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Dynamic Exchange Capabilities for Value Co-creation in Ecosystems

Abstract

Open sources and digital platforms offer significant opportunities for knowledge-intensive entrepreneurship (KIE) firms to participate on the platforms of existing firms while enabling the existing firms to develop dynamic capabilities (DC). However, the processes through which KIE and existing firms co-create and co-capture value from each other in ecosystems remain less understood. Synthesizing the diverse streams of literature on DC development in ecosystems, entrepreneurial ecosystems development by KIE firms, and service-centred views of value co-creation, we develop what we refer to as a 'dynamic exchange capabilities (DEC) framework' to delineate the processes through which firms co-create and co-capture value in ecosystems. Emphasizing the transience and potential trajectory of exchanges in ecosystems, we highlight how potential benefits of exchanges in ecosystems may affect the relationships and resource integration of both existing and KIE firms. The implications for the theory and practice of dynamic exchange capabilities for value co-creation are outlined.

1. Introduction

Knowledge-intensive entrepreneurship (KIE) constitutes a key part of an emerging socio-economic phenomenon driving economic competitiveness and innovative capabilities (Acs, Stam, Audretsch & O'Connor, 2017). KIE firms are "new firms that are innovative, have significant knowledge intensity in their activity, are embedded in innovation systems, and exploit innovative opportunities in diverse evolving sectors and contexts" (Malerba & McKelvey, 2020, p. 511). Although they operate under different country and sector conditions, KIE firms exhibit a common characteristic of *interacting* more with innovation *systems* than with other new firms, irrespective of sector or country of operation (Malerba & McKelvey, 2020). Such interactions with systems have been explained in both the regional development literature, which emphasises value creation by firms in related industries at the regional and local levels (e.g., Agrawal & Cockburn, 2003; Asheim, Smith & Oughton, 2011) and in the strategic management literature, which emphasises value creation and capture at the global level co-ordinated by a focal orchestrator firm (e.g., Acs et al., 2017; Gilbert, Audretsch & McDougall, 2004).

However, scholars have highlighted the limitations in both the regional development and strategic management literature in accounting for the role of entrepreneurship in new value creation in such systems (e.g., Acs et al., 2017). Several scholars recommend entrepreneurial ecosystems (EE) to illuminate our understanding of the role of entrepreneurship in new value creation with regards to KIE

firms' interaction with innovative systems. EE offer digital affordances for discovering entrepreneurial opportunities and pursuing business model innovation, voluntary horizontal knowledge spill-overs and cluster-external locus of entrepreneurial opportunities (Autio, Nambisan, Thomas, & Wright, 2018; Song, 2019; Sussan & Acs, 2017). Digital affordances in EE enable KIE firms to engage as complementors in exchanges on digital platforms of open innovation, rather than serving as inputs for innovation by established firms (Nambisan, Siegel, & Kenney, 2018). By serving as complementors on the platform of existing firms, KIE firms can emerge and thrive while enabling existing firms to develop dynamic capabilities through value co-creation and co-capture in ecosystems (Ceccagnoli, Forman, Huang & Wu, 2012; Faridian & Neubaum, 2021; Helfat & Raubitschek, 2018).

However, the processes through which KIE firms' exchanges with incumbents enable KIE firms to emerge and thrive while facilitating DC development by existing firms remains less understood. Thus, the aim of this study is to develop a DEC framework to explicate the processes through which existing and KIE firms engage each other in mutually beneficial exchanges for value co-creation and co-capture in ecosystems. The term (DEC) refers to a firm's ability to facilitate encounters, interactions, and engagement with actors for both exploitation and exploration of capabilities on a platform-based ecosystem of value co-creation and co-capture (e.g., Faridian & Neubaum, 2021; Gronroos, 2011; Marcos-Cuevas, Nätti, Palo & Baumann, 2016; Payne, Storbacka & Frow, 2008). Although both DEC and DC emphasise the matching of internal resources to the changing environment, DEC differs from and builds on the DC framework because DC focuses on resource accumulation, replicability, and inimitability (Teece, Pisano & Shuen, 1997) of what is an inside-out strategic exercise, whereas DEC emphasises the opportunities in the exchange processes that facilitate resource accumulation, replicability, and inimitability.

Since KIE firms display significant knowledge intensity, are embedded in innovation systems, and exploit innovative opportunities in diverse evolving sectors (Malerba & McKelvey, 2020), DEC are important for accessing specific types of resources during the pre-entry, the establishment, and the post-entry phases in specific sectors (Hermanson, McKelvey & Zaring, 2018). DEC overcome the

paradox of openness for innovation opportunities while protecting internal knowledge and intellectual assets, in order to appropriate value from the innovations within or across sectors (Lassen, Ljungberg & McKelvey, 2020). Accordingly, DEC require KIE firms to adopt an EE approach in order to leverage digital platform affordances in ecosystems for entrepreneurial opportunity discovery and pursuit (Autio et al., 2018).

However, DEC will enable existing firms to adopt a fluid and open-boundaries approach for value co-creation (Chesbrough, 2007; Reypens, Lievens & Blazevic, 2016) in order to constantly learn, unlearn and relearn how the structures of their internal and external boundaries facilitate ambidexterity for entrepreneurial capabilities development (Faridian & Neubaum, 2021; Santos & Eisenhardt, 2005). Accordingly, DEC require existing firms to adopt a value co-creation approach in order to emphasise competitive association with and differentiation from actors in exchanges, without limiting the role of the actors in the exchange to customer, competitor or supplier, for instance. To this extent, DEC thinking draws on the service-centred view of value co-creation in ecosystems, which emphasises service-for-service exchanges between actors engaged in resource integration in order to facilitate multi-actor value co-creation in ecosystems for *strategic benefits* beyond competitive advantage (Vargo & Lusch, 2011; 2016).

This article proceeds as follows: first, the paper discusses the conceptual underpinnings of DEC for value co-creation in an ecosystem. In this discussion, the paper reviews DC development in an ecosystem by existing firms, EE for opportunity discovery and pursuit by KIE firms, and the service-centred view of value co-creation in service ecosystems, to address the limitations of DC ecosystems for established firms and of EE for KIE firm. Second, the paper presents the DEC framework with associated propositions on its antecedents and outcomes. Subsequently, the study discusses the theoretical and managerial implications of the framework and suggests avenues for future research.

2. Conceptual Underpinnings of DEC for Value Co-creation in Ecosystems

2.1. DC Development in Ecosystems

DC is an important theoretical framework which extends our understanding of the significance of inimitable resources and capabilities of an organisation by emphasising a firm's ability to "integrate, build, and reconfigure internal and external competences to address rapidly changing external environments" (Teece et al., 1997, p. 516). DC is crucial for organisations because, as a collection of resources, organisations break down and lose their competitiveness in high-velocity markets where the only constant is change (e.g., Sunder, Ganesh, & Marathe, 2019). These high velocity markets characterise ever-changing innovation systems. To this extent, scholars (e.g., Sunder & Ganesh, 2020) have used systems thinking perspective to propose a DC ecosystem which captures organisations as complex systems with bundles of capabilities and inter-relationships, all of which facilitates sustained competitive advantage.

Accordingly, Teece (2018) argues for firms to design appropriate business models which enable them to profit from innovation by providing complementary assets to facilitate innovations on open-source platforms. Building on Teece's (2018) argument on profiting from innovations with complementary asset provision, Helfat and Raubitschek (2018) identified innovation capabilities, environmental scanning and sensing capabilities, and integrative capabilities for ecosystem orchestration as the minimum necessary DC for the creation and capture of value in ecosystems by platform leaders. These authors emphasise innovation capabilities development as the strategic path for ecosystem orchestration based on a platform leader's environmental scanning and sensing capabilities, and integrative capabilities around innovation. However, although Helfat and Raubitschek (2018) emphasise platform-based exchanges in an ecosystem, they limit value creation and capture to the platform orchestrator or leader and ignore other actors on the platform who may create and capture value.

Highlighting the importance of other actors on the platform, Faridian and Neubaum (2021) argue for inter-organisational relationships based on asset sharing for DC development in open-source ecosystems. From such inter-organisational relationships, the authors argue for exploitation- and exploration-oriented network ties, in order to strengthen the intrapreneurial capabilities of a firm in

dynamic environments. Exploitative-oriented networks enable firms to co-create and to co-capture value in existing networks for intrapreneurial capabilities development, whereas explorative-oriented networks facilitate the cultivation of new networks for future value co-creation and co-capture, which sustain the firm's intrapreneurial capabilities. However, DC research is yet to establish the processes through which existing firms develop intrapreneurial capabilities on their platforms to enable value co-creation and co-capture with other firms, such as KIE firms. Nonetheless, understanding the value co-creation and co-capture between existing and KIE firms on platform-based ecosystems requires a critical evaluation of the DC framework and its dimensions. These dimensions include the building blocks, input variables, influencing factors, desired outcomes, and assessment measures for DC (Sunder et al., 2019).

First, the building blocks of DC involve the assumptions and characteristics that underlie DC for firms. A key assumption of DC, which limits its application to EE, is that DC overcome the limitations of a firm's resource-based view (RBV), which focuses on firms' short-term competitiveness based on valuable, rare, inimitable, and non-substitutable (VRIN) resources, excluding non-VRIN resources. DC therefore enable sustained competitive advantage by ensuring that firms always possess the VRIN resources required for competitive advantage at any given period. Based on this assumption, the underlying characteristics of firms' DC are change and dynamism of resources because of the changing environment (e.g., Teece, 2007). If change characterises DC, then resources considered non-VRIN at a particular period may become VRIN in another period and vice-versa, depending on the changes in interplay between resources and the changing environment. Understanding the transitions between VRIN and non-VRIN resources for sustained competitive advantage is essential for meeting the reliability requirements of DC, if we consider markets and firms to operate in a Schumpeterian world where there is a necessity for creative destruction to constantly create environments of change (Teece, 1997; Peteraf, Di Stefano & Verona, 2013). Therefore, although non-VRIN resources *per se* may not offer competitive advantage in an ecosystem, they may offer an opportunity to develop VRIN resources for future competitive differentiation.

Second, the input variables dimension of DC involves firms' processes, positions and paths. The term 'processes' refers to managerial and organisational "routines" such as work, behavioural and change processes. 'Positions' encompasses current resources such as staff, capital, infrastructure, technology, networks etc (Teece et al., 1997; Sunder et al., 2019). 'Paths' signifies the available strategic alternatives for DC development. Strategic alternatives involve trade-off, instead of alignment, between various alternatives because of the organisational structure and specificity of a firm's position in value chains. This understanding of strategic alternatives with regards to paths limits the input variables of DC to the internal boundaries of the firm. From an ecosystem perspective, the input variables for DC may involve the firm's boundaries of efficiency, power, competence, and identity (Santos & Eisenhardt, 2005).

Boundaries of efficiency minimise governance cost for any exchange through a legal understanding of the firm as a governance mechanism distinct from the market. Boundaries of power maximise strategic control over key external forces through the reduction of resource dependence on other firms (to avoid being controlled) and increase the firm's power in a particular industry (in order to control the industry). Boundaries of competence maximise the value of a firm's resource portfolio through a dynamic matching of the resources with the environmental opportunities to gather, exploit and renew organisation-specific, resource-based advantages. Finally, boundaries of identity achieve a coherence between what the firm stands for (mission) and its activities, by shaping the *logic* behind managerial actions and the *ethics* that govern the behaviour of employees and managers. The implication of these boundaries for the input variables of DC is that a firm's quest to create DC may affect other firms and resources beyond those controlled internally by the firm's governance.

Third, existing research captures the influencing factors of DC. These include endogenous factors such as culture, leadership, firm-specific factors and managerial actions, and exogenous factors e.g., competitors, suppliers, customers, market influence or social, economic, regulatory, and legal factors (Martin, 2011; Moon, 2010; Sunder et al., 2019; Teece, 2007; Teece et al., 1997). Additionally, inter-related factors such as best practices, path-dependency lock-ins, strategic liabilities and firms' strength

and weakness sets have been captured as influencing factors of DC for firms. However, the current consideration of influencing factors on firms' DC defines such factors based on transaction-cost approach (benefiting directly from a relationship) to exchanges with other firms or actors. The reliance on a transaction-cost approach to define the influencing factors on DC limits the application of influencing factors to ecosystems. This is because in ecosystems a transaction-cost approach to exchanges limits the exchanges to profit (benefit-costs) motives alone at the micro level and leaves out other benefits such as relational benefits at the meso (e.g., triads) and macro (networks) levels (e.g., Chandler & Vargo, 2011; Jacobides, Knudsen & Augier, 2006).

Fourth, the desired outcome for DC for firms emphasises competitive advantage in both the short and long term (Teece 2007; Teece et al., 1997; Sunder et al., 2019). While competitive advantage underlies the very essence of markets for firms, such advantage is currently considered from firms' fixed perspective, rather than based on what firms offer. This leads to adversarial tactics and strategies with potential competitors, in terms of opportunity discovery and pursuit. In fact, if DC emphasises the meaningfulness and supportiveness of resource heterogeneity for competitive differentiation (Teece et al., 1997), then it makes sense to emphasise the advantages firms enjoy based on what they offer, rather than who they are. In an ecosystem, emphasising the advantages firms enjoy based on their offering may facilitate more alliances for collaborative, rather than competitive, advantages. For instance, Google specialises in software and operating system development, but their alliances with device producers or vendors as well as other software producers enable Google to focus more on the collaborative advantage to be enjoyed by making their systems and software more accessible even to those who may be considered competitors.

Finally, the DC framework emphasises resources accumulation, replicability, and inimitability as key measure for DC in a firm that has committed to developing DC (Martin, 2011; Teece et al., 1997; Sunder et al., 2019; Zollo & Winter, 2002). While these assessment measures provide a clear understanding of how new capabilities leverage existing ones and vice versa for transformation of capabilities by the firm, the quest for reliance on existing capabilities when developing new ones can

lead a firm into success traps thereby limiting the extent to which they open their existing internal competences to the rapidly changing external environment (e.g., Wang, Senaratne & Rafiq, 2015). These success traps often lead to missed opportunities in an environment which changes substantially or totally in the shortest possible time. For instance, Nokia spent so much resource and time in developing their Symbian operating system internally that they ignored other operating systems such as iOS and Android (by Apple and Google respectively). However, Nokia's environment changed so rapidly that their Symbian operating system became obsolete within a short period of time. EE offer the opportunity to exercise greater openness and alignment of internal capabilities within the changing external environment in order to remain competitive.

In summary, the DC framework resonates with a systems thinking perspective, and thus with a firm's orchestration of ecosystems with complementary assets in order to facilitate value co-creation and co-capture. In particular, the use of exploitation- and exploration-oriented network ties to co-create and co-capture value in an ecosystem may facilitate DC development for incumbent firms while enabling KIE firms to emerge and to thrive. However, existing research on the DC framework and its application to ecosystems offers a limited understanding of how exploitative- and explorative-oriented networks facilitate value co-creation and co-capture in ecosystems for DC development by existing firms, while enabling KIE firms to emerge and to thrive.

2.2. KIE firms and EE Development

KIE firms, as new and innovative firms, draw on the significant knowledge intensity in their activities when exploiting innovative opportunities in diverse evolving sectors and contexts through their embeddedness in innovation systems (Malerba & McKelvey, 2020). While KIE activities occur within and outside of high-tech or highly research-intensive sectors, examining KIE's close interaction with firm's environment or innovation systems remains fundamental for assessing and making specific generalisations about their activities (Gifford & McKelvey, 2019; Malerba & McKelvey, 2020). For instance, understanding how KIE firms can use their embeddedness in systems to access specific types

of resources during the pre-entry, the establishment and the post-entry phases in specific industries or sectors helps us to assess and generalise entrepreneurial ventures for KIE firms (Hermanson et al., 2018). Nonetheless, KIE firms must overcome the paradox of opening up for collaborative innovation while at the same time protecting their internal knowledge and intellectual assets, for greater appropriation of value from such innovations (Lassen et al., 2020).

In managing this paradox, Amankwah-Amoah and Adomako (2021) find contextual ambidexterity, which emphasises both exploration and exploitation activities of the firm: as a mediator of innovation (exploration) and knowledge integration (exploitation) for entrepreneurial ventures. However, such contextual ambidexterity ignores the embeddedness of KIE firms in systems. Considering the embeddedness of KIE firms in systems and the interdependence of actors in such systems in creating new value, EE has increasingly gained traction for understanding the emergence, growth, and context of KIE firms (Acs et al., 2017). According to Autio et al. (2018), EE differ from traditional clusters by their organisation around entrepreneurial opportunity discovery and pursuit through the exploitation of digital affordances for business model innovation, voluntary horizontal knowledge spillovers and cluster-external locus of entrepreneurial opportunities. Digital affordances enable KIE firms to participate as complementors on existing platforms, rather than serving as inputs for innovation with established firms (Nambisan et al., 2018). These affordances also facilitate EE development by KIE firms (Autio et al., 2018). Spigel and Harrison (2017) propose a process-based view for understanding, for instance, how KIE firms' participation on existing platforms for innovation with existing firms facilitates KIE firms' development of EE. Up to now existing research into such a process-based view of KIE interactions and its impact on EE development has been limited.

The EE literature offers different perspectives for understanding those characteristics of EE that could potentially help to establish the processes through which KIE firms participate on established platforms and emerge from ecosystems (Velt, Torkkeli & Laine, 2020). Among these perspectives, research on geographical location of EE elements emphasises regional development, clusters, and innovative milieus (Brown & Mason, 2017; Martínez-Fierro, Biedma-Ferrer & Ruiz-Navarro, 2019) and

largely overlooks the role of systems in explaining the prevalence and performance of entrepreneurship (Acs et al., 2017). However, the agency perspective of EE studies accounts for the role of systems in explaining the presence and performance of entrepreneurial actions, by emphasising both purposive and unintentional interventions by individual or collective actors and interdependent stakeholders, which influence EE emergence and development (Cunningham, Menter & Wirsching, 2019; Erina, Shatrevich & Gaile-Sarkane, 2017). Nonetheless, the agency perspective lacks an analytical framework concerning the causes and effects in such environments beyond focal actors (Alvedalena & Boschma, 2017).

Although the network perspective of EE outlines some causes of EE development by highlighting how networks at different levels of analysis impact the development of EE (Neumeyer & Santos, 2018; Nicotra, Romano, Del Giudice & Schillaci, 2018), the network perspective does not sufficiently demonstrate the ways in which networks are connected in EE for entrepreneurs and their firms (Alvedalena & Boschma, 2017). The context perspective of EE focuses on entrepreneurial innovation and distinguishes EE from clusters, districts and innovation systems based on the interplay between digital and spatial dimensions, with actors initiating and accelerating entrepreneurship, and human and financial actors influencing entrepreneurial activity (Autio et al., 2018; Brown, Mawson, Lee & Peterson, 2019; Spigel & Harrison, 2018; Velt et al., 2020). The context perspective establishes some connectivity in networks through actor initiation and acceleration, and influences of entrepreneurial activity in EE for KIE firms. However, the key challenge with the context perspective is to establish which institutions impact on the structure and performance of actors in EE (and at what spatial scale) (Alvedalena & Boschma, 2017).

The governance perspective of EE research appears to address the limitations of the context perspective by establishing that while institutions influence entrepreneurial action and rate positively in EE, knowledge spillovers fuel the ecosystem, with failure acceptable as part of entrepreneurial culture (Acs, Estrin, Mickiewicz & Szerb, 2018; Acs et al., 2017; Cumming, Werth & Zhang, 2019). Institutions influence EE through effective resource allocation in a confined space in order to exploit

innovations on a multisided digital platform, which requires an appropriate governance mechanism to regulate internal and external factors, facilitating entrepreneurial action. The governance perspective captures institutions and how they impact the structure and performance of actors in EE. However, there is a lack of a comparative and multiscale assessment measure for the structure and performance of EE. The complexity perspective emphasises entrepreneurship infrastructure for a symbiotic relationship between environment and new venture creation, in order to support ecosystem life cycle and mechanics, together with the measurement of emergence and formation of elements of EE for KIE firms (Auerswald & Dani, 2017; Liguori, Bendickson, Solomon & McDowell, 2019; Roundy, Bradshaw & Brockman, 2018). Despite providing some important assessment measures to measure the structure and performance of EE, the complexity perspective mostly employs static frameworks, such as perceptual measures, to take a snapshot of EE without considering the systematic evolution of EE over time for KIE.

In emphasising how EE elements, i.e. institutional arrangements and resource endowments, constrain or enable entrepreneurship in a particular territory, Stam & Van de Ven (2021) propose that EE elements are interdependent and co-evolutionary, while those elements have both upward and downward causation of entrepreneurial activity. 'Upward causation' emphasise how EE elements facilitate new value creation and ventures for KIE firms. 'Downward causation' is how new venture creation affects the established EE elements, such as institutional arrangements and resource endowments. Research remains limited on how the interdependence and co-evolution of EE elements facilitate upward and downward causation of entrepreneurial activity for KIE firms in their relationship with existing firms.

2.3. Service-centred View of Value Co-creation in Ecosystems

Value co-creation has been practised by firms since long before Vargo and Lusch's (2004) seminal article on what has now become known as the service-dominant (S-D) logic. Ever since Vargo and Lusch's article, however, value co-creation has gained traction in the literature of various disciplines including

marketing, management, strategy, and information systems (Vargo & Lusch, 2017). The understanding of value co-creation in the service-centred view offers some important implications for both existing firms' application of DC to ecosystems and EE development by KIE firms, as established above. The service-centred view emphasises five main building blocks or characteristics revolving around value co-creation in ecosystems (e.g., Vargo & Lusch, 2008; 2011; 2016; 2017).

First, the service-centred view argues that value co-creation occurs between actors, including economic and social actors, who have no fixed identity in ecosystems (Appiah et al, 2021; Breidbach & Maglio, 2016; Ekman et al., 2016). From the actor perspective, a firm can engage in exchanges with any other firm with the intention of co-creating value; the exchanges need not be limited to value chain positions (suppliers, customers, and competitors, among others). The actor perspective of exchanges in value co-creation enables firms, especially incumbents, to overcome the limitations of the DC framework in ecosystems which result from pursuing competitive advantage with adversarial strategies or tactics instead of pursuing collaborative advantages with alliance strategies or tactics. While the lack of a defined identity for an actor in an exchange relationship makes it challenging to define the scope and parameters of benefits to be derived from the exchange, the adoption of relationship management dynamics with specific actors, such as a KIE firm, can regulate the parameters of the exchange in order to distinguish between the roles required in such exchanges.

Second, the service-centred view of value co-creation in ecosystems considers resource integration as the basis for actor exchanges in ecosystems (Vargo & Lusch, 2008; 2011). Such resource integration facilitates interactions between emerging and already established resources (Peters, 2016; Peters, Löbner, Brodie et al., 2014). Resource integration as the basis of actor exchanges enables a firm to overcome the limitations of DC development in an ecosystem based on the assumption that VRIN, rather than non-VRIN, resources facilitate competitive differentiation. From this perspective, the ability of a firm to integrate resources, both VRIN and non-VRIN, may facilitate exchanges between the firm and other firms, such as KIE firms, for capabilities development and renewal in ecosystems. However,

since such resources may be heterogeneously distributed in ecosystems, existing firms must develop resource integration capabilities which facilitate both mobility and complementarity of such resources.

Third, the service-centred view of value co-creation considers service, rather than tangible goods or assets, as the unit of exchange between actors in ecosystems (Vargo & Lusch, 2008). With service as a unit of exchange, resources act as distributing mechanisms of service. Service as a unit of exchange helps to overcome the limitations of DC in ecosystems because of the transaction-cost approach underlying the endogenous, exogenous and inter-related factors which influence DC (e.g., *Sunders et al., 2019*). From a service-for-service exchange perspective, a firm's exchanges may transcend transaction-cost orientation in the value chain where they are active, enhancing both complementarity and mobility in parts of the value chain where they are not active with innovation for industry architectures (e.g., *Jacobides et al., 2006*). This ensures that firms can co-create value with internal resources, such as the provision of complementary assets, and can co-capture value with and from external resources, e.g., the relationships generated by the complementary asset. Accordingly, service-for-service exchange requires firms to manage exchange processes based on encounters, interactions, and engagement on complementary assets, which serve as platforms for building relationships with other firms. Additionally, the firm must develop capabilities to manage orientations of exchange beyond those regulated by transaction-cost mechanisms.

Fourth, the service-centred view considers institutions and institutional arrangements as the enabling and constraining mechanisms of service-for-service exchange between actors engaged in resource integration in ecosystems (Vargo & Lusch, 2016; 2017). While institutions involve rules, norms and beliefs which give meaning and some predictability to exchange activities, institutional arrangements involve the inter-relationships between those rules, norms, and beliefs among actors in value co-creation. Thus, institutions give meaning to an exchange action, but institutional arrangements facilitate the meaning of an exchange action among other exchange actions in value co-creation. Institutions and institutional arrangements as enablers and constrainers of service-for-service exchange help to overcome the limitation of DC in ecosystems which consider input variables for DC from an

internal boundaries' perspective, including firms' boundaries arising from boundaries of efficiency, power, competence and identity (Santos & Eisenhardt, 2005). From this perspective, existing firms must develop different exchange orientations in order to manage exchanges instantiated by a firm's boundaries with other firms, such as KIE firms.

Finally, the service-centred view of value co-creation in ecosystems considers the establishment of nested and interlocking ecosystems to endogenously generate institutions and institutional arrangements which enable or constrain service-for-service exchange (Vargo & Lusch, 2016; 2017). Such established ecosystems include dyads, triads, simple and complex networks nested and interlocked in relationships in ecosystems (Chandler & Vargo, 2011; Vargo & Lusch, 2016; 2017). An ecosystem is defined as a "relatively self-contained, self-adjusting system of resource-integrating actors connected by shared institutional arrangements and mutual value creation through service exchange" (Vargo & Lusch, 2016, p. 161). Establishing nested and interlocking service ecosystems helps to overcome the limitations of the DC framework which emphasises exploitation of internal competencies, instead of exploration of competencies within and outside the internal confines of the firm as a governing mechanism (Wang et al., 2015). This might include the existing firm's platform-based ecosystem interlocked with that of a KIE firm's endogenous EE. Nested and interlocking ecosystems require existing firms to develop DEC to co-create and co-capture value with actors such as KIE firms for DC development, whilst enabling such KIE firms to emerge and thrive.

3. Building Dynamic Exchange Capabilities for Value Co-creation in Ecosystems

Exchange capabilities enable firms to renew existing resources and capabilities by facilitating an open flow of competencies between a firm's internal and external environments. The DC framework explains this renewal of firm resources through dynamic processes, positions and paths which facilitate resource accumulation, replicability, and inimitability for sustained competitive advantage (Teece, 2007; Teece et al., 1997). The DC framework overcomes the limitations of the RBV of the firm, which assumes that the firm, as a bundle of resources, breaks down in high-velocity markets. The RBV

emphasises VRIN, rather than non-VRIN, resources for a firm's competitive advantage (Barney, 1991; Conner, 1991; Schulze, 1992). Although both the DC framework and the RBV consider VRIN resources as the basis for competitive advantage, RBV considers resources as fungible over time whereas DC considers dynamic and irreplaceable resources accumulated within the firm across time.

The assumption of DC is that fungibility of resources in RBV does not sustain firm performance: under the DC framework resource accumulation, replicability and inimitability sustain firm performance (Teece et al., 1997). However, this is not always the case in practice. For instance, in the case of Nokia and their Symbian operating system development, they emphasised resource accumulation, replicability and inimitability under the DC framework, but their environment changed rapidly to undo almost all the inimitable resources accumulated over time. Therefore, although DC is important for sustained firm performance, DC depends on how firms open-up both their internal resources to other firms and their resources in the external environment, by developing exchange capabilities to facilitate resource fungibility as well as accumulation, replicability, and inimitability over time.

Grant (1996) distinguishes these resources, including capabilities, into tangible, intangible and human-based resources. Tangible resources involve physical assets such as equipment, machinery, buildings, and financial capital, whereas intangible resources involve invisible assets including brand image, goodwill, and product quality. Human-based resources involve knowledge assets such as technical know-how, employee expertise and skillsets, and organisational culture. Among these three categories of resources, knowledge asset plays a central role in identifying and integrating all the resources in an effective manner for firm performance (Hedlund & Nonaka, 1993; Lin & Wu, 2014). Indeed, research shows that firm performance is affected by building internal knowledge management infrastructure for knowledge acquisition, conversion, application, and protection (Gold, Malhotra & Segars, 2001; Nguyen, Ngo, Northey & Siaw, 2018).

While internal infrastructure and knowledge management processes remain important for DC development, they limit DC development only to the internal boundaries of the firm as a governance

mechanism. From a firm's boundaries perspective, knowledge management for DC development may occur within the firm's boundaries of efficiency, power, competence, and identity (e.g., Santos and Eisenhardt 2005). With 'boundaries of efficiency', the benefits of knowledge management arise from a firm's value chain exchanges facilitated by transaction cost mechanisms. However, 'boundaries of power' refers to knowledge management from exchanges involving strategic relationships in order to reduce a firm's resource dependence and increase its autonomy. 'Boundaries of competence' denotes the importance of knowledge management in exchanges which match internal resources and capabilities to the ever-changing external environment. Finally, 'boundaries of identity' signifies the benefits of knowledge management in exchanges which align a firm's activities to its legally and morally defined identity as a business.

The implication of firms' boundaries for knowledge management is that firms must adopt a service-centred view, in which both competitive and collaborative exchanges facilitate value co-creation for firms in ecosystems (Vargo & Lusch, 2016; 2017). The service-centred view captures knowledge-based resources, termed 'operant resources', as the fundamental source of strategic benefit in ecosystems. These strategic benefits include those based on a firm's competitive differentiation from and competitive association with firms in the ecosystem. Such benefits require firms to develop capabilities for more open exchanges on the platforms, which enable value co-creation in the ecosystem and yet offer competitive differentiation from other firms in the ecosystem (e.g., Ceccagnoli et al., 2012; Faridian & Neubaum, 2021). Thomas, Autio & Gann (2014) identify four typologies of platforms as a) a set of organisational capabilities enabling superior performance, b) the stable centre used for a family of products, c) an intermediary between two or more market participants and d) a system or architecture that supports a collection of complementary technology assets. In this context, an 'exchange platform' in an ecosystem is defined as an intermediary between two or more market participants, which enables encounters, interaction, and engagement between at least two actors in an ecosystem. Such an intermediary can be tangible or intangible resources and capabilities – the most

important thing is not the specific resource or capability of the platform, but its ability to facilitate exchange processes between at least two actors in an ecosystem.

The exchange processes for which knowledge management in ecosystem is required can be conceptualised in three main dimensions: capabilities in exchange platform encounters, interaction, and engagement (Gronroos, 2011; Marcos-Cuevas, Nätti, Palo & Baumann, 2016; Payne, Storbacka & Frow, 2008). 'Exchange platform encounters' involve the contact points established on the same platform between at least two actors in the ecosystem (Payne et al., 2008). These contact points can be based on either contractual agreements such as transactions, subscription, adoption and sign-ups, or access to the platform in a way that establishes connectivity between two or more actors in the ecosystem. 'Exchange platform interaction' refers to the way in which two or more actors influence each other's actions, in a discrete manner beyond the connectivity established by the exchange platform encounter in the ecosystem (e.g., Grönroos, 2011). For instance, interactions can be measured by activities which succeed contractual agreements or by access to exchange platforms through mutuality of actions by the actors involved. 'Exchange platform engagement' denotes the sustained participation by at least two actors in the activities of the platform over an extended period with a more purposeful intent (e.g., Marcos-Cuevas et al., 2016). This may involve a broader economic and social element, the creation of longer-term converging goals and a complex social and economic interdependence. Accordingly, 'exchange process capabilities' involve a firm's ability to *establish connectivity with other actors* on an ecosystem platform (encounters), *facilitate mutuality of actions between the firm and other actors* on the platform (interactions), and *drive sustained participation in the activities* on the platform by actors on the platform (engagement).

Within the context of the above conceptualisation, the service-centred view makes it abundantly clear that actors involved in value co-creation in ecosystems assume several roles simultaneously and may perceive multiple forms of exchanges on the same exchange platform (Breidbach & Maglio, 2016; Ekman et al., 2016). Hence, the development of exchange process capabilities for strategic benefits in an ecosystem may involve different exchange orientations which

may emphasise competitive differentiation as well as competitive association of the firm's value creation activities in the ecosystem. Such exchange orientations may include a) innovation development and support, b) innovation licensing and commercialisation, c) market position management and d) ties and boundaries structures (Faridian & Neubaum, 2021).

'Innovation development and support' encompasses the exchanges in which firms allocate shared portfolios of financial assets to R&D and related activities, in order to explore and exploit innovative capabilities in ecosystems. Innovation development and support may facilitate exploration of *variability and novelty* in innovation capabilities, or exploitation of innovation capabilities through *incubation* of innovative new ventures; it supports *improving reliability and quality* of innovations for product optimisation. Thus, 'innovation development and support exchange orientation' involves innovation capabilities exploration and exploitation in ecosystems.

'Innovation licensing and commercialisation' indicates the exchanges through which firms in ecosystems explore and/or exploit the maximum economic potential of innovations through access to a generic complementary asset or resource. From an innovation licensing and commercialisation perspective, a firm can 'license out' its internal innovation to other actors in the ecosystem in order to unlock or enhance the economic potential of such innovation, while 'licensing in' the innovation of other actors in the ecosystem in order to minimise the cost of developing such innovations internally (e.g., Chesbrough, 2007). Thus, 'innovation licensing and commercialisation exchange orientation' focuses on the exploration and exploitation of the economic optimisation capabilities of innovations in ecosystems.

'Market position management' involves the exchanges in which a firm explores and/or exploits both competitive and collaborative capabilities in the same relationship, in order to establish or maintain market dominance. Market position management enables a firm to share resources in a network characterised by both competition and collaboration i.e., 'co-opetition', for rapid renewal of innovation and to strengthen market position. This enables a firm to manage exchanges such that competition is not based on reputation, neither is collaboration based on the value chain position of

firms in a network. Rather, competition and collaboration arise based on resources offered by members in the network. Thus, 'market position exchange orientation' focuses on exploring and exploiting *competition* capabilities to establish or maintain a market position.

'Ties and boundary structures' signifies the exchanges in which a firm explores and/or exploits capabilities in formal and informal relationships for value co-creation and co-capture. Such exchanges are important for leveraging value chain relationships through both vertical and horizontal exchanges, enabling the firm to co-create and co-capture value in multi-actor networks. Thus, 'ties and boundary structures exchange orientation' refers to the exploration and exploitation of *relationship formalisation* capabilities for value co-creation in ecosystems.

Nonetheless, irrespective of whether an existing firm or a KIE firm is engaging in the above exchange orientations for either DC development in ecosystems or EE development respectively, ambidexterity plays a major role (Amankwaah-Amoah & Adomako, 2021; Faridian & Neubaum, 2021). Ambidexterity enables both exploration and exploitation of resources and networks so that firms can maintain a reasonable balance between existing and new resources, as well as existing and new networks. Ambidexterity thus facilitates upward causation as well as downward causation of dynamic exchanges. 'Upward causation' involves the combination of existing resources and networks to create new resources and networks, whereas 'downward causation' signifies how new resources and networks enhance existing resources and network configurations (Stam & Van de Ven, 2021).

Accordingly, DEC in ecosystems involves exchange process capabilities – capabilities to establish encounters with actors on the same platform (connectivity), facilitate interactions with actors (mutuality of actions) and drive engagement of the actors on the platform over an extended period (sustained participation). However, these three dimensions of exchange process capabilities apply to exchange orientations such as innovation development, innovation licensing and commercialisation, market position management, and ties and boundary structures. Such exchange orientations for actors may involve upward causation (from ties and boundary structures to innovation development) or downward causation (from innovation development to ties and boundary structures). Figure 1 below

illustrates the conceptual framework for the dynamic exchange capabilities, its antecedents and outcomes.

Insert Figure 1 About Here

3.1. Antecedent Dynamic Exchange Capabilities for Value Co-creation in Ecosystems

3.1.1. Relationship building capabilities in the ecosystem: ‘Relationship building capabilities’ refers to a firm’s ability to build a portfolio of dyadic, triadic, simple network and multi-actor network relationships across sectors, which are nested and interlocked with one another for value co-creation on a platform-based ecosystem (Corsaro, Ramos, Henneberg & Peter Naudé, 2012; Enz & Lambert, 2012; Vargo & Lusch, 2017). The DC framework highlights the role of networks in building DC (Capaldo, 2007; Dyer & Nobeoka, 2000; Wu, 2010). In ecosystems, established firms may develop DC through ambidexterity in exploration of new network ties and exploitation of existing network ties for intrapreneurial capabilities development (Faridian & Neubam, 2021). However, since networks at different levels of development affect overall EE development (Neumeyer & Santos, 2018; Nicotra et al., 2018), KIE firms need ambidexterity strategies to address the paradox of openness to innovation versus protection of internal knowledge and intellectual assets (Amankwah-Amoah & Adomako, 2021; Lassen et al., 2020). While ambidexterity is important for both established and KIE firms in ecosystems, DC ecosystems and EE research limit such ambidexterity as a result of defined and static identities of firms from either the sector or value chain positions.

The service-centred view of exchange for value co-creation, argues that a firm’s exchanges in ecosystems involve generic actor roles enabling fluid transition between specific identities such as supplier, customer, partner and competitor (Breidbach & Maglio, 2016; Ekman et al., 2016). Such generic actor roles require firms to develop exchange capabilities beyond dyadic relationships in order to respond effectively to several other relationships which are jointly connected (Ekman et al., 2016). Therefore a firm’s participation in value co-creation may motivate the firm to build relationships such

as dyads, triads, simple networks and multi-actor networks, which are nested and interlocked with one another in the ecosystem (Corsaro et al., 2012; Enz & Lambert, 2012; Vargo & Lusch, 2017).

For existing firms developing DC ecosystems, building nested and interlocking relationships with firms from diverse sectors facilitates greater space of exchanges (Reypens et al., 2016), exploitation of the indirect effect of such exchanges (Han et al., 2012) and recognition and leveraging opportunities for value co-creation in an ecosystem (Faridian & Neuubaum, 2021). However, KIE firms' embeddedness in innovation systems enables them to draw on diverse relationships from across sectors (Malerba & McKelvey, 2020) in order to access specific types of resources across various phases of their development (Hermanson et al., 2018). The capability to draw on diverse relationships may affect exchanges in ecosystems between incumbents and KIE firms across time.

Nonetheless, from a service-centred view of value co-creation in ecosystems, a firm's ability to configure multi-actor networks and occupy a key position in those networks enables the firm to easily integrate resources, facilitating value co-creation with and for the actors in those networks (e.g., Corsaro et al., 2012; Lempinen & Rajala, 2014; Storbacka & Nenonen, 2011). Established and KIE firms may come into exchange with different network backgrounds and may occupy a central or key position in their networks, which may affect their exchanges. Such a position makes the firm's role an entrepreneurial activity in the ecosystem, with the firm acting as an interface for opportunity identification and business competence development with the aim of harnessing these opportunities (Kasouf, Darroch, Hultman & Miles, 2008) in the ecosystem (Acs, Stam, Audretsch & O'Connor, 2017). As a focal actor, the firm coordinates various other actors from individual firms and, by exchanging micro-specialised resources within a network, gets a lower cost than could be achieved individually on the market (Corsaro et al., 2012; Vargo & Lusch, 2008). For incumbent firms, the key position facilitates exchanges both as a platform leader (Helfat & Raubitschek, 2018) and as a participant in value co-creation and co-capture with other firms including KIE firms (Faridian & Neubaum, 2021). However, for KIE firms, the key position facilitates exchange as a knowledge intensive firm that exploits innovative opportunities in diverse evolving sectors (Malerba & McKelvey, 2020; Nambisan et al., 2018). Thus, centrality of existing

and KIE firms in configured networks within ecosystems leads to different exchange orientations between the firms in a specific context.

Furthermore, from the service-centred view, the ability of a firm to link one exchange orientation with another helps it to respond rapidly and effectively to the changes in the demands of value co-creation (Enz & Lambert, 2012). Sunder and Ganesh (2020) argue that firms, either incumbent or KIE firms, are complex systems made up of multiple combinations of capabilities and inter-relationships, whose effects cannot be attributed to a single relationship or capability in isolation. While some exchanges may require multi-functional teams (Aarikka-Stenroos & Jaakkola, 2012; Enz & Lambert, 2012), others may require uni-functional teams to co-create value (Kohtamäki, Partanen, Parida & Wincent, 2013; Salomonson, Åberg & Allwood, 2012). Accordingly, it is important for an established or KIE firm, in its relationship building for value co-creation in ecosystems, to effectively align different exchange orientations in order to minimise the economic cost involved in exposing its internal capabilities to the external environment. Such alignment of exchanges, emphasising compatibility in a relationship with KIE firms, is important for incumbent firms to achieve economies of scale (Faridian & Neubaum, 2021). However, the alignment is important for KIE firms in order to minimise resource slack in exchanges (Amankwah-Amoah & Adomako, 2021). Therefore, relationship compatibility between established and KIE firms may lead to minimal internal costs involved in different exchange orientations.

Finally, while effective alignment of exchange orientations may broadly facilitate minimisation of costs in exchanges, exchanges between incumbent and KIE firms in ecosystems may have differing levels of intensity. The intensity of a relationship denotes the degree of commitment and direction of change in commitment over a given period (e.g., Palmatier, Houston, Dant & Grewal, 2013). Such intensity requires trust, inclusiveness, and openness, to build a relationship which facilitates experimentation and enhancement of market positions (Pera et al., 2016). In value co-creation, research has shown that a more intensive relationship facilitates maximisation of exchanges within such relationships (Marcos-Cuevas et al., 2016).

While intensity of relationship may facilitate maximisation of exchanges, relationship building capabilities between incumbent and KIE firms may lead to upward dynamic exchange for incumbent firms and downward dynamic exchange for KIE firms. This is because the established platforms of incumbent firms facilitate capabilities of building relationships in order to profit from innovations as a platform leader (Faridian & Neubaum, 2021; Helfat & Raubitschek, 2018). However, KIE firms' significant knowledge intensity and innovativeness in diverse sectors lead to relationship building capabilities of accessing different types of resources at the pre-entry, the establishment, and the post-entry phases of markets in specific sectors (Hermanson et al., 2018). Hence, we propose as follows:

P1a) For firms engaged in value co-creation in ecosystems, relationship building capabilities facilitate different exchange orientations i) differently across contexts ii) simultaneously within contexts, iii) to minimise the cost involved in exchanges, and iv) to maximise the benefits in exchanges.

P1b) Between existing and KIE firms, relationship building capabilities will facilitate downward dynamic exchanges for KIE firms and upward dynamic exchanges for existing firms.

3.1.2 Resource integration capabilities: 'Resource integration capabilities' refers to the ability of the firm to identify, source, match and transform the potentially relevant tangible and intangible resources for value co-creation in ecosystems (e.g., Peters, 2016; Teece et al., 1997; Vargo & Lusch, 2008). Within the DC framework, resource availability is a pre-requisite for the existence or development of DC (Teece, 2007; Lin & Wu, 2014). Existing firms seeking to orchestrate DC ecosystems as platform leaders may offer such resources as complementary assets (Helfat & Raubitschek, 2018) in order to facilitate value co-creation and co-capture in inter-organisational relationships for the development of intrapreneurial capabilities (Faridian & Neubaum, 2021). Such complementary assets and value co-creation are what enable resource accumulation, replicability and inimitability (Teece et al., 1997). However, KIE firms display a significant intensity in knowledge asset integration, which enables ambidexterity in KIE firms (Amankwah-Amoah & Adomako, 2021) to facilitate EE development as agents or stakeholders (Cunningham et al., 2019; Erina et al., 2017). Thus, both existing and KIE firms engage in exchanges as

a result of resource integration. However, both DC ecosystems and EE emphasise resource integration, by assuming that resources are inherently defined irrespective of how those resources create value.

The service-centred view of resource integration argues that resources are not inherently defined; rather, they come to be defined through their interaction with other resources in systems (e.g., Vargo & Lusch, 2011). In this regard, the 'resourceness' of resources, based on their integration, has been classified as emergent or summative in nature (Peters, 2016; Peters, Löbler, Brodie et al., 2014). Emergent resource integration refers to "the process of constituting a new entity with its own particular characteristics (i.e., structures, qualities, capacities, textures, mechanisms) through the interactive combination of other, different entities that are necessary to create the new entity, but that do not contain the characteristics present in the new entity" (Smith, 2010, p. 26). However, summative resource integration means that the specific set of interactions occurring between actors and potential resources during the integration process enables potential resources, such as specific things, persons, machines, money, institutions, or concepts, to acquire resource status (Peters, 2016; Peters, Löbler, Brodie et al., 2014).

Emergent and summative resource integration brings into sharp focus the understanding of resource integration capabilities for complementarity and mobility of resources (Jacobides et al., 2006). While resource integration capabilities in complementary resources enhance the economic potentials of those resources over a protracted period, integration capabilities in mobile resources unlock the economic potentials of those mobile resources within a short period of time. Therefore, it is important for firms to develop resource integration capabilities which emphasise the appropriate mix of complementary and mobile resources such that current and future needs of the firm can be addressed through DEC development. Such a mix of resources may involve high/low complementarity and mobility of resources (Jacobides et al., 2006).

First, a firm's capability to integrate resources which are high in mobility but low in complementarity will enable the firm to benefit from exchange of fungible assets and resources in the ecosystem. Considering that these assets are highly mobile and less complementary, they become easily

transferable across different actors within an ecosystem for value co-creation. Although the high mobility of the resources makes them more fungible and therefore liquid, this mobility also predisposes these resources to replication and imitation. For existing firms, integration capabilities in fungible resource facilitate the allocation of funds to support innovation activities of KIE firms (Faridian & Neubaum, 2021). Within KIE firms, fungible resource integration capabilities involve capabilities to attract relevant investments through initial public offerings to scale-up their innovations (e.g., Ceccagnoli, et al., 2012). Thus, integration capabilities in fungible resources facilitate different exchange orientations between existing and KIE firms across time.

Second, a firm's capability to integrate resources with high mobility and high complementarity enables the firm to facilitate strategic resource dependencies for the benefits of a more effective outcome of fungible resources (including know-how, processes, and solutions) for actors in the ecosystem (e.g., Biggemann et al., 2013; Storbacka, 2011). While the high mobility of these resources makes them easily transferable, the high complementarity of such resources requires the resources to interact simultaneously for value co-creation in ecosystems. Integration capabilities in strategic resource dependencies enable a firm to enhance both complementarity and mobility in parts of the value chain where they are not active, so they can benefit from both fungible and inimitable knowledge resources (Jacobides et al., 2006). For instance, the existing firm Intel benefits from selling chips to firms providing IT devices and services, as well as selling knowledge resources arising from the use of the IT devices and services, meaning that Intel can respond simultaneously to the demands of different actors thanks to the mobility and complementarity of Intel's chip. However, for KIE firms, strategic resource dependencies enable them to access mobile resources at the initial stages of entry into a given sector through licences to integrate those complementary resources into their activities during establishment or post-entry (Hermanson et al., 2018). Thus, integration capabilities in strategic resource dependencies may facilitate different exchange orientations between incumbent and KIE firms in specific contexts.

A firm's capabilities to integrate resources with low mobility but high complementarity enable the firm to facilitate the dependencies in co-specialised resources for the purpose of minimising the cost

involved in the dependencies between internal and external resources for the ecosystem. Typically, this resource integration capability facilitates licensing, franchising, partnering or outsourcing arrangements, which unlock or enhance the economic potentials of such resources, both internally and externally (Chesbrough, 2007; Santos & Eisenhardt, 2005). Considering that specialised resources are less mobile but highly complementary, firms commit them to exchanges which facilitate effective alignment of these specialised resources for greater multipliability of the resources in the ecosystem (e.g., Maiti, Krakovich, Shams & Vukovic, 2020). For existing firms, integration capabilities in co-specialised resource involves market assets or reputational assets which enable a firm to align internal resources with external resources for exchanges making the retention of internal resources cheaper than buying in external resources (Chesbrough, 2007; Faridian & Neubaum, 2021). However, for KIE firms, integration capabilities in co-specialised resources facilitate the protection of knowledge and intellectual assets while opening up for collaborative innovation in order to enhance their internal knowledge resources (Lassen et al., 2020). Thus, integration capabilities in co-specialised resources will lead to different exchange orientations between existing and KIE firms in order to minimise internal cost.

Finally, a firm's capabilities to integrate resources with low mobility and low complementarity enable the firm to facilitate bilateral dependencies between resources whose benefits emanate from a conscious effort to unlock or enhance the economic potentials of those resources in ecosystems (e.g., Jacobides et al., 2006). Considering that these resources have low mobility and complementarity, they represent the core competencies which are extremely difficult to imitate, unless the actors with the capabilities open up these resources to opposite resources for a conscious development of those resources in the ecosystem. Therefore, for both existing and KIE firms, bilateral resource dependencies require a conscious effort to develop these resources in exchanges involving trusted and committed parties. Bilateral resource dependencies may drive exchanges based on formal agreements in order to ensure maximisation of the potentials of such resource dependencies between existing and KIE firms (Faridian & Neubaum, 2021).

Nonetheless, resource integration capabilities for exchanges between existing and KIE firms could lead to a downward dynamic exchange for existing firms and an upward dynamic exchange for KIE firms. This is because, while existing firms integrate resources for exchanges with KIE firms in order to increase their intrapreneurial capabilities internally, KIE firms integrate resources to facilitate exchanges with existing firms with the aim of scaling-up their innovations and accessing market opportunities (Faridian & Neubaum, 2021; Lassen et al., 2020). Accordingly, we propose as follows:

P2a) For firms engaged in value co-creation in ecosystems, resource integration capabilities will affect their ability to facilitate different exchange orientations i) differently across contexts ii) simultaneously within contexts, iii) to minimise the cost involved in the exchanges and iv) to maximise the benefits in exchanges.

P2b) However between incumbent and KIE firms, resource integration capabilities will facilitate upward dynamic exchanges for KIE firms and downward dynamic exchanges for incumbent firms.

3.2. Outcomes of dynamic exchange capabilities in ecosystems

Research on DC development in ecosystems by existing firms argues that platform-based ecosystems facilitate exploitation of knowledge spillovers (Han et al., 2012), sustained competitive advantage (Sunder & Ganesh, 2020), profit from innovation (Helfat & Raubitschek, 2018) and intrapreneurial capabilities development (Faridian & Neubaum, 2021). However, for KIE firms, participation in or development of EE facilitates new market entry (Susan & Acs, 2017), business model innovation, exploitation of voluntary horizontal knowledge spillovers and exploration of cluster-external locus of entrepreneurial opportunities (Amankwah-Amoah & Adomako, 2021; Autio et al., 2018). While both DC ecosystems and EE emphasise internal outcomes of participation or development of exchanges by firms in ecosystems, the service-centred view emphasises a systemic perspective for the outcome value co-creation (Marcos-Cuevas et al., 2016; Reypens et al., 2016). From a systemic perspective, participation, or development of exchanges in ecosystems may facilitate both upward and downward outcomes (Stam & Van de Ven, 2021), which may in turn affect the firm's internal resources and

capabilities, as well as its relationship with other firms in the networks involved in such exchanges for value co-creation in ecosystems (Jacobides et al., 2006; Santos & Eisenhardt, 2005).

With an upward outcome in exchanges between existing and KIE firms, either side benefits from new capabilities which were not present prior to the exchanges between the two. Such benefits from new capabilities involve innovations, proprietary rights to innovations, market leadership and dominance, and firm boundary expansion (Faridian & Neubaum, 2021). With innovation, existing and KIE firms can benefit from incremental to radical innovations as a result of the exchanges between the extant resources of the existing firm and the significant knowledge intensity and innovativeness of KIE firms. Proprietary rights to innovation involve the benefits that existing and KIE firms derive from exchanges with each other as a result of access to resources which are protected by intellectual property rights. Market leadership and dominance arise from the mutual benefits derived by existing and KIE firms, consolidating their market position or expanding to new markets as a result of the complementarity between the resources of both. With firm boundary expansion as an outcome of upward exchange between existing and KIE firms, both firms benefit from exchanges between each other, by expanding their network boundaries because of their dynamic exchange relationship. Accordingly, we propose that:

P3: An upward dynamic exchange between existing and KIE firms in ecosystems will lead to a) innovation benefits, b) rights to proprietary innovations, c) market segment leadership and dominance, and d) boundary expansion for both existing and KIE firms.

However, with a downward outcome in exchanges between existing and KIE firms, either side benefits from enhanced capabilities as a result of the feedback or integration of new capabilities into the existing capabilities prior to the exchanges (Faridian & Neubaum, 2021; Stam & Van de Ven, 2021). These outcomes essentially affect the firm's participation in a particular value chain or industry architecture (Gunasekaran, Lai & Cheng, 2008; Jacobides et al., 2006), and thus affect the firm's boundaries of efficiency, competence, identity, and power in ecosystems (Santos & Eisenhardt, 2005). Regarding boundaries of efficiency, existing and KIE firms may benefit from minimal resource slack

and obsolescence because of the exchange mechanisms enabling dynamic flow of both mobile and complementary resources between the parties. Boundaries of competence also facilitate growth in the resource disposition of both existing and KIE firms because of the alignment of their resources to different exchange orientations in order to maximise the potentials of those resources in ecosystems. Regarding the boundaries of identity, existing and KIE firms can derive benefits of identity synchronisation in ecosystems as a result of the structure of the exchanges between the parties in ways that are consistent with what the firm stands for (mission). In addition, boundaries of power facilitate the benefit of achieving autonomy by either party in the ecosystem, in order to maximise strategic control of critical strategic resources and to occupy a position of influence for co-ordinating exchanges in the ecosystem. Hence, we propose that:

P4: A downward dynamic exchange between existing and KIE firms will lead to a) minimisation of resource slack and obsolescence, b) maximisation of resource potentials, c) firm identity synchronisation, and d) increased co-ordination of relational exchanges for either party in the ecosystem.

4. Discussions and Future Research

4.1. Theoretical Implications

The propositions and conceptual framework in this paper demonstrate how dynamic exchange capabilities can facilitate mutually beneficial exchanges between firms involved in value co-creation and co-capture in ecosystems. The conceptual framework draws on the DC framework (Teece, 2007; Teece et al., 1997) and its application to innovation ecosystems (Faridian & Neubaum, 2021; Helfat & Raubitschek, 2018), as well as the service-centred view of multi-actor value co-creation in service ecosystems (Vargo & Lusch, 2011; 2016; 2017), to highlight the underlying dynamism of mutually beneficial exchanges between firms involved in value co-creation and co-capture in interlocking ecosystems. The framework was explained using the exchanges between incumbent and KIE firms as a context to exemplify the processes through which incumbent firms develop DC while enabling KIE firms to emerge. In this vein, the framework offers several important theoretical implications for DC

development, knowledge resource management and ecosystem sustenance or reconfiguration by existing firms.

4.1.1. DC ecosystems for resource development: First, by establishing resource integration capabilities as a determinant of DEC, the framework offers an important theoretical implication for the RBV of the firm, by highlighting the need to integrate both VRIN and non-VRIN resources for competitive differentiation. It is well-established that VRIN, rather than non-VRIN, resources offer short term competitive advantage (Barney, 1991; Schulze, 1992) and mediate DC to improve firm performance (Lin & Wu, 2014). However, our framework suggests that by developing resource integration capabilities, non-VRIN resources of an existing firm can be combined with VRIN resources of other actors, such as KIE firms in ecosystems, to facilitate exchanges which can improve the existing firm's performance.

In addition, the DEC framework emphasises relationship building capabilities as an important antecedent enabling a firm's relationships, such as dyads, triads, simple and complex networks nested and interlocked with one another in ecosystems, to serve as input variables for DC development. The literature on DC makes it abundantly clear that while relationships and networks are important input variables for DC development, different relationships serve different purposes (Capaldo, 2007; Dyer & Nobeoka, 2000; Wu, 2010). Moreover, relationship building capabilities as an antecedent to DEC means that the same relationship can serve different purposes. Thus, a competitor can become a strategic partner for different exchange arrangements. In this regard, DEC theory expands the understanding of input variables for DC with the view that a relationship between the same actors or firms in an ecosystem can serve as an input for different exchanges between those actors and can lead to different outcomes for the actors at different times.

Furthermore, although the DC framework establishes various endogenous (internal to firm), exogenous (external to firm) and inter-related (cutting across internal and external environments) factors that may either constrain or enable a firm to create and capture value, these factors have been considered from a closed business model perspective (Martin, 2011; Moon, 2010; Sunder et al., 2019;

Teece, 2007; Teece et al., 1997). This impedes minimisation of obsolete or unused internal capabilities and maximisation of new external capabilities. The DEC framework emphasises exchange processes such as encounters, interactions and engagement as strategic actions enabling a firm to co-create and co-capture value with other actors in platform-based ecosystems. Thus, the enabling or constraining elements of DC development transcend boundaries created by transaction cost mechanisms, to include the firm's boundaries of efficiency, power, competence, and identity as influencers of DC development. This requires firms to adopt a more open business model (Chesbrough, 2007) to DC development in order to maximise the advantages in the firm's changing environment while minimising the risk of falling into success traps based on internal capabilities (Wang et al., 2015).

Nonetheless, the DC framework makes it abundantly clear that DC development facilitates sustained competitive advantage (Teece, 2007; Teece et al., 1997). While this perspective is important in highlighting competitive differentiation in the market, it leads to the reliance on less collaborative strategies, which have the potential to limit the openness of the firm's internal capabilities to the changing environment. The DEC framework, however, requires firms to build capabilities in exchange management such that both competitive differentiation and association may be facilitated for the firm in its exchanges with the same actor or firm in ecosystems, depending on the orientation of the exchange. This approach enables firms to identify areas of DC development in which they can differentiate themselves from their partners in networks, while identifying areas in which they can collaborate with their competitors in the market.

Lastly, existing research on the measures for DC development emphasises the development of capabilities internally but in relationship to other firms in the industry (e.g., Martin, 2011; Sunder et al., 2019; Teece, 2007; Zollo & Winter, 2002). Such internal measures or even external benchmarking of capabilities focuses on areas of DC where the firm is currently performing better compared to its own or other actors' previous performance. As a result, it ignores measures that are based on the external potentials of internal capabilities or internal potentials of externally available capabilities. However, by establishing value co-creation and co-capture as the underlying mechanism for different exchange

orientations with actors in an ecosystem, DEC highlights the significance of imitation in developing DC, as well as its potential to provide an important measure of DC. From this perspective, a firm can benefit from exchanges which encourage imitation of its internal capabilities. As the value of these capabilities appreciate, the firm is motivated to invest in complementary assets to the imitated capabilities for greater value capture or appropriation (e.g., Jacobides et al., 2006).

4.1.2. KIE and EE development: The DEC framework offers significant theoretical implications for KIE firms and their development in EE through the platforms of established firms. First, while the agency perspective of EE research emphasises purposive and unintentional interventions by individual or collective actors and interdependent stakeholders which influence EE emergence and development (Cunningham et al., 2019; Erina et al., 2017), it is not clear how specific actors, other than established or recognised focal actors, influence the development of EE. To provide some clarity in this regard, the DEC framework posits that by building resource integration capabilities, specific actors in EE, such as KIE firms, can influence the configuration of EE. In many respects, this assertion is consistent with the network perspective of EE research, which emphasises that networks at different levels of development impact the development of EE (Neumeyer & Santos, 2018; Nicotra et al., 2018). However, while the network analysis at different levels assumes a distinction between those levels in EE, DEC extends the argument by emphasising relationship building capabilities which connect networks at different levels to one another as a result of a specific actor's engagement in different exchange orientations, upward or downward. Therefore, by building relationship capabilities, actors, or firms, including KIE firms, can easily identify and focus on upward or downward exchanges which provide the maximum impact on the ecosystem, in order to either maintain or reconfigure the ecosystem to their benefit. Establishing relationship building capabilities as antecedent to upward and downward dynamic exchanges clarifies the ways in which elements in networks are connected in EE (Alvedalena & Boschma, 2017; Stam & Van de Ven, 2021).

It is well argued in the literature on EE that actors in EE initiate and accelerate entrepreneurial innovation whereas human and financial resources influence this innovation in specific contexts (Autio et al., 2018; Spigel & Harrison, 2018; Velt et al., 2020). And while digital affordances may play a major role in such contexts, the main factors that enable or constrain EE development involve innovation. Such innovation in those contexts may be initiated, accelerated, and influenced by actors from diverse sectors. By highlighting exchange processes through encounters, interactions and engagement, the DEC framework provides an alternative means of enabling KIE firms to identify the impact of various institutions and actors on the structure and performance of actors in EE. This implies that KIE firms can identify and pursue opportunities to optimise innovation for various sectors and avoid falling into the trap of engaging in constant innovation without considering the relevance and timing of such innovations.

In addition, EE research from a governance perspective suggests that institutions influencing EE positively through effective resource allocation in a confined space, with the aim of exploiting innovations on a multisided digital platform, must deploy governance mechanisms which regulate their internal and external factors, in order to facilitate the fuelling of the ecosystem with knowledge spillovers (Acs et al., 2018; Acs et al., 2017; Cumming et al., 2019). However, fuelling an ecosystem with knowledge spillovers requires that such institutions drive entrepreneurial action in EE, in order to identify areas of competitive differentiation and association with actors in the ecosystem. The DEC framework emphasises different exchange orientations through the upward or downward trajectory, which enables KIE firms to clearly differentiate between exchanges requiring competitive differentiation from or association with actors in the ecosystem.

Moreover, an EE complexity perspective requires KIE firms to build entrepreneurship infrastructure with a view to facilitating a symbiotic relationship between their current environment and new venture creation, in ways that capture the dynamics of emergence and formation of elements of EE for KIE firms (Auerswald & Dani, 2017; Liguori et al., 2019; Roundy et al., 2018). While this approach seems to focus on the same actors and elements that KIE firms engage across time (Stam &

Van de Ven, 2021), the approach ignores the inherent benefits in the same exchange orientation that can ensue between a KIE firm and different actors or firms over time. However, by delineating the exchange orientations between KIE firms and other firms across time, we show that KIE firms can benefit from differentiation by protecting their intellectual properties from innovation-oriented exchanges, while opening avenues for commercialisation of such innovations in other exchange orientation(s).

4.1.3. Service ecosystems for exchange development: The service ecosystem literature emphasises that value co-creation occurs between actors, including economic and social actors, who have no fixed identity in ecosystems (Breidbach & Maglio, 2016; Ekman et al., 2016). While this presents opportunities to maximise exchanges for value co-creation in ecosystems, DEC draws attention to the relationship building capabilities necessary for a firm to identify and separate strategic opportunities in exchanges from the threats in the relationships facilitating those exchanges in ecosystems. Additionally, the service-centred view argues for resource integration as a key driver of value co-creation in ecosystems (Peters, 2016; Peters et al., 2014). Resource integration enables firms to compete and collaborate with other actors or firms based on resource exchanges for value co-creation in ecosystems. Given that the ‘resourceness’ of a resource can be ascertained and appraised by its ability to facilitate service for actors engaged in value co-creation in ecosystems (Vargo & Lusch, 2011), DEC expands the understanding of resource integration for value co-creation by proposing that firms build resource integration capabilities which separate the potentials of resources from the ownership of those resources, in order to facilitate optimisation of resources in exchanges for value co-creation.

From the service centred-view, service is the unit of exchange between actors engaged in resources integration for value co-creation (Vargo & Lusch, 2008; 2017). This service-for-service exchange enables a firm to assume multiple roles in an exchange relationship with actors involved in value co-creation in ecosystems, to facilitate exchanges beyond those constrained or enabled by transactions (Ekman et al., 2016). The DEC framework maintains this understanding but goes beyond it to argue that firms should differentiate relationships from the resources driving exchanges in those relationships. With this separation, firms or actors with established resources in ecosystems can trace

the contact points where those resources offer opportunities for a more productive relationship. Also, firms with established relationships in the ecosystem can trace the contact points where the relationship offers opportunities to explore the potentials of resources in the ecosystem.

The service-centred view considers institutions and institutional arrangements as the enabling and constraining mechanisms of service-for-service exchange between actors engaged in resource integration in ecosystems (Vargo & Lusch, 2016; 2017). Institutions and institutional arrangements enable a firm to identify the governance mechanisms that regulate its exchange of resources internally and externally with other actors within the ecosystem. In this regard, DEC emphasises the need for firms to build capabilities for different exchange orientations based on resources and upward or downward orientations based on actors involved in those exchanges. This will help firms to identify competitive associations with actors where resources collaboration is required and to focus on competitive differentiation from actors where resource competition is involved. Finally, the service-centred view elaborates on the establishment of interlocking and nested service ecosystems of actors engaged in resource integration for value co-creation (Vargo & Lusch, 2016; 2017). Nested ecosystems enable firms to engage in different orientations of exchange in different networks, in order to co-create innovations in one network and market or commercialise the innovation in another network. DEC theory further illuminates our understanding in this area by proposing that firms develop relationship building and resource integration capabilities to engage in innovation in one network and commercialise the innovation in another network through platform management.

4.2. Managerial implications

The DEC framework presents some significant managerial implications, particularly for DC development in ecosystems by existing firms, EE development by KIE firms and any firm that seeks to participate in value co-creation in ecosystems. For established firms seeking to develop DC ecosystems, the framework suggests building open business models that enable a differentiation of relationships from the resources and capabilities which facilitate exchange in those relationships. This differentiation

remains important in protecting firms from success traps (Wang et al., 2015) by developing individual DCs in isolation (Sunder & Ganesh, 2020). In this regard, firms can collaborate with other firms or actors, who may be considered as competitors, through an effective alignment of internal resources and capabilities with external ones. This, however, requires DEC relationship building and resource integration capabilities, which minimise internal resource obsolescence and maximise external resource opportunities, without compromising competitive differentiation. Also, drawing on DEC implies that firms must provide free access to complementary resources which facilitate exchanges between actors or firms in parts of the value chain where the firm is not active (Jacobides et al., 2006). This would enable firms to learn from encounters, interactions and engagement by actors in different parts of the value chain where they are not active, in order to identify specific actors with whom to engage in upward dynamic exchanges for innovation support, and downward dynamic exchanges to structure boundaries and ties for specific innovation. These upward and downward dynamic exchanges do not only facilitate greater value so that orchestrators of platform-based ecosystems may profit from innovations (Helfat & Raubitschek, 2018) but they also facilitate ambidexterity for firms to develop DC through exploitation- and exploration-oriented network ties (Faridian & Neubaum, 2021).

In addition, the DEC framework suggests that KIE firms seeking to develop or reconfigure EE to their benefit must focus on relationship building capabilities in order to establish networks involving actors from different sectors. Maintaining that KIE firms are embedded in innovation systems, DEC theory argues that KIE firms can develop relationships with firms from different sectors and separate such relationships from the resources that enable exchanges in those relationships. Such differentiation is important so that KIE firms can use their embeddedness in systems to access specific types of resources from specific relationship during the pre-entry, the establishment and the post-entry phases in specific industries or sectors (Hermanson et al., 2018). In addition, given that EE is built around opportunity discovery and pursuit through digital affordances, DEC posits that KIE firms can leverage their embeddedness in systems in order to learn from encounters, interactions and engagement with

specific actors, which affords opportunities for collaborative innovation in a downward dynamic exchange, and in upward dynamic exchanges protects their internal knowledge and intellectual assets. Such exchanges remain important for KIE firms to address the paradox of opening up for innovation while protecting key knowledge assets in different relationships and facilitating ambidexterity strategies across contexts of innovation in ecosystems (Lassen, et al., 2020; Amankwah-Amoah & Adomako, 2021).

Finally, the framework suggests that firms seeking to participate in value co-creation in service ecosystems must emphasise a differentiation between on the one hand relationship building capabilities which enable resource integration, and on the other hand resource integration capabilities which enable relationship building in ecosystems. This is particularly important so that firms may leverage their generic actor roles in service-for-service exchange, in order to learn from encounters, interactions and engagement with different actors in ecosystems. Consequently, these firms can identify actors with whom to engage in upward dynamic exchange through functional teams from a single department and utilise downward dynamic exchange through multi-functional teams from multiple departments (Aarikka-Stenroos & Jaakkola, 2012; Enz & Lambert, 2012). Furthermore, firms involved in value co-creation in service ecosystems can leverage their occupation of a position in configured networks to engage in upward dynamic exchanges for innovations, thereby maintaining the existing configurations in the ecosystem to their advantage. In the same vein, firms with key resources or innovations in the ecosystems can engage in downward dynamic exchange with actors occupying key positions in configured networks, in order to alter the configuration of the networks in the ecosystem to their advantage.

4.3. Future Research Directions

The DEC framework offers several avenues for future research to expand our understanding of firm participation in ecosystems and the orchestration of value co-creation for greater value capture. First, the framework suggests that relationship building capabilities are important antecedents to

relational exchanges in ecosystems for value co-creation. However, a firm's relationships in networks may also involve roles such as competitor, partner, customer, user, supplier, provider etc, which may require formal and informal arrangements. In this regard, we believe that future research should examine the conditions or circumstances in which the specific roles of a firm affect its exchanges, in terms of orientation and direction, with other actors or firms for value co-creation in ecosystems. Second, although the DEC framework emphasises resource integration capabilities as an important antecedent of exchanges in ecosystems, we are of the view that a firm's ability to integrate both existing and emerging resource capabilities (Peters et al., 2014) would require the firm to identify, match and reconfigure the potentials of resources. As such, we direct future research to examine the circumstances in which formed and emerging resources affect a firm's relational exchanges, in terms of orientation and direction, for value co-creation in ecosystems.

Third, the DEC framework suggests that platform encounters, interactions and engagement are three important dimensions of specific exchange orientations for firms involved in value co-creation in ecosystems. However, such dimensions may arise from resources in specific exchange contexts with parties in the exchange. We direct future studies to examine how resources, context and parties enable platform encounters, interactions and engagement between firms involved in value co-creation in ecosystems. Fourth, we maintain that varying exchange orientation between actors in the same relationship is an important mechanism facilitating both competitive differentiation and association for firms involved in value co-creation in ecosystems. However, this competitive differentiation and association may arise from the role of the firms and the resources involved in the exchange. In this regard, future research should examine the conditions in which the role of firms and resources involved in relational exchanges instantiate competitive differentiation and/or association for the firms involved in value co-creation in ecosystems. Finally, our framework suggests that dynamic exchanges between firms involved in value co-creation in ecosystems, on the one hand comprise an upward exchange outcome which unlocks new resources, capabilities and innovations for firms, and on the other hand

comprise a downward exchange outcome that enhances existing resources, capabilities and innovations for firms. Academic endeavour has yet to explore whether the benefits from upward exchange outcomes are directly or inversely related to the benefits of downward exchange outcomes for a firm involved in exchanges for value co-creation in ecosystems.

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Figure 1: Unpacking dynamic exchange capabilities for value co-creation in ecosystems

