Steering for Sustainable Development Goals: A Typology of Sustainable Innovation

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STEERING FOR SUSTAINABLE DEVELOPMENT GOALS: A TYPOLOGY OF SUSTAINABLE INNOVATION

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Definitions

Process and product innovation are defined as an organizational ability to discover and translate creative approaches to solve multiple organizational problems. Process and product innovation contribute to the supply of economic, social, and environmental benefits, thus ensuring sustainable environmental growth. It helps companies to achieve greater profits, reduce environmental burden, and use a material that can be more resource-efficient. Process and product innovation have become ubiquitous and part of everyday life. Sustainable process and product innovation are contemplated as an essential means for addressing infrastructure resilience for sustainability challenges. Although the perspective is huge, the governance and capability structure eventually dictate what innovation is likely to be developed.

Introduction

In late 2010 and early 2015, United Nation announced 17 Sustainable Development Goals(SDGs(and 169 targets on the idea of eight-millennium development goals (MDGs). The aim of UN SDGs focuses on achieving a common future for all. The SDGs provided an important counterbalance to nearly all spheres of the natural environment. The aim of UN SDGs focuses on achieving a common future for all. The SDGs provided an important counterbalance to the ecosystem. The SDG 9 provides an ample conceptual basis for discovering which area of manufacturing firms can be considered valuable to promote industrial revolution 4.0 and foster the transformation of innovation in a contemporaneous context. Industries 4.0 is the introduction of Internet technologies into the sector (Drath and Horch 2014). Over the past few years, sources of process and product innovation have become a priority area for the industrial sector as the firm transit to more socially, environmentally, and economically sustainable patterns of development. Thereby, reconfiguring the potential of process and product innovation came to mean the minimization of environmental vandalization at the point of the production process rather than at the upstream customer. The sustainable development term is widely used as interdisciplinary in many fields(Adejumo and Adejumo 2014)

Innovation remains a primary means with which technology firms pursue their value appropriation growth (Teece 1986). Value appropriation is a firm's capability to capture profits after value creation (Teece, 1986). Today's innovation economy has long relied on a foresight approach for improving the performance of innovation systems(Aguirre-Bastos and Weber 2017). The green product development approach can be noticed from the green marketing approach, that is, how a firm's activities are configured to support an environmentally friendly process. At the same time, the global context in which innovation increasingly occurs has been sufficiently reflected in the innovation and organisational context (Pandit et al. 2018). A few scholars have explicitly taken into account the concept of value creation and value appropriation (Preston et al. 2017); arguing that organisations must look not only internally but also for an external source of innovation ideas (Chesbrough et al. 2006). Value creation refers to activities that leveraging the relationship and combine resources and capabilities to create common benefits as a source of mutual value creation. On the other hand, value appropriation maximizing firm-specific resources and capabilities to value appropriate within the boundaries of relational strategy (Ritala and Tidström 2014). The particular concern is that innovation scholars tend to do little more than link innovation to only firm performance at the micro-level. The collaborative organizational culture tends to lead a better innovation performance, and have

clear operational implications(Awan et al. 2013). Innovation researchers have begun to explore the typology to examine the innovation process(Wang et al. 2015). However, understanding the inter-relationship among service-product and service-process and innovation business model still needs more attention (Ostrom et al. 2015).

From a broad viewpoint, value creation and value appropriation are not just corporate strategies or management tools for process and product innovation; they represent management vision and strategies to achieve the growth targets. Specifically, few innovation scholars have explicitly taken into account the context of the global innovation system. The present article examines how the presence of governance mechanism and firm capabilities in inter-firm across border relationships lead to building different innovation portfolios in technology-oriented environments. A typology of innovation roles builds upon prior typology theory literature (Reiche et al. 2017; Schroeder 2017) that place typology in a wider perspective of leadership and branding. In the present article, It is argued that value appropriation and value creation in technological innovation, firms are mainly driven by the presence of governance mechanisms and firms' absorptive capabilities. The technology-environment setting offers several advantages to address the research objectives. First, technology innovation now constitutes the largest type of market, and they have sufficiently large potential to exercise for a firm change. Second, the characteristics of a technology-related firm allow examining the strategic use of the governance mechanisms firm use in an environment where capabilities are effectively mandated for innovative outcomes.

Developing Effective Innovation

SDG9 is one of the 17 thematic goals in the outcome document of the United Nations (UN) post-2015. The SDG 9 aims for a fundamental transformation in the way manufacturing firms build infrastructure, nurture industrialization and cultivate innovation in industry 4.0. Process and product innovation are a broad, holistic concept to support the transformation of the production process to a sustainable production system. The successful sustainability transition requires to make adjustments and reliance on integrated sustainability initiative(Awan et al. 2020). Currently, manufacturing industries in a product-service ecosystem tends to be moving from linear to a circular system. Since the product-service system is embracing all other cleaner production management system. The cleaner production is defined as the high performing innovation strategy for developing a process for reducing energy consumption, minimizing waste generation, pollution control, and saving material resources (Awan et al. 2019). The concept of the industrial revolution 4.0 (IR) or industry 4.0 was developed by Klaus Schwab in 2015 a Word Economic Forum member. The industry 4.0 encompasses a set of future industrial developments including Cyber-Physical Systems (CPS), the Internet of Things (IoT), the Internet of Services (IoS), Robotics, Big Data, Cloud Manufacturing and Augmented Reality (Pereira and Romero 2017).

As emerging digitization tools continues to dominate, it is regarded as one of the most crucial objectives for the organisations, which are important to create innovation in a socially, economically and acceptable ecological manner. Industry 4.0 sought new sources of innovation growth and has been grown up around artificial intelligence (AI), internet of things and blockchain technologies. Some examples of AI in process innovation included, words suggestions in typing email, chat messaging assistance is linked, and many manufacturers like BMW, Tesla, Amazon adopting to enhance their product and process innovations. Today, the application of the internet of things and artificial intelligence is to provide decision-making tools with no intervention of human correctness. The mismatched in IR 4.0 strategic application and its AI will inevitably affect innovation performance as well as sustainability goals. Implementation of a strong AI governance is necessary for successful global innovation. Many industries have progressively reduced human intervention in their operations and moved out to launch more AI-based solutions in the market. The changing nature of the dynamics of doing automation production and application of internet of things(IoT) requires change management and governance for effective value creation and value appropriation. Internet of things defined as the "Interconnection of sensing and actuating devices providing the ability to share information across platforms through a unified framework, developing a common operating picture for enabling innovative applications" (Gubbi et al. 2013). In future, good value of product and process will associate the firm ability to integrate process-oriented capabilities, develop better database administration infrastructure management capabilities, business intelligence and business analytics capabilities, predictive analysis and use of machine learning capabilities for management of big data for the creation of innovative products. Business analytics(BA) involves the collection, arrangement, and examination of data collected using AI and IoT to obtain

better insights into operational decision making and optimize resources to firm innovation and process performance. The research on the Internet of things(IoT) has become increasingly popular and have the potential for innovation. IoT enables both incremental and radical innovations (Bucherer and Uckelmann, 2011). These subsets of IR 4.0 paved the way for global innovation structure and value appropriation.

Innovation systems have been suggested most prominently in forms of technological innovation systems (TIS) (Hekkert et al. 2007). This calls for a more integrative view in which innovation can take place in a diverse range of business environments and organisations, which are relevant to the design of an appropriate governance structure. One of the problems in most countries is the inability of the governance system to take into account the policies that foster and strengthen indigenous capabilities to use, adapt to create scientific knowledge and technologies (Aguirre-Bastos and Weber 2017). As a result, the global governance context is increasingly difficult to escape for any technology firms, highlighting the importance of coordination, communication, greater concentration and commitment to achieve the innovation transition (Martin and Johnston 1999). The lack of contextualization of innovation for value creation and value appropriation is problematic for deficiency in explicating the different innovation construct, and lack of shared conceptualisation of what a multifaceted typology of global governance roles is. There is little understanding about how governance mechanism among the technology firms across the globe manage capabilities for short term and long-term process and product innovation outcomes, to support UN SDGs goals.

Fostering innovation via the use of typologies

A typology is one form of a decision matrix to create knowledge, leading to successful processes Typologies approach is important for thinking about organisational structures and strategies, and predicting specified dependent variable, they are normally developed concerning some organisational outcome (Doty and Glick 1994). A typology is a theory-driven approach which emphasizes on multiple ideal types, but they do not provide decision rules for classifying organisations. From an organisational perspective, typologies are very popular in the formulation of strategies (Porter, 2011) and others have enhanced research in the field (Reiche et al. 2017). The use of typology in the contextualization of relationship has been recently used by Reiche et al. (2017). Typologies are popular among the researchers and widely used for guiding strategic analysis and mapping the competitive landscape (Porter 2011). Typologies are furthermore helpful as heuristic tools for researchers and practitioners alike (Mintzberg 1993). Typologies are the ways to organise complex cause-effect statements (Delbridge and Fiss 2013).

Two of the most familiar types of typologies is “monothetic” and “polythetic” typologies. In monothetic typologies, a set of the feature is insufficient, and polythetic can be developed from different combinations of values on the feature of interest (Bailey 1973). A typology is “monothetic if possession of a unique set of features is both necessary and sufficient for identifying a specimen as belonging to a particular cell of the typology”(Sokal and Sneath 1963, p.13). The conceptual study of (Doty and Glick 1994), suggest that the use of typology theory approach does not establish the hypothesis, rather it describing the relationship among the phenomenon under study between the dependent variable and the level of similarity of an actual unit of analysis to an ideal type. From an organizational perspective, contingency factors affect the target outcomes; hence organization typologies are theoretical devices that are mainly used for categorization. A core assumption of this approach is that strategy effectiveness should, therefore, involve identifying what constitutes fit among multiple and differing demands. In the present article, I focus on such polythetic typologies. Typology reveals a rich array of knowledge and aspiration to demonstrate different perspective that could be used to develop a framework for conceptualising (Boyd et al. 2017). Even though the critical role of typologies in theory development has increasingly been recognised, extant literature is still limited. A recent study by (Snow and Ketchen 2014) conceptually shows that the relative status and importance of the use of typologies in emerging topics. Emerging topics are those areas that involve innovation developments requiring new organisational approaches through which to exploit and explore different structure and context; thus, typology is an important tool for the theory development (Wang et al. 2015). The use of typology as theoretical construct explains the process of conceptualization which allows for modelling multiple patterns of

relationship between independent and dependent variables which is assumed to be consistent across all observed unit of analysis (Reiche et al. 2017). Typology theory usually considers either a narrow focus or a wide context based on a reorganisation form or phenomenon under study. The recent research has found that typology perspectives are used as development and transformation strategy for the organization process.

A distinguishing feature of green innovation is the use of environmental goals with product and process innovation to structure sustainable development (Awan et al. 2019). In the case of innovation, the use of context is very critical that it affects the type of innovation practices and activities necessary to influences others. This chapter adopted a typology theory framework as a guiding theoretical framework to identify the causal relationship among relational governance and dynamic capability, to identify the elements of potential sustainable innovation leading to value creation and value appropriation. Guided by these building blocks and typology theory, this artilce identifies four innovation roles, depicted in Fig.1. Typology theory focuses on the behaviour type of activities and contingency context that affects the type of behaviours, which are inter-related by their place in the organisation structure. The four groups of innovation roles can be taken as representing new sets of inter-relations among governance and capabilities. These four categorizations(Reflexive innovation, Integrative innovation, Connective innovation and Structural innovation) of innovation roles turn out to have attributes importantly different from functional innovation.

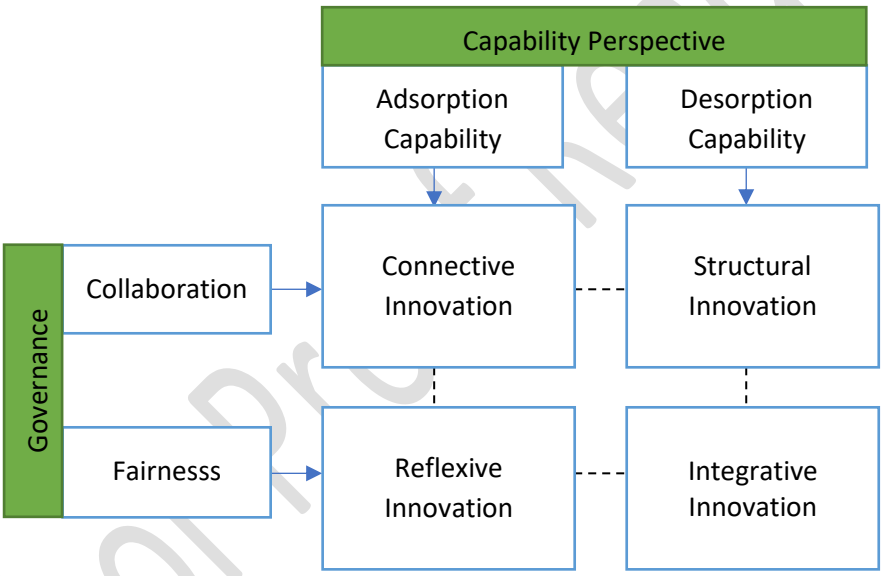

Figure1. A typlogy of Innovation

Imperative of governance and capabilities—Ridding two horses

A key challenge in current innovation portfolio structure is that, the stage at which types of innovation has been expanded. Whereas capabilities were confined to a few firms, one of the key enablers of innovation structure is governance, which radically changes the speed of innovation for the creation of value. The concept of governance is the form of system that emerges from governing the coordination activities which present an opportunity to create a new set of process and innovation activities that enable the firm to rapidly focus into new patterns of doing business in the existing supply chain. The Governance mechanisms are essentially important for the stability of the supplier relationship. A buzz word for the relationship management in today's competitive market "fairness"- which refers to the notion of "inequity aversion" (Fehr and Schmidt 1999). With the evolution of global sustainability challenges in recent decades, there is a need to articulate strategies that assume value appropriation as well as

achieving environmental sustainability (Adejumo 2019). There exists a perception of inequality in channel or supply relationship. However, there is little understanding of how fairness concerns influence partner capabilities. The fairness among actors and institution relationship can play an important role in constituting practices and forms to engage better with industry themselves. The concept of collaboration in governance involves working collectively with customers for an extended period that resulted in better sustainability performance (León-Bravo et al. 2017). Collaboration on sustainability initiative can generate mutual benefits and permit the realization of the need for planning and promoting changes in the supply chain structure (Aschemann-Witzel et al. 2017).

Adsorption Capability and Desorption Capability

The literature has increasingly focused on adsorptive capacity for assisting product and process innovation. Therefore, enhancing more knowledge acquisition has been a subject that has fascinated researchers and academics for two decades. Developing adsorption capability is thus becoming an important issue to acquire, disseminate and implement as a widely used performance indicator. The adhesion to knowledge acquisition is known as an adsorbent or adsorptive capability- a process in which acquired knowledge becomes an integral part; and the second is Desorption, in which the firm is unable to hold previous knowledge but to update existing knowledge.

Adsorption Capability

Following previous studies in product innovation, such as accumulation learning (Driessen and Hillebrand 2013) and embedding integrative routines (De Medeiros et al. 2014); the adsorption capability, emphasizes the ability to accumulate experiential knowledge and entrench integrative routines used to design sustainable products. At the operational level, firms need a set of adsorption and desorption capabilities for a specific innovation. Adsorption capabilities are conceptualized if they relate to accumulation and embedding learning. Adsorbate capability is important for improving the organisational structure for sustainability integration to trigger collaboration for successful generation of eco-innovation and their implementations. It is well known that the effect of knowledge acquisition through collaborative activities play a significant role in the integration or assimilation of sustainability initiatives. Accumulating knowledge, in this process, two or more actors are involved, one is a local firm on which knowledge adsorption occurs is called adsorbent, and other firms who are providing the key knowledge resources are called adsorbate firm.

The adsorption capability accumulates of all types of knowledge from various stakeholders. Previous research (Arvanitis et al. 2015; Flor et al. 2017) have focused on acquiring knowledge from a few stakeholders.overtime. Next, firms need to embed knowledge from various stakeholders. It could be further divided it into two types, Adsorbate, where provider firm has a very high market attraction, and receiver firm (adsorbent) has low market attractions. In this case, where one firm has a high market attraction, and the other is low, is called physical adsorption. The provider firm may terminate the relationship if it does not see any attraction from receiver firm. The receiver firm cannot integrate the knowledge resources received by external stakeholders. The capability of integrating the knowledge resources may largely depend on the proximity to the knowledge resources previously have already been adsorbed by the receiver firm. The adsorption of knowledge resources among the partners is of broad importance in innovation networks and largely depends on a wide range of system support capabilities. Sometimes it occurs at dissociative adsorption and disconnective adsorption. However, this type of adsorption can be easily reversed by sudden changes in the market demands or under market dynamism forces. On the other hand, if there exists high market attraction in both Adsorbate (provider) and receiver (adsorbent) firms, the bonds are further strengthened. This type of Adsorption capability cannot be easily reversed. This capability involves achieving connective and reflexive innovation.

Desorption Capability

The Desorption capability view is based on the previous studies on hybridizing organisation that must be engaged with customers and take action to achieve a mechanism of change and innovation (Jay 2013) and second-order capabilities (learning capability) (Schilke 2014). The desorption capability emphasizes the ability to codify foresight

customer demands by bringing new perspectives and creating sensemaking engagement concerning the previous experience. Desorption capability is defined as a shared vision of internal actors involved with the external actors to deliberately recreate existing knowledge through partnership for action learning ecological change that contributes to sustainable product design. In this state, the desorption capability for a firm is to move with some support provided by the external actors to develop innovative products on demands, which deliver sustainable benefits to all actors involved. This capability does not hold the knowledge on permanently, rather it is focused on implementing externally acquired knowledge immediately for co-creating solutions for eco-innovation. As it may shape various knowledge combination and creation features; thus, adsorption capabilities are critically important for innovation. This capability exists, as long as the receiving firm receive knowledge from an external resource and vice versa. Nevertheless, it is also possible that some firms are not able to hold this learning capabilities capability continuously over the long term. They are not able to retain this strategy, and this is called Desorption capability. This form of capability provides an opportunity to acquire knowledge while simultaneously implementing and incorporating environmental business models. This capability involves achieving integrative and structural innovation.

Peripheral Benefits of Typology For Innovation

Researchers have acknowledged the relevance of typology in strategic management research in an organisational context. The important classification of innovation shown in the figure 1.

Reflexive Innovation

Reflexive innovation, by definition, refers to innovations that actors interact and drawing on a system of regulations, institutions and actor's capabilities(Windeler 2018). The Reflexive innovation happens when there is a process of governance among the institutions and actors' capabilities. Reflexive innovation occurs in the presence of collaboration and adsorption capabilities. Reflexive innovation (RI) is generating new action and awareness among the actors of the firms, within their practices. The RI concept is based on the idea to develop new modified products with the use of extracted parts and components from the end of life products. Circular Economy (CE) "is an industrial economy aiming at enhanced sustainability through restorative intent and design" (Ghisellini et al. 2016). Kirchherr et al. (2017) recently analysed and discussed the barriers to the CE from the European Union(EU) perspective. The discussion indicates that exploring barriers to circular economy implementation open the way for companies to start exploring factors that shape successful transition firms to circular economy business models. The quest for sustainability is forcing firms to change the way they think about technologies, products and process and utilize applied tools that recognize both ecological and social impacts (Nidumolu et al. 2009). This kind of internal approach will lead to the development of new processes that reduce environmental incidents and costs. RI envisioned future generation needs and saving the planet from brinkmanships. RI may lead to support sustainable development agenda to meet the needs of existing generation and save material resources to meet the demands of future generations.

Integrative Innovation

Integrative innovation seeks to contribute to all hierarchical level of organisations in all environments for all process, resources, self-management for sustained progress based on the use of capabilities and governance for high innovation value appropriation. The Integrative innovation is described as a process of preparing users, creating a support system and reconfiguration of experimentation and plan to learn about the integration of new technology (Barton 1998). The Integrative innovation refers to user involvement approach that can help to enhance a support system to use the end of life products to reassess their expectations and foster shared vision in seeking ideas and developing the new products. The aspects of Integrative innovation seek to maintain the desired balance between two or more parts or components of products, such as products developed with virgin material and some parts or components developed with the recycling of materials. It occurs when there are a strong collaboration and level of desorption capability. The advantage is that the firm is not uncertain of material availability, instead of firm increase profit through adopting circular economy practices mainly through the end of life products in building,

designing new, improved products. Successful patterns of circular economy development are especially applicable here. Integrative innovation is increasingly important for the organisation to develop new links and design architectural process and patterns for sustainable innovation.

Connective Innovation

Connective innovation can become a catalyst for sustainable development growth. The Connective innovation is defined as a firm relying on design thinking approach in creative mapping ideas and go beyond an open line of communication to identify product design issues and mainly focus on triple bottom line aspects and customers needs. Connective innovation is all about the ability to rethink an existing product to transform innovation in artificial intelligence and IoT environment. Some previous studies have suggested that IoT increases productivity, to create better operations management, customised productions and change the organisational structure towards inter-operation networks for creating challenging opportunities for the young workplace (McDonald 2011). Harrington and Ladge (2009) concluded that management commitment more explicitly drives innovative ways to manage the workforce in an integrated work-life perspective. Similarly, Awan and Raza (2010)suggested that drivers behind green products are a better understanding of consumer needs.

The escalation of the internet of things over the world has led to a green innovation environment. For example, light-emitting diode (LED) light as with a sensor that maps activity across an entire building or office can help the management to make an informed decision. These IoT enable LED lights help about understand exactly what happens in the workplace, how employees enter the workplace, casual chat, spent time in working and leave at the end (LUMB 2015). From the perspective of production management, these LED lights permit effective management of safety practices in the operational area, and data can be used to see either employee compliance with safety practices or not. For an organisation to succeed, connective innovation is claimed to be as important as organisation, marketing, disruptive, frugal, social, radical, incremental, modular, open and architectural innovation. The changing nature of the dynamics of doing automation production and application of internet of things (IoT) requires change management and governance for their effective value creation and value appropriation. In future, good value of product and process will be associated with the firm ability to integrate process-oriented capabilities, develop better database for administration infrastructure management capabilities, business intelligence and business analytics capabilities, predictive analysis and use of machine learning capabilities for management of big data for the creation of innovative products. The fundamental importance of connective innovation is to leverage the power of resources for effective collaboration. Today, this connective innovation has greater potential with the growing adoption of the internet of things, social media, the industrial revolution, artificial intelligence and blockchain technologies to create paths ways for effective sustainability. The innovation will create a cohesive relationship journey between the organisation actors and institutions to tackle the system from failures in innovation and provide interaction and networking supports.

Structural Innovation

Structural innovation is distinguished from other innovations as it addresses the challenges of a firm on climate change issues. Structural innovation focuses on the management of sustainability activities and more access to natural resource management to build and mee ecological innovation. The Structural innovation structure has long recognised the importance of interaction between organisation actors to tackle system failures in innovation system (Howells and Edler 2011). Structural innovation developed through customer knowledge and resource provision. Structural innovation, by definition cover novel forms of governance, institution and arrangement of relationship within the innovation ecosystem (Howells and Edler 2011). This type of innovation is very common in a relationship, where customer demands some incremental product innovations for a short period under contract agreements. This form of innovation exists when a contract manufacturer develops innovative products when knowledge and skill come from the other party, and the product is developed. These involve new configuration of knowledge and skills with the new supplier as they are organised with trust and desorption capabilities. Structural innovation addresses the unique challenges organisation face when and how to implement new technology. There is a growing interest of researchers and practitioners on how innovation can be turned into the sustainable use of capabilities and governance. .Structural innovation is always difficult and often decompose established actors' interests, so that desorption capability does not generate the necessary conditions for continuous innovation.

Discussion

This article argues that 3Ps (path, process, and position) conditions of dynamic capabilities motivate for understanding the innovation roles (Teece 1986). This suggests that relational governance forming the conditions for the dynamic capabilities will motivate them to form engagement in learning that will further help them to build more resources and create value. Therefore, it is argued that relational governance and dynamic capabilities play an important role in explaining the different innovation processes in technology firms. This article contributes to the strategic management literature by addressing the call for a more typology driven theory building approach in organizational studies (Snow & Ketchen, 2014), as in the case of innovation typology. The strength of the typology theory was that it allowed building blocks of ideal type to relate the governance process and capability, which are traditionally less emphasized in the literature. Beyond the novel typology approach, the findings provide an opportunity to explore in-depth the relationship between the different modes of innovations and inter-firm governance; that is, the reflexive innovation, structural innovation, connective innovation, and integrative innovation. This process requires an established governance system with digital organizational capabilities.

In the emerging IR 4.0, innovative global analysts will be working at the interface of artificial intelligence, the Internet of things, and big data. On the other hand, integration of adsorption capability, desorption capability, and the principle of fairness and collaboration allow the organization to trigger process and product innovation. This process turns into a practiced mechanism for supporting the collective innovation ecosystem, both for the creation of value appropriation in the IR 4.0 environment. For example, inelastic innovation, when a firm develops a new product with the use of recycling and end of life components and parts, if product demand is increasing with the increase in the price, then this type of innovation is said to have an elastic innovation and vice versa. The Reflexive innovation is most appropriate in the industry 4.0 context, which depends more on understanding, product usage, and consumption patterns. The Adsorption capability is a company capable of the internet of things (IoT). A company's ability to respond to a wave of innovation depends on its ability to deploy, use, collect, and interpret data. The future of sustainable innovation will be created by developing an industrial innovation ecosystem in industry 4.0 infrastructure that allows the value of connective innovation, structural innovation, to develop process and products which satisfy the human and natural environmental needs. By applying the typology of innovation for a sustainable process and product innovation, many of the key challenges of sustainable development goals9 can be better supported, including, the development of resilient technology infrastructure; promote sustainable industrialization: increase integration of small enterprises, and access to the internet resources; enhance technological capabilities and increase access to information.

Conclusion

This article has sought to outline and contribute to the understanding of the innovation roles, with a focus on technology firms and their governance and capability impact on the organizational value outcomes (value creation and value appropriation). Based on the literature analysis, organizations can be seen as adaptive and flexible engaged in a changing capability perspective described in terms of adsorption and desorption. In the emerging technological environment, collaboration and fairness facilitated the organizations to find and deliver solutions to meeting sustainable development goals and changing customers' needs. Consequently, organizations seeking to transform their capability and governance must focus on (1) reflexive innovation, (2) structural innovation, (3) connective innovation, and (4) integrative innovation to create valuable outcomes. This article concluded that adsorption and desorption capability with appropriate governance structure might lead to breakthroughs in reflexive innovation, structural innovation, connective innovation, and integrative innovation in the management of global innovation roles. This article is in line with the UN SDG 9 that highlights the need for innovation and industry infrastructure through promoting inclusive and sustainable industrialization by 2030, which would be promising and support upgrade infrastructure to meet the demands of the next industrial revolution (IR), that is, IR 5.0. This is particularly in accordance with the reality that reflexive innovation, structural innovation, connective innovation, and integrative innovation provides opportunities for value creation, and these have the prospective to foster sustainable innovation for sustainable development.

This typology of innovation has resulted in re-inventing and re-setting the innovation ecosystem and provide important insights for the firm's growth towards building resilient infrastructure for sustainable innovation in IR 4.0. The developed typology provides how the capability and governance system of an innovation ecosystem is placing together to conceptualize the value of the sustainable innovation landscape. The developed typology is relevant for practitioners and researchers also characterizing a different perspective on the innovation roles. It has the potential to help in identifying the value creation activities, that lead to value appropriation to the firms. For innovation policymakers, however, there is a convergence view, and clarifying different perspectives could reopen know-how governance and sharing capabilities to affect value appropriation. For managers, the intention to start innovating should commence with governance integration, as a certain degree of governance is beneficial with certain capabilities to affect the innovation roles. Managers, therefore, should look at the companies with similar governance structures and capabilities, to fit better together, as to achieve the desired innovation outcomes.

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