are intelligent pioneers and have a remarkable capacity to be creative, dynamic and different thinking (Adeoti, 2019). Thus, universities must develop strategic thinkers with the necessary expertise to prosper in this ever-transforming worldwide situation (Fowosire et al., 2017).

Industry 4.0 revolutionises cross-border relations and economic interaction and thus also impacts on a regional

scale. To have a positive impact will require the government to implement policies that make this digital agriculture revolution a national priority (Siregar, 2019). There needs to be a very high priority to providing opportunities for employment to graduates and youth start-ups. An innovation and technopreneurship development programme can be established to nurture and incubate entrepreneurs. Thus, next, we look at designing an institutional framework for technopreneurship development in digital AVCs in South Africa.

## Interpretation of the evidence and presentation of results

Industry 4.0 requires new skills to innovate business models, strategies and practices that impact entire value chains, the environment and the whole of society (Gaur & Sharma, 2020). The components of a technopreneurship ecosystem include human resources, environment, laws and policies and financial resources (Gaur & Sharma, 2020). Many developing countries cannot keep pace with the developed countries in supporting the development of technopreneurs. In developing countries, governments should provide financial grants to universities and scientific centres to lead technopreneur development projects (Abbas, 2018).

In this section, the study aligns the components of a technopreneur ecosystem with frameworks from existing global literature. It then highlights government policies to align with and finally proposes a design of such a framework.

## Digital innovation hubs structure and composition

Digital innovation hubs (DIHs) use a network of competency centres to bring together implementation and research, accelerating innovation through the use of digital platforms. The DIHs provide digital services to the agriculture sector providing access to competence centres, brokerage services, finance, market intelligence and training (EIP-AGRI, 2017; Smidt & Jokonya, 2022). Thus, DIHs can provide incubator and mentoring services to new technopreneurs.

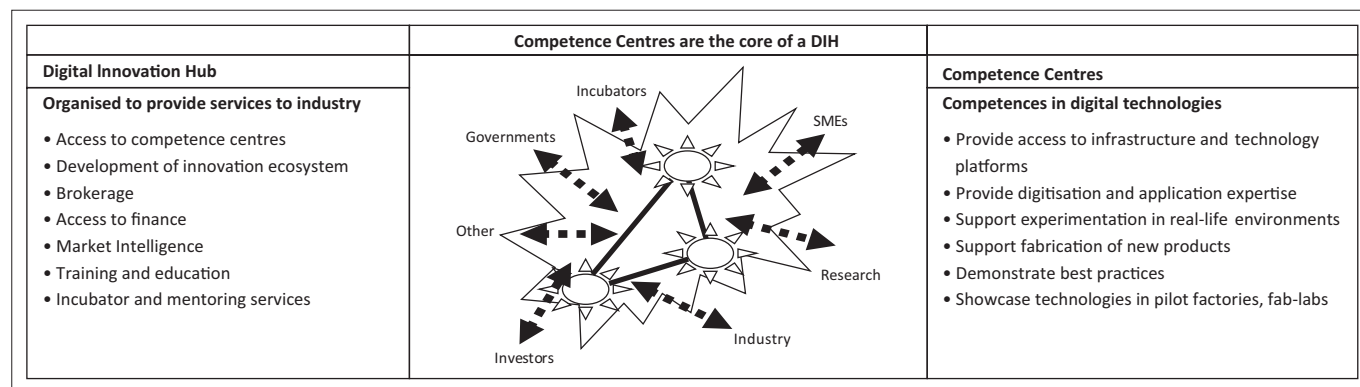
Figure 3 gives a schematic presentation of a DIH where competence centres form the core of the development of an innovation ecosystem. The DIHs use start-up technopreneurs to provide a service for companies that use digital technologies to upgrade and grow their businesses. Different forms of support are available at different phases of the innovation sequence of a service or product such as concept, development and production (EIP-AGRI, 2017).

## Extended agro-food sustainability knowledge hub

The extended agro-food sustainability knowledge hub (The Agro-Food Hub) approach addresses the challenges of current monopolistic practices and facilitates partnerships among agricultural small and medium enterprises (SMEs), to create value by forming alternative distribution and processing channels. This enables producers to reduce logistics costs by consolidating these cost savings through economies of scale and utilising its resources. As can be seen in Figure 4, for many AVC actors, the Agro-Food Hub acts as a knowledge intermediary. Technopreneurs can be used to facilitate effective communication among these AVC actors, which is essential for building long-term relationships (Manikas et al., 2019).

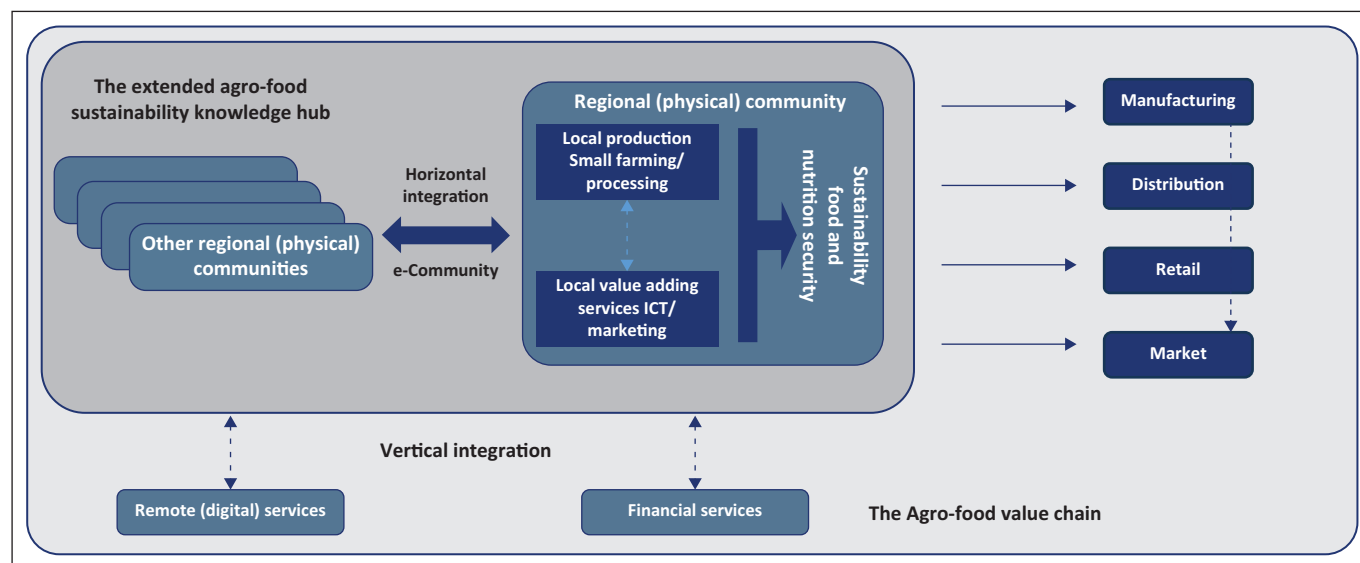
The Agro-Food Hub concept is based on a stakeholder approach system that integrates farming, value addition, distribution and consumption to better the social, economic, environmental, plus the nutritious makeup for a certain area. This strengthens or develops new associations between stakeholders of AVCs with a long-term goal to build a food system that strives for the economic, environmental and social sustainability of a community (Manikas et al., 2019).

The Agro-Food Hub model integrates farms or enterprises horizontally where several local communities or farms are integrated into a regional community. Similarly, regional communities, local communities and individual farms integrate to form a national community. With the support of digital adoption, the concept of e-community is formed to expand into an extended agro-food sustainable knowledge hub. This enables communities to create e-marketplaces that link with social networks and can interact with potential customers or investors directly (Manikas et al., 2019).



Source: European Innovation Partnership-Agricultural Productivity and Sustainability (EIP-AGRI). (2017). *Seminar digital innovation hubs for agriculture*. Final report. European Commission  
 DIH, Digital innovation hub.

**FIGURE 3:** Schematic presentation of a digital innovation hub.



Source: Manikas, I.G., Malindretos, G., & Moschuris, S. (2019). A community-based agro-food hub model for sustainable farming. *Sustainability*, 11(4), 1017. <https://doi.org/10.3390/su11041017>

**FIGURE 4:** The extended agro-food sustainability knowledge hub.

The models discussed earlier can go a long way to assist us to design a framework to develop technopreneurs in digital AVCs to achieve an inclusive Industry 4.0 society in South Africa. However, it is important that we first identify government policies we need to consider.

### Policies to consider for the development of technopreneurs in digital agriculture value chains of South Africa

The new District-Centred Development Model was launched in South Africa during 2019. The model seeks to maximise how the three spheres: district, provincial and national government coordinate and cooperate. It partners with stakeholders at the district level to speed up service delivery nationally (DPME, 2019).

The South African government recommended Agri-Parks to develop enduring rural industries and businesses. These hubs produce and process food, provide financial services and develop trade for local or global markets. The National Development Plan further calls for increased investment in research and new agricultural technologies to develop agro-processing and small enterprises. The strategy creates a network innovation system situated in district municipalities to transform rural areas (DRDLR, 2015).

The iKamva National e-Skills Institute (iNeSI) Bill (November 8, 2017, Government Gazette, Vol. 629, No. 41233) from the Department of Telecommunications legislates the creation of an institute responsible for future digital technology skills capacity development. The Bill establishes the governance arrangements of the iKamva Digital Skills Institute and cooperative education, knowledge-production and coordinating labs for digital skills (Ungerer et al., 2018).

A schematic representation of the iKamva Digital Skills Institute, which consists of provincial e-skills Colabs and

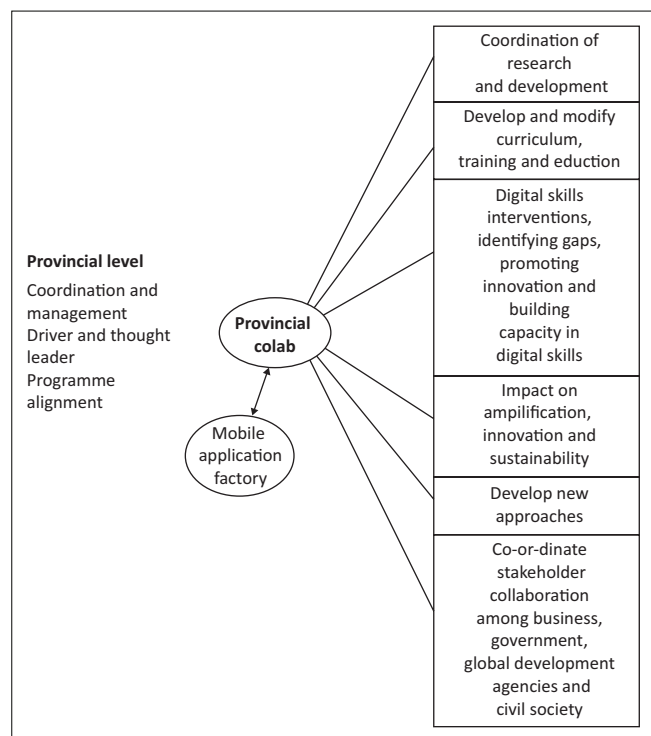
mobile application factories located at at least one university in each province across the nation, is shown in Figure 5. Colabs align national and developmental priorities for digital-skills initiatives and mobile application factories support local innovative mobile application development. This method raises awareness of digital development with a technopreneur focal point. It is a local physical space that creates a student environment to collaborate and innovate (iNeSI, 2018).

### Towards an institutional framework for the development of technopreneurs in digital agriculture value chains

Institutionalisation is an evolutionary process and is initially influenced by how organisations are currently structured and the methods they use for their operation (Anandajayasekaram, 2011). The new District-Centred Development Model is aligned with institutionalisation for this framework. The model strengthens stakeholder participation through consultation from planning to implementation in each district (DPME, 2019).

The iKamva Institute collaborates with global, national, provincial and local partners to implement e-skills projects. The provincial Colab space is used as a driver and thought leader, building knowledge production, and strengthening digital skills in South Africa (iNeSI, 2018). Thus, this study proposes provincial digital agriculture innovation hubs (PDAIH) that collaborate with the iNeSI on a provincial level to assist in the development of technopreneurs in digital AVCs. The framework proposes DIHs and the use of competence centres to reduce current knowledge gaps. On a district level, this study proposes the establishment of Agro-Food Hubs in district municipalities that utilise alternative channels of distribution and value creation to create opportunities for technopreneurs (Smidt & Jokonya, 2022).





Source: Ikamva National eSkills Institute (iNeSI). (2018). *Ikamva National eSkills Institute Bill (As introduced in the National Assembly (proposed section 75))*. Government Gazette No. 41581 of 20 April 2018. Department of Telecommunication and Postal Services. Retrieved from <https://www.inesl.org.za/pages/collaborative-network.php>

**FIGURE 5:** Provincial e-skills knowledge production and coordination (Colab).

The iNeSI forms part of a South African stakeholder framework that maximises impact. The framework identifies gaps through research and aligns them to national priorities (iNeSI, 2018). Given the aforementioned, a proposed institutional framework conforms to the district-centred development paradigm in collaboration with iNeSI that promotes a platform for innovation. On a provincial level, PDAIH and Colabs works closely with district Agro-Food Hubs. Figure 6 represents the institutional arrangements of a framework to develop technopreneurs in digital AVCs in South Africa (Smidt & Jokonya, 2022).

The management layer is initiated with input from the district Agro-Food Hubs, the foundation layer and the PDAIH. The foundation layer stakeholders are representatives of local, national and international stakeholders, including small-scale farmers, commodity groups, non-governmental organisations, women, young people, startups, incubators, research institutes, state companies, investors, banks, donor agencies and agricultural extension (Manikas et al., 2019; Smidt & Jokonya, 2022).

The district development model gives priority to supporting, promoting and developing local technopreneurs through local buying of products and services. The model creates an enabling environment that boosts business and public confidence to invest in local economic development (DPME, 2019). Technopreneurs use DIHs to assist the agriculture sector to understand how to create value with digital technologies. In the beginning stages of the concept, DIHs

collaborate and network with diverse actors that are developmental focused (EIP-AGRI, 2017). In addition, a district Agro-Food Hub supports technopreneurs to develop spinoff companies that provide economies of scale to store, distribute and market locally produced food using a coordinated development network (Manikas et al., 2019).

Technopreneur development is associated with the role of youth in digital technology implementation and internet use. University graduates and young people as future leaders need special attention as they form both the current and future channels to develop a community economically, socially and culturally (Siregar, 2019). Digital development has a greater probability to be successful if the broader stakeholders see them as relevant and trustworthy. Technopreneurs can use two development strategies such as stakeholder participation and the collaborative approach to gain the trust of stakeholders (Bayer, 2018).

Competence centres as the nucleus of PDAIH operations provide technical experts and infrastructure. Through innovation, new digital business opportunities can be created for technopreneurs. The approach raises awareness with a technopreneur focal point and development collaboration. It is a local physical space that creates a graduate and youth environment to collaborate and innovate. A key role for universities to develop technopreneurs is to lead the establishment of PDAIHs and Agro-Food Hubs.

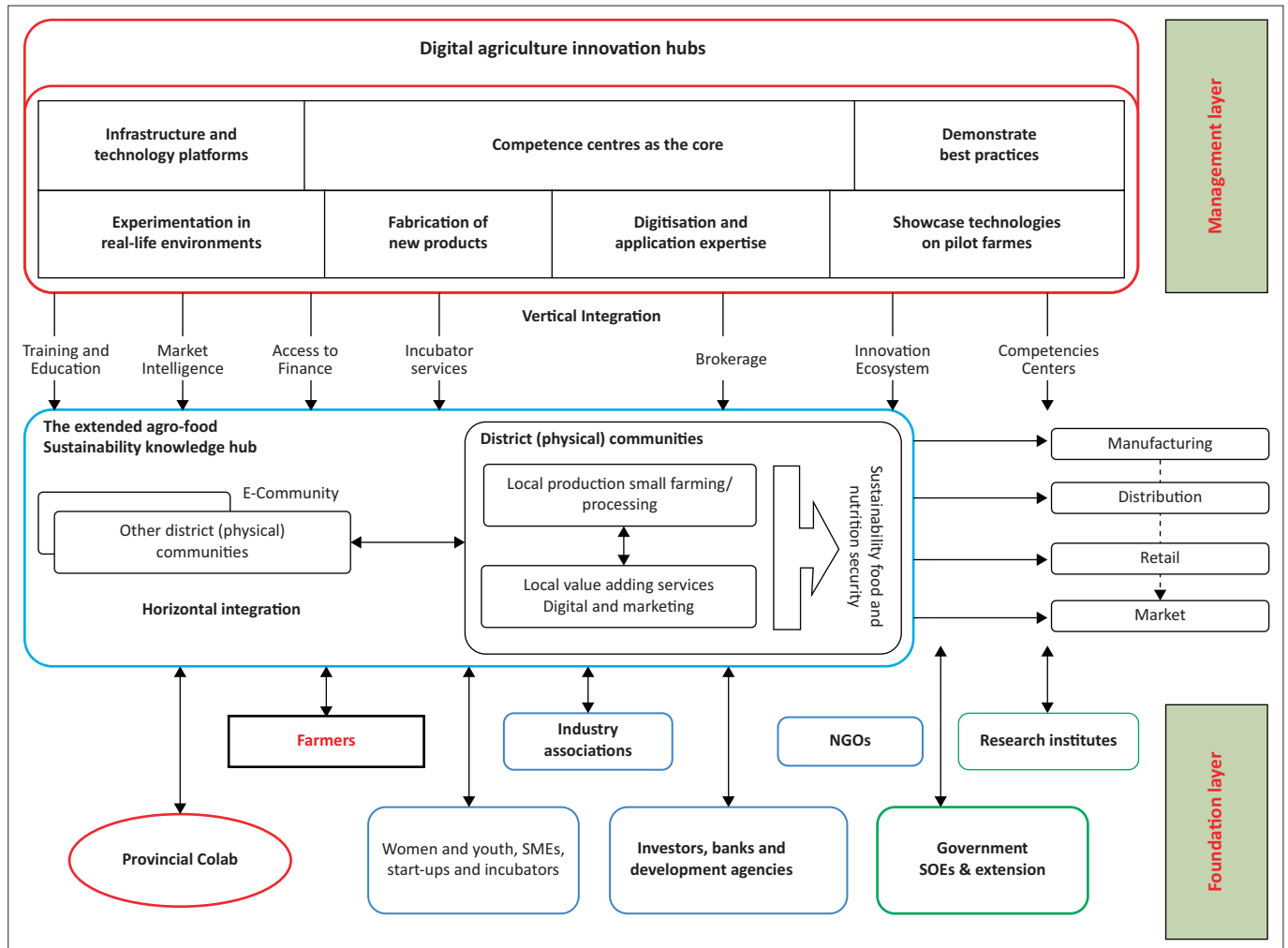
## Discussion

### Training, innovation and research

The capacity to translate research findings into useful products and services, as well as the capacity to sell such items and offerings through commercialisation, advertising and support services are crucial components of innovation (Anandajayasekeram, 2011). SMEs generally are constrained and limited to access only local markets. Their potential to expand is constrained by limited access to information, funding and business support. Technopreneurs can create digital marketplaces and online support to equip and assist SMEs to connect to big global markets (Siregar, 2019).

Technopreneurs have a chance to have an impact on new agricultural technologies because the agriculture sector needs to enhance output while using fewer resources. Global recognition of the significance of technopreneurs in developing markets and stronger African partnership could lead to improved AVC inclusion (Ungerer et al., 2018). Research and development must get government assistance as it continues to be a crucial component of agricultural innovation systems. Technopreneurs that drive technology adoption in AVCs use innovation systems to transform the agriculture sector (DAFF, 2018).

When an invention is successfully applied economically, that is innovation. The innovation may consist of brand-new



Source: Adapted from Smidt, H.J., & Jokonya, O. (2022). Towards a framework to implement a digital agriculture value chain in South Africa for small-scale farmers. *Journal of Transport and Supply Chain Management*, 16, a746. <https://doi.org/10.4102/jtscm.v16i0.746>

NGO, non-governmental organisation; SOE, state owned organisation.

**FIGURE 6:** Institutional arrangement for a digital agriculture value chains.

ideas, things, methods or products based on human creativity, academic inquiry or a mix (Anandajayasekeram, 2011). The scientific community should promote the use of verified technologies and their benefits as soon as they are released publicly (Ungerer et al., 2018).

The processes and institutions through which policy is made, implemented and maintained on digital adoption in agriculture should promote grassroots innovation among graduates and youth (Foster & Heeks, 2015). Rose and Chilvers (2018) argue that when developing digital policy in the agriculture sector, policymakers, funders, technology companies and researchers should consider incorporating technopreneurs.

Any organisation's level of institutionalisation is influenced by four factors: independence, adjustability, intricacy, plus clarity. This influence how structures must be transformed to continue and be able to control their surroundings (Peters, 2000). Provincial digital agriculture innovation hubs aligned with tertiary institutions link up with stakeholders in digital AVCs to promote

technopreneurs and create an innovation culture to help SME agribusinesses transform into online businesses. Provincial digital agriculture innovation hubs support district Agro-Food Hubs involved with innovation, new technologies and networking as an intermediary on a district level (Smidt & Jokonya, 2022).

The internalisation of training, collaboration and curriculum creation in academic institutions is facilitated by training key stakeholders in institutionalisation (Anandajayasekeram, 2011). In the subsection that follows, it is explained how stakeholders might collaborate and participate in research, invention and capacity building related to the development of technopreneurs in the digital AVC.

### The necessity to collaborate and participate

Value re-orientation and a strong commitment from the political leaders are fundamentals for technopreneurs to effectively address national development challenges. Innovation in AVCs must be promoted through encouraging actions that permit technopreneurs to enhance goods and

manufacturing procedures (Adeoti, 2019). South African technopreneurs need access to funding and opportunities to ensure that they are commercially profitable (Ungerer et al., 2018). In order to attract funding, technopreneurs must work with financiers and investors. In order to attract funding, technopreneurs must work with financiers and investors (Campion, 2018).

The district Agro-Food Hub engage stakeholders in a strategic collaborative network. It also networks between agro-food supply chain companies and adjacent sectors including tourism and academic institutions. By overcoming obstacles, the Agro-Food Hub creates new opportunities through the development of innovative technopreneurs that collaborate to build sustainable value creation networks (Manikas et al., 2019).

Collaboration with the international community is critical to riding this new technological wave. Sharing knowledge and information and conducting the research could assist in the design of the correct policies, strategies and initiatives. This helps to build capacity in the national innovation system to address market, innovation systems and capabilities failures in Industry 4.0 (Sirimanne, 2022). Without collaborating with the industry, graduates from universities won't have the necessary skills to enter the workforce. A partnership between universities and industry allows authentic lessons to be taught that are responsive to the economy and enhance the employability of graduates (Tran, 2016).

The adoption and widespread usage of agricultural technologies will be ensured by their user-centred design (Campion, 2018). Technopreneurs can impact elements that were previously out of their control thanks to partnership, which gives them more transparency and vision along AVCs. Partnerships can benefit from better participation in market structures as a result of this (Ungerer et al., 2018). Knowing what drives farmers and how to harness and promote the acceptance of novel technologies require an awareness of the local culture. Often, the advantages from science and the economy are inadequate to encourage this (Campion, 2018).

Integration of theory and practice can only be achieved through a close collaboration between industry and universities. Enterprises and universities face many challenges to develop sustainable and effective collaboration to enhance the employability of graduates. Diverse interests and expectations are represented and developing partnerships means that strategies must be adequately resourced and well prepared (Tran, 2016).

Technopreneurs will need to work together more frequently in sectors outside of agriculture in the future. The operations of all stakeholders must clearly benefit from the partnership, and the participant's goals must be consistent across cultures, matched and not in conflict between themselves. The legal and statutory standards must permit for proper leadership, transparent governance and continual openness and sincere dialogue (Smidt & Jokonya, 2022).

## Final observations

This study expands on earlier research by Smidt and Jokonya (2022), which offers a framework for the adoption of digital AVCs by smallholder farms. The preceding work concentrated on the institutional and digital technology architectural demands plus supplying small-scale farmers with digital services. By fostering technopreneurs in inclusive Industry 4 growth, this study adapts the framework by Smidt and Jokonya (2022) and presents an institutional arrangement that could fulfil the requirement to address the challenge graduate and youth unemployment.

The following two research questions were intended to be addressed by this study:

- How can we develop technopreneurs, for new venture creation in digital AVCs?
- What are the implications for governance and institutional challenges that affect policy considerations for the development of technopreneurs in digital AVCs?

In order to alleviate graduate and youth unemployment, a different vision of inclusive Industry 4.0 is imagined in order to address the research questions. This helps to better comprehend the institutional setup required to support technopreneurs in their development of innovative agricultural value chains.

In order to avoid a digital gap in the agriculture industry, South Africa must take action. To fully realise the digital potential of the sector, the government must assist technopreneurs (Ungerer et al., 2018). In order to create an inclusive Industry 4.0, it has been suggested by the current study that agriculture stakeholders look beyond service quality and are required to identify social and ethical standards. To transform towards sustainable development of agriculture, trade-offs must be made between individual productivity and collective sustainability.

For this study, the literature on several frameworks that can promote the development of technopreneurs in digital AVCs was examined. An institutional framework for the development of technopreneurs in digital AVC was put out after research on the policies and techniques used in South Africa. The framework recommended district Agro-Food sustainable knowledge hubs (DASKH) implementation, with Provincial digital innovation hubs (PADIH) assistance. District Agro-Food sustainable knowledge hubs cultivate technopreneurs with a worldwide reach to ensure an influence at a district, provincial, national and global level. Farmers and technopreneurs work together at various levels of integration and collaboration while pursuing a common strategic goal. With a focus on SMEs, PDAIHs offer digital services to the agricultural sector (Smidt & Jokonya, 2022).

In summarising the current state of affairs, this research revealed a number of promising prospects where digital

adoption redefines the role of technopreneurs in digital AVCs to become a coordinated model. It aids in altering the unfair terms of the present AVCs, which are governed by a small number of multinational organisations. A competitive advantage can be attained by pre-arranged collaboration and the cooperative use of assets and knowledge.

AgTech initiatives that foster the growth of technopreneurs must receive encouragement and support from the government and the banking sector. Using advising services and analytic data services, agribusiness owners could work together in digital AVCs (Ungerer et al., 2018). To ensure the long-term provision of services, innovative public private partnership (PPP) collaboration models must be investigated.

## Recommendations

An industry for digital agricultural services is required, one that creates opportunities and supports technopreneurs maintain their commercial viability (Ungerer et al., 2018). The coordination of activities for digital skills research, development, training and teaching falls under the oversight of PDAIHs. Provincial digital agriculture innovation hubs will place a developmental emphasis on networking and cooperation among a variety of actors, with the requirements of the farmers acting as the primary motivator. Technopreneurs provide services related to digital solutions (Smidt & Jokonya, 2022).

The development of the current commercial infrastructure and the expansion of the digital economy depend on technopreneurs. Young technopreneurs could provide SMBs with the technological creativity they need to advance in the demanding global business climate (Gaur & Sharma, 2020). The government can do a great service by providing a technopreneur education system for the benefit of graduates and young people. For the economy to grow more quickly and intelligently, it is necessary to harness the invention, artistry and creativity of technology.

Smart agriculture must be prioritised in national sustainable agriculture goals through programs that assist innovators (Kanoktanaporn et al., 2019). The government ought to encourage the sharing economy through creative challenges for technopreneurs (Ungerer et al., 2018). In order to reduce the cost of physical and electronic infrastructure, existing fixed and wireless communication networks should be used (ITU & FAO, 2016). A tertiary institution's competent Colabs in each province serve as the foundation for PDAIHs. As a result, those facilities can be used as the foundation for new PADIH business initiatives. Instead of beginning from scratch, a connection to current funding sources should be made for some services that are already provided by public programs (Smidt & Jokonya, 2022).

## Study's limitations

This study attempted to critically synthesise and assess the contributions of earlier research. After examining each

component, a framework for the deployment of a successful network of PADIHs and DASKHs was offered. The limits of this study, although, include the following:

- In this study, databases were individually searched before the analysis as part of a SLR technique. These articles from databases could have been assembled in a different way.
- Technopreneur development employing digital AVCs is a notion that's still in its beginning phases and may require extra aspects to be considered when putting it into practice.
- Most of the literature in this review is based on discoveries made in scholarly journals or business reports. The results of this review could have been improved if the category of literature had been enlarged.
- Database keyword searches provide the basis of the results. This is sensitive because results from slightly different inputs could have varied substantially.

## Areas for future research

Findings and suggestions are made on the creation of alternative AVCs by DASKHs with the assistance of PADIHs that support the long-term growth of technopreneurs. Technopreneurs can create new revenue-generating company strategies through entrepreneurship. The following questions are suggested for future investigation in order to improve the innovative capacities and sustainability of technopreneurs:

- What are the most important capabilities for inclusive development of technopreneurs to address graduate and youth unemployment in South Africa?
- How can we develop technopreneurs, through new venture creation in AVCs?
- How can innovative-driven technopreneurs be developed at all phases of an AVC?

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## Authors' contributions

H.J.S. contributed to the conceptualisation, visualisation, methodology, formal analysis, investigation and writing the original manuscript. O.J. contributed in the conceptualisation, review and supervision.

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## Data availability

Data sharing is not applicable to this article as no new data were created or analysed in this study.

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