Governing Data-Driven Innovation: Policy and Strategic Implications in Global Competition and Collaboration

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The emergence of data-driven innovation based on the rapid advancement in the Internet of Things (IoT) and artificial intelligence (AI) creates exciting opportunities as well as considerable challenges in promoting societal benefits while regulating the risks associated with it. As a vast amount of diverse kinds of data is increasingly available from various sources that were not previously accessible, a wide range of sectors are currently undergoing a significant transformation. In the energy sector, smart grid systems lower costs, integrate renewable energies, and balance loads. In the transport sector, smart congestion-charging systems adjust traffic flows and offer incentives to use park-and-ride schemes, depending upon the conditions of traffic and air quality (Curley, 2016). As the speed of technological change accelerates in each of the devices and equipment involved, including sensors, microchips, and cloud computers, they are increasingly interconnected and interdependent through data communication in the context of smart cities.

By bundling various types of smart equipment and practices, along with the introduction of novel functionalities, smart cities have been developing sophisticated systems of hardware and software that are capable of processing an increasing amount of data on the multifaceted aspects of cities. The idea of smart cities hence reflects different dimensions of complex technological assemblages and, as such, there are significant differences in the nuances and emphases within the concept. These depend upon the specific contexts and conditions. Because there are numerous functionalities discussed as part of the smart city, there are also a wide range of benefits envisioned for societies when smart cities are implemented. Potential benefits include higher overall energy efficiency, lower costs of operating the electricity grid, lower environmental impacts, higher resilience of the energy system and greater empowerment of end-users in the energy system.

Given the potential benefits for societies that are facing the effects of air pollution and climate change and the high hurdles faced by such complex systemic technology areas,

public policies are crucial in facilitating innovation for smart cities. With a variety of hardware as well as software for smart cities, the technologies, stakeholders, and institutions involved are diverse and influenced by economic, social, and environmental conditions. An in-depth examination of the processes of creating innovation will generate valuable lessons for public policies and institutional design. Utilizing the experiences of industrialized countries to generate policy and institutional implications will be particularly important for many countries in the developing world, where urbanization is proceeding rapidly in many major cities. This is generating difficult challenges in pursuing sustainability. Within the relatively short period of time in which smart cities have evolved, there have not been many studies with macroscopic views on innovation for smart cities, particularly those studies conducted from policy perspectives (Lin, Yang et al., 2013).

The innovation systems approach examines the processes of creating innovation by looking at the kinds of actors that are involved, the areas of knowledge and technological expertise, and the effects and impacts made by institutional conditions (Soete, Verspagen et al., 2010). As there have not been many previous attempts to apply the systems of innovation approach to analyzing the mechanisms of creating innovation in smart cities, it is hoped that some useful findings will be obtained with implications for public policy and institutional design.

A preliminary study of the innovation system of smart cities shows a significant degree of diversity in terms of the knowledge, actors, and institutions involved, depending on the specificities of the local conditions (Yarime and Karlsson, 2018). In Japan, knowledge and technological domains basically concern renewable energy, energy storage, community energy management, and electric vehicles, and the network of the actors shows a concentrated structure dominated by large, well-established organizations in the energy and electric industries and the public sector. In the United States, there is a specific emphasis on security, involving key features such as self-healing and resilience against physical and cyber threats, and knowledge and technological domains center around energy transmission and distribution based on sophisticated information and communication technologies. The main actors are utilities, system integrators, and smart meter manufacturers, including many small- and medium-sized enterprises and start-up companies. Basically speaking, the innovation system of smart cities in Japan is emerging from the innovation system of the energy and electric sectors, whereas the innovation system of smart cities in the U.S. is strongly driven by the information and communication technology sector.

As illustrated in smart cities, data-driven innovation is facilitated through readily availability of and accessibility to data and its mutual exchange with stakeholders in different sectors. Unlike the traditional mode of innovation, which tends to rely on closed, exclusive relationships between enterprises, the new mode of innovation requires open, dynamic interactions with stakeholders possessing various kinds of data. Close coordination on data becomes crucial at the stages of innovation process ranging from the creation of future visions, setting of concrete targets, and the development of novel technologies to deployment through social experimentation, feedback to decision makers, and legitimation of innovation in society.

Data-driven innovation critically depends on how to facilitate efficient as well as effective collection, diffusion, and utilization of data among stakeholders. While open data access and sharing can contribute to promoting long-term benefits from the societal point of view, private enterprises have their own interests in competing in the market and would not necessarily be willing to disclose, exchange, or share data with each other. We need to understand the mechanism of promoting or inhibiting collaboration on data, incorporating the motivations and incentives to the relevant stakeholders. Institutional conditions influence significantly the governance of open data and intellectual property in multi-stakeholder engagement.

A key challenge to industry and policy makers in Japan is how to transform the Japanese innovation system so that data-driven innovation will be stimulated and implemented. The traditional mode of government-industry coordination in well-established sectors would not function effectively, as start-ups and entrepreneurs are creating novel innovative technologies, bringing in new players in a rapidly evolving field. The Japanese innovation system has relatively strong manufacturing industries, such as the automotive and electronic sectors, while the information and communication industry is less competitive, without having any platform companies such as Google, Apple, Facebook, and Amazon in the United States, or Baidu, Alibaba, and Tencent in China.

As these data giants are moving into areas where the cyber space is increasingly linked to the physical space, there will be a significant amount of opportunities to explore innovation by assembling and integrating various kinds of data through IoT positioned in manufacturing fields and also real physical fields such as smart cities. That requires an active promotion of the free flow of data across the boundaries of organizations and industries. As we are seeing a rise of data protectionism in some parts of the world, it is also critical to collaborate with other countries to maintain openness in the global data ecosystem. At the same time, we also need to address societal concerns such as

privacy, security, intellectual property rights, and the loss of employment as a result of the creative destruction induced by data-driven innovation in the context of global competition and collaboration.

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