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Innovation ecosystems & industry 4.0

— Leveraging technological change to create ecosystems

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In today's digital economy, the boundaries between the physical and digital are disappearing and innovation is no longer a firm or industry specific activity. In this context, the concept of an ecosystem has become a powerful analogy to explain joint value creation where actors from multiple industries, including competitors, co-create value.

Value creation in ecosystems

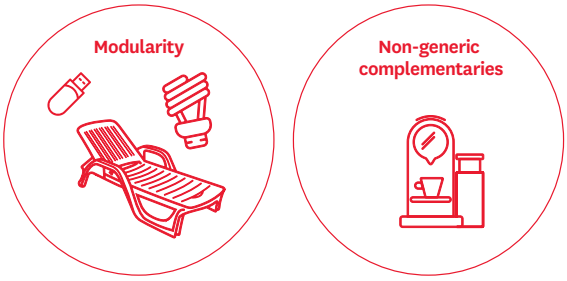
Big data, distributed processing, cloud computing, etc. have led to the convergence of the digital and the physical in the industrial world and has altered the competitive dynamics of industries. For firms developing hardware products, industry 4.0 demands integrating IoT-based technologies to physical products. In contrast to physical products, digitized products (such as smartphones and autonomous vehicles) are characterized by generativity and continuous creation of value based on the ability to allow users to access and consume other digital products and services. Subsequently, manufacturing firms are increasingly interested in understanding the underpinning of value creation beyond industry and organizational boundaries.

Management scholars have increasingly adopted the notion of "ecosystems" to explore value co-creation in distributed networks. The term "ecosystem" embodies a system in which diverse members co-exist in mutually dependent relationships. In business and management literature, scholars have identified various types of ecosystems including, among others, innovation and entrepreneurial ecosystems. Interactions within an innovation ecosystem (IE) are typically organized around a technology platform consisting of shared assets, standards, and interfaces.

Several scholars describe value creation and capture in an ecosystem, but few explore the process of ecosystem emergence. This is particularly problematic for industries facing disruption due to digitalization. Managers and entrepreneurs struggle to understand the microprocessors that underpin the emergence of a new ecosystem. Also, most studies on ecosystem focus on well-established and mature ecosystems (such as Apple's iOS and Google's Android). Furthermore, the studies have largely focused on software or technology firms operating in digital ecosystem. There remains a void in our understanding of innovation ecosystems involving firms from industries such as banking, healthcare, and automotive industry.

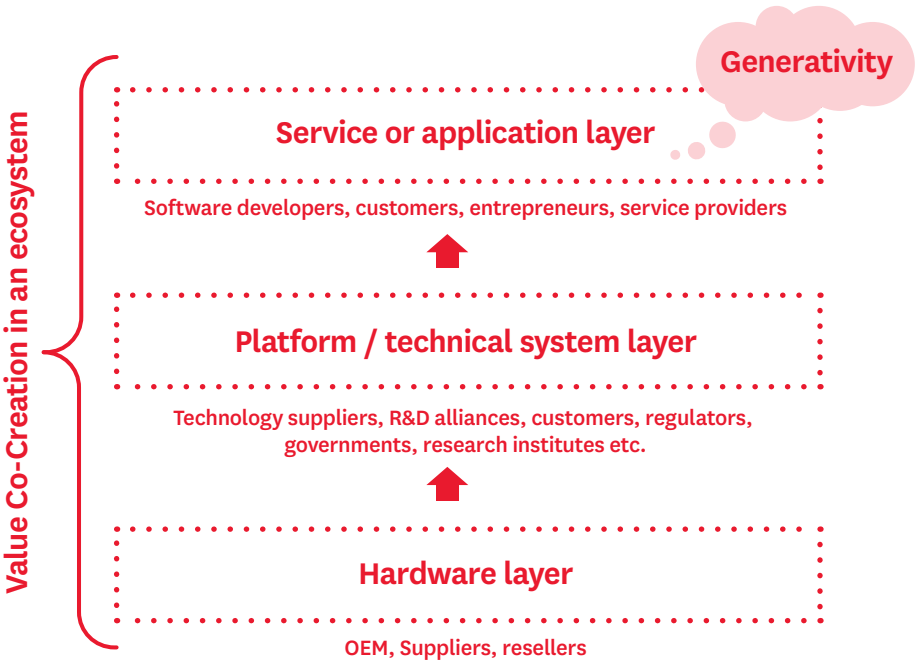
Layered Modularity and ecosystem emergence

Innovation ecosystem researchers acknowledge that 'modularisation' (i.e., breaking down a complex product or system into independent modules) and 'non-generic complementarities' (i.e., assets that complement one another in a confined way) are important underpinnings of an ecosystem. For instance, Nespresso transformed the generic complementarity between coffee and coffee machines and transformed it into a 'non-generic complementarity' by designing capsules (or pods) and specialized machines for the capsules. Thus, firms that develop modular products with non-generic complements can create ecosystems. Modularity enables the building of complex products and systems, based on independent sub-systems. Complementarity implies that the two assets are unproductive unless they are used together, and non-generic complementarities means that the assets are specific rather than generic.



However, not all modular products (or platforms) develop into successful ecosystems. Further, incumbent firms in traditional industries are accustomed to operating in linear value chains with hierarchical organizing logic. With advancements in Information and Communications Technology (ICT), the organizing logic is moving away from integrated architecture, with one-to-one coupling between components, towards modular architecture with standardised interfaces.

My thesis contributes to scholarly discourse on innovation ecosystems by explaining the transition of an incumbent firm's internal platform into an 'external' modular platform. The resulting modularization highlights an important distinction between modularity as understood in the traditional product development literature and modularity needed for



the "emergence" of an ecosystem. For instance, traditional industries use modularity as way to "outsource" and/or reach "economies of scale". However, the modularity that allows the development of ecosystem should facilitate value co-creation, and allow actors to both cooperate and compete.

Incumbent firms in traditional industries are accustomed to working in industrial value chain where they reduce or eliminate competition amongst the actors in the value chain. In the digital era, this is seen as stifling innovation and limits start-ups or new ventures to enter the industry and promote new products or services. In my thesis, I touch upon this conundrum by showing how industrial actors can embrace ecosystem innovation through a "Layered Modular Architecture" (LMA). By studying various activities undertaken by an incumbent manufacturing firm, during a discontinuous technological change (DTC), the thesis describes the concept of LMA as a design mechanism to support generativity, which means that value is continuously created through unexpected combinations and unpredictable innovations.

In addition, ecosystem scholars do not explain the capabilities needed for incumbent manufacturing firms to orchestrate an ecosystem. My thesis makes contributions associated with the capabilities needed to orchestrate an innovation ecosystem. Previously, manufacturing firms used their manufacturing capabilities, resources, etc. to establish their position in the value chain. This thesis proposes three keystone capabilities – cooperation, coordination and competition capabilities – that are important for orchestrating an emerging ecosystem

Conclusion

The purpose of my PhD thesis was to explore how incumbents leverage a technological change to create ecosystems. The thesis contributes to literature on innovation ecosystem by describing how a layered modular architecture allows managers to organize innovation activities across multiple layers. This allows manufacturing firms to balance between the vertically integrated hierarchy of industrial value chain and vertically disintegrated value network of digital technologies.

As physical products transition into platforms, it is making value creation more difficult. Incumbent firms, especially from manufacturing industries, possess organizational capabilities related to their resource base, intellectual assets and hierarchical industry structure. The future of industrial production involves not just developing physical products and related services. In contrast to physical products, digitized products (such as smartphones) are characterized by generativity and continuous creation of value based on the ability to allow users to access and consume other digital products and services.

This thesis proposes the idea of layered modularity as a mechanism to support development of digital technologies. With developing the physical product (such as a car or a camera), the incumbent firms can innovate within their existing hierarchies and traditional development methods. To develop digitized functions and features, managers can leverage the device (or hardware layer) to integrate software and technologies created by heterogenous firms, thereby intertwining a range of innovation trajectories.

RECOMMENDED READING:

> Pushpananthan, G. (2022). Becoming a Keystone: How Incumbents Can Leverage Technological Change to Create Ecosystems (Doctoral dissertation, Chalmers Tekniska Hogskola (Sweden)).

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