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Digital Technology Adoption in Agro- processing Value Chains

Reena das Nair and Nwabisa Nontenja

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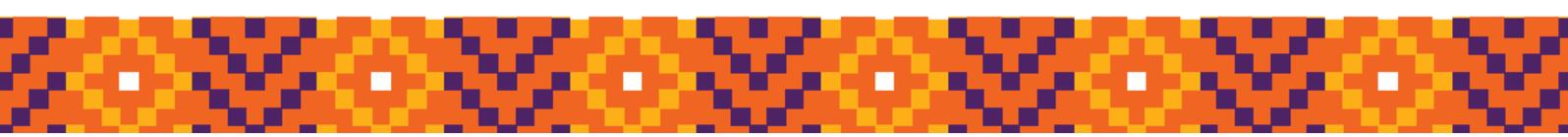
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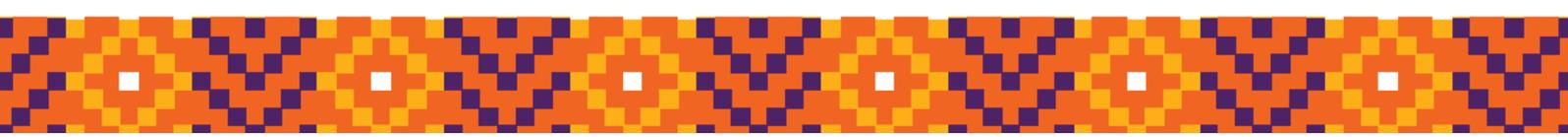


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1. Introduction

The adoption and use of digital technologies in the supply chains of large and lead firms has the potential to increase the participation of small and medium-sized enterprises (SMEs) along food value chains in various ways. At the primary level of food value chains, better traceability through digital technology enables farmers to realize more value from their crops by allowing for a degree of differentiation (traceability back to individual farms). This could facilitate the development of niche markets and the sale of higher value crops. Simple digital technologies can also be used to monitor and control outbreaks of disease through early detection and warning systems disseminated to farming communities. It could further give the farmer greater visibility when selling through supermarket chains. Research by Chisoro-Dube, das Nair and Landani (2018); Barnes and Higginson (2020); das Nair and Landani (2020) and Krishnan and das Nair (2021) has further showcased how digital technology can be used to address challenges at the primary production level to increase productivity, disseminate valuable information, enable payments, and facilitate access to inputs, information, finance and end markets in food value chains.

These studies further highlighted the benefits that digital technologies can bring to SMEs at the agro-processing or secondary level of food value chains. For instance, technologies like blockchain can improve traceability by enabling the implementation and monitoring of food safety and quality standards of SMEs. Digital technologies can also facilitate good labour and environmental practices along the value chain through providing a platform to store and verify certifications. Sustainability has emerged as a major driver of technology adoption at the processing level. Not only is technology increasingly utilised for more sustainable production methods, but required compliance with environmental and carbon emission guidelines has increased the information required by buyers of food products. Digital technology is also becoming a useful tool to track counterfeit goods, the trade of which can have significant negative consequences on health and safety and illicit cash flows.

Many processed food product markets in South Africa are concentrated with a few large companies. These large companies tend to be vertically integrated and with a presence in multiple product markets (Hodge, Govinda, Leuner and Mkwanzazi, 2021). For instance, Tiger Brands has substantial market share within several segments in the food sector, including rice (43%), pasta (35%), bread/baked goods (33%), grains (29%), flour (30%), cereal (24%) and to a lesser extent maize (12%) (Competition Commission, 2021). Three sugar milling companies, RCL, Illovo, and Tongaat account for 27.4%, 29.7% and 29% of sugar cane crushed by milling companies respectively (Competition Commission, 2021). Smaller food producers and processors face a host of barriers to entry and expansion, and struggle to participate effectively in food markets in South Africa (Competition Commission, 2019; Roberts, 2016; das Nair and Chisoro-Dube, 2016). Like food processing, the grocery retail sector in South Africa is also dominated by a few, large and highly sophisticated supermarket chains. It is estimated that the top 5 supermarket chains account for 64% of total value of grocery retail sales in South Africa (Competition Commission, 2019). These supermarkets act as 'gatekeepers' to end consumers, just as they are strategically positioned to be drivers of inclusive development in food value chains given their influence and control over procurement practices, standards and requirements (Das Nair and Shedi, 2022).

To meet all these requirements, certifications of mandatory standards and private standards that suppliers have invested in can be uploaded on digital platforms and made visible to

buyers and end consumers. Digital initiatives by supermarkets could further encompass supplier on-boarding and management, to inventory management, and warehouse, logistics and distributor systems as well as sales. The integrating of inventory management between suppliers and buyers enables SMEs to better manage production in line with buyer demand and to improve wider business management issues such as cash flow and employment costs. Such technologies can therefore better link up producers and processors to buyers. Rules of origin requirements as part of the Africa Continental Free Trade Area agreement (AfCFTA) further mean that digital technologies that facilitate traceability will become a necessity in the very near future for intra-regional and intra-Africa trade.

Digital technology, however, can be a double-edged sword. Technology adoption can be a barrier to entry for SMEs, given the risk that firms that are not digitally enabled can be excluded over time.¹ Digital technologies can worsen inequalities in value chains if they serve to exclude SMEs. The use of digital technologies also generates valuable data that can be monetized. This attributes considerable market power to firms that own the data, and competition law concerns emerge when this power is used to exclude competitors. Enabling digital adoption also requires access to resources and skills development, which come at a cost.

Against this backdrop, this research aims to better understand digital technology as an enabler or barrier in agro-processing value chains in South Africa. It does this through a case study on a specific type of digital technology, the GS1 barcoding technologies for standards. GS1 South Africa is a Member Organisation of GS1, a global standards organisation with 116 Member Organisations around the world. GS1 South Africa is also closely affiliated to the Consumer Good Council of South Africa. It aims to improve the “*efficiency, safety and visibility of supply chains across physical and digital channels*” through providing a mechanism by which important information in the production process is identified, captured and shared via the scanning of a barcode.² Such technologies can make SMEs ‘retail-ready’, allowing retailers to readily access SMEs’ product and process data by scanning a barcode. Lead firms such as large retailers and large, often multinational, food processors are well-positioned to facilitate the adoption of such platforms given their capabilities, resources and exposure to new technologies. They are also better able to respond to key challenges within their supply chains, such as the need to reduce costs, improve traceability, ensure compliance with standards and meet requirements in end markets.

On-going policy discussions, for instance as part of the Agriculture and Agro-processing Master Plan (AAMP)³, also recognise the challenges faced by SMEs. While the AAMP incorporates objectives to enhance competitiveness and entrepreneurial opportunities through technological innovation infrastructure development and digitalisation (the AAMP specifically mentions GS1 as a digital tool), it also acknowledges that this requires complementary support measures, such as access to affordable finance, skills development and support in the form of supplier development programmes. We expand on this in Section

¹ E.g. The exclusion of Kenyan potato farmers from KFC’s value chain, where KFC cited a lack of traceability and quality assurance as a reason why they do not procure from Kenyan potato farmers even in light of import shortages: IFDC Staff. 2022. KFC Kenya Potato Shortage Highlights Barriers to Local Sourcing. IFDC. Online. Available: <https://bit.ly/3LqBAOr>. (Accessed 16 March 2023).

² <https://www.gs1za.org/>.

³ <https://www.namc.co.za/aamp/>

4.5. The Digital Economy Masterplan⁴ has also identified concerns that digital technology may deepen the country's inequality rather than drive inclusion, emphasizing this risk that comes with a digital-driven development path. The digital masterplan aims to put forward a coherent action plan to ensure that the adoption of digital technology across the country's economy drives *both* inclusion and productivity. Our case study on GS1 is therefore timely as we interrogate the value of the standard and the GS1 platform for SMEs and whether it can serve to create more inclusive value chains in food markets. Importantly, we provide recommendations in Section 6 on how the platform can be improved to be more 'SME-centric' than it currently is.

Primary data for the case study has been gathered from GS1 itself through several in-depth interviews and datasets; from semi-structured interviews with a large supermarket chain that uses the GS1 platform and from five SME food suppliers on the platform in South Africa. Secondary data has been gathered through reports and case studies on GS1. While we acknowledge that the case study is limited to one use of digital technology in agro-processing, several of the insights gathered are generalisable across different digital technologies. These insights offer direction on the types of interventions and support needed by SMEs to access and utilise digital technologies more effectively.

Key questions that are addressed in this study include:

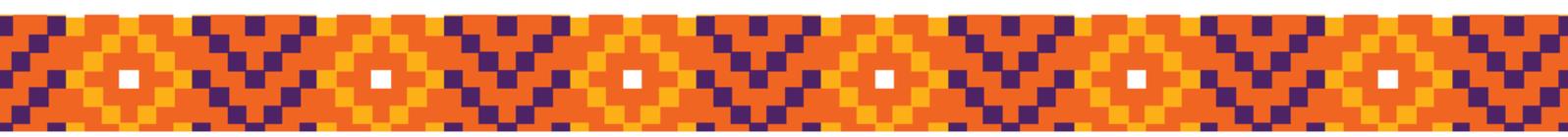
1. What factors drive the adoption of digital technologies in agro-processing-to-retail value chains?
2. What set of capabilities are exhibited by firms that are adopting digital technologies? What are the requirements in terms of investments?
3. What are the implications of not adopting digital technologies in terms of participation and competitiveness?
4. What are the challenges from an organisational, industrial and competition policy lens?
5. What are the mechanisms through which digital technology adoption reinforces unequal power relations within the value chain?

Section 2 provides the conceptual framework through which we view these issues and approach the research questions. In section 3, we briefly highlight our methodology. We discuss how GS1 features in the AAMP and describe how the platform works in Section 4. In this section, we also highlight how GS1 has been adopted globally and what alternatives are available in Southern Africa. In Section 5, we answer the research questions using a case study approach. Section 6 concludes with key insights from the case study and recommendations.

2. Value chain governance – who determines digital adoption and upgrading?

Agro-processors, and manufacturing companies more generally, face various challenges such as volatile demand, changing consumer preferences and changing requirements from buyers and their own suppliers (see Demartini, Pinna, Tonelli, Terzi, Sansone and Testa, 2018). As

⁴ https://www.ellipsis.co.za/wp-content/uploads/2020/08/ICT-and-Digital-Economy-Masterplan-for-South-Africa_Draft-for-discussion_-August_-2020.pdf



highlighted in the introduction, digital technology can not only address some of these challenges but also enhance productivity and enable the efficient use of organisational resources. This is behind the drive toward the wide-scale adoption of these technologies. The advent of Industry 4.0 is underpinned by this new wave of technological advancement and adoption.

Industry 4.0 refers to a new phase in the organisation of production based on interconnectivity, automation, machine learning, and real-time data (Mosconi, 2015). Industry 4.0 technologies include advanced robotics, augmented reality, the Internet of Things (IoT), the cloud, Big Data and Big Data Analytics (Bär, Herbert-Hansen, Khalid, 2018). These digital technologies enable a merging of the digital and physical worlds for increased automation, predictive maintenance, and the self-optimization of process improvements to ensure a new level of efficiencies and responsiveness to customers not previously possible (Schume, 2020). By creating inter-connected company ecosystems, these digital technologies are set to transform manufacturing and supply chain processes. Sharma, Parhi and Shishodia (2020) state that Industry 4.0 brings a new paradigm to manufacturing where digital technologies collaborate to deliver maximum output with minimum resource utilisation.

Agro-food value chains consist of various operations from agriculture production through to food consumption, involving a range of actors from primary producers, transport and logistics providers to food manufacturers and processors and retailers among many others. Digital technologies are of great relevance to the food industry due to their potential impact on the productivity and efficiency of the wide range of actors that make up the agro-food value chain and the implication of these changes for the wider economy. Digital technologies can also be used to convey important information to end consumers on product characteristics, nutritional value, product journey etc.

The agro-processing sector has been earmarked by the South African government as one of the strategic industries with the potential to contribute significantly to inclusive growth and job creation (AAMP, 2022; Chitonge, 2021). This is largely due to the industry's strong linkages to the agriculture sector and its share of manufacturing output (33.6%) and manufacturing employment (40%) in 2019 (Chitonge, 2021).

2.1 Digital technologies in agriculture and agro-processing

Digital technologies have a wide range of applications throughout the food value chain, from upstream primary production that encompasses farming and primary production to downstream activities such as food processing, manufacturing and ultimately, retail. The three previous industrial revolutions transformed agriculture from rudimentary farming to mechanisation and the integration of advanced software and information technology to enable automation (Liu, Ma, Shu, Hancke and Abu-Mahfouz, 2021). These developments have transformed agriculture into industrialised food production and distribution and created advanced value chains that are global in scale. The next advancements in agriculture brought about by Industry 4.0 and its associated digital technologies include precision agriculture and smart farming (United Nations Development Programme, 2021; Barreto and Amaral, 2018). These technologies are becoming increasingly affordable and accessible to even small-scale farmers in developing countries bolstered by growing mobile phone and internet penetration and the falling costs of data worldwide, which has enabled farmer adoption of precision agriculture technologies (UNDP, 2021). Mobile phones equipped with cameras, GPS, various sensors and a processor have given small-scale farmers access to experts and customised

information, real-time monitoring, and the collection and digitisation of large sets of field data (UNDP, 2021). The large datasets collected and the digital tools for collecting, aggregating, and analysing them are together referred to as big data (Bronson and Knezevic, 2016). Big data has been formally defined as *'the information asset characterised by such a high volume, velocity and variety to require specific technology and analytical methods for its transformation into value'* (de Mauro et al., 2016: 122).

The collection of big data by firms has however also raised questions about how large firms access and use the data, and the anti-competitive effects that may result (das Nair and Landani, 2020). The ownership and access to big data can tip the scales towards monopoly ('winner-takes-all' market outcomes) or enhance market power of firms with preferential access to the data and who can use it to improve their customer offering and/or attract greater advertising revenue at the expense of rivals who do not have access to it (OECD, 2016). For example, in the agricultural sector, multinational agriculture equipment manufacturer, John Deere fits all its tractors and other equipment with sensors that stream data about the operation of this equipment and soil and crop conditions. The large datasets of information collected by John Deere through their sensors are not openly accessible to farmers. The corporation requires farmers to subscribe and pay for access to this information (Bronson and Knezevic, 2016). Furthermore, John Deere has used software locks and restricted access to repair documentation and tools for its equipment, making it difficult for farmers to fix their own agricultural equipment or make use of more affordable third-party repairers (Gault and Koebler, 2022). Farmer groups in the US, where John Deere has a lion's share of the market, subsequently filed a complaint in March 2022 with the US Federal Trade Commission accusing the corporation of unlawfully restricting access to the diagnostic software and technical data necessary to repair its machinery (Claburn, 2022).

Technologies like blockchain enable end-to-end data transparency for fresh and processed products and traceability at all nodes of the value chain. Blockchain and smart labelling technology enable the tracking of historical, real-time data linked to the product, such as time of harvest, location data tracing its journey from 'farm to fork', data on farming methods, and adherence to labour, environmental, or ethical standards (Kamilaris et al., 2018; Chisoro-Dube et al., 2019). Within the blockchain, information is tied digitally to each individual product, creating a digital record to prove provenance, compliance, authenticity, and quality (Bumblauskas, Mann, Dugan and Rittmer, 2020). With distributed ledger technology, consensus between multiple nodes is required to alter data, so no single party in the supply chain can alter existing information (Bumblauskas et al., 2020). This immutable food and transactions register will help ensure transparency and food chain integrity and improve food safety (Aung and Chang, 2014). Blockchain has enabled the participation of small farmers and processors in food value chains by enabling compliance with traceability and quality requirements of large retailers and brands (Das Nair and Landani, 2020). An example of such an application is the UK-based company, Provenance, which links small farmers with large retailers by smart-tagging the farmer's produce, providing verified social sustainability claims for export markets.⁵

Directly relevant to this study, unique digital identifiers of food products that make them traceable through supply chains can be assigned to blockchain and other digital technologies (Antonucci, Figorilli, Costa, Pallottino, Raso and Menesatti, 2019). These identifiers include

⁵ <https://www.provenance.org/news-insights/tracking-future-meat-blockchain>

smart labels such as barcodes or those powered by Radio Frequency Identification (RFID) tags. RFID is a product identification tool that uses a wireless microchip and an antenna in the tag that does not need physical contact or sight positioning with the reader as is the case with barcodes (Abad, Palacio, Nuin, Gonzalez de Zarate, Juarros, Gomez and Marco, 2009). Because RFID technology enables contactless identification of products, it allows for effective and efficient information sharing throughout the supply chain. The amount of data that can be stored using RFID technology significantly exceeds that of barcodes allowing for rich digital records of each product (Fan, Qian, Wu, Du, LiJi and Xin, 2019).

Digital technologies have also been applied to simplify and automate retail buying. Retail buying involves several steps with activities performed by different individuals in different departments. These activities vary in terms of extensivity and complexity (Johannsen, 2001). They include need recognition and production specification, followed by a supplier search, evaluation, and selection of preferred supplier. Retailers then define the order specifications, receive goods and review (Johannsen, 2001). Depending on the retailer's internal capabilities, many aspects of the retail buying process may be paper-based and labour intensive. Internal stakeholders may engage in back-and-forth exchanges to make decisions related to each order. The retailer may also have several exchanges with prospective suppliers during the evaluation process. These may be to determine supplier compliance with the retailer's product specifications. Large retailers have sought to simplify and make this process efficient through automation and the adoption of digital procurement systems, also known as e-procurement.

E-procurement is a technology solution that facilitates corporate buying using the internet (Johnson and Klassen, 2005). E-procurement is used to carry out procurement functions like resource planning, sourcing, pricing, tendering, and payments. An important component of e-procurement is the incorporation of a digital marketplace which is an internal digital multi-vendor, multi-product catalogue that is often hosted and maintained by a third party (Croom and Brandon-Jones, 2005). Prospective suppliers must be listed on a firm's catalogue before they are considered for a contract or order. Large firms often adopt proprietary e-procurement technologies that are very costly and that are customised to the needs and specifications of individual firms (Kauffman and Mohtadi, 2004). E-procurement systems would therefore vary between firms. As a result, individual suppliers seeking inclusion on firm vendor catalogues would have to adapt product information formats multiple times to meet the specifications of each individual firm's e-procurement system – an exercise that can be labour intensive, costly and time consuming, particularly for SMEs.

2.2 Value chain analysis as a framework to understand the impact of digital technologies on SME participation and upgrading

Value chain analysis provides a useful framework for understanding the role of lead firms in driving digital technology adoption in the value chain through their exercise of governance and through their leadership in industrial upgrading. The global value chain (GVC) framework can therefore be adapted to understand the impact of technological adoption on the participation of SMEs in the value chain. The framework provides a methodology for understanding the governance and power relationships that impact technological learning and the adoption of technologies for upgrading within the value chain. Though the GVC framework was developed to understand how globalisation has shaped global trade and transnational production systems, its core concepts of governance and industrial upgrading

provide a useful framework for understanding the development of regional and local value chains (Gereffi, 1994; Gereffi, 1999; Chisoro-Dube et al., 2019).

According to Humphrey and Schmitz (2008: 263), “*governance refers to the inter-firm relationships and institutional mechanisms through which non-market, or explicit coordination of activities in the value chain is achieved*”. Governance analysis allows one to understand how a value chain is controlled and coordinated when certain actors in the chain have more power than others (Gereffi and Fernandez-Stark, 2016). Gereffi (1994) identifies two patterns of coordinated trade or value chain governance, “buyer-driven” and “producer-driven” chains. Buyer-driven chains refer to those industries in which large retailers as well as large, branded merchandisers play the central role in controlling the production system. These large firms can dictate the way that the chain operates by requiring suppliers to meet certain standards and protocols, despite limited or no production capabilities themselves (Gereffi and Fernandez-Stark, 2016). Producer-driven commodity chains refer to those industries in which large firms play the central role in controlling the production system, including its backward and forward linkages (Gereffi, 1994). Producer-driven chains are more vertically integrated along all segments of the supply chain such as those that characterise capital and technology intensive industries such as automobile manufacturing and computers (Gereffi, 1994). In producer-driven chains, large firms leverage the technological or scale advantages of integrated suppliers often in chains that are often at a trans-national scale (Gereffi, 1999). More nuanced forms of governance (modular, market, relational, hierarchical, captive) have since been identified, including different forms of governance at different nodes even within the same value chain (Gereffi, Humphrey and Sturgeon, 2005).

Value chain governance therefore emphasises the role of powerful ‘lead’ firms in coordinating production activities and shaping distribution of profit and risks within an industry. Entering a value chain governed by a lead firm/s can fast-track upgrading and the acquisition of production capabilities by suppliers (Humphrey and Schmitz, 2001). Lead firms are typically demanding with regard to reducing costs, raising quality and increasing speed. But they also transmit best practices and provide hands-on expertise. Humphrey and Schmitz (2002: 20) further note that “*it is this combination of high challenge and high support that is often found in highly governed chains that explains how relatively underdeveloped regions become major export producers in a short period of time*”.

Directly relevant for this study is how governance can be ‘collective’ and how a group of lead players, including at different levels of the value chain, can shape requirements and outcomes in a value chain. An example of this is through joint private standards such as GS1 standards. Private standards are prominent among large food retailers, food manufacturers and food service operators, reflecting their considerable market power and competitive strategies (Smith, 2009). Mather (2005) states that the proliferation of private standards is also driven by market liberalisation and the shift in responsibility for food safety from the public to the private sector as well as the weakening of health and quality regulations for food products. This has led some retail chains to establish private grades and standards for food products. They may also require that food suppliers and processors meet internationally accepted standards such as the Hazard Analysis and Critical Control Point (HACCP).

Henson and Humphrey (2010: 1631) describe private standards as follows. Firstly, they are voluntary, that is, there is no legal compulsion for compliance. The entities involved in the setting of private standards have no power to compel implementation. Rather, the

compulsion for compliance is wielded by private adopters such as large retailers. Henson and Humphrey (2010: 1631) further state that the market power of the adopters may make the standard *de facto* obligatory for access to markets. Secondly, all the major functions associated with the system of standards are undertaken by private entities. Thus, the standard is set by a commercial or non-commercial private body. Compliance with the standard is assessed by a private auditor and the standard is enforced by a private certification body. In addition to individual firm standards, Rossignoli (2014) identifies collective private standards that retailers establish when the transaction costs of establishing their own, chain-specific standards are high. Retailers react by creating organisations for the development of collective standards that allow them to jointly pursue common interests and reduce compliance, monitoring and auditing costs.

Standards and technical regulations are important for several reasons. Food safety standards help to ensure that consumers are protected from health risks and deceptive practices (Wilson, 2008). Standards increase the transparency of product information, enabling efficiencies within a retailer's operations and ensuring consumer safety (Wilson, 2008). Standards can therefore be described as instruments for value chain governance where lead retailers manage and administer their relationships with their suppliers (von Hagen and Alvarez, 2011). This is particularly true in arms-length relationships between a retailer and its suppliers. In this case, rather than monitoring quality and other product attributes directly, retailers leave direct control to certification and auditing bodies (Ponte and Gibbon, 2005). Standards may also be instruments through which lead firms can reorganise aspects of the market to better suit their needs (Tallontire, Opondo, Nelson, and Martin, 2011).

2.3 Value chain governance and upgrading

Governance impacts and shapes upgrading. Industrial upgrading is defined as firms, countries or regions moving to higher value-adding activities in the value chain (Gereffi and Fernandez-Stark, 2016). According to Gereffi and Fernandez-Stark (2016), governance provides a top-down view, focusing on the role of lead firms in the value chain, while industrial upgrading provides a bottom-up perspective, focusing on the strategies used by countries, regions and economic stakeholders to maintain or improve their positions within the global value chain.

Humphrey and Schmitz (2002) highlight that firms in developing countries face increasing competitive pressure as integration into global markets increases. To overcome these pressures, and increase their incomes, firms must undergo upgrading. Gereffi and Fernandez-Stark (2016: 12) list several types of upgrading including process upgrading, which refers to transforming inputs into outputs more efficiently by reorganising the production system or by introducing a superior technology; product upgrading which refers to moving into more sophisticated product lines; functional upgrading, which entails acquiring new functions (or abandoning existing functions) to increase the overall skill content of the activities; entry into the value chain, where firms participate for the first time in national, regional or global value chains; and end-market upgrading, which can include moving into more sophisticated markets that require compliance with new, more rigorous standards or into larger markets that call for production on a larger scale and price accessibility. Upgrading therefore involves firms "*making better products, improving processes to make these products and/or taking over new functions*" (Ponte and Ewert, 2009: 2). Digital technologies are relevant to all these forms of upgrading because of their potential to confer firms with enhanced capabilities (Lee, Meissner, Radosevic, and Vonortas, 2021).

By including the adoption of certain digital technologies as a required standard, lead firms can drive technology adoption. The implications of this on SME participation can vary depending on the SME's capabilities. However, digital technology adoption in the value chain may have the undesirable effect of restricting the participation of SMEs and of widening the gap between established incumbents and new entrants (das Nair and Landani, 2020). SMEs are generally less able to adopt new technologies due to the lack of financial resources and due to a lack of technical know-how and skills to operate these technologies (Avenyo, Bell and Nyamwena, 2022). Where power relations make value chains generally exploitative of small players, SMEs may be included in these value chains but on adverse or unfair terms that significantly limit their possibility for growth and long-term security (Hickey and Du Toit, 2007). The adoption of digital technologies by lead firms may perpetuate the conditions and terms that lead to the adverse incorporation of SMEs into the value chain.

By providing institutional support to SMEs such as technical training and funding, lead firms can enable SMEs to overcome some of these challenges and successfully adopt new digital technologies. Through supplier development programmes, for example, lead firms that are important buyers can transfer skills, information, knowledge and capabilities to their supply chain to capacitate suppliers and facilitate their participation and upgrading (Das Nair and Landani, 2021; Das Nair and Shedi, 2022). As the adoption of digital technology in food value chains grows in South Africa, it is important to understand the role that lead firms play not only in driving this, but in supporting adoption along the value chain.

3. Methodology

Our selected method of analysis to understand the role of digital technology adoption in agro-processing value chains is a case study method. A case study approach is appropriate to illustrate key developments in markets and is a commonly used research method in social sciences. It allows for in-depth investigation and understanding of complex economic and social phenomena (Yin, 2013). Case studies are useful to explore new processes or behaviours that have not yet been widely researched or understood and are useful to understand how and why certain events happen (Meyer, 2001). Importantly, case studies provide for the generation of concrete, practical and context-dependent knowledge (Flyvbjerg, 2006).

In this paper, we undertake a case study analysis of the GS1 system of standards enabled through digital technology (discussed in detail in Section 4 below). Active on a global basis, GS1 South Africa has been adopted by lead supermarket chains such as Pick n Pay and Shoprite, as well as large agro-processors such as Tiger Brands and Pepsico. In addition to secondary data obtained from case studies on GS1 worldwide, we collected primary data through three in-depth interviews with GS1 South Africa directly. We also obtained data on the SMEs that use the GS1 platform to understand who these SMEs are in the agro-processing space and the nature of the service they can access through the platform. Table 1 provides an example of the data on SMEs on the platform. We note that it is not possible to 'filter' by size of supplier in the data base. The data for a sample of SMEs (of which Table 1 is an example) had to be manually extracted for us by the GS1 team for follow-up interviews with the SMEs. This is a limitation of the platform in that large buyers cannot search easily specifically for SME suppliers. We discuss this in sections 5.2 and 6.

We supplemented this data with in-depth interviews with five SMEs from this database to assist in answering the research questions. To triangulate the findings, we further interviewed a large supermarket chain who utilises the GS1 platform. A limitation of the study is that this

sample of SME interviewees was provided by GS1 and this may introduce bias in the results. There is therefore an opportunity for future research that makes use of a wider sample, including SMEs who have not adopted GS1.

There are numerous digital technologies that processors in food value chains can invest in. We selected GS1 for an in-depth case study over others for several reasons. First, GS1 has been explicitly identified in the AAMP as a digital tool to enable greater SME participation in food value chains. Second, it is a platform that large and lead firms in agro-processing to retail value chains in Southern Africa are increasingly requiring their suppliers to adopt. Third, given that it is a web-based platform, there is no specialised or expensive software required for SMEs to invest in. Fourth, given that the standards are recognised globally, SMEs who invest in GS1 have the opportunity to expand into export markets. Fifth, for very practical reasons, through the DTIC we have direct access to GS1 and its databases.

4. GS1: What is it?

The primary digital offering of GS1 is through the scanning of a barcode. Barcodes emanated from the need to use a universal product standard for product identification. In 1973, the grocery industry in the United States of America came together to form the Ad Hoc Committee comprised of manufacturers, wholesalers and the country's largest retailers to select a single standard for product identification, the Universal Product Code (UPC) barcode (Basker, 2012). This would be a description that would be common to all goods sold in supermarkets and imprinted by the manufacturers and retailers (Weightman, 2015). The code would carry information about the product, including the company that made it. In-store computers would read this information with scanners at the point of sale. The aim of the barcode was to improve speed and efficiency at retail check-out points (Weightman, 2015). The Uniform Code Council (UCC) was established in 1974 to administer the UPC standard. By 1980, the barcode was widely adopted in the grocery and retail business and in manufacturing, having proven to be a reliable means of product identification (Weightman, 2015).

Today, the UPC and European Article Number (EAN) barcodes are the most widely used and recognisable barcode formats in retail (GS1, 2015). The UPC is the original standard for product barcodes consisting of 12 digits. In 1977, the European Article Numbering Association, an international association with affiliates in Japan, Germany, the United States and the United Kingdom, established the EAN barcode that was fully compatible with the UPC barcode. The EAN barcode added country codes to the front of the UPC barcode number. An EAN-13 number includes a 3-digit GS1 prefix indicating country of registration. In 2005, the US-based Uniform Code Council and the European Article Numbering Association merged to form a single international organisation under GS1 (GS1, 2023). The EAN standard is subsumed into GS1's Global Trade Item Number (GTIN) standard. The GTIN barcode now includes a 3-digit GS1 prefix indicating country of registration.

Table 1: Selected SME data from the GS1 Activate platform

GTIN	Brand name (may or may not be the same as company name)	Sub brand name	Functional Name	Variant	Image URL	Countries of Sale	Global Product Category	Net Content	Unit of Measure	Company name
0600165XX XXXXX	SME 1		Biscuits	Chocolate chip		South Africa	1000016 1	4	Kilogram	SME 1
0600165XX XXXXX	SME 2		Honey	Organic		South Africa	1000021 3	500	Gram	SME 2
0600165XX XXXXX	SME 3		Mallow Cones		https://bit.ly/3JJOyFL	South Africa	1000004 7	4	Piece	SME 3
0600988XX XXXXX	SME 4	XXX	Chips Snack Food	Assorted		South Africa	1000017 7	20	Gram	SME 4
0600990XX XXXXX	SME 5		Dumpling (Steamed Bread)	Wholewheat	https://bit.ly/3JJOyFL	South Africa	1000059 8	885	Gram	SME 5
0600165XX XXXXX	SME 6		Edible Oil	Pure	https://bit.ly/3JJOyFL	South Africa	1000004 2	750	Millilitre	SME 6
0600165XX XXXXX	SME 7		Edible Oil	Blend	https://bit.ly/3JJOyFL	South Africa	1000004 0	750	Millilitre	SME 7
0600165XX XXXXX	SME 8		Eggs	Large		South Africa	1000621 0	6	Piece	SME 8
0600165XX XXXXX	SME 9		Nuts and Raisins		https://bit.ly/3JJOyFL	Zambia	1000020 7	150	Gram	SME 9
0600988XX XXXXX	SME 10	XXX	Relish	Hot	https://bit.ly/3JJOyFL	South Africa	1000024 4	350	Gram	SME 10

Source: GS1 (2023)

4.1 Overview of GS1 South Africa

GS1 is a global, not-for-profit organisation that develops and maintains the most widely used global standards for efficient business communication (GS1, 2023). The GS1 system of standards enables the identification of business items and communication of data about these items in ways that can be used in any industry, in any country and with any trading partner. The aim of these standards is to provide a global language of business that enables organisations to identify, capture and share information among trading partners in a uniform, structured, seamless and consistent manner, with the 'barcode' being the best recognised standard (GS1 South Africa, 2023). Adherence to the GS1 standards by all trading partners enables barcodes to be read by any standards-based scanning system within the supply chain. Today, GS1 is the most widely used supply chain standards system in the world with member organisations in 116 countries, 2 million user company members and over 6 billion transactions a day. The organisation's key industries are retail, healthcare, transport and logistics, food service, market places and the technical industries.

In South Africa, GS1 was established in 1982, initially known as the South African Numbering Association (GS1 South Africa, 2023). GS1 South Africa is the only authorised entity to administer GS1 barcodes, GTINS and other global GS1 standards in South Africa and several other countries in Southern Africa. The organisation also oversees the process for local retailers to be listed on the Global Data Synchronisation Network (GDSN). The GDSN is the world's largest product data network that makes it possible for any company, in any market, to share and access product information. The organisation currently supports 12,000 companies in South Africa, which includes SMEs (GS1 South Africa, 2023). Table 2 below shows some of the members of GS1 South Africa and internationally.

Table 2: GS1 Members in South Africa and internationally

Industry	Member
South Africa	
Large retail/supermarkets	Massmart, Checkers, Shoprite, Woolworths, Clicks, Dischem, Food Lovers, Pick n Pay, Spar
Online retail	Takealot
Manufacturer	RCL Foods, Clover, RFG Food, Tiger Brands, Pepsico
Healthcare	Netcare
International	
Technology company	Facebook, Google
Online retail	Amazon
FMCG	Loreal, Johnson & Johnson, Dr Oetker, Proctor & Gamble, Nestle
Large retail	Walmart

Source: GS1 South Africa (n. d. -a)

Internationally, GS1 is governed by a management board composed of key leaders from multi-nationals, retailers, manufacturers and GS1 Member Organisations from across the globe and

from multiple sectors. GS1 South Africa is governed by a Council made up of key industry stakeholders. These are mainly large organisations in retail and manufacturing. The GS1 Council is tasked with ensuring good governance, aligning GS1 strategy to industry needs, overseeing GS1 South Africa's financial position and reporting back to the organisation's main board that is also affiliated with the CGSA board. Below are the organisations represented on the GS1 South Africa Council.

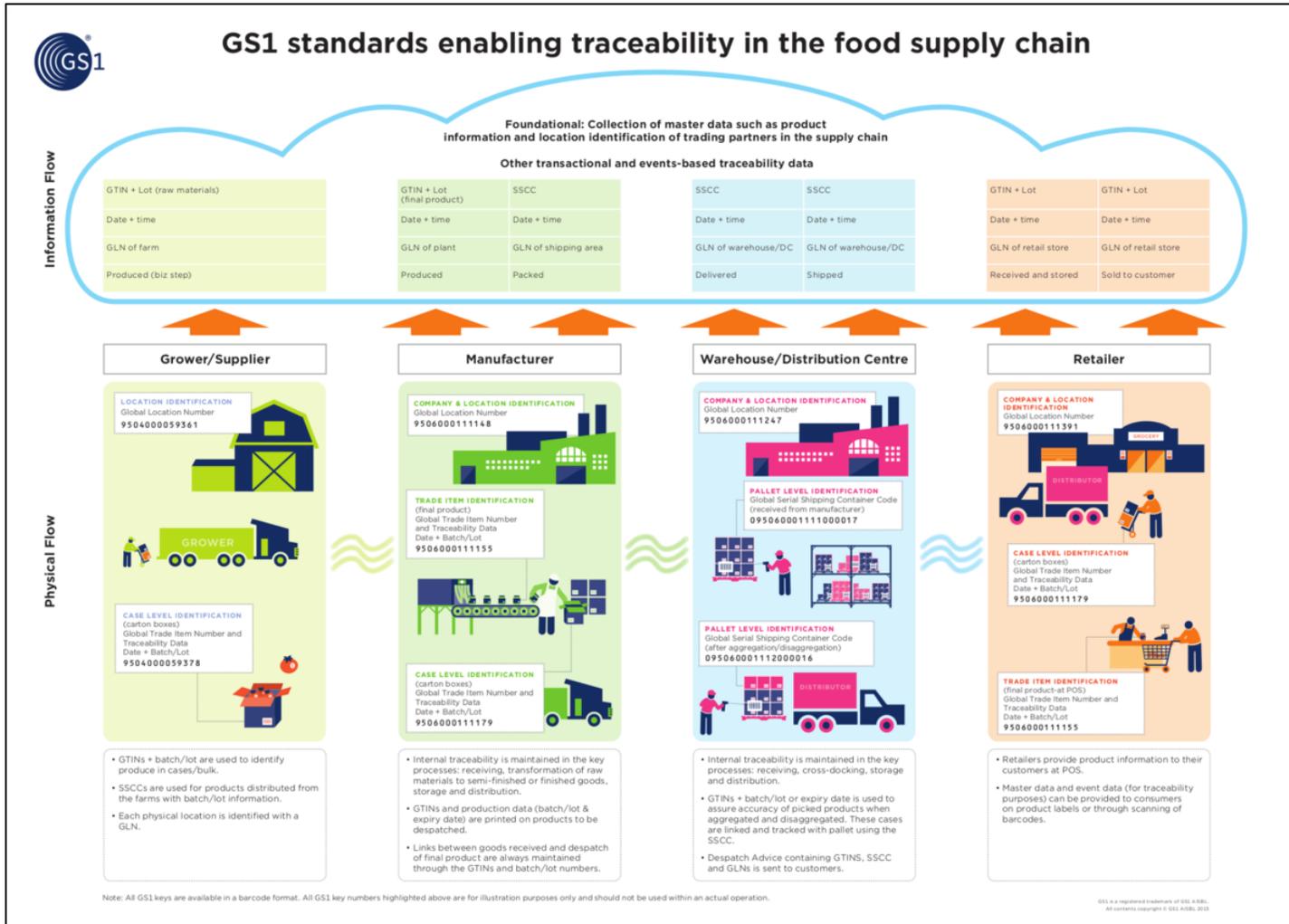
- Large retail: Shoprite, Pick n Pay, Spar, Massmart
- Manufacturer: Rhodes Food Group (RFG) Food, Tiger Brands, Pepsico
- Higher education: University of Cape Town
- Industry organisations: E_Commerce Forum Africa

4.2 Adoption in retail

Retailers and large FMCG firms are currently the largest adopters of GS1 technology.⁶ As highlighted, they are also on the Council of GS1. We discuss the implications of this in Section 5. Applications of GS1 technology within these industries include traceability and in procurement from an operational perspective. GS1 standards provide an obvious implementation tool for traceability within supply chains. As shown in Figure 1 below, traceability in food supply chains typically begins at the grower or supplier level where each batch is assigned a GTIN that identifies produce in cases or bulk. The Serial Shipping Container Code (SSCC) is used when products are distributed and details the batch or lot number. The SSCC is the GS1 Identification Key used to identify a logistic unit. The SSCC enables a logistics unit to be tracked individually to support order and delivery tracking and automated goods receiving. A Global Location Number (GLN) identifies each physical location of the objects moving throughout the supply chain until finished goods reach store shelves. GTINs, batch/lot numbers and SSCC are used at the manufacturing and warehousing or distribution centre nodes of the supply chain for internal traceability as raw materials are received, processed and the final products are packed, stored and dispatched. At the retail node, master data and event data can be provided to consumers on product labels or at points of sale through the scanning of barcodes.

⁶ GS1 South Africa (Interview: 08 December 2022).

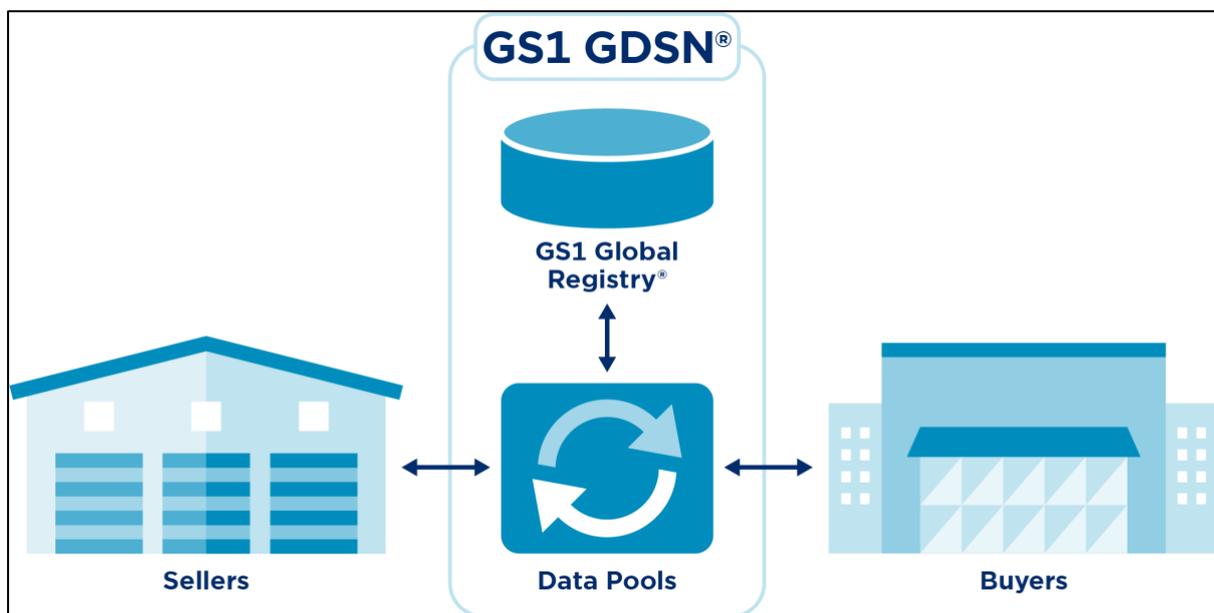
Figure 1: GS1 standards enabling traceability in the food supply chain



Source: GS1 (n. d. -a)

The GS1 GDSN allows retailers to verify product data and to automate parts of the sourcing and buying process. Figure 2 provides an overview of how the GS1 GDSN works. Retailers can subscribe to a certified data pool where suppliers, also known as brand owners, provide verified product data that adheres to GDSN standards. The seven core (minimum) product attributes that brand owners must provide are the GTIN, brand name, product description, product image URL, global product classification code, net content and unit of measure, and country(ies) of sale. This data is collated into Registry Platforms that allow retailers to look up the product information supplied by the brand owner to verify product identities. GDSN also supports digital content such as the product description and images. Of importance, there are significant untapped opportunities to add a wide range of other information on product and process of production. We discuss this below and further in Section 5.

Figure 2: How GS1 Global Data Synchronisation Network (GDSN) works



Source: GS1 (n. d. -b)

Each GS1 location has country or region-specific platforms that member businesses can subscribe to. In South Africa, GS1 offers firms access to its cloud-based Registry Platform, Trusted Source that allows brand-owners to create and manage their product information based on GDSN (Trusted Source, n. d. -a). It supports different use cases, such as a Product Information Management system for suppliers wanting to create, enrich and distribute product information. Retailers and other data consumers can receive and manage products from vendors and other parties or own brands. Trusted Source also allows sellers to upload higher levels of data and information, including certifications and nutritional information. The platform was developed for GS1 South Africa and was launched in 2020 by a third-party consultancy of the same name, Trusted Source (Trusted Source, n. d. -b). The consultancy also manages the platform on an ongoing basis.

Trusted Source makes several layers of product data available. Basic data includes product identification data such as the product barcode, also known as the GTIN, the Global Location Number, also known as the GLN, the brand name and product name, and packaging

measurements and weight that are defined according to GS1 standards. Information on product dimensions is used by retailers in logistics and distribution planning and in merchandising to determine shelf space requirements. Additional data on logistics unit width, depth, height and weight is also available. The GLN enables traceability as products move through the supply chain onto retail shelves.

Figure 3 displays the additional data available on Trusted Source. These include marketing data and product descriptions, ingredients, nutritional information, allergen information, the hierarchy of logistics units and their GTINs identified from the individual product units up to shipping pallets, as well as other digital assets such as product images. Along with product images, the platform also allows brand owners to upload product certifications as digital assets. These may include food safety certifications and other differentiating certifications such as 'organic' or 'Halaal'.

Figure 3: Example of Available data on Trusted Source

The screenshot displays the Trusted Source platform interface, divided into several sections:

- Marketing Data (Section 2):** Shows a product description for Knorrox Chilli Beef stock cubes. The text describes the ingredients (rosemary, coriander, herbs, and spices) and provides instructions for use. It also mentions the product's shelf life and its popularity in South African cuisine.
- Digital Assets (Section 3):** Displays a product image of Knorrox Chilli Beef stock cubes. The image includes text like "KNORROX", "CHILLI BEEF FLAVOUR", "RICH MEATY FLAVOUR", "12 CUBES", and "LESS SALT*". Below the image is a "Download asset" button.
- Asset Metadata Table:**

GTIN	06001038062668
ASSET TYPE	tiff
ASSET NAME	06001038062668_C1N1.tiff
VALID FROM	
EXPIRATION DATE	
IMAGE BACKGROUND	
ASSET SOURCE	
IMAGE FACING	
TYPE OF INFORMATION	PRODUCT_IMAGE
FILE VERSION	0
- Completeness:** A progress bar indicates 67% completeness.
- Navigation Menu:** A vertical list of sections: 1 Basic Data, 2 Marketing Data, 3 Ingredients, 4 Nutritional Data, 5 Allergens Info, 6 Digital Assets.
- Published to:** A list of retailers where the product is available:
 - Shoprite Checkers (21st Jan 2022)
 - Pick n Pay (Pty) Ltd (21st Jan 2022)
 - Spar Group Ltd (21st Jan 2022)
 - GS1ZA QC Retailer (21st Jan 2022)

Source: Trusted Source (n. d. -c)⁷

⁷ <https://prod.trustedsource.co.za/#/>

GS1 also offers the GS1 Activate platform that allows businesses to purchase and manage barcodes, also known as GTINs (see Figure 4 as an example). This online platform allows a business to generate barcode symbols to be used on product packaging, to upload product data according to the GS1 Standard and to share product data with its customers (GS1, n. d. - c). The basic product data shared on Activate is made available globally and is viewable by retailers and marketplaces.

For each barcode, the platform requires that the business add data that includes the product name, description, weight, size, variant or flavour and a product image. After products have been submitted, GTINs and barcodes are created, which can be downloaded from GS1 Activate in a variety of formats. The basic product data that the business adds to GS1 Activate will be uploaded to the GS1 Registry Platform and made available globally so that retailers and marketplaces can view it. GS1 South Africa offers free training to business on how to use the platform.

Figure 4: Example of the GS1 Activate user interface

The screenshot shows the GS1 Activate user interface for a product. The product name is "Cosmo Dumpling Pty Ltd Dumpling(Steamed Bread) Wholewheat 885 Gram". Below the name, there is a checkbox labeled "Allow customer to edit this product for next 24 hours" which is currently unchecked. There is a link "Edit this product >". Under the "Information" section, it shows "Associated with: Cosmo Dumpling (Pty) Ltd" and "Licence: 60099004841". Under the "History" section, it shows "Created: 15 Jun 2021 by at Cosmo Dumpling (Pty) Ltd" and "Last updated: 15 Jun 2021 by". Under the "Product attributes" section, there is a product image of several steamed bread dumplings in a white bowl. To the right of the image, the GTIN is displayed as "06009900484105" in a red-bordered box. Next to the GTIN is the GS1 logo, which consists of a green checkmark inside a blue square with "GS1" written below it. Below the GTIN and logo, the product name is repeated: "Cosmo Dumpling Pty Ltd Dumpling(Steamed Bread) Wholewheat 885 Gram". Underneath that, the GPC is listed as "Bread/Bakery Products Variety Packs (10000596)". In the bottom right corner, there is a "Save" button.

Source: GS1 (n. d. -c)

One of GS1's key value propositions is the ability to verify and authenticate product data. The 'Verified by GS1' platform allows GS1 member companies to authenticate the identity of a product by searching the GS1 Registry Platform (Figure 5). Retailers and marketplaces can use the platform to verify the identity of a product and access product data. The Verified by GS1 platform validates seven pieces of information: the GS1 GTIN, the product name, the product description, the product image URL, the global product category, the net content and country of sale (GS1 SA, 2021). This verification is important for food safety standards.

Figure 5: An example of a Verified by GS1 search result

The screenshot shows the GS1 South Africa website interface. At the top, there is a navigation bar with the GS1 logo, the text 'Welcome to GS1 South Africa The Global Language of Business', a search bar, and a 'Member Login' button. Below the navigation bar are menu items: 'About us', 'Get a barcode', 'Our industries', 'Our Services', 'Events', and 'Resources'. The main content area features a 'Verified by GS1' section with a sub-header 'Verify a products identity based on trusted information from brand owners.' and a background image of a woman in a grocery store. Below this is a search bar and a green confirmation banner that reads 'Product found and complete' and 'The number is registered to Vip Cosmetics Laboratories'. The main product details are displayed in a table format:

Afro Naturals 6 in 1 Curls and Coils 250 mlt	
GTIN	06009829990282
Brand name	Afro Naturals
Product description	Afro Naturals 6 in 1 Curls and Coils 250 mlt
Product image URL	https://activate.gs1.org/media...
Global Product Category	Hair - Conditioner/Treatment
Net content	250 MLT
Country of sale	GS1 South Africa

Source: GS1 SA (2021)

GS1 also offers Barcode Verification for a fee (GS1 SA, n. d. -b). This is a service where GS1 tests a barcode printed on a product package to ensure that it scans correctly once at the Point of Sale. GS1 also tests artwork, labels and packaging on various aspects including compliance with global standards, size, colour, and print quality. Businesses receive a report indicating the compliance of the barcode and packaging, along with any changes or adjustments that are necessary.

Regarding GS1's fee structure, businesses (including SMEs) pay a once-off fee to purchase GTINs and thereafter pay a yearly renewal fee (Table 3). The annual renewal fee represents a cost to businesses over and above what they would pay should they purchase a barcode from a reseller instead of GS1. Purchasing a GTIN grants access to the Activate and Trusted Source platforms, however these services are for a fee. Activate has an annual license fee of R 65 for SMMEs. The cost to access the Trusted Source service is detailed in Table 3.

Table 3: GS1 Pricing as at March 2023

Price of barcode / GTIN		
Number of items needing a barcode/GTIN	Initial Fee/Once-off Entrance fee	Annual Renewal Fee – March 2023
1	R 156	R 68
10	R 1,745	R 385
100	R 6,065	R 2,141
1,000	R 7,302	R 4,186
10,000	R 8,046	R 8,559
100,000	R 8,790	R 25,672
GLN	R 156	-
Annual fee for the Trusted Source access		
GTIN count range	Upper range count	Exclusive VAT
1	1	R 86
1-10	10	R 804
10-100	100	R 8 034
100-500	500	R 26 780
500-1000	1000	R 53 560
>1000	5000	R 136 578

Source: GS1 (2023)

GS1 is currently developing standards for next generation barcodes such as QR codes and RFIDs which can hold vastly more information such as allergen information, whether a product is organic, and a product's carbon footprint (GS1 SA, 2021). This is going to be important to track environmental sustainability indicators for climate change considerations. GS1 is also working towards integrating the GS1 standards into Google Search.⁸ This will enable greater interoperability and wider data exchange across supply chains to the consumer.

In South Africa, GS1 barcodes and GS1 SA has undertaken several initiatives in collaboration with its large retailer members to assist SMEs to adopt GS1 standards and make use of its platforms. These include the SMME Retail Ready initiative that offers SME-focused training programs and pricing developed to help small businesses navigate the process of adopting GS1 standards and registering on its platforms (GS1 SA, 2023). SMEs are assisted to generate

⁸ GS1 South Africa (Interview: 08 December 2022).

product barcodes and to provide correct product data and standardised images required by retailers, distributors, and other trading partners. While there are alternatives to GS1, the functionality of these alternatives appears to be declining over time⁹. The GS1 platform, endorsed by retailers, will become the dominant platform in Southern Africa. We discuss the implications of this in Section 5 below.

4.3 GS1 and the Agriculture and Agro-processing Master Plan

GS1 has been explicitly earmarked as a tool for greater SME participation in the Agriculture and Agro-processing Master Plan (AAMP). The AAMP is centred around greater participation of SMEs in South African food systems, and several value chain specific and cross-cutting interventions have been mapped out for further development as the AAMP is operationalised in Phase II. Specific opportunities and potential commitments directly linked to GS1 identified in the AAMP include the following:

- *“Develop and implement identification and traceability systems to help farmers and SMME suppliers meet mandatory national, export and private standards.*
- *Develop digital systems tailored to the needs of SMMEs and value chain players to enable traceability of certifications, standard compliance, labour and environmental practices (e.g., GS1)” (AAMP, 2022: 27).*

The AAMP goes on further to highlight the following commitments:

- *“Support SMMEs, especially those owned by black, female, and worker-owned businesses (by):*
 - *Increase(ing) traceability to gain better access to markets through GS1 and GIs.*
 - *Adoption of GS1 standards as a de facto identifier in the consumer goods sector” (AAMP, 2022: 54)*

It is critical that these commitments on GS1 are not viewed in a vacuum. There are further commitments that large buyers must make which are complementary to the adoption of such standards so that SMEs truly benefit from them and so that they are not simply driving the agenda of big businesses in terms of efficiency considerations in their supply chains. These complementary interventions are highlighted in the AAMP and include commitments to invest in enterprise and supplier development (ESD) programmes that target SMEs, black-owned, women-owned and worker-owned enterprises. The use of GS1 barcodes was identified to further assist SMMEs specifically in complying with ESD programmes and for tracking, tracing and reporting purposes (AAMP, 2022). After much discussion in the AAMP process, larger retailers in principle agreed to spend at least 3% of their NPAT on ESD programmes. The understanding is that this is over and above their current mandatory spend as part of B-BEEE requirements. If not, then the negotiations have clearly not been in good faith.

5. Analysis – can GS1 platforms enable greater participation of SMEs in food value chains?

Through the case study on GS1, we seek to answer the research questions set out in the introduction to understand how digital technologies adopted or endorsed by large and lead

⁹ See Appendix A.

firms facilitate and improve the participation of SMEs in the agro-processing level of food value chains in South Africa. We do this through the application of a value chains framework to understand the implications of governance on participation and upgrading.

5.1 GS1 GTINs as a collective private standard

SMEs in Southern Africa looking to sell through the large retailers' corporate stores are required to have a valid barcode as a minimum requirement for entry. There appears to be a bit more flexibility with respect to franchise stores, where franchise owners have some discretion over supplier requirements for their suppliers.

The SMEs we interviewed noted that a valid barcode was required even before they engaged further with the retailer and before they were informed of further requirements.¹⁰ Furthermore, large retailers like Pick n Pay and Shoprite now require that their suppliers make use of barcodes issued by GS1 specifically and require that products be listed on the GS1 Registry. The ability of large retailers to impose this requirement on their suppliers is tied to the buyer-driven nature of the South African grocery retail industry. A key characteristic of buyer-driven value chains as highlighted in the conceptual framework is the emergence of private standards (Mather, 2005). Due to their position and control within food value chains, retailers and large processors have the capacity to adopt, implement, and enforce rules that are privately set (Rossignoli and Moruzzo, 2014).

The evolution of GS1 and GTINs represents one such collective private standard. GS1, as the body that sets the standard, is a non-profit organisation comprising members from several industries, including manufacturers and retailers. As more retailers impose this standard as a requirement, registering their products with GS1 is becoming a prerequisite for entry onto supermarket shelves in South Africa. In effect, this is becoming, if not already, a *de facto* standard for suppliers in South Africa. With the main retailers, Shoprite, Pick n Pay, Spar and Massmart as well as large food processors, RFG Food, Tiger Brands and Pepsico being on the GS1 Council, they drive industry adoption of the standard, while reducing their own, individual transaction costs. These players even sponsor SME workshops and training to increase the uptake of GS1.¹¹ This highlights the collective governance of large lead firms in the food value chain in Southern Africa and how they drive collective standards like GS1 through digital platforms.

5.2 Large retailers as drivers of the adoption of the GS1 GTIN¹²

One of the retailers on the GS1 Council is a large supermarket chain. Understanding this retailer's requirements for its food suppliers is important to evaluate how GS1 fits in to its procurement process, and what the implications are for not adopting it.

To supply this retailer, small businesses must meet several requirements. In addition to being a registered and tax-compliant business with a VAT number, the business' facilities must meet minimum food safety standards and undergo a food safety audit. The business must also ensure that all ingredients and raw materials used in manufacturing have full traceability regarding source, quality and shelf life. The product must have a full ingredient statement. Any ingredient claiming to be organic or free-range must have the appropriate certificates of

¹⁰ Mopani worm-based snack manufacturer (Interview, 27 February 2023); Plant-based desert manufacturer (Interview, 09 March 2023).

¹¹ Fruit juice processor (Interview, 23 February 2023).

¹² Retailer 1 (Interview: 7 February 2023).

declaration. The retailer also requires that products adhere to all specific product-related and labelling standards and regulations in terms of South African law. The broad nature of these requirements is not unique to this retailer, although the specifics may be. All retailers have requirements and standards for suppliers, both legal and private (see das Nair and Landani, 2021).

To transact with the retailer, suppliers are required to register onto its portal. The portal is a web-based interface between the retailer and its suppliers (called vendors). This service is free and manages suppliers' trading documents, article information and cost prices. To register onto the platform, the retailer requires that products entering their supply chain have a Value-added tax number, a GTIN and a Global location number (GLN) for the purpose of tracking and tracing. The GTIN and GLN are exclusively issued by GS1. Therefore, as a very first step to register as a vendor for the retailer, a GS1 barcode, GTIN and GLN are required.

The retailer is among the South African retailers that have implemented the GS1 Global Data Synchronisation Network by linking its internal portal to Trusted Source (GS1 SA, 2021). The retailer's portal is provided and maintained by a "Software as a service" (SaaS) provider. The service provider offers businesses a customisable, cloud-based supplier portal that is the interface between suppliers and retailers. By implementing the platform, the retailer sought to diversify its supplier base and enable the integration of small suppliers into its supply chain. The platform enabled small suppliers to reconcile their orders and invoices online. Small suppliers provide product data through Trusted Source, which as discussed, is part of the GS1 system. The platform does not require that small suppliers have any special software to trade and collaborate with the retailer. This is because Trusted Source and the supplier portal provided by the SaaS service provider can be accessed by suppliers and retailers via the Internet.

Though a supplier can register onto the retailer's portal with a UPC product barcode that is issued by a source other than GS1, the retailer states that the absence of GS1-issued barcode in the EAN 13 format means that an order is highly unlikely to be placed with the supplier. The retailer requires that products that enter its supply chain have GS1-issued EAN 13 barcodes. This is to maintain data integrity and efficiency within its supply chain. A product that does not have the required barcode format cannot be tracked and traced as it moves through the retailer's supply chain. This can be a major source of inefficiency. The retailer explained that an error in capturing product master data is very costly. The steps to correct the error increase with time and the further it is in the supply chain. It is therefore much more efficient and cost-effective to ensure that suppliers comply with the right standards and barcodes from the beginning.

The requirement for GS1-issued barcodes extends to the retailer's franchise stores. However, as highlighted, there appears to be a bit more flexibility for franchises. Alternative barcodes may be accepted in the case where the franchise store makes very small orders of the respective products and therefore scans limited quantities at the point of sale. However, as orders grow, and as the SME begins to deliver larger quantities (especially in caseloads), a GS1-issued barcode will be required. Therefore, not only is GS1 increasingly important for entry, but it is also critical for expansion and growth.

Most of the retailer's suppliers make use of GS1 barcodes and labelling standards because of this requirement. The retailer has had instances where both large and small suppliers have incurred significant costs to undergo relabelling before their products were accepted because

they made a use of a barcode or labelling standard that was not GS1 compliant. These suppliers may have successfully supplied other retailers before who did not require compliance with GS1 standards before being confronted with this requirement at the retailer. If an SME is compliant with GS1 standards and their data is available on Trusted Source, then their listing process will be faster and smoother at the retailer. This highlights the 'must-have' nature of the barcode standard for this retailer. Therefore, though businesses are not required to make use of a GS1 barcode by law, it has nevertheless become *de facto* obligatory for entry onto the shelves of large retailers such as the one interviewed. Suppliers are therefore 'nudged' towards a common standard which is the most widely accepted so that the investments they make in this standard meet the requirements of majority of their buyers. This is the essence of course of a collective private standard. The costs of having different barcoding, labelling and packaging requirements for different buyers is prohibitive for SMEs, as well as inefficient. The standard therefore coalesces to the one demanded by the most significant buyer or groups of buyers, and these are often the buyer/s that have considerable power in the value chain.

The retailer we interviewed further also makes use of Verified by GS1 and Trusted Source to verify product barcodes and to obtain product data that adheres to GS1 standards. The retailer notes that 40% to 50% of FMCG and edible and non-edible groceries product data is sourced from GS1. Access to the digital product data catalogue has saved the retailer a significant amount of time. Manually capturing product data would require 15 minutes compared to five minutes or less with GS1. The retailer states if all retailers used the same standard to capture product data, it would increase efficiency and save both retailers and suppliers time and paperwork. Other GS1 services that the retailer uses include a daily feed that indicates any changes to product data to ensure that the retailer has up to date product data on its systems, and the Verified by GS1 that allows the retailer to verify product data and information.

The retailer notes that there is potential to expand the application of GS1's platforms to enable traceability within supply chains. However, this will be costly due to businesses changing their systems and processes and adopting new technologies. Other countries have already expanded the application of GS1 technology and platforms. Examples include using QR Codes for traceability and to make product information available to consumers in the Netherlands and Australia.¹³ GS1 identifiers have also been used for cross-border traceability of fruit exports from Malaysia to China (GS1, n. d.). Large retailers in France and Turkey have integrated the GS1 Global Data Synchronisation Network into their e-procurement systems to manage supplier and product data (GS1, 2021a, b). Similar applications of GS1 are yet to be deployed in South Africa. Though the current GS1 platforms, Activate and Trusted Source, can potentially enable businesses to share rich product data such as certifications, it does not appear as though businesses have made use of this functionality. Furthermore, GS1 identifiers have not been widely applied to enable traceability in South Africa.

¹³ Dutch dairy manufacturer, FrieslandCampina, developed an app called TrackEasy, which is based on GS1 standards. Customers scan a QR code on the product package using their phones that takes them to the app. Here, consumers can see the product's journey from farm to shelf and verify product authenticity (GS1 Netherlands, n. d.). Woolworths Australia started piloting 2D barcodes at the point-of-sale to take advantage of the large amount of data the code can hold, including pack date, product batch, expiry date and price (GS1 Australia, n. d.).

A key benefit of the adoption of digital technology highlighted in the introduction and conceptual framework is the increase in transparency throughout the value chain, and therefore greater visibility of SMEs who are on these platforms. We sought to find out if being on the GS1 and associated platforms increased visibility of SMEs to retailers. We found this to not necessarily be the case. Retailers do not 'actively' search for SMEs on the GS1 platform. SMEs approach retailers. In fact, the platform as we previously highlighted does not readily allow for users to filter for size of firms and therefore search for SMEs as part of diversifying their supplier bases. Other important elements such company size, B-BBEE status, women-ownership and product certifications such as Halaal or Organic are also not easily searchable by user/buyers as we understand. Such functionality would be highly relevant to buyers seeking to improve their own B-BBEE scores by procuring from SMEs or B-BBEE compliant suppliers, making SMEs more visible to these buyers.

The GS1 standard and associated platforms therefore primarily serve an efficiency role for large buyers in the industry, allowing for smoother product flow and tracking of product and packaging characteristics. It also plays an important verification role. The platform does not play a matching role of SMEs/BEE suppliers/women-owned businesses to retailers or other large buyers. This reflects the 'retail-centric' or 'buyer-centric' focus of the standard.

This does not mean that the standard is not beneficial for SMEs. Compliance to the standard opens many more markets to them. Going forward, as SMEs get used to the functionalities of the platform, more and more information on certifications and other data can be added which increases traceability, and which will have important implications for rules of origin requirements for the AFCFTA. As it stands however, these functions appear to be limited. What it does mean is that when promoting the benefits of the standard for SMEs, the functionalities of the platform must be improved to benefit SME suppliers more actively. We return to this in Section 6.

Some large retailers, such as SPAR which uses a franchise model, do not necessarily require GS1 barcodes. One interviewee highlighted how they used SPAR in-store barcodes which they printed out. However, it was acknowledged that it would have been much easier if the product had its own barcode that could be easily scanned even though SPAR did not specify a barcode format or issuer (such as GS1). Further, as volume orders increased, not having a proper barcode would become more challenging. This is a consistent theme that has emerged from interviews. It again points to the buyer-centric, efficiency focus of the platform.

5.3 Standards and regulations as barriers to entry – is GS1 adding to the already-long list of requirements?

Standards are important, particularly from a health, food safety and nutrition perspective. Standards can also spur environmentally and socially responsible production processes along value chains. Further benefits of standards were discussed in Section 2. Standards and requirements however, whether through digital technologies or not, also erect structural barriers to entry. Small businesses find it difficult to upgrade to private or international grades and standards that may require costly investments. The costs associated with compliance with these standards usually lie with suppliers and represent a substantial impediment to access to supermarket shelves (das Nair, Chisoro-Dube and Ziba 2018). Compliance requires substantial investments that include new facilities and premises that comply with food safety regulations, the testing of products to verify nutritional information and to ensure food safety, larger production capacity to meet the minimum order volumes required by retailers,

and expensive environmental health and safety certifications stipulated by South African and international regulations. Furthermore, some of these requirements, such as the Food Safety System Certification (FSSC 22000) and HACCP, involve ongoing audits at the supplier's cost (Chisoro-Dube et al., 2018).

SMEs interviewed for this paper cited compliance with these standards as a significant structural barrier to entry into retail.¹⁴ It was also notable that the SMEs interviewed who achieved some level of compliance, did so with assistance in the form of skills training, incubation, or funding. One SME relocated from Johannesburg to Cape Town to participate in an incubation programme that provided skills training, an operating facility and equipment.¹⁵ The operating facility was shared among a number of SMEs and was already certified with a Certificate of Acceptability (COA). Leveraging this facility's COA represented a significant saving in the costs of compliance for the SMEs. Another SME interviewed received funding from the Gauteng Enterprise Propeller to upgrade their operating facility in order to obtain a COA.¹⁶ This highlights the importance of a range of different and complementary interventions and measures that have to work concurrently through the various growth stages of an SME for it to successfully enter and participate in a market.

The high barriers to entry into large retail have also highlighted the importance of alternative routes to market for SMEs. Online stores and independent, owner operated retailers are key routes to market for SMEs excluded from large retailers. SMEs interviewed stated that sales from their online stores were a significant contributor to revenue.¹⁷ Furthermore, independent outlets represent entry into formal retail shelves but have significantly lower compliance thresholds and barriers to entry and can act as a 'stepping-stone' to gain expertise required to start supplying big chain stores. Some SMEs interviewed noted that while they were in the process of complying with the requirements of large retailers, they were successfully supplying their products to independent retailers within their regions.¹⁸ The levels of compliance required by the independent retailers varied across size and consumer demographic. Small independent retailers only required consistent and reliable delivery. Larger niche and speciality retailers such as health stores required that products undergo testing to verify nutritional claims and that SMEs comply with legislated food safety regulations.¹⁹

In general, independent retailers and online listings did not require a GS1 barcode. Some independent retailers did not require a barcode at all and made use of internal systems of product identification such as store issued barcodes.²⁰ The lower barriers to entry led some SMEs to tailor their strategies toward independent retail. For example, a small manufacturer

¹⁴ Mopani worm-based snack manufacturer (Interview, 27 February 2023); Plant-based desert manufacturer (Interview, 09 March 2023); Dumpling manufacturer (Interview, 16 February 2023); Fruit juice processor (Interview); Plant-based dairy manufacturer (Interview, 27 February 2023).

¹⁵ Plant-based dairy manufacturer (Interview, 27 February 2023).

¹⁶ Fruit juice processor (Interview, 23 February 2023).

¹⁷ Mopani worm-based snack manufacturer (Interview, 27 February 2023); Plant-based desert manufacturer (Interview, 09 March 2023); Plant-based dairy manufacturer (Interview, 27 February 2023).

¹⁸ Mopani worm-based snack manufacturer (Interview, 27 February 2023); Dumpling manufacturer (Interview, 16 February 2023); Fruit juice processor (Interview, 23 February 2023).

¹⁹ Mopani worm-based snack manufacturer (Interview, 27 February 2023); Plant-based dairy manufacturer (Interview, 27 February 2023).

²⁰ Mopani worm-based snack manufacturer (Interview, 27 February 2023); Dumpling manufacturer (Interview, 16 February 2023); Plant-based dairy manufacturer. (Interview, 27 February 2023).

of plant-based cheeses stated that the costs associated with compliance led them to avoid seeking entry into large retailers altogether.²¹ This business changed their model to target independent retailers and the food service industry instead. Notably, this business has successfully met legislated food safety regulations, including obtaining a COA for their premises that is issued by the local municipality. However, this was still below the compliance threshold required for entry into large retail shelves.

GS1 compliance and barriers to entry

In the context of the high cost of compliance with standards as discussed above in food value chains, SMEs found it relatively easy and cost-efficient to comply with the requirement to register with GS1 and to make use of GS1-issued barcodes or GTINs.²² As highlighted in Table 3, the costs of acquiring GS1 barcode standards are not prohibitive, particularly for SMEs who typically only have a very limited product range which requires only a few barcodes. The online platform used for GS1 also does not require special or expensive software over and above a computer and internet access.²³

The ease of compliance has allowed some of the SMEs interviewed to obtain GTINs while their products were still in the testing phase, well before they were ready for market.²⁴ An SME that manufactures 100% fruit juices states that it purchased a batch of GTINs several years before the company's product was shelf ready.²⁵ A key enabler of SMEs complying with GS1-related requirements was the extensive awareness drive that the organisation engages in and its trainings and workshops that have assisted SMEs to comply. The organisation's engagements with large retailers and government departments also aids its visibility. An SME that obtained GS1 GTINs of their own volition prior to any engagement with a retailer did so after learning about GS1 at a workshop where the organisation presented.²⁶ Another SME was directed to GS1 and their 'Getting Retail Ready Development Program' by a government department after applying for funding and technical assistance from the department.²⁷ Greater synchronisation efforts by all stakeholders could assist in creating awareness of the standard at different stages of the SME's growth path.

Through the programme, GS1 provides training, consultation, and support to SMEs to be compliant in multiple aspects of their supply chain. This includes registering GS1 barcodes, ensuring print and packaging compliance, food safety advice, labelling compliance, and specific product regulatory compliance.

Registering with GS1 ensures that retailers have access to accurate product data, allowing a product to be listed on the retailer's internal e-commerce platforms quickly. This product data is accessed easily by retailers on GS1's Activate and Trusted Source platforms. However, SMEs must still comply with the remaining stringent standards before a listing can be converted into a transaction with the retailer and before there is presence on its shelves. A further

²¹ Plant-based dairy manufacturer (Interview, 27 February 2023).

²² Mopani worm-based snack manufacturer (Interview, 27 February 2023); Plant-based desert manufacturer (Interview, 09 March 2023); Dumpling manufacturer (Interview, 16 February 2023); Fruit juice processor (Interview, 23 February 2023).

²³ GTINs are purchased online and product data is uploaded onto GS1's Activate platform online.

²⁴ Mopani worm-based snack manufacturer (Interview, 27 February 2023); Fruit juice processor (Interview, 23 February 2023).

²⁵ Fruit juice processor (Interview, 23 February 2023).

²⁶ Dumpling manufacturer (Interview, 16 February 2023).

²⁷ Fruit juice processor (Interview, 23 February 2023).

benefit of GS1 is that the SME can have all the data on all their products in a central place, without having to manage a second separate database. GS1 can have all information on dimensions, weights, ingredients and certification on one standard platform.²⁸

GS1 has assisted some SMEs to adopt its standards through its 'Getting Retail Ready Development Program' and its other SME skills development initiatives. These programmes provide training and assist SMEs with compliance. An SME interviewed stated that GS1 provided training and technical assistance for each level of compliance that they achieved. The SME acquired commercial premises and transferred production from their kitchen to this new location, after completing the GS1 Development Program. The SME returned to GS1 to attend more workshops and training regarding the next steps of compliance, including a COA for its new premises. SMEs accessed further training, seminars and workshops by becoming members of CGCSA. The trainings by GS1 and CGCSA addressed skills and information gaps. Some SMEs stated that they did not need any assistance as the process to purchase and register a barcode with GS1 was simple and self-explanatory.²⁹ Another SME stated that they did not receive support from GS1 and opted for an alternative barcode provider, Barcode SA.³⁰ The main reason cited was a lack of responsiveness from GS1 when the SME made an enquiry about purchasing barcodes. This was at a stage when the SME was relatively unfamiliar with barcoding. A barcode reseller, Barcode SA, allowed the SME to purchase barcodes quickly online and download copies that were according to the SME's specifications³¹. The SME also obtained information about which barcoding format was appropriate for its products from the Barcode SA website and this informed the SME's choice. The SME has not experienced any problems with the resold barcodes thus far because its main routes to market are its online store and independent retailers that do not require a GS1-issued barcode.

SMEs still need basic digital skills training to effectively make use of digital platforms. The SMEs we interviewed (some which were very small, with less than 5 employees) were already digital 'savvy' to some degree. But this is not always the case. Basic digital skills are needed to be able to navigate the platform, and to make full use of all the functionalities the platform can offer.

Several SMEs noted that issues of traceability will become important as their businesses grow and as they enter more markets. However, GS1 is currently not widely applied to traceability in South Africa and is not useful in assisting SMEs to comply. An SME noted that tracing origin for one of the main ingredients of its product, cashew nuts, has proven difficult because the nuts are harvested in several African countries and processed in Asia.³² This has meant that the SME is unable to claim product attributes that are important to its consumers, such as Organic or Fair Trade. Another SME that sources wild-harvested mopani worms from Botswana and South Africa noted that it gets enquiries about ingredient origin mainly from curious consumers. The SME states that because it purchases the worms from resellers who currently do not have formal traceability protocols, it anticipates difficulties in future as the business grows and as it is required to comply with traceability requirements.³³

²⁸ Retailer 1 (Interview: 7 February 2023).

²⁹ Mopani worm-based snack manufacturer (Interview, 27 February 2023).

³⁰ Plant-based dairy manufacturer (Interview, 27 February 2023).

³¹ See Appendix A.

³² Plant-based dairy manufacturer (Interview, 27 February 2023)

³³ Mopani worm-based snack manufacturer (Interview, 27 February 2023)

5.4 Implications for competition policy and inequality in food value chains

The GS1 case study brings to the fore important insights on drivers of digital technology adoption in food markets in South Africa, with lessons applicable to other forms of digital technology and across the Southern African region. The roll-out of the collective private GS1 industry standard for barcoding is reflective of the power of large, lead players in food value chains. This illustrates the power of these players to shape standards which make the supply chain more efficient for them.

Standardising the barcoding requirements benefits SMEs in that a single and globally recognised barcode is accepted across multiple markets. This increases their opportunities to sell locally, to export into the region via the main South African supermarket chains, and to access deep sea export markets. But this benefit is secondary or a by-product of the main motivation for the barcode and standards – which is efficiency for buyers in the supply chain. On one hand, not having a GS1 barcode is an entry barrier for SMEs as it is soon becoming a requirement to access retailers. On the other hand, obtaining and maintaining the standard is relatively low-cost and appears fairly easy as illustrated by the interviews conducted, and therefore, not insurmountable.

The ownership of the data generated on the GS1 platform is another important question for competition matters. We have been unable to get a clear indication of who ‘owns’ the data on the different GS1 platforms. This is important, and something that requires clarity in future engagements on the AAMP around the adoption of GS1. A large retailer highlighted that they do not actively collect data on potential suppliers from the GS1 platform, except for weight dimensions.³⁴ It appears that the retailer only uses the vendor data that is on their vendor database. At present, as we understand, there is no interface between this retailer’s vendor master data and the GS1 platform, although once the master data is migrated onto a digital platform, there is greater potential to utilise the data more effectively. However, this is not customer data but rather vendor/supplier data. Unlike the competition concerns that arise from big data on customers as highlighted in Section 2, data on suppliers can result in more traditional foreclosure concerns for buyers that do not have access to it. Data in this sense is still treated as an ‘input’, and buyers without access to supplier data may be disadvantaged. In the current case however, we understand that the data is equally available to all buyers on the GS1 platform (i.e., there is no single firm that benefits disproportionately from access to the data if they are on the platform).

The key question then is whether all buyers can easily access the platform, and therefore have the same access to the data. In this case, the concern is whether independent retailers can easily be part of the GS1 platform, or if there are any limitations imposed by existing GS1 Council members (made up of large retailers and processors) to their access. If there are restrictions to their access, there may be some concerns that independent retailers might be at a disadvantage, reinforcing unequal power relations within grocery retail value chains between large chain stores and independent retailers, and between large and small food processors. Currently, independent retailers can become data recipients and have access to the same information as large retailers. As the platform grows, this should be monitored.

³⁴ Interview with Retailer 1, 7 February 2023

6. Conclusions and recommendations

We sought to understand how digital platforms and technologies, particularly the GS1 standards and associated digital platforms, can enable or hinder participation and upgrading in agro-processing value chains. This is against the backdrop of highly concentrated markets at both the agro-processing and retail levels in food value chains in South Africa. Effective participation of SMEs throughout the value chain has been curtailed because of several barriers to entry and expansion. The GS1 case study was motivated, among other reasons, by the AAMP's explicit identification of it as a potential *de facto* standard for identifiers in consumer goods markets. This required more in-depth understanding of how the platform works, and whether it truly had the potential to support SMEs.

As highlighted in the conceptual framework chapter, scholars have touted the benefits of digital platforms in agricultural value chains globally. Many of the arguments for the use of digital solutions centre around efficiency, transparency, traceability and verifiability rationales. Verifiable data on products, processes, packaging and certifications can make the process of linking SME suppliers to larger agro-processors and retailers more seamless and less burdensome. We argued that this will become increasingly important as the borders in Africa open up as part of envisaged growth in trade under the AfCFTA. It is also well established in past Centre of Competition, Regulation and Economic Development (CCRED) and other research that SMEs struggle to 'be visible' to large buyers, and often are not able to access supermarket shelves given onerous requirements. These SMEs are forced to sell through alternative retail models which can be precarious. GS1 certainly has the potential to increase this visibility and make SMEs more 'retail ready'.

The study illustrated that large lead firms in food value chains are driving the adoption of GS1 as a collective private standard. Having a GS1 barcode is becoming a minimum entry requirement for suppliers to large retailers in South Africa. Not adopting GS1 therefore directly negatively affects the participation of SMEs. The rationale for large lead firms collectively driving this standard is primarily on efficiency and verification grounds. We have argued that this reflects the buyer-centric or retailer-centric focus of the standard and its associated platforms. This focus is reinforced by the platform not enabling the filtering for size of firms. The platform as it stands cannot play a matching role of SMEs to retailers or other large buyers. For it to be more SME-centric or to benefit SME suppliers more actively, the platform has to allow large buyers to be able to actively search for SMEs, for instance, for beneficiaries for their supplier or enterprise development programmes. Added beneficial searches would be for BBEEE compliance, women-owned business, and various social and environmental certifications and accreditations.

Past research has emphasised that there is an obligation for large buyers to diversify their supply base to include SMEs, not only for redistributive purposes, but for commercial reasons in the medium-to-long run given uncertainties in global food supply chains and climate change challenges (das Nair and Landani, 2021; das Nair and Shedi, 2022). These are directly linked to food security issues and therefore it is important that platforms like these facilitate the matching of SMEs to retailers more deliberately – this appears to be the stated intention of parties to the AAMP. The full functionalities of the digital platform also appear to not be used by SMEs currently. This must be improved to benefit SME suppliers. It would require greater training and capacity building on the use of the platform along with wider support and capacitation for other business aspects necessary for the SME's success. A package of support measures therefore with a developmental orientation encompassing multiple tools of

support (finance, training and capacity building, information sharing etc.) can make a significant difference, and this is something government must ensure in practice when implementing the AAMP with respect to GS1 adoption.

We further found that the financial investment and capabilities required by SMEs to adopt GS1 digital technologies are minimal for those SMEs requiring only a few barcodes for a few product lines. In addition to the fact that no specialised or expensive software is required for SMEs to invest in. As such, the standard itself does not present a substantial barrier to entry. However, SMEs still need basic digital skills training to effectively make use of all the functionalities that the platform can offer. The AAMP highlights coordinating with Food and Beverage SETA and other organisations to develop skills for SMME suppliers in food value chains that complement ESD needs. The use of GS1, and similar platforms as they emerge, as part of these programmes is recommended to assist SMEs.

Competition concerns may possibly emanate from the collection of big data from suppliers, especially if it serves to foreclose non-CGCSA members such as independent retailers and smaller processors. As highlighted above, the membership needs to be inclusive and this needs to be monitored, potentially as part of AAMP monitoring and evaluation processes. This is also important to ensure that the platform does not reinforce unequal power relations within the value chain.

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Appendix A: Alternatives to GS1 in Southern Africa

There are alternative barcode resellers in South Africa that sell UPC and EAN barcodes. However, GS1 is the exclusive provider of the GTIN. Barcode resellers do not issue barcodes but rather purchase them from the companies or individuals to which the barcodes were originally issued by GS1. Barcodes such as the UPC and EAN barcodes have a Company Prefix

which is a unique identifier of a particular company. When a company purchases a UPC or EAN barcode from a 'reseller', they receive a barcode whose company prefix is currently assigned to another company. Barcode SA (2019), one of South Africa's largest resellers purchases barcodes that were originally issued by the UCC prior to August 2022. After this date, the UCC issued notices demanding that past prefix holders pay renewal fees for the barcodes and agree to new terms and conditions. This prompted a class action suit to be filed against the UCC and the organisation subsequently settled the case. This outcome allowed the prefix owners the rights to do whatever they desired with the prefixes, including selling them on. Barcodes SA purchases these prefixes from the company or individual that purchased them directly from the UCC and resells them to its customers. According to Barcode SA (2019), these barcodes are valid because they were issued by the UCC and have only been resold. The key value offering of barcode resellers such as Barcode SA is that resold barcodes do not have annual renewal fees. Payment is made once off, and the business has permanent use of the barcode thereafter.

Resold barcodes however do not have the 600 Country Prefix for South Africa that is exclusively issued by GS1. Furthermore, only the original owner of the company prefix is listed on the GS1 Registry Platform as this database does not reflect the new information now associated with the resold barcode (Barcode SA, 2019). A notable implication of this is that businesses that make use of resold barcodes are excluded from retailers that require a GS1-issued barcode that is verifiable on GS1's Registry Platform. It also means that information on origin is lost, and this has implications for Rules of Origin standards required under the AfCFTA.

Another challenge within the barcode reseller market is the proliferation of unscrupulous resellers that sell inauthentic barcodes. One large reseller, SA Barcodes (n.d.), provides a certificate of transfer along with each barcode purchase that confirms the exclusive rights to the use of the barcode worldwide. However, given that resellers do not issue barcodes directly, they do not have a platform comparable to Verified by GS1 that buyers can use to authenticate a product's barcode and identity. The ability to authenticate a product's identity is therefore a key advantage and point of differentiation for GS1, particularly for large retailers that manage large order volumes, many suppliers and wide distribution networks.

The problem of inauthentic barcodes is of relevance to illicit trade and product counterfeiting. GS1 has therefore highlighted the application of its standards in the fight against illicit trade and counterfeiting (Padayachee and Parker, 2018; GS1, 2013; Interview with GS1, 2022). GS1 states that its standards and services can support the fight against illicit trade by enabling globally unique object identification and traceability, and by providing a common language for organisations across supply chains to communicate and interoperate seamlessly as they do business (GS1, 2013). GS1 argues that its system of global standards for identification of products, locations, and the communication of data associated with each should therefore form the basis for a company's anti-counterfeit protocols and brand protection strategies.

Appendix B: International examples of GS1 adoption in retail

GS1 has documented the adoption of its standards and platforms by retailers and businesses around the world. For example, Carrefour France was one of the first companies globally to join the GS1 GDSN with the aim of simplifying exchanges with its suppliers. Following internal pilots, Carrefour, integrated its product catalogue into GS1 GDSN. The process required that the retailer along with GS1 engage its suppliers and internal stakeholders to communicate

and demonstrate the new platform and integrate it into the retailer's operations. According to GS1 (2021a), GS1 GDSN eliminated the need for manual input of product data via a Microsoft Excel spreadsheet for instance. GS1 GDSN also eliminated the need for back-and-forth exchanges with suppliers to verify product attributes as this information was readily available on the Verified by GS1 platform. The retailer has integrated not only its large suppliers onto the platform, but SME suppliers as well. In addition to efficiency gains, GDSN has also enabled Carrefour to make product attribute data such as size, weight and composition, as well as digital content such as product description and images available to consumers.

Turkish retailer, Migros Turkey, is another example of a retailer that has adopted GS1 GDSN and required its suppliers to capture product data using the platform. Migros has had instances when a brand owner repurposed an old GS1 GTIN for a new product resulting in data discrepancies as the new product scans into the retailer's systems under the identity of the original product (GS1, 2021b). To avoid this and to ensure high-quality product data, the retailer sent a memo in 2019 to all brand owners of products sold at their stores outlining three requirements. These were that 1) every product must have a GS1 GTIN, 2) every product must be entered into the Verified by GS1 registry, and 3) brand owners must become familiar with the GS1 Global Data Model and prepare to deploy it in future. Before a product is listed, Migros' buying staff compare the product data they have on file with the information from Verified by GS1. In other words, GS1 became a private standard for Migros which all suppliers had to comply with to supply them.

As a growing number of retailers adopt the platform, small businesses looking to sell their products on retail shelves are increasingly required to make product data available on the GS1 GDSN. GS1 (2021c) identifies one such small business, a German manufacturer of plant-based ice cream, NRDS GmbH. The company's product, Nomoo ice cream saw notable success, being sold in 2,000 stores across Germany and Austria. As demand for Nomoo increased, the company was faced with increasing demand from retailers and end consumers for detailed and reliable product information. Furthermore, larger retailers required that the company make this information available not manually using Excel spreadsheets as they had done previously but on the GS1 GDSN. Registering its products on the GS1 GDSN was therefore required for their business to scale and enter large retail shelves. To do this, the company registered on a GS1 GDSN-certified data pool that enabled digital data exchange of product data with retailers. Access to this service came at an ongoing fee that was paid either monthly or annually.