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Sources of value creation in aggregator platforms for digital services in agriculture - insights from likely users in Kenya

John Kieti [a,*], Timothy Mwololo Waema [a], Elijah Bitange Ndemo [b], Tonny Kerage Omwansa [a], Heike Baumüller [c]

[a] School of Computing and Informatics, University of Nairobi, Chiromo Campus, P. O. Box 30197 - 00100 GPO, Nairobi, Kenya
[b] School of Business, University of Nairobi, Lower Kabete Campus, P. O. Box 30197 - 00100 GPO, Nairobi, Kenya
[c] Centre for Development Research, University of Bonn, Genscherallee 3, D-53113, Bonn, Germany

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ABSTRACT

A fragmented digital agriculture ecosystem has been linked to the slow scale-out of digital platforms and other digital technology solutions for agriculture. This has undermined the prospects of digitalizing agriculture and increasing sectoral outcomes in sub-Saharan African countries. We conceptualized an *aggregator platform for digital services in agriculture* as a special form of digital platforms that can enhance the value and usage of digital technologies at the industry level. Little is known about how such a platform can create value as a new service ecology in agriculture. We set out to examine the underlying structure and prioritizations of value creation sources in such a platform from the perspective of likely users in Kenya. We used a parallel convergent mixed methods approach to the study. Confirmatory factor analysis of data from 405 respondents supported a two-factor structure, being an adaptation of the framework on value creation sources in e-Business by Amit, R., & Zott, C. (2001). We conceptualized the two factors as *platform-wide efficiency* and *loyalty-centeredness*. User experience related search costs were most impactful on platform-wide efficiency, while *loyalty-centeredness* was impacted most by providing guarantees for quality and reliability to platform users. Thematic analysis of 369 qualitative responses obtained *platform inclusivity* - comprising *value chain coverage* and *digital inclusivity*, as additional considerations for amplifying sector-wide benefits of an aggregator platform for digital services in agriculture. We discuss implications for policy and practice in the light of resource constraints and the promise to digitally transform agriculture in SSA countries.

1. Introduction

The distributed nature of digital platforms and their intertwinement with institutions, industries, markets, and technologies have given rise to new research objects several orders of magnitude larger than in traditional information systems (de Reuver, Sørensen, & Basole, 2018). Such platforms have been observed to provoke the reorganization of markets, work arrangements, and ultimately value creation and capture in entire industries (Kenney & Zysman, 2016). Transformational effects of disruptive crossovers from digital technologies to finance, mobility, health care and energy being fuelled by multi-sided digital platform logic has been a major phenomenon in the last decade (de Reuver et al., 2018). These transformational effects of digital platforms are however largely missing in the agriculture sector, especially in sub Saharan Africa (SSA). This is despite an increasing deployment of services intended to unlock the transformative power of digital technology in agriculture in the region (Baumüller, 2017; Disrupt Africa, 2018).

According to Phatty-Jobe (2020) who tracked 713 digital services for agriculture, the majority (437) were in SSA countries. This was consistent with the author's observation that agriculture is the backbone of the economy in most of SSA. Kenya is one of the SSA countries where the agriculture sector is overwhelmingly important (Ministry of Agriculture, 2019; Raithatha, 2019). The sector for instance contributed[1] directly to over 30% of the country's GDP in the five years preceding 2020. The sector also contributes an additional 27% to the country's GDP indirectly through linkages to other sectors. Furthemore, it is estimated that the sector directly contributes[2] to over 50% of employment in the country. Kenya also produced the continent's first wave of digital agriculture startups a decade ago according to Disrupt Africa, 2018. The country tied with Nigeria in having the continent's highest number of digital agriculture startups as active businesses according to the Disrupt Africa report. Kenya also has by far the highest number of active digital agriculture services in SSA at 95, being double the number in second placed Nigeria (Phatty-Jobe, 2020).

While equating a digital service to a digital platform may go unchallenged as both are technological architectures (Gawer, 2011), such generalization can be conflating (Han, Martinez, & Neely, 2018). For clarity in this

* Corresponding author at: University of Nairobi, School of Computing and Informatics, P. O. Box 30197 - 00100 GPO, Nairobi, Kenya
E-mail address: jkieti@gmail.com (J. Kieti).

[1] https://data.worldbank.org/indicator/NV.AGR.TOTL.ZS?locations=KE (% of GDP)
[2] https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=KE (Employment Contribution)

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paper we define a digital service for agriculture (DSA) as a *solution that uses digital equipment and devices such as mobile phones, computers, satellites, and sensors to solve challenges in agriculture*. DSAs can also be equated to digital solutions for agriculture. They may be deployed to end-users in the form of device native applications, websites, Short Message Services (SMS), Unstructured Supplementary Service Data (USSD) shortcodes, and other combinations of software, data, and electronic hardware. Phatty-Jobe (2020) broadly classified DSAs and quantified them in SSA as :- a.) "access to services" where they included digital advisory - 42% and digital finance - 25%, b.) "access to markets" where they placed e-commerce - 16% and digital procurement - 13%, and c.) "smart farming" - 4%.

Digital platforms can be viewed as "*software and applications on the web that act as mediators between the service providers and service recipients*" (Hanafizadeh, Khosravi, Tabatabaeian, 2020). We note however that being on the web is not necessarily a qualifying condition to be a digital platform. This is because digital platforms have been deployed successfully on more accessible technologies in SSA as with *wefarm* via SMS and *DigiFarm* via USSD technology. By this definition, *wefarm*[3] qualifies as a digital platform since it mediates between farmers seeking answers and those providing answers. We argue, however, that with *Arifu*[4], their SMS based training solution on agricultural practices to farmers does not qualify as a digital platform. This is to the extent that there is a sole service provider of the training who happens to be the digital service provider. No mediation is expected on the supply side. This means no network externalities can be anticipated on the supply side by this economic perspective (Gawer, 2011; Ghazawneh & Henfridsson, 2013). Therefore, *Arifu's* SMS based training solution may not pass as a digital platform.

de Reuver et al. (2018) define a digital platform as "*An extensible codebase to which complementary third-party modules can be added*" p. 127. This technical perspective anticipates modularity of the stable codebase, a common core to which third party services can plug in to extend functionality and generate complementarities. We argue that it would be superfluous for *Arifu* to incorporate such a core codebase for third party farmer training services. This is as long as it is the sole provider of such services in its solution. Applying the two focus characteristics of platforms in Han et al. (2018, p. 13), we argue that *Arifu's* solution neither leverages a core codebase to technologically incorporate third party training providers, nor does it generate any network externalities on the training provision side. It is therefore not a digital platform inasmuch as it can pass as a digital service for agriculture.

We proceed to adapt the digital platform definition in Hanafizadeh et al. (2020), and mesh it with the technical view in de Reuver et al. (2018) for a working definition. As such, we regard a digital platform for agriculture (DPA) as *"a digital artefact comprising an extensible codebase to which complementary third-party modules can be added to extend functionality and to enhance mediation between service providers and service recipients in agriculture"*. We argue in addition that while a DSA may not pass as a DPA, elements of a DSA exist in a DPA. This is because service provision is anticipated and mediated in digital platforms. As such, DSAs are incorporated as components of DPAs by their nature. This view is supported by the findings in Blaschke, Haki, Aier, & Winter, 2019 that service constitutes one of the dimensions of a digital platform. The "*core"* aside as one of the dimensions, Blaschke et al. indicate "*service"* alongside "*infrastructure"*, and "*ecosystem"* as the dimensions that capture the dynamic periphery of platform components. Furthermore, digital *services* delivered are the value output of digital platforms according to the authors.

Users of DSAs have been depicted to prefer a comprehensive information systems solution, a one-stop-shop for their agricultural activities (Ezeomah & Duncombe, 2019; Gichamba, Waiganjo, Orwa, Wario, & Ngari, 2016). The existence of a variety of standalone DSAs has furthermore implied a fragmented digital agriculture ecosystem[5] which has contributed to slow scale-out of DSAs (Deichmann, Goyal, & Mishra, 2016). This is characterised by difficulties among the providers in creating awareness about their services (Crandall & Kieti, 2013). We conceptualize an Aggregator Platform for Digital Services in Agriculture (AP4DSA) as a special form of digital platforms. We define an AP4DSA as "*a digital platform that can permit the aggregation of digital services developed by independent providers so as to generate more value to providers and consumers of agricultural goods and services than if the digital services were delivered separately by their respective providers"*. This definition excludes DPAs such as wefarm to the extent that they are not designed to permit the aggregation of digital services developed by independent providers. Moreover, we build on the taxonomy in Blaschke, Haki, Aier, & Winter, 2019 to contend that treatment of such DPAs as constituent actors in an AP4DSA is similar to that of a DSA. This is because it is the dynamic periphery of the DPA rather than its core, and more so the service dimension that would be targeted for aggregation into an AP4DSA.

We identify examples of nascent AP4DSAs to include Safaricom's *DigiFarm* and Bayer's *Climate FieldView* as described in Appendix A. We also consider an imaginary equivalent of "*Google Play Store for Agriculture*" as an instance of an AP4DSA.

We posit that comprehensiveness and discoverability challenges of DSAs call for redress through a modular industry platform configuration (Gawer, 2014, p. 1245). As such, an AP4DSA should not only combine services developed by its orchestrator. Neither should it end at merely coordinating the orchestrator's supply chain. It should build on the generativity of digital platforms expected to yield expansive novelty and virtual infinite variety as the third parties contribute new functionalities and service combinations (Boudreau, 2012; Gawer, 2014; Langley & Leyshon, 2017). Generativity can also be expected to result in exponentially growing participation by sectoral ecosystems actors in a platform (de Reuver et al., 2018). Furthermore, Boudreau (2010) argued that diversity in the pool of individual specialized innovators is so paramount that platforms with large numbers of producers may come to depend on variation generated by population-level processes, rather than heroic efforts of any one innovation.

Going by the digital platform archetypes described in Blaschke, Haki, Aier, & Winter, 2019, we envisage the thriving of an AP4DSA as an orchestration platform. This is whereby access openness can be attained through boundary resources such as Application Programmable Interfaces (APIs). Additionally, resource openness can be attained through forfeiture of intellectual property rights as with open source code and open libraries of accumulated data. With this platform archetype, the ecosystem is a federated network of actors including third parties augmenting the platform. There is also a high dependency on established digital infrastructures such as the Internet, computing devices and open standards under this configuration. We expect that in addition to allowing platform derivatives through strong design orientation on the *service* dimension, a strong exchange orientation is possible in an AP4DSA. Exchange orientation, though deemed weak in orchestration platforms can be enhanced in an AP4DSA. This is by enabling buyer and seller matches not only for digital services but also for actual agricultural goods and services. Furthermore, we cannot rule out the reverberation of an AP4DSA with the innovation platform archetype. This is with a caveat that such a configuration would be anchored on a novel digital infrastructure for agriculture that may not exist yet.

The study of market and behavioral enablers in digital platforms constitutes a research agenda by itself according to Rossotto et al. (2018). Technology platform research has been argued to focus most on the stages of development *after* initial establishment, yet in the earlier stages, carefully orchestrated cross-component design is crucial (Boudreau, 2010). In the recent clamour for a research agenda on digital platforms, need has been expressed for more scholarly and practice-oriented enquiries for a better understanding of how such platforms should be designed so as to be feasible and sustainably of value (de Reuver et al., 2018; Shaikh, Sharma, & Karjaluoto, 2021). Little is known or understood about how value can be created in an AP4DSA especially in SSA countries. Neither is much known

[3] https://wefarm.co/ (Wefarm website)
[4] https://www.arifu.com/ (Arifu website)

[5] *We regard a digital agriculture ecosystem as a coexistence of actors in digital technologies for agriculture including the surrounding environment that each actor has to deal with as they pursue their independent objectives.*

about which sources of value creation should be optimized for. This knowledge seems critical if such a platform is to warrant initial uptake by actors and expanded usage that is transformational to the agriculture industry.

Beyond conceptualizing an AP4DSA as a special form of a DPA, we sought to contribute to the explanation of how sources of value creation in an AP4DSA can be structured and prioritized. We found that the theoretical framework on sources of value creation in e-Business by Amit and Zott (2001) had been used to explain the structure of such value drivers. We, however, found a paucity of literature applying the framework in quantitative inquiry. In concurrence with Zaborek, Doligalski, and Sysko-Romańczuk (2016), we were also keen not to rule out context sensitive insights especially in the prioritization of the value drivers. Therefore, we zeroed in on the context of Kenya, the SSA country setting with the most deployments of DSAs and with a heightened economic significance of agriculture as described earlier in the introduction. The perspectives of likely AP4DSA users was another focus lens we applied in the zeroing in. We also sought to apply a combination of qualitative and quantitative data methods that was bound to increase our chances for heightened knowledge and validity (Schoonenboom & Johnson, 2017). A basis was established for an exploratory mixed methods study of the parallel convergent design to examine the perspectives of likely AP4DSA users on the platform's sources of value creation. In particular, we set out to answer the question: "*How are the sources of value creation in an AP4DSA structured and prioritized in the perspective of likely users in an SSA country?*".

2. Theoretical background

This section is informed by a review of the literature pertaining value creation in digital platforms, being instances of digital business or electronic business (e-Business). We initially applied the search string *("value driver" OR "value creation") AND ("Digital Platform")* on Google Scholar, screening the first 100 results. We then supplemented the results with the search string *("value driver" OR "value creation") AND ("e-Business" OR "digital Business" OR "digital service platform"),* yielding an overlap with previous results but including additional relevant publications. We prioritised 40 results for more in depth review by the number of times they were cited, relevance, and recency. We also applied a snowballing strategy to prioritize attention to additional relevant literature.

In this section, we first describe value creation in digital platforms as synthesised in the literature. We also highlight the theoretical frameworks proposed or applied in past studies on value creation in digital platforms and e-Business in general as alternatives to ground our investigation. We then justify our choice of the theoretical framework in Amit and Zott (2001) to guide our inquiry on the structure and prioritization of value creation sources in an AP4DSA. We further highlight the studies' key findings on the respective value drivers in the Amit & Zott framework.

2.1. Value creation in digital platforms

Digital platforms are new economic institutions functioning in a new reality characterised by being transaction intermediaries while giving rise to new economic ecosystems and new value creation logic (Gawer, 2014; Hänninen, Smedlund, & Mitronen, 2018; Hein et al., 2019). These digital artefacts have been argued to become new hubs for industry level ecosystem integration (Hodapp, Hawlitschek, & Kramer, 2019; Riasanow, Jäntgen, Hermes, Böhm, & Krcmar, 2020; Spremić, Ivancic, & Vukšić, 2020). Digital platforms create complementary sides of actors, each independently adding a part of the value proposition but being interdependent in regard to value creation and value capture (Gandia & Parmentier, 2017). Laczko, Hullova, Needham, Rossiter, and Battisti (2019) argued that continuous management of the synergies between value creation and value capture by the platform orchestrator is crucial to the viability of such platforms. The value creation logic alongside platform ownership, value capture mechanisms, and the ecosystems of autonomous complementors have been depicted among the building blocks of digital platforms (Bonina, Koskinen, Eaton, & Gawer, 2021; Hein et al., 2019; Spremić et al., 2020). We acknowledge that our investigation of value creation sources relates to a section in a larger picture of the interconnected building blocks in digital platforms (Hein et al., 2019).

The basis of value creation in digital platforms has been argued to differ by whether they are innovation platforms or transaction platforms (Bonina et al., 2021). The innovation platforms archetype enables the creation of third party applications and services, and includes digital marketplaces such as *Google Play Store*, *SAP* and *iOS App Store* (Gawer, 2014). Such platforms create value by opening up functionalities for third party application developers and resourcing them with capabilities to be innovative (Bonina et al., 2021). Drawing from the perspectives of mobile application developers Ghazawneh and Mansour (2015) proposed six value drivers digital marketplaces arising from three resource combination arrangements. According to the authors, sources of value creation firstly included (a) distribution of applications and services, and (b) payment handling from the marketplace sales perspective. Secondly from the marketplace review viewpoint the value drivers were (c) users' review and evaluation, and (d) the platform's application review process. Thirdly marketplace deployment included (e) availability of development resources and the availability, and (f) reliability of deployed applications. Wulf and Blohm (2020) found economies of scope in production, and innovation promotion as the two value creation strategies moderating the empowerment of third party developers in innovation platforms. Transaction platforms were deemed to match users or groups of users as exemplified in *Alibaba*, *Uber* and *MPesa* (Gawer, 2014). Such platforms were deemed to create value by matchmaking whereby an increase in the size of user groups in the multisided market places amplifies value. These platforms were also deemed to create value by reducing friction in the interactions or transactions between the user groups (Bonina, Koskinen, Eaton, & Gawer, 2021; Müller, 2019). Combining strengths of enterprises, realising economies of scale and economies of scope was also deemed to be a source of value creation in such platforms (Müller, 2019). Solving problems of lack of trust, competitive thinking, high coordination costs and loss of confidential information can also give rise to value creation in digital platforms (Müller, 2019). Drawing from perspectives of service providers on *Uber*, Mansour and Ghazawneh (2017) proposed eight sources of value creation in transaction platforms. These sources were :- (1) transaction processing, (2) review and rating system, (3) publicity and exploitation, (4) technology reliability, (5) safety, (6) membership and affiliations, (7) work flexibility, and (8) rewards and support

We argue that an AP4DSA combines characteristics of both transaction platforms and innovation platforms. This is to the extent that it is expected to achieve an aggregation effect of being a one-stop-shop for both DSAs as independently developed digital artefacts, and agricultultural goods and services. Moreover, we contend that a blurry line exists in the dichotomy of innovation and transaction platforms. This is to the extent that the innovation platforms also end up being marketplaces matching supply and demand sides of the innovations generated and needing transaction efficiency. Furthermore, regardless of the innovation and transactions platform perspectives, digital platforms have been depicted as data aggregators, enabling data driven value creation such as targeted advertising and artificial intelligence (AI) (Hänninen, Smedlund, & Mitronen, 2018; Kenney & Zysman, 2020). Having resources such as the internet *per se* has been argued not to guarantee value creation but rather play a key critical role in creating capabilities (Soto-Acosta and Meroño-Cerdan, 2008). This suggests mediation of value creation by the e-Business capabilities of likely AP4DSA users participating digital platforms as e-Businesses. Similarly having resources such as big data alone can be disadvantageous as pertains to business costs and risks, as they are required in combination with variety and veracity to unlock value creation in digitalized environments (Cappa, Oriani, Peruffo, & McCarthy, 2021). For platform orchestrators, Helfat and Raubitschek (2018) proposed dynamic capabilities needed for value creation and value capture to include innovation capabilities, environment scanning and sensing, and integrative capabilities for ecosystem orchestration. Likewise, Laczko et al. (2019) proposed value creation mechanisms for platform orchestrators to include stakeholder alignment,

platform control, knowledge unification, and breadth of value capture under the theme of stakeholder profitability. The authors also proposed stakeholder altruism, stakeholder empowerment, access to unified knowledge and breadth of stakeholder value under the theme of platform stickiness.

2.2. Alternative theoretical frameworks

Traditional information systems (IS) theories such as technology diffusion, the digital divide, e-Inclusion, technology adoption and usage, and participatory design exhibit inadequacies when applied in the study of digital platforms (Hanafizadeh et al., 2020). This is especially as pertains to platform governance which is connected with value creation, hence value capture and platform survival (Blaschke, Haki, Aier, & Winter, 2018; Hein et al., 2019; Laczko, Hullova, Needham, Rossiter, & Battisti, 2019).

In the literature, we found the *sources of value creation in e-Business* framework proposed by Amit and Zott (2001) applied to investigate value creation in digital platforms. The framework was derived from integrating four theoretical frameworks that could explain value creation in the entrepreneurship and strategic management fields. These theoretical frameworks were:- (a) the resource based view (RBV), (b) schumpeterian innovation, (c) strategic networks, and (d) transaction costs economies. The contexts of applying this framework varied from software application ecosystems (Hyrynsalmi, Seppänen, & Suominen, 2014) to content aggregator platforms (del Águila-Obra, Padilla-Meléndez, & Serarols-Tarres, 2007; Pesce, Neirotti, & Paolucci, 2019), to mobile money platforms (Iheanachor, David-West, & Umukoro, 2021). Other than in consumer-facing e-Business, the framework was also applied in business-to-business Internet products contexts (Johansson & Mollstedt, 2006). We found the framework to be applied in quantitative inquiries (Zaborek et al., 2016) albeit more scarcely. (Hanafizadeh, Mehri, & Hasanabadi, 2020) also applied the framework in a teaching case study on value creation in electronic retailing.

In our exploration for theoretical grounding of our research, we considered the framework of six value drivers for digital application marketplaces proposed by Ghazawneh and Mansour (2015). We also considered the eight value sources framework proposed in Mansour and Ghazawneh (2017). We argue that these frameworks built on the schumpeterian innovation perspective are too focused on the world views of application developers and transactional service providers respectively, to adequately capture the perspectives of end users in agriculture. We also considered the service-dominant (S-D) framework as used alongside the dynamic process of boundary objects (Hein, Weking, Schreieck, Wiesche, Böhm, & Krcmar, 2019)(. The S-D framework entails the application of competences to benefit others while expecting reciprocation through service-for-service exchange. We found the S-D logic suitable for examining the perspectives of DSA providers and platform value co-creators (Lusch & Nambisan, 2015). We however considered the framework unsuitable for understanding the sources of value creation among likely platform end users who may not necessarily offer any services in reciprocation. We found that the resource-based theory could explain value creation among digital platform actors as e-Businesses (Cappa, Oriani, Peruffo, & McCarthy, 2021; Soto-Acosta & Meroño-Cerdan, 2008). We found the Profiting From Innovation (PFI) framework applied by Helfat and Raubitschek (2018) to explore dynamic capabilities suitable for exploring value creation among AP4DSA actors especially formal businesses. We also took note of the platform Stickiness – stakeholder profitability framework proposed by Laczko et al. (2019) which focused on perspectives of the platform orchestrator.

We argue that the above frameworks by themselves were not comprehensive enough to capture the varied perspective of end users in an AP4DSA. They also leaned towards capturing concerns of formalized enterprises which are atypical of most agricultural sector actors in SSA countries (Shimeles, Verdier-Chouchane, & Boly, 2018; Phatty-Jobe, 2020; Raithatha, 2019). Nonetheless, our choice of the Amit and Zott (2001) framework was justified not only by its integration of several base theories for comprehensiveness. The choice was also justified in that we found its application in the context of platforms aggregating digital artefacts (del Águila-Obra et al., 2007; Hyrynsalmi et al., 2014; Pesce et al., 2019). Furthermore, the operationalization of the framework by Hyrynsalmi et al. (2014) was advantageous to build on, for data gathering instruments in our research. We further describe the framework and findings of studies it anchors, in the next subsection.

2.3. Amit and Zott's Framework on Sources of Value Creation in e-Business

The resource-based view framework considered resources as critical to firm and actor performance. The schumpeterian innovation view theorised innovation in enterprise as the basis for increased investments and any entrepreneurial variabilities. The strategic networks view theorised how and why business networks take specific forms. The transaction costs economies theorised that the optimal organizational structure often achieves economic efficiency by minimizing the costs of exchange. Amit and Zott (2001) argued that each of these frameworks had limitations in the context of highly interconnected electronic markets. However, they argued that the value drivers present in these theoretical frameworks enhance value creation potential in e-Business. Building on this, Amit & Zott proceeded to propose an integrated theoretical framework for explaining the sources of value creation in e-Business that drive business model innovation. The integrated framework postulates four value creation sources namely:- (a) efficiency - from the transaction costs theory (b) complementarities - from the resource based view, (c) lock-in - from the strategic networks view and (d) novelty - from the schumpeterian innovation theory. The authors also noted the interdependence of these drivers such that the presence of one can improve the effectiveness of another. Fig. 1 shows Amit & Zott's visualization of this integrated theoretical framework. We dedicate the next few paragraphs to describe the four constructs in the integrated framework in Amit and Zott (2001) as well as to highlight the findings of studies we found applying the framework.

Efficiency as a source of value creation was explained in that transaction efficiency increases as the cost per transaction decreases. The transaction costs were broadly defined to include aspects such as information asymmetry and other non-monetary costs in efforts and time spent to realize value (Hyrynsalmi et al., 2014)(. For instance, del Águila-Obra et al. (2007) found that web content aggregators created value by reducing the associated information searching costs for news. Zott and Amit (2007) also found the positive influence of efficiency only manifesting itself during a period of resource scarcity. Zaborek et al. (2016) found a negative relation of efficiency as a source of value creation with improved financial performance especially in an intensely competitive environment. Pesce et al. (2019) found efficiency to be one of the primary value creation drivers in digital platforms. This arose from leveraging big data interconnectivity to reduce search costs and as well as reduce the costs of acquiring customers and serving them, according to the authors.

Complementarities as a source of value creation relates to the value-enhancing effect of the interdependencies among the offerings of goods and services on the platform. This is to the effect that greater value is delivered overall than when the same set of the goods and services are offered separately. Hyrynsalmi et al. (2014) found that complementarities as a value driver were sparsely used by Scandinavian application developers in platform ecosystems. Johansson and Mollstedt (2006) suggested that when complementarities are the main aspect under evaluation, they may be replaced by the nature of the core product in the base model. Zaborek et al. (2016) found that among the four drivers, only complementarities were closely linked to improved financial performance among Polish Internet companies. In del Águila-Obra et al. (2007), complementarities contributed to value creation with web content aggregators providing vertical and horizontal complementarities while also playing a value chain integration role. Pesce et al. (2019) found reduced interest in actors contributing to digital platform value where avenues for complementing platform features with their own capabilities were constrained.

Lock-in as a source of value creation is where customers are motivated to use the platform repeatedly and are willing to continue their relationship

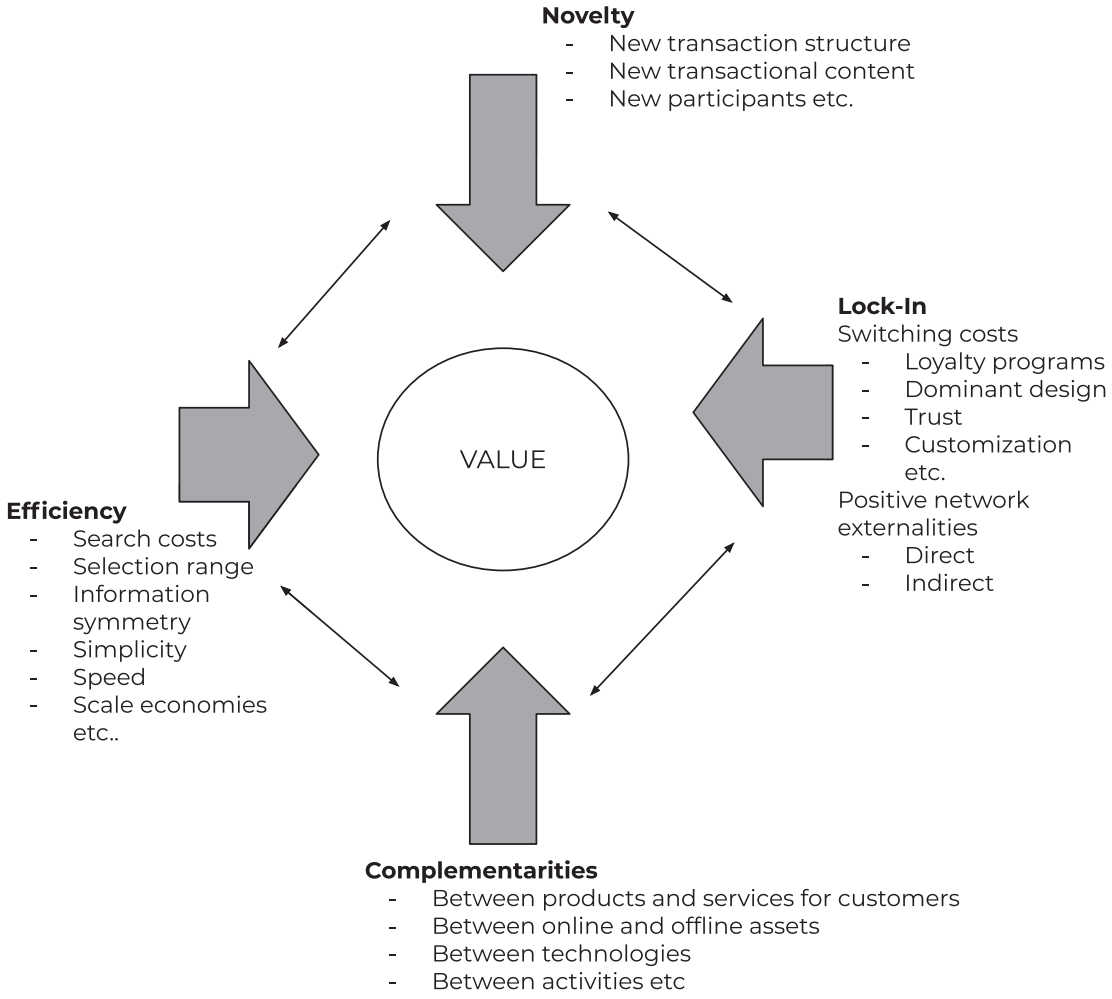

Figure 1. Integrated framework on Sources of Value Creation in e-Business. Source: Amit and Zott (2001).

with the platform. This increases switching costs and the customers are more willing to pay more for goods and services on the platform. The use of lock-in varied among application developers in Hyrynsalmi et al. (2014). The authors suggested mechanisms affecting lock-in as :- (a) loyalty programs - which were rare, (b) trust - relating to security and safety guidelines, (c) customer service / contact points such as communities on Twitter and Facebook, (d) customizations and personalization, and (e) network effects - as found in massive multiplayer games and social networks such as Facebook. In del Águila-Obra et al. (2007), personalized information to users contributed to value creation in the form of customer loyalty and increased switching costs. Zaborek et al. (2016) on their part did not find lock-in as a viable predictor of value creation. Johansson and Mollstedt (2006) suggested that there may exist a main service in a platform or business that can be the source of repeat usage even where additional services do not have loyalty enhancing effects. Pesce et al. (2019) observed the ability of digital platforms owned by powerful digital players to create value through lock-in mechanisms. Google in this case was shown to achieve relational dependency among users on their platform by allowing customization based on Google's other services such as Google Maps, Google Maps and the GMail digital identity infrastructure.

Novelty as a source of value creation relates to the introduction of new features, products or services. It also entails the introduction of new methods of conducting and organizing business, including new methods of production and distribution. Novelty can also be expected to yield new ways of addressing existing problems or isolating and solving new problems (Zaborek et al., 2016). On the one hand, the positive influence of novelty in value creation was reported in Zott & Amit (2007). It was shown as a source of value creation through innovations in the structure of transactions in del Águila-Obra et al. (2007). On the other hand, both Zaborek et al. (2016) and Johansson and Mollstedt (2006) did not find novelty as a viable predictor of value creation. In the cultural heritage sector, Pesce et al. (2019) found novelty as a source of value creation in digital platforms in the form of new features, services and processes for content dissemination and doing business in general. In the mobile financial platforms study by Iheanachor et al. (2021), novelty was acknowledged as a value driver drawn more from the platform provider than arising among its agents.

The application of all four sources of value creation in the Amit and Zott (2001) framework was argued by Pesce et al. (2019) to offer competitive advantage in digital platforms. The authors argued that such an approach facilitated the alignment of interests among a multiplicity of stakeholders of diverse or unrelated strategic objectives and beliefs.

3. Materials and methods

We adapted the work of Hyrynsalmi et al. (2014) to operationalize measures for sources of value creation in e-Business for the likely users of AP4SAs in Kenya. This operationalization of the Amit and Zott (2001) framework by Hyrynsalmi et al. was intended for administration by researchers knowledgeable in the information systems domain. Our data collection approach was to have a questionnaire self-administered by the likely users, differing slightly from the approach in Hyrynsalmi et al. (2014). On this account, we simplified the statements for brevity and

easy comprehension by our respondents as they were not information systems experts. Our adaptation also included the use of a Likert-like ordinal scale with the options being "*Not Important At All*", "*Of Average Importance*" and "*Absolutely Essential*" in the questions. We additionally referred to lock-in as loyalty and novelty as innovativeness in the instrument to enhance our respondents' comprehension. We also incorporated open-ended questions to solicit additional qualitative evidence on how the sources of value creation were viewed. The refinements above were also informed by inputs from the instrument's pre-testing among 10 farmers in a Kenyan peri-urban setting as well as from the agriculture and information systems experts consulted.

We defined likely AP4DSA users as *individuals engaged in activities along agricultural value chains who had Internet-enabled devices and basic access to Internet services*. We took advantage of virtual communities that have flourished online (Wright, 2005) with large agriculture themed social media groups in Kenya whose combined membership we observed to be above 300,000 to collect data. The questionnaire was filled out between February and July 2019. This was after we broadcasted invitations for members of these agriculture themed social media groups to take part in the survey via a weblink. A selection bias was likely with the opt-in and self-administration nature of the survey. We re-circulated the broadcast message throughout the period to increase positive chances for likely AP4DSA users to access and complete the survey. We also considered the speed and cost effectiveness in the data gathering approach to warrant the trade-off for the likely selection bias. We received responses from 887 participants of which 785 were retained as valid after data cleaning. On the one hand, we proceeded to use only the responses that did not have missing values for the quantitative aspects of this inquiry totalling 405. Table B.1 in the appendix shows the distribution of how the respondents rated the 21 items. On the other hand, we obtained rich qualitative insights with 369 participants providing answers to at least one open ended question related to this inquiry. A total of 449 respondents filled out all closed-ended questions or at least one open-ended question on sources of value creation in an AP4DSA.

We employed Confirmatory Factor Analysis (CFA) to ascertain dimensionality and patterns of association in the sources of value creation. The diagonally weighted least squares (DWLS) estimator method was used rather than Maximum Likelihood (ML). This was as DWLS was specifically designed for ordinal data and was even superior to Robust ML (MLR) in the estimation of factor loadings (Li, 2016). We analysed the polychoric correlation matrices rather than the Pearson correlation matrices as the data was ordinal. To assess goodness of fit we used the following indices:- Comparative fit index (CFI), Tucker-Lewis index (TLI), Root mean squared error of approximation (RMSEA), and Standardized root mean squared residual (SRMSR). This was because they were deemed superior in detecting model misspecification and had independence from sample size (Jackson, Gillaspy Jr, & Purc-Stephenson, 2009). Measures of CFI>.90, TLI>.90, RMSEA < 0.08, and SRMSR < .08 were expected to indicate a good fit (Hooper, Coughlan, & Mullen, 2008; Hu & Bentler, 1999). For factor analysis we used R (R Core Team, 2020). For the open-ended responses, thematic analysis was conducted using Atlas.ti software and followed the seven-step procedure adapted from Braun and Clarke (2006) and proposed by Friese, Soratto, and Pires (2018). The diagram in Figure 2 Illustrates the steps taken in the research process in this paper

4. Results

Among the 449 participants, the majority were male at 75%. The median age-range was 25-34 and 74% had attained education levels of a diploma certificate or higher. Reliance on agriculture for income among the participants was 82%. Primary agricultural production activities such as rearing animals and growing crops were the most represented activities among the participants at 84%. A detailed breakdown of the sample profile is found in Table C.1 in the appendix. In the sub-sections next we report the results upon analysis of our data seeking to explain how the sources of value creation in an AP4DSA can be structured and prioritized in the perspective of likely users in Kenya. Section 4.1 describes results from quantitative and qualitative responses relating to the four constructs in the Amit and Zott (2001) theoretical framework on sources of value creation. Section 4.2 describes the themes generated from the open-ended responses with sentiments that we placed outside the conceptual confines of the four-factor framework.

4.1. Towards a two-factor structure

For the ratings on sources of value creation we obtained the Henze-Zirkler statistics of 16.97786, p-value < 0.001. The Shapiro-Wilk tests for all 21 items were significant with p-value < 0.001. This indicated that the ratings were not normally distributed. We estimated the CFA using the DWLS method to assess how well the data fit the four-factor Amit and Zott (2001) model. We obtained $\chi 2(183) = 154.87$; p-value = 0.935 for the model. This yielded a Chi-square/Degrees of freedom ratio of 0.846 suggesting an acceptable fit of the data as it was below the 2.0 cutoff. In further support to this good fit, we obtained CFI = 1.000 and TLI = 1.003. For absolute fit indices, we obtained SRMR = 0.055 and RMSEA = 0.000 with a confidence interval of 0.000 to 0.006.

The standardised loadings for all the items were above 0.63 and as high as 0.86. This suggested strong relationships with their associated constructs, suggesting construct validity. Internal consistency of the four subscales was ascertained with the Chronbach's alpha and Composite Reliability (CR) measurements being above 0.70 and below 0.95 (Hair, Black, Babin, & Anderson, 2014; McNeish, 2018). In addition, the Average Variance Extracted (AVE) was above 0.5 for all subscales indicating that convergent validity was established (Fornell and Larker, 1981). Discriminant validity was however not established. The HTMT ratio was 0.965 between "Efficiency" to "Complementarities". The ratio was 0.882 between "Loyalty" to "Innovativeness". Both ratios were above the $HTMT_{0.85}$ criterion threshold (Henseler, Ringle, & Sarstedt, 2015). Table 1 below shows the reliability and validity measures for the four-factor structure while Figure 3 shows the pattern of association and standardised loadings.

To address the discriminant validity problem in the four-factor structure, we followed the procedure in Henseler et al. (2015). The procedure informed our proposal for a two-factor structure. In the two factor-structure we merged efficiency with complementarities into a new construct which we named "*platform-wide efficiency*". By the same procedure, we merged Loyalty with Innovativeness into a second construct which we named "*loyalty-centredness*". The proposed two-factor structure had discriminant validity established based on the $HTMT_{0.85}$ criterion, having an HTMT ratio of 0.840 between the two constructs. Other reliability and validity measurements for the two-factor model indicated that internal consistency was established with both CR and Chronbach's alpha values being above 0.7. Convergent validity too was established as AVE values were above 0.5 in addition to the reliability established. Figure 4 shows the pattern of association including the standardized loadings for the two-factor structure. Table 2 shows the reliability and validity measures for this new structure.

We obtained $\chi 2(188) = 175.268$; p-value = 0.738 for the two-factor structure. This evaluated to a Chi-square/Degrees of freedom ratio of 0.932 suggesting an acceptable fit of the data. In further support to the good fit we obtained CFI = 1.000, TLI = 1.001, SRMR = 0.058 and RMSEA = 0.000 with a confidence interval of 0.000 to 0.017.

In the two-factor structure, the user experience search cost *(E2)* was most impactful on platform-wide efficiency as a source of value creation with a factor loading of 0.87. This meant that all factors constant, a unit increase in this item increases platform-wide efficiency as a source of value creation in an AP4DSA by 87%. This impactfulness was further illustrated in the qualitative evidence: *"Of course ease of use. Customer journey needs to be seamless; easy to use platforms for people of all ages and education levels are essential"*. With a loading of 0.84, information symmetry (E5) was the second most impactful indicator of platform-wide efficiency as a source of value creation. Among the complementarity aspects, combining online and offline capabilities (C4) had the highest impact on platform-wide efficiency with a loading of 0.76. The respondents also expressed the need to

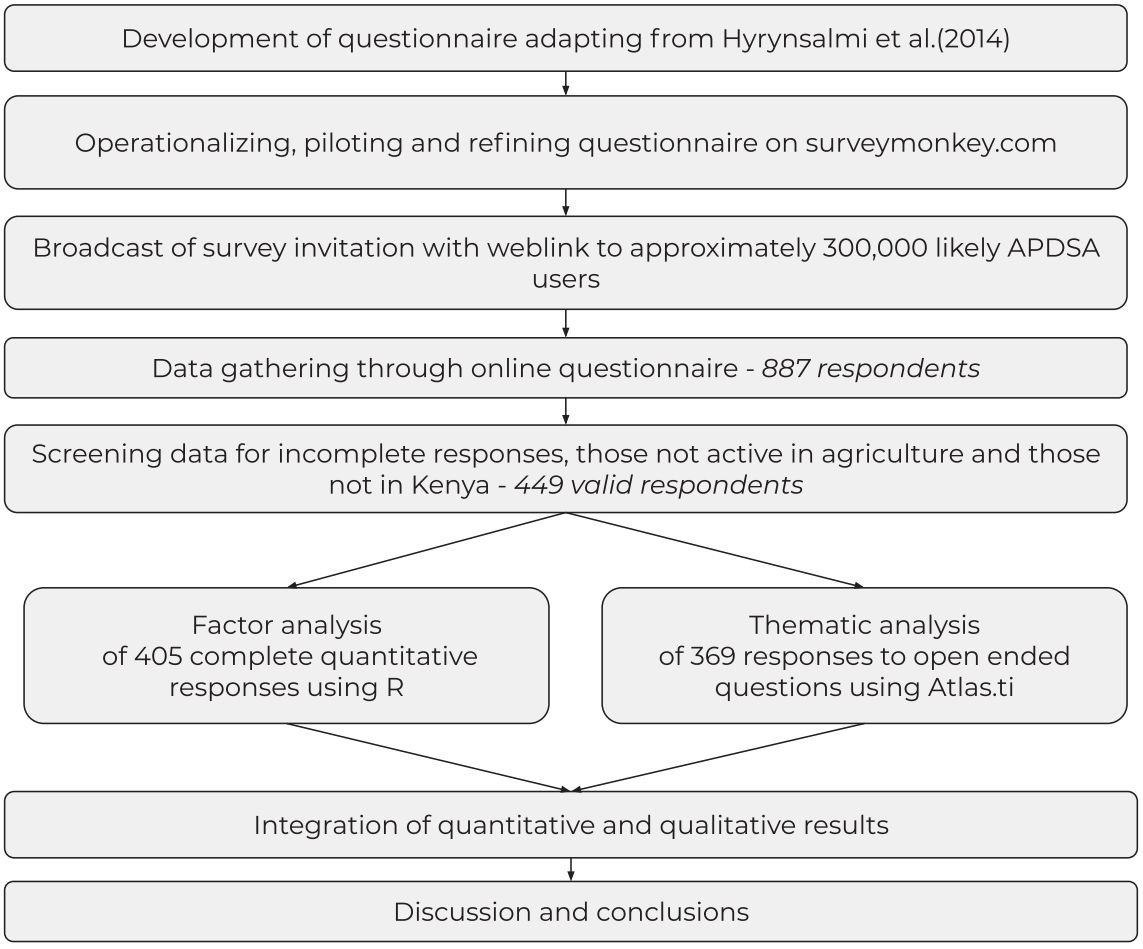

Figure 2. Summary of the research process.

Table 1
Measurements for Amit & Zott model on sources of value creation.

Construct	Items	CR	α	AVE	HTMT ratio			
					A	B	C	D
Complementarities (A)	5	0.849	0.846	0.531	1.000			
Efficiency (B)	6	0.908	0.904	0.623	**0.965**	1.000		
Loyalty / Lock-in (C)	6	0.867	0.861	0.523	0.788	0.846	1.000	
Innovativeness / Novelty (D)	4	0.843	0.838	0.574	0.732	0.823	**0.882**	1.000

exploit the complementaries between online platforms and the physical infrastructure on the ground such as administrative offices and farmers centres: "*Farmers centers and resource centers to be as many as possible; Access to information is a greater challenge in rural areas and with installation of a database at the Chief's office is vital*".

Providing guarantees for quality and reliability (L6) was most impactful among the items loading on *loyalty-centredness* with a loading of 0.81. According to the qualitative evidence, this high impactfulness can arise from certification of goods and services being delivered through the platform, cash-back guarantees, and from the quality of online support provided. "*Both consumers & producers (should) benefit, (in that) verified quality product or service equals (results in) a win-win situation for both producer & consumer; Encourage cash-back for unsatisfactory products*". Ensuring data protection, safety and security guidelines are adhered to (L2 - Trust) was the second-most impactful item on *loyalty-centredness* with a factor loading of 0.78. Vetting of service providers was also proposed as a way of guaranteeing trust: "*ONLY (allow participation of) professional accredited service providers (in the AP4DSA), trust is key; aggregator platforms should be genuine and trustworthy so that users can maintain loyalty*". Among the novelty items, "*N2 - New features and processes*" with a loading of 0.77 was most impactful on *loyalty-centredness* as a source of value creation. This item relates to introducing new features or processes in existing products or services on the platform. It was followed by "*N1 - New to the world products, services or information*" at a loading of 0.75. Moreover, respondents expressed wishes for radically improved or new DSAs as well as a desire to be ahead of others in discovering and utilising new services: "*A total overhaul of services offered to farmers is essential if farmers are to use this platform; bring new solutions oriented products; it's important to find products and services for the first time there as you will be ahead of others"*. Rewarding repeat use or purchase from the platform (L1) at 0.62 was notably the least impactful intervention area for *loyalty-centredness* as a source of value creation.

We further observed that in the two-factor structure, covariance was strong and positive between *platform-wide efficiency* and *loyalty-centredness*. Specifically, a change in *platform-wide efficiency* as a source of value creation by one unit changes *loyalty-centeredness* as a source of value creation by 85% and vice versa.

4.2. Additional themes from qualitative evidence

Beyond the four constructs in the Amit and Zott (2001) framework, we identified platform inclusivity as a high order theme on increasing benefits to users of an AP4DSA. The thematic map in Figure 5 summarizes the content and hierarchy of the sub themes generated under platform inclusivity.

Under platform inclusivity we generated four sub themes, three of which we grouped together as digital inclusivity as the main subtheme.

Figure 3. Sources of Value Creation in an AP4DSA - Four-factor structure.

The respondents expressed the need for an increased digital skills-base among farmers and other agricultural value chain actors: "… *combining tutorials and quick lessons; building confidence to farmers by visiting their farms and advis(ing) accordingly"*. They also expressed desire to be inclusive in maximizing the number of people aware about the existence of an AP4DSA and being able to access it. Emphasis on reaching small scale farmers with services was repeated by respondents as a way to increase the platform's benefits: "… *accessibility should be greatly considered to grant a wide audience; keeping in touch with low leveled associations (of actors such as farmers as to reach them easily)"*. Affordability in the respondents' views also related to the platform serving as a sourcing avenue for cost effective agricultural inputs and outputs: "*Charges should be looked into as one of the factors critical to success; availability of cost effective goods"*.

The second main sub theme of platform inclusivity was *value chain coverage*. It related to the respondent's desire for wide variety and comprehensiveness of the service portfolio in the AP4DSA. This was expected in ways that could cover a broad range of value chains, hence agricultural product verticals: "*(Include) avocados, chicken, passions, onions, bananas, sweet potatoes; buying and selling of farm products, where to buy certified seeds and pesticide and fungicides, weather warnings, diseases outbreaks on both crops and animals"*. Furthermore, a desire was expressed for the AP4DSA to be both a marketplace facilitating transactions as well as a source of agricultural knowledge: "*(The AP4DSA should be) 1. A unified digital market for agricultural products as compared to let's say amazon for consumer goods. 2. A 'wikipedia' for agriculture that unifies the knowledge bank from experts or alternatively a search engine dedicated to all things agriculture*". The respondents also desired coverage of all stages of each value chain for solutions to challenges experienced by the multiplicity of actors: "*(Provide digital services ranging) from land preparation through to harvesting, post-harvest and markets all under one umbrella; (include) digital input startups, fintech startups, digital crop production and agronomy startups, digital market linkage startups, digital agro processing startups"*.

5. Discussion

5.1. Theoretical contributions

Our findings suggest a two factor-structure to explain the dimensionality and prioritization for value creation sources in an AP4DSA. The two-factor structure encompasses *platform-wide efficiency* and *loyalty-centeredness* as the value creation sources. *Platform-wide efficiency* comprises 11 items from the *complementarities* and *efficiency* constructs in Amit and Zott (2001) while *Loyalty-centredness* comprises the 10 items under the *lock-in* and *novelty* constructs. Item prioritization within each source of value

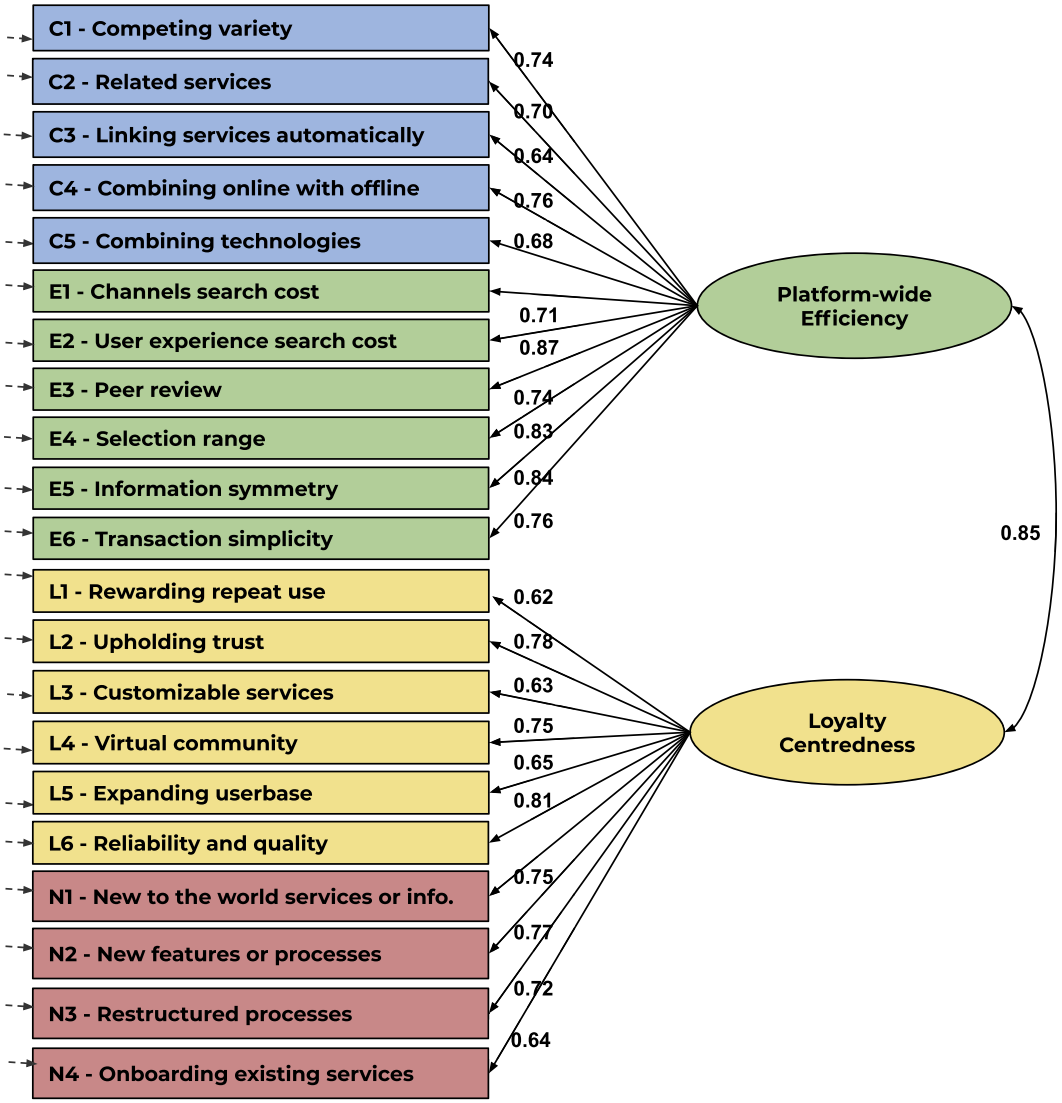

Figure 4. Sources of Value Creation in an AP4DSA - Two-factor structure.

Table 2
Reliability and validity for 2 factor model on sources of value creation.

Construct	Items	CR	α	AVE	HTMT ratio	
					A	B
Platform-wide efficiency (A)	11	0.935	0.933	0.569	1.000	
Loyalty-centredness (B)	10	0.912	0.908	0.512	0.840	1.000

creation was evident in their respective CFA factor loadings. In addition to the two-factor structure, the qualitative evidence suggests *platform inclusivity* as a composite theme for enhancing sector-wide benefits in an AP4DSA. In the next paragraphs of this subsection, we discuss the findings on the two-factor structure and the additional theme of *platform inclusivity*.

5.1.1. Suitability of a two-factor structure for value drivers in an AP4DSA

A departure from the Amit and Zott (2001) four-factor structure to a two-factor structure reflects the views of likely AP4DSA users in the SSA country setting. The strong covariance between the two dimensions of *platform-wide efficiency* and *loyalty-centeredness* suggests that likely users of AP4DSAs deem the two dimensions to be highly complementary. This may appear to contradict the suggestion in Zott and Amit (2007) that there might be diseconomies of scope when efficiency centered and novelty centered approaches are bundled together in business models for value creation. Our contention is that our findings embody the perspective of likely AP4DSA users which may not always coincide with the prioritizations of the constituent service providers or the platform owner as was the case in Zott and Amit (2007). Moreover, while diseconomies of scope may arise with a platform orchestrator's dispersed attention to multiple sources of value creation, the likely users have no reason to discriminate against value arising from either source. We further contend that the two-factor structure is suggestive of the ambidextrous attribute of digital platforms argued out in Wang, Guo, Wang, and Lou (2020). On the one hand, *platform-wide efficiency* relates to the transaction perspective of platforms whereby enhanced transaction matching is desired. On the other hand, *loyalty-centredness* relates to the innovation perspective of platforms whereby new products and services are desired to adequately meet user specific needs.

Our findings were consistent with the findings of other studies applying the Amit and Zott (2001) model. This is as varied combinations were found

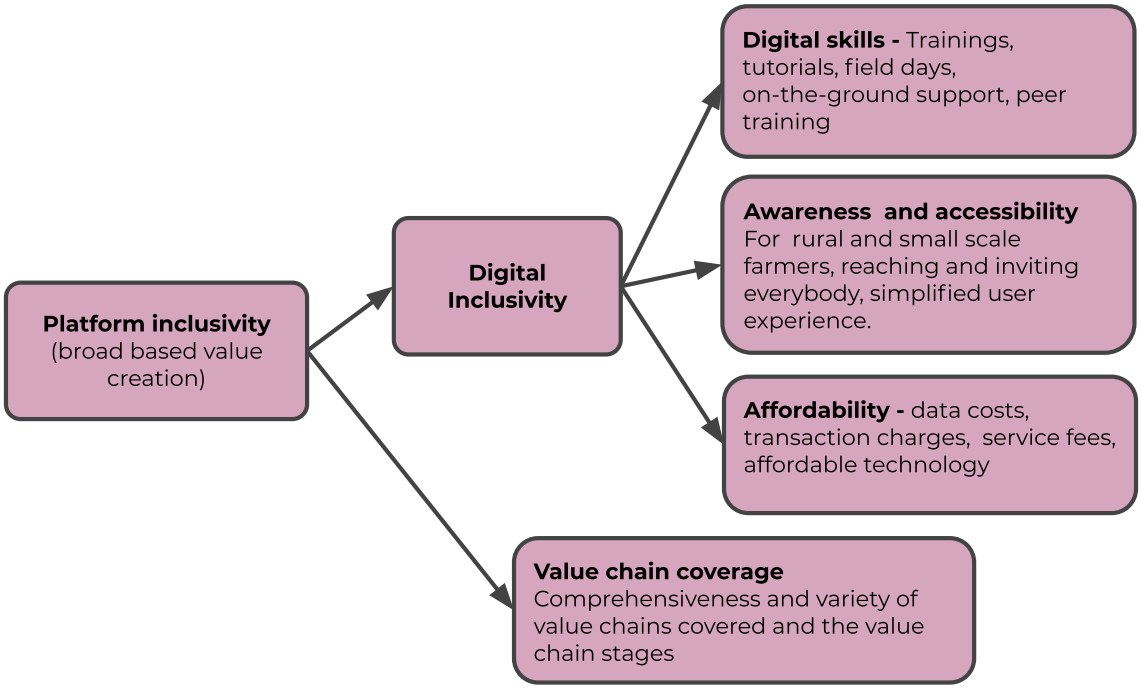

Figure 5. Value amplification themes derived from qualitative evidence.

of the main drivers of value creation among the four constructs depending on the contexts applied (Johansson & Mollstedt, 2006; del Águila-Obra et al., 2007; Hrynysalmi et al., 2014; Pesce et al., 2019). Of particular note was the significant impactfulness of items from each dimension in the four-factor structure to the respective dimensions in the two-factor structure. In concurrence with Pesce et al. (2019) we argue that this suggests the existence of multiple diverse actors in an AP4DSA with diverse objectives and needs. We discuss this diversity of actors further under platform inclusivity in sub-section 5.1.4. Resource constraints imply prioritization of intervention areas in the implementation of an AP4DSA to realize low hanging fruits early. We posit that prioritizing value creation strategies in an AP4DSA using the two-factor structure can be more ideal than using the original four-factor framework especially in the resource-constrained environments in developing countries such as Kenya. This is because the two-factor structure systematically reduces the areas of focus from four to two while respecting the underlying pattern of association among the variables involved.

5.1.2. Platform-wide efficiency

Our findings point to the magnitude of the frustration that users may face with information overload or being distracted as they seek to efficiently derive value from an AP4DSA. This was indicated in that user experience related search costs constituted the most impactful item under *platform-wide efficiency* as a source of value creation. With the sheer complexity of an AP4DSA as a concept to users who are likely busy and with limited digital skills, the user experience can be overwhelming. The sheer number of service offerings possible in the menu too can be overwhelming or cause distraction to users. Making it easy to locate and use products in an AP4DSA is therefore paramount. Information symmetry coming second on impactfulness to *platform-wide efficiency* indicated desire among users for uptodate information about constituent services. This is especially as new innovations are expected to regularly be onboarded as constituent services. Likewise, there are likely older services becoming obsolete or irrelevant especially as the service providers lose interest in maintaining them. For DSAs providing information services such as weather, the users can be assumed to expect relevantly uptodate weather data. Likewise, for a product verification service, users can expect queries to reflect the most uptodate dataset of authentic products. These findings are consistent with the knowledge unification and stakeholder knowledge access sub themes found in Laczko et al. (2019).

We suggest that under *platform-wide efficiency*, it is the complementarities that amplify the efficiency items to be felt platform-wide. Among the items under complementarities in the Amit and Zott (2001) structure, combining online and offline capabilities was ranked most impactful on *platform-wide efficiency*. A probable reason for this is that an AP4DSA is expected to account for the subsisting physical nature of agricultural activities, and to integrate them into the digital aspects of the platform. We suggest that such approaches can not only increase *platform-wide efficiency*. They can also increase platform inclusivity as they address the concerns related to awareness, geographical reach, technology access and overall digitalization of processes in the sector. This aspect can therefore be linked to the *platform inclusivity* theme generated from the qualitative evidence. Granted all the 11 items in the proposed structure of *platform-wide efficiency* were important with the lowest factor loading at 64%, relatively lower loadings of the items under complementarities compared to efficiency in the four-factor structure was notable. A probable reason for this is that the likely AP4DSA users are focused on even the simplest value offering as long as it works and is cost saving timewise or moneywise. This is moreso as AP4DSA use is likely in a business context of revenue maximization and cost minimization. Our findings are slightly divergent from those in Hrynysalmi et al. (2014) where complementarities were sparsely used for value creation, suggesting their diminished significance. In spite of our findings merging complementarities into platform-wide efficiency, the complementarities items still loaded relatively high on the new construct.

5.1.3. Loyalty-centredness

Self-reinforcement between an AP4DSA and the actors affiliating with it are implied to constitute the most impactful aspects of *loyalty-centredness*. The highest loadings to this factor seeking guarantees for “quality and reliability”, and “upholding trust” suggests the essence of striving for excellence among all actors on an AP4DSA. It alludes to the platform safeguarding ecosystem-wide integrity whereby genuineness and legitimacy of actors as well as the information, goods and services accessed through the platform can be guaranteed. It connotes an accountability arrangement among participating actors to generate win-win scenarios for both providers and consumers of services on the platform. Notably, *loyalty-centredness* relates

closely to the theme of platform-stickiness found in Laczko et al. (2019) as it seeks to incorporate both stakeholder altruism and stakeholder empowerment. We argue that *loyalty-centredness* instills a sense of pride and new value creation among those affiliating to the platform.

A probable reason for "rewarding repeat use and new purchases" being ranked of lowest impact to *loyalty-centeredness* is that while users may desire a sense of affiliation to the platform, they would wish to maintain a liberal outlook of not being locked in. They therefore would resist overt ensnaring advances such as being rewarded for use or purchases. We suggest that the relatively low impactfulness observed among the novelty items on *loyalty-centredness* as a source of value creation in an AP4DSA can be linked to the long existence of digital agriculture innovations that remain underutilised. Furthermore, a new innovation may be onboarded and showcased on a platform yet not be ready to exhibit the kind of reliability and quality guarantees expected by the loyal platform users. The comparatively lower impactfulness of items under novelty is consistent with the variability in how relevantly each of the four constructs in Amit and Zott (2001) predicted value creation in past studies. It however contrasts with the extremes in Zaborek et al. (2016) and Johansson and Mollstedt (2006) whereby novelty was altogether not identified as a predictor of value creation.

5.1.4. Platform inclusivity

The additional theme of *platform inclusivity* constitutes *value chain coverage* and *digital inclusivity* and are indicative of multiple archetypes for potential AP4DSA actors with a diversity of needs, beliefs and interests. It is consistent with the sub-themes found in Laczko et al. (2019) of broadening stakeholder value and value capture. The theme suggests that an AP4DSA being of great value to just a section of the digital agriculture ecosystem is not enough to generate desired sector-wide transformation. The three sub-themes grouped together under *digital inclusivity* related to characteristics of the first and second-level digital divide (Mutula, 2008; Van Dijk & Hacker, 2003). These digital divide concerns include mental and material access barriers to technology as well as barriers to digital skills access (Hargittai, 2001; Scheerder, van Deursen, & van Dijk, 2017) among potential platform actors. They point to the imperative for an AP4DSA orchestrator being involved in interventions to limit the effects of the digital divide and are instructive to the design of such interventions. Providing technology access options that are universally accessible such as USSD and SMS deployments is also implied as a *digital inclusivity* intervention of the platform.

The desire for a broadened *value chain coverage* implies demand diversity and high supply-side openness which Wang et al. (2020) found to lead to better platform performance. It is also consistent with Cappa et al (2020) who found the variety of big data positively moderating the effect of volume in firm performance. As such data accumulation in an AP4DSA can be more value adding if it covers not only diverse value chains but also diverse types of actors. This suggests expectations for the AP4DSA orchestrator to take up mobilization roles that attract DSA providers and other contributors to broaden diversity in platform participation. Accordingly, collaboration between the AP4DSA orchestrator, DSA providers and other digital agriculture ecosystem actors is implied to address the various imperatives for *platform inclusivity*. A sector-wide approach is implied as the mechanisms for achieving *platform inclusivity* are not entirely in the purview of the AP4DSA, yet the digital transformation of agriculture is a sector-wide goal. Inasmuch as the findings in this theme are not tested in this study with quantitative measurements, we contend that it constitutes an additional source of value creation for an AP4DSA backed by the qualitative evidence.

5.2. Implications for practice and policy

We highlight below implications for practitioners in the digital agriculture ecosystem. These include digital entrepreneurs, managers of information technology organizations, government agencies and development organizations intent on developing or supporting an AP4DSA in SSA country settings. Attention to *platform-wide efficiency* and *loyalty-centredness* as sources of value creation is called for among practitioners involved in AP4DSA implementation. We concur with Pesce et al. (2019) that the diversity of interests among potential platform actors calls for the application of multiple value drivers as mechanisms for alignment with their diverse interests. Therefore AP4DSA orchestration should consider incorporating multiple value drivers simultaneously or incrementally depending on its resource availability. The platform orchestrator may not alway be powerful or resource endowed as with the case of Google in Pesce et al. There is therefore an imperative to prioritize the value drivers based on the impactfulness of the various items (intervention areas) under the two major value drivers. For instance, under *platform-wide efficiency*, ensuring users are not overwhelmed by the platform's complexity or distracted by the multiplicity of value offerings should be prioritized highest. This is to address the item "user experience search costs" which was found most impactful on the value driver. As such, paying attention to "automatically linking services" (the lowest ranked item) before the user experience item would be a misallocation of priorities. Likewise under *loyalty-centeredness*, the items on "quality and reliability" and "upholding trust" would require priority attention over the item on "rewarding repeat use". This is following the relative impactfulness of each item on the construct as ascertained in the study. We contend that such prioritization is relevant for platform orchestrators who may experience resource constraints at some point in the implementation. This is more so as an incremental implementation prioritising rapid proof of concept and unlocking low hanging fruits is bound to unlock increased investment in an AP4DSA as it evolves. We also find an imperative to pursue digital agriculture ecosystem-wide collaboration as a role of the AP4DSA orchestrator. This collaboration can be such that *platform inclusivity* for amplified sector-wide benefits of an AP4DSA can be attained incrementally or simultaneously in step with resource availability and the platform stage of growth.

For policy makers, a long-term role for the protection of the digital agriculture ecosystem and the agriculture sector at large is implied to uphold the tenets of *loyalty-centeredness*. This is to the extent that as an AP4DSA becomes successful, its transformative power may need to be harnessed to advance the greater good of all industry actors rather than create powerful exploitative monopolies unable to inspire trust. For instance, since service aggregation can technically permit aggregation of data handled by constituent actors, such accumulation of data can be harnessed to enhance industry level interventions such as food sovereignty and economic inclusivity. The data aggregation effect also implies large scale access to individual actor participation data which may include personally identifiable information as demonstrated in Hayes, Cappa, and Le-Khac (2020). A fine balancing act therefore arises between infringing on individual data privacy and exploiting transaction data to inform formulation and enforcement of economic or fiscal policies such as taxation. For policymakers it is also implied to institute mechanisms for eliminating the aspects of the digital divide that undermine *digital inclusivity*. These include challenges such as low or uneven access to digital skills and physical technology infrastructure. This is more so as *digital inclusivity* is a component of *platform inclusivity*, deemed to amplify sector-wide benefits of an AP4DSA.

5.3. Limitations and directions for future

The online questionnaire used in this study covered a wider scope than sources of value creation in an AP4DSA. As such, the questionnaire length posed a problem for completion rates (Liu & Wronski, 2018). We suggest further research to quantitatively test the appropriateness of incorporating *platform inclusivity* as an additional dimension to the structure of sources of value creation in an AP4DSA. Research to further explicate the link between the two-factor structure and the ambidextrous attributes of platforms is also called for. Specifically for the innovation perspective, further research may explain why the impactfulness of innovativeness items from the four-factor structure was comparatively less than the impactfulness of loyalty items on the merged construct in the two-factor structure. We note that SSA countries share development characteristics in regard to technology infrastructure development (Fuchs & Horak, 2008; Mutula, 2008) and the economic relevance of agriculture (Shimeles, Verdier-Chouchane, & Boly, 2018). They also share the nascent nature of digital technologies for agriculture (Disrupt Africa, 2018). We therefore contend that our

study can be analytically replicated in SSA countries other than Kenya as well as in other human development sectors. We recommend further inquiry into how sources of value creation in an AP4DSA compare with value drivers for similar digital platforms in other human development sectors.

6. Conclusion

In this study, we conceptualised an AP4DSA and set out to investigate how sources of value creation in such a digital platform can be structured and prioritised from the perspective of likely users in an SSA country. We estimated a CFA with the quantitative data gathered to ascertain its fit to the four-factor structure proposed in Amit and Zott (2001). We then applied the procedure in Henseler et al. (2015) to resolve discriminant validity and arrived at a two-factor structure. Consequently, we propose the two-factor structure encompassing *platform-wide efficiency* and *loyalty-centredness* to explain sources of value creation and their prioritizations in an AP4DSA. The qualitative evidence complementing the quantitative findings in the CFA gave rise to *platform inclusivity* - comprising *value chain coverage* and *digital inclusivity,* as an additional theme for increasing benefits to AP4DSA users. Our findings inform the identification and prioritization of value creation sources in an AP4DSA among practitioners implementing such a platform. These include the teams working on the nascent AP4DSA initiatives described earlier as well as similar initiatives likely to spring up across SSA countries. As such, focused attention to platform-wide efficiency, loyalty-centredness and platform inclusivity is bound to increase prospects of an AP4DSA. This can go a long way in actualizing the promise of an AP4DSA as a remedy to scale out challenges of DSAs such as ecosystem fragmentation, lack of comprehensiveness and absence of a one stop shop especially in an SSA country setting. In turn, this can unlock the transformational effects of digital technologies in agriculture, an industry that is the mainstay of many SSA economies.

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Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Description of Nascent forms of an AP4DSA

Digifarm

DigiFarm is "*an integrated mobile platform that offers farmers convenient, one-stop access to a suite of products, including financial and credit services, quality farm products and customized information on farming best practices" a*ccording to the CGIAR platform for Big Data in Agriculture[6]. It was developed in 2017 by Safaricom and the Vodafone group with the assistance of Mercy Corps' AgriFin Accelerate program, funded by the Mastercard Foundation. Safaricom, Kenya's largest mobile network provider is the platform's host and data hub. The platform initially entailed a collaboration with digital service providers iProcure for just-in-time agricultural input supply, FarmDrive for credit scoring and farmer profiling, and Arifu for interactive information services and e-learning. The platform has on boarded more services[7] including iCow, the Kenya Livestock Producers Association (KLPA), AgroCares and Georgetown University's gui2de. Digifarm is accessible as a mobile application on the Google's Play Store as well as by safaricom subscribers dialing **944#*.

Climate FieldView

Climate Fieldview is a product of the Climate Corporation, founded in 2006 as a provider of weather services and acquired by Bayer in 2018. The digital platform was launched in 2016, combining the company's offerings with those of its digital agriculture partners. The platform assists farmers to make year-round, data-driven decisions to help maximize returns potential on their farming acreage. The platform also assists farmer to seamlessly collect, store and visualize critical field data for customized plans to optimize crop performance according to Stoneseed[8]. To deliver on this, the platform collaborates through data connectivity and data interchange with digital agriculture service providers such as Sentera for imagery, SlantRange for sensors, FieldAlytics for agricultural inputs, FarmLead for grain markets and John Deere for equipment connectivity. An updated list of Climate Fieldview's digital partners may be accessed on their website[9]. The platform is accessible via its website or through its mobile applications on the Google Playstore and the Apple Store.

[6] Article on CGIAR big data platform - https://bigdata.cgiar.org/digital-intervention/safaricom-digifarm/
[7] Mercy Corps website article https://www.mercycorpsagrifin.org/2019/05/27/building-the-digifarm-innovation-platform-the-journey-to-one-million-farmers/
[8] Stone seed website article - https://www.stoneseed.com/en-us/climate-fieldview.html
[9] Climate FieldView partners' page - https://climate.com/partners

Appendix. B

Table B.1
Distribution of 405 responses to 21 measured items.

Measured items	Rating*			% Abs. essential
	1	2	3	
C1 - Variety: Ensuring variety of competing products and services	8	81	316	78%
C2 - Related Services: Ensuring access to products and services that are related	13	61	331	82%
C3 - Linking services: Automatic access to features of a product X while using another product Y	32	144	229	57%
C4 - Combining online and offline capabilities	8	60	337	83%
C5 - Combining multiple technology capabilities	11	69	325	80%
E1 - Channels search cost: Being accessible on multiple types of devices or channels	16	58	331	82%
E2 - UX search cost: Making it easy to locate and use the products I need in the platform	7	43	355	88%
E3 - Peer reviews: Having a system for rating and reviewing suppliers and service providers	7	64	334	82%
E4 - Selection range: Offering a range of products to serve specific needs of different customers	17	64	324	80%
E5 - Information symmetry:Providing up-to-date and complete information on each product offered on the platform	7	44	354	87%
E6 - Transaction simplicity: Ensuring that performing transactions across the platform is simple to users	8	57	340	84%
L1 - Rewarding repeat use or purchase from the platform	31	162	212	52%
L2 - Ensuring data protection, safety and security guidelines are adhered to	10	54	341	84%
L3 - Customizability of products: Allowing users to customize products found in the platform	28	145	232	57%
L4 - Virtual Community: Creating and moderating a virtual community for users to interact	10	105	290	72%
L5 - Increasing userbase actively	19	103	283	70%
L6 - Quality and reliability being guaranteed	7	40	358	88%
N1 - New content: Having new to the world products, services or information	13	102	290	72%
N2 - New Features: Introduction of new features or processes in existing products, services of information	6	97	302	75%
N3 - Restructuring existing processes or transactions offered previously in the market-place	18	120	267	66%
N4 - Onboard new services - Providing existing products or services through the platform the first time	17	112	276	68%

* *1 = Not Important At All; 2 = Of Average Importance; 3 = Absolutely Essential.*

Appendix. C

Table C.1
Sample profile.

Category	Measure	Frequency	Percentage
Gender	Female	108	25%
(N = 438)	Male	330	75%
Age range	18-24	94	21%
(N = 438)	25-34	162	37%
	35-44	97	22%
	45-54	65	15%
	55-64	17	4%
	65 +	3	1%
Highest education level attained	Did not complete any formal education	1	0%
(N = 440)	Primary School	7	2%
	Secondary School	43	10%
	Short Course Certificate After Secondary School	62	14%
	Diploma Certificate	119	27%
	University Degree	167	38%
	Master's degree	39	9%
	Doctor of Philosophy (PhD)	2	0%
Income reliance on agricultural activities	Fully reliant	210	48%
(N = 433)	Partial reliant	147	34%
	Not reliant	76	18%
Involvement in Agricultural value chain activities (N = 443)	Farm inputs provision	49	11%
	Production - crops and animals	372	84%
	Post harvest logistics	41	9%
	Marketing and brokerage services	56	13%
	Specialized services	60	14%
	Finance and insurance	20	5%

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