Diffusion of Connectivity Technology and development of new business models: How Connectivity Technologies redefine the role of human within organization?

Haruki Sawamura

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Empirical learnings from Japanese mobility service providers

Haruki Sawamura

(École Polytechnique)
2019 FFJ/Valeo Fellow

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Fondation France-Japon de l'EHESS
2, cours des Humanités 93300 Aubervilliers - ffj@ehess.fr

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Abstract

Digitalization changes the industrial structure of all sector: the business models of existing companies are challenged. Since late 2000s, so-called Artificial Intelligence (AI), based on deep learning and machine learning techniques, has developed and the autonomous driving cars is gradually implemented in the society. The realization of autonomous driving are supported by Connectivity Technologies (CTs) and CTs facilitate different innovations in urban spaces. The optimal mobility and transport management contributes to reduce environmental impacts and increase the welfare of citizens.

In this context, this research aims at understanding how the human role is redefined by the introduction of CTs and what are the impacts of these redefinitions on business model of organizations. These two questions are important since wider range of people in the society are expected to benefit from the autonomous (or automated) products and services regardless of his/her age nor job.

The author conducted an explorative field survey in Japanese cities (Tokyo, Maebashi and Fukuoka) so as to study most recent social implementations of CTs in mobility service sector. The five case studies are on 1) autonomous bus pilot project, 2) taxi dispatch online platform, 3) multimodal itinerary search platform, 4) on-demand bus service, and 5) tourism route recommendation system.

The empirical observations tell that there are, at least, four human role that remain after the introduction of CTs. The research also reveals that the significance of human role change does not necessarily correlate to the significance of business model change. Rather, the technological application that has less impact to the change in human role can result in changing the existing business model radically. The author points out that human resource management and organizational strategy should align with the potential changes in the value creation process since the CTs redefine the role of human. The author suggests a categorization of technologies taking human factor into consideration. The author claims that the access to the locally produced data can be a critical element to develop a competitive advantage and for that, local stakeholder management is a key along with the ecosystem-level business model.

Keywords

Business model innovation, Connectivity Technology,
Autonomous Human role, Mobility service

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Haruki SAWAMURA

Associate researcher at FFJ EHESS, 2019 FFJ/Valeo Fellow
Associate researcher at i3-CRG Ecole Polytechnique
haruki.sawamura@gmail.com

Introduction

This research aims at understanding how the introduction of Connectivity Technologies changes human roles in value creation process. The research focuses on mobility service sector in Japan taking five recently implemented projects as cases. The research takes an exploratory approach so as to obtain up-to-date empirical data of these projects and the author develops discussions based on the results. Some scholars claim that a new industrial stage called Industry 4.0 emerges in today's society (Jeschke, Brecher, Meisen, Özdemir, & Eschert, 2017; Wang, Wan, Li, & Zhang, 2016). It is an on-going industrial transformation (Qin, Liu, & Grosvenor, 2016) that succeeds the first industrial revolution in 18th century with the steam machine, the second one in 19th century with the use of electricity in industrial processes and the third one in 20th century with the use of ICT and industrial automation (Dalenogare, Benitez, Ayala, & Frank, 2018). This series of industrial revolution can be seen as a part of long human history. Hanari (2014) points out that the human being has experienced four major revolutions in its history. The first one is the cognitive revolution in approx. 70,000 BCE when Homo sapiens evolved its capacity of imagination. The second one is the agricultural revolution in approx. 10,000 BCE when Sapiens developed agriculture. The third one is the unification of humankind in 34 CE when human started to form political organisations towards one global empire. And the fourth one is in 16th century when human started to develop its scientific knowledge based on objective science method.

Today, the most advanced technologies such as Artificial Intelligence (AI), quantum computing, brain wave detection and bio-robotics are ready for commercialization and the deployment of certain technologies is considered as fifth industrial revolution for some scholars (c.f. Nahavandi, 2019). These emerging technologies have a distinct difference from conventional automation technologies such as automobile, airplane, industrial-robots etc. that have replaced “moving” function of human: they have potential to replace “thinking” function of human. This is the principal reason why the research addresses the changes in the human role with the introduction of newly developed Information and Communication Technologies (ICT).

Connectivity Technologies in urban space

Since late 2000s, so-called Artificial Intelligence (AI), based on deep learning and machine learning techniques, has developed. The AI technology enables computing much more advanced than conventional computing[1]. A representative social implementation of AI technology is autonomous driving system and autonomous vehicle. The group of technologies that support the realization of autonomous driving and autonomous vehicle is Connectivity Technologies that the research defines below. Connectivity is an emerging topic in the mobility sector along with the realization of fully automated self-driving: autonomous vehicle. The technological advancements of next generation Information and Communication Technology (ICT) potentially bring different technological innovations that can be integrated to vehicles such as small energy-efficient sensors, high-speed large-capacity telecommunications and improvements in computing technologies.

Autonomous machines – driverless or pilotless machines - are already in use under some limited contexts. One type of autonomous machines is such as unmanned satellite and industrial robots (National Research Council, 2005) that do not have physical contact with human. The other type of autonomous machines are such as elevator and unmanned metro trains (Myhre, Hellandsvik, & Petersen, 2019) that have physical contact with human. The diffusion of Connectivity Technologies in the society increases the physical interaction between machine and human since it enables the development and

[1] Conventional computing technology executes the programs that are pre-programmed by human so as to reduce the work burdens of human or to support the work of human. Historically, software computing is integrated to hardware engineering to realise automated machines such as elevators and automated doors. In industry, manufacturing robots are also good examples of the automated machines. Recent development of ICT enables to make smaller devices such as mobile phones, laptop computers and tablet computers and the ICT devices become a part of our everyday life.

The most recent development in computing is so-called Artificial Intelligence (AI) that imitates the mechanism of human brain (c.f. neural network technics). Though it is called Artificial Intelligence, it is not a perfect replicate of huma brain and its capacity in problem solving is limited. Nevertheless, in some specific domains, AI technologies outperform conventional computing and human brain. This is thanks to the development of machine learning and deep learning technics that enables to deal relatively ambiguous data sets such as natural languages. The most advanced AI technologies is able to “figure out form *ambiguous* information such as natural languages and visual image” and “learn appropriate outputs by itself through learning process”. These aspects of AI technology are advantageous against human brain in dealing problems that have infinite possible answers. The conventional computing technologies outperform human brain by executing more calculations than human. However, the conventional computing has not been optimal when there are infinite possible answers. The most advanced AI technologies are getting attention since they have potential to give relatively appropriate answers dealing based on *ambiguous* information.

deployment of consumer products and home appliances such as autonomous vehicles[2], autonomous house cleaning robots[3] (Mir-Nasiri, Hudyjaya Siswoyo, & Ali, 2018; Pandey, Kaushik, Kumar Jha, & Kapse, 2014; Rhim, Ryu, Park, & Lee, 2007), autonomous health care robots (Broadbent, Stafford, & MacDonald, 2009), autonomous security robots[4] (Carnegie & Prakash, 2004; Luo, Liao, Su, & Lin, 2005) and autonomous delivery robots. These autonomous machines are closer to people's daily life: wider range of people in the society will benefit from the autonomous products and services regardless of his/her age nor job. In this context, the research aims at deepening the understanding on the changes triggered by the diffusion of Connectivity Technologies, especially in the changes in the role of human.

The research focuses on mobility service sector. Autonomous vehicles have a potential to play a central role in future urban transformation (Cohen & Hopkins, 2019; Cooper, Tryfonas, Crick, & Marsh, 2019; Duarte & Ratti, 2018; Inkinen, Yigitcanlar, & Wilson, 2019). The emerging trends in urban mobility revolve around the concept of platform-centric transport, on-demand transport (Koster, Kuhnert, & Stürmer, 2018) and data infrastructure (Aoyama & Alvarez Leon, 2021). For example, Cooper, et al. (2019) indicate three concomitant phenomena: the emergence of Mobility As A Service (MAAS), the development of smart cities and the promotion of digital innovation. The combination of these three phenomena would generate multiple obstacles that hamper the implementation of effective experiments and innovations (ibid, 2019) since different types of actors constitute a multilayer ecosystem in urban transport and mobility sector.

Connectivity Technologies enable optimal management of urban transport and mobility and therefore its deployment has potential to contribute to mitigate social issues for sustainable development such as Global warming, aging society and urban environmental problems such as noise and safety.

Definition of Connectivity Technologies

The installation of advanced telecommunication technologies, such as 5G technology, significantly increase data transfer capacity both in rural and in urban space. This facilitates the integration of different technologies to vehicles: as the consequence of this wireless data transfer capacity increase, variant real-time data about cars, roads, city traffic, weather, drivers and passengers can be used to provide practical information to drivers or concerned people, or to directly control the vehicle. This is the principal idea of a connected car. A connected car is defined in this research as:

> a vehicle that has continuous connectivity to the Internet and to nearby objects via wireless communication technologies[5], having the capability to optimize its own operation and

[2] Autonomous vehicles are in development, for example, by Tesla and also autonomous buses are in development, for example, by Navia.
[3] One example is Roomba by iRobot.
[4] One example is K5 by Knightscope.
[5] Wireless communication technologies such as 4G (/5G) and Bluetooth.

maintenance as well as to increase the convenience and comfort of drivers and passengers with the help of different sensors, computing systems or human interventions.

In this context, this research supposes that the realisation connected car is led by Connectivity Technologies (CTs) defined as following: CTs are the technologies that are used to 1) collect data, 2) transfer data, 3) process data, 4) communicate processed-data through human interface or 5) project processed-data to control vehicle.

Table 1. Five technological components of Connectivity Technology

Use	**Corresponding technologies**
Data collection	Sensing technologies
Data transfer	Telecommunication technologies
Data process	Computing technologies
Processed-data communication	Human interface technologies
Processed-data projection	Machine (vehicle) controlling technologies

The definition of Connectivity Technologies in the research is wider than some purely technical definitions – narrow definitions - of Connectivity Technologies that only focuses on the data transfer aspect (e.g., Ding, Nemati, Ranaweera, & Choi, 2020). This is because this research intends to integrate human aspect into the definition of Connectivity Technologies. Once the narrow-defined Connectivity Technologies – data transfer technologies – are applied to the product that human can use, the other technological components – data collection, data process, data communication and data projection – naturally become indispensable (e.g., Baldus, Corroy, Fazzi, Klabunde, & Schenk, 2009). This is why the research adopts the wider definition of Connectivity Technologies.

Connectivity serves different purposes: it could increase convenience, security, and accessibility of mobility as well as seamlessness and energy efficiency of transport systems. The connectivity of mobility has thus far increased to date by the installation of real-time navigation systems (VICS in Japan), Electronic Toll Collection Systems (télépéage in France) and mobile-based ride-sharing services such as Uber, for example. These Intelligent Transport Systems are supported by wide range of CTs: 1) sensors that collect data, 2) telecommunications that transmit the data and 3) computing system that analyses the data. Further advancements of these technologies are awaited: brain-wave detection sensors, next-generation network technology such as 5G and quantum computing, for instance. The most significant advancement expected to be brought by advanced CTs is further automations in mobility system such as autonomous driving mentioned above.

Research objective

This research aims at understanding different innovations in mobility service sector brought by the introduction of connectivity technologies. The research takes mobility service as case to describe:

1. Integrations of connectivity technologies in mobility service sector
2. Redefinitions of human role in organisations

While some business processes are (semi-)automated in service sector, there care cases where business processes remain non-automated and depend on human interventions such as scheduling and dispatch of vehicles, drivers and passenger (Sawamura, 2021). Are the reasons technological, emotional, financial or regulatory? Will they be automated by introducing further advanced technologies or will they remain as they are despite the technological advancement? These are the primitive questions and the motivations of the research.

1. Literature review

The main interest of the research lies on the changes in human role within organization by the introduction of new technologies: Connectivity Technologies. These changes at individual level coincide with the changes at macro levels: at the level of company's organizational process and at the level of the ecosystem that the company belongs to. In order to better understand this mutual influence, this research mobilizes Business Model and Innovation ecosystem as analytical frameworks. Business Model (BM) "articulates the logic, the data and other evidence that support a value proposition for the customer, and a viable structure of revenues and costs for the enterprise delivering that value" (Teece, 2010, p. 179), whereas Innovation ecosystem is defined as a "collaborative arrangements through which firms combine their individual offerings into a coherent, customer-facing solution" (Adner, 2006, p. 2). This section of literature review firstly presents literatures on business model innovation and organisational change management. Then the section reviews the relation between digitalisation and business model change. In this research, the change of human role by the introduction of new technologies is seen as an element that triggers change in organisation and in business model. Thirdly, the section reviews literatures on automation and human role so as to better understand recent discussion on automation and human role. At last, the distinction between automation and autonomous is explained based on the definition of Xu (2021).

1.1 Business Model Innovation and organizational change management

More advanced CTs, including Artificial Intelligence (AI) technologies, will be integrated into business processes and they are expected to increase its business performance. The findings of the research will give significant insights on business model innovation and organizational change management study: the integration of CTs requires the companies to rethink different parameters in their business process such as the efficiency, credibility, accountability and resilience. The efficiency of the works could be, for example, improved by using sensors and voice recognition. In terms of the credibility, AI could propose optimal recommendation to as many people as a human can deal with but certain numbers of people may feel that a recommendation suggested by a human is more credible. Related to the credibility, the accountability is another critical component to be considered. The result of AI's action can be **interpreted** by human but since AI does not have its own conscience. It **cannot explain** why the action is taken with its own will especially when the neural-network technic, for example, is used: the logic for decision making is developed by the machine by learning process and not directly programmed by human. When it comes to the resilience, the companies may need to think if the business process can be recovered quickly in case of the fault of the system. This last point is pointed out by Hoc (2001) as "loss of expertise" of skilled human.

This research aims at contributing business model innovation study from organizational change perspective. While business model innovation is defined as the process of designing a new, or modifying the firm's extant activity system (Zott & Amit, 2010), no precise definition of business model innovation has yet emerged (Schneider & Spieth, 2013). The role of organizational design has been almost completely neglected in business model innovation research (Foss & Saebi, 2017) and the process of organizational change can be one key phenomenon to better understand the nature of business model innovation. Organizational design is important to maintain firms' uniqueness and competitive advantage (Teece, Pisano, & Shuen, 1997). Appropriate organizational design is required to configure resources to firms' uniqueness and competitive advantage (Benner & Tushman, 2003).

This research addresses this organisational change aspect of business model by observing the redefinition of human role and responsibilities in organizations integrating CTs into value creation/capture process of the business. For the sake of research facilitation, this research adapts the definition of business model innovation as "a new integrated logic of value creation and value capture, which can comprise a new combination of new and old products or services, market position, processes and other types of changes (Björkdahl & Holmén, 2013)." As it is mentioned above, the definition of business model and business model innovation remains under discussion in academia.

There are several important concepts that constitute a business model of a company. Here, the author reviews two of them: value proposition and value network.

Value proposition constitutes an important aspect in business. Linder & Cantrell (2000) argue that "a business model is the organization's core logic for creating value." They imply that a good business model is one that creates value: "how do managers develop a good business model—one that creates value?" Yunus, Moingeon and Lehman-Ortega (2010) explain that a value proposition answers "who are our customers and what do we offer to them that they value?" The value proposition of a business is not strictly limited to customers, as "the value stream identifies the value proposition for the buyers, sellers, and the market makers and portals in an Internet context" (Mahadevan, 2000). Within the context of strategic innovation, Lehmann-Ortega & Schoettl (2005) emphasise that the value proposition can be a source of differentiation of a business from its competitors. (See also value curve of Kim and Mauborgne (1999).) According to Doganova & Muniesa (2015, p111), value became a centric concept in business models in 2000.

Value networks appear to be a core concept that connects business models and business strategy. The value network is an extended concept of value chain. Peppard & Rylander (2006) state that "it [value chain] has proved a very useful mechanism for portraying the chained linkage of activities that exist in the physical world within traditional industries, particularly manufacturing. Furthermore, it has also framed our thinking about value and value creation. However, as products and services become dematerialised and the value chain itself no longer having a physical dimension, the value chain concept becomes in an inappropriate device with which to analyse many industries today and uncover sources of value" (p. 6). According to Mariotti (2002), a value network is "an interactive combination of information machines, and people" while Peltoniemi (2004) explains that "value networks are concentrated in creating value in each node" and "value network is not seen as bound to certain region - it can even be global" while "companies inside a value network can be parts of different industries". Value network, as an extended concept of value chain, exist within a business ecosystem. A business ecosystem is defined as "the community of organizations, institutions, and individuals that impact the enterprise and the enterprise's customers and supplies" (Teece, 2007, p. 1325). That is to say, a business ecosystem "includes complementors, suppliers, regulatory authorities, standard-setting bodies, the judiciary, and educational and research institutions (Teece, 2007, p. 1325) where a value network of a company nests in.

1.2 Business model and digitalisation

Chesbrough (2007) pointed out that technology innovation can be a source of added value when combined with a good business model: competition takes place on the basis of outperforming business models (Linz et al., 2017). Digitalisation and digital translation are one of drivers that changes the recent industrial structure and the society through the implementation of new technologies based on the Internet (Kiron et al., 2017). Digital technologies improve the performance and the scope of business (Westerman et al., 2011) that changes the organization and the organization's business model: digitalization, as a form of technical evolution, impacts any kind of organization (Rachinger, Rauter, Müller, Vorraber, & Schirgi, 2019). According to Bloching et al. (2015), the digital transformation is both the actor-side adaptation to the digital economy and the continuous interconnection of all business sectors. The digital world is converging with physical world: manufacturing companies, for example, become digital to form an Industry 4.0 (Linz et al., 2017). The Internet of Things (IoT) and digital services are integrated into industrial processes (Kagermann et al., 2013), generating value by better managing and better analysing data that in turn become a source of competitive advantage (Porter and Heppelmann, 2015). Any existing business models can be challenged or can be replaced by new ones (Souto, 2015; Matzler et al., 2016) even for the companies that are dominating the market since new competitors are redefining the established industries with new technologies (Linz et al., 2017).

1.3 Automation technology: human role and responsibility

The research focuses on the role and responsibility of human that is increasingly important to design the social infrastructures of the near future including Information Communication Technology (ICT) infrastructures: wider range of people in the society will benefit from the automated products and services. Automations and human interactions have been studied for different types of piloting such as space ships and aircrafts (McFarlane & Latorella, 2002; Sarter & Woods, 1992). Automations in industrial systems should be designed to take advantage of human factors such as judgment, flexibility, experience, adaptability and motivations while minimizing the possible human errors (Haight & Kecojevic, 2005). Norman (1990) indicates that, as automations can deskill humans and lower their morale, soft and compliant technologies rather than rigid and formal ones are needed. It is similar to the phenomenon explained as loss of expertise by Hoc (2001). In addition to the loss of expertise, Hoc (2001) lists three other difficulties in human-machine interaction: complacency, trust and loss of adaptivity. Complacency, according to Hoc (2001), is when “expert operators, aware of the machines’ limits, can adopt the machines’ proposals although they know that their solutions are not optimal in relation to the actual situation”. Multiple studies (e.g., Layton, Smith & McCoy, 1994; Mosier, Skitka, Heers & Burdick, 1998; Hoc & Lemoine, 1998) have shown the complacency in practice and suggesting multiple proposals of solution can encourage mutual control (Clarke & Smyth, 1993: Layton et al., 1994). The trust issue is another difficulty that exists in human-machine cooperation: it happens, for example, “when the operators have the feeling that the machine is leading them towards a situation they think they cannot manage (Hoc, 2001, p.511)” and the operators end up overriding the machine (Amalberti, 1996; Parasuraman, 1997). According to Hoc (2001), it occurs due to a low level of trust and the operators’ behavior is related to a lack of self-confidence. The fourth difficulty pointed out by Hoc (2001) is loss of adaptivity: “adaptation needs anticipation and feedback. Designers neglect the two when they conceive human cognition as a pure reactive system (p. 511).” Reason (1988) points out that the system designers can badly create a human-machine cooperative situation that damages the adaptive characteristics of human cognition and that may rather transform it into dangerous liabilities.

The augmentation of connectivity leads business process more autonomous and the role of human can be subsidiary in the automated process. This is why the research focuses on human role and responsibility aspects. Human would not interact regularly with the system but rather intervene in it if there is a need. The level of automation would differ depending on the cognition and credibility towards connectivity technologies in the organization. While autonomous technologies are defined as the technologies that do not require human intervention nor human supervision, the autonomous technologies and human role are non-separatable within complex socio-technical systems (Mallam, Nazi, & Sharma, 2020). Myhre, Hellandsvik, & Petersen (2019) suggest to define the levels of autonomy using the concept of human responsibility while claiming that conventional levels of automation are defined using technical capability. The distinction between automation and autonomous will be explained in the following sub-section.

They also point out that the concept of accountability is critical to discuss the autonomy level: "autonomy is inextricably related to the exchange of accountability from an operator to the system designer (Myhre et al., 2019, p. 6)." The research does not directly deal with the accountability issue, but the author develops a part of discussion on this issue.

1.4 From automation to autonomous

The literatures show that the further advancement of automation technologies would change the way of people's work in organization and has potential to induce BMI. The role and responsibility of human can be a key component and that is why this research aims at understanding the state of art of how new Connectivity Technologies are currently redefining the role of human in value creation process. While the main focus of the research lies on the role and responsibility of human in relation with Connectivity Technologies, it seems important to clarify two similar but different concepts: automation and autonomous.

To understand the differences between automation and autonomous, the author cites Xu (2021) that describe differences between automation and autonomy. According to Xu (2021):

> automation is the ability of a system to perform well-defined tasks and to produce deterministic results (typically relying on a fixed set of rules and algorithms). It does not usually replace the human; instead, it changes the nature of the human's work from direct operations to a more supervisory role. For example, on a commercial aircraft, the autopilot can carry out certain flight tasks with pre-setup done by pilots, moving them away from their traditional role of directly controlling the aircraft to a more supervisory role managing the airborne automation. However, in abnormal operating scenarios which the autopilot was not designed for, pilots must immediately disconnect the autopilot and manually intervene to take over the control of the aircraft. Autonomy is the ability of a system to perform specific tasks independently without human intervention in specific scenarios. It may successfully operate under a variety of situations that are possibly not fully anticipated. With AI technologies, they have the capability to perform learning, reasoning, problem solving, and self-adaptation over time, and the results may not be deterministic. (p. 2)

Xu (2021) explains that the key difference between automation and autonomy lies on the ability of the machine to perform specific tasks without human intervention. With the capability of Artificial Intelligence technologies such as learning, reasoning, problem solving and self-adapting, the autonomy can be strengthened. This accords with Cugurullo (2020) pointing out that "the condition of being autonomous is examined from a technological point of view, and it is in the nascent capacity of AI to think and act in an unsupervised manner (p. 2)". They suggest that the human intervention or human supervision is one critical component that distinguishes automation and autonomy. Xu (2021) and Cugurullo (2020) give a clear distinction between automation and autonomy from technical point of view by the existence of human intervention and human supervisory: *autonomy is an extreme case of the automation where no human intervention nor supervision is required for the entire process of a task operation by a machine or a system*. This is an example of how the most recent article distinguishes Automation and Autonomy. One should be careful about what can be *a task* here. The author considers that it is not a simple repetitive job but rather a task here is a job within a dynamic environment with considerable parameters to take into account to accomplish it.

The research stands on this distinction of automation and autonomy. Still, the use of the term automation and autonomy overlaps sometimes. For example, the level of autonomation in major categorisation such as in BASt, SAE and NFAS signifies how the concerned automation technology is close to the (fully) autonomous technology. In the same way, the term partial autonomy is used (e.g., Abidi, Eason & Gonzalez, 1991; Shiomi et al., 2008) to describe an automation technology emphasizing that less human intervention or less human supervisory is needed as compared to the similar conventional technology or product. It should be noted that there is still a discussion on the definition of autonomy (e.g., Myhre et al., 2019).

The literature review section above overviewed academic discussion relevant to the research. The further advancement of automation technologies would change the way of people's work in organization and has potential to induce BMI. The role and responsibility of human can be a key component and that is why this research aims at understanding the state of art of how new Connectivity Technologies are currently redefining the role of human in value creation process. Some literatures on the automation and autonomy are presented so as to better understand the differences between two concepts.

The following sections explain the research question, methodology, case description, results and discussion.

2. Research question

The research question is two folds:

1. How the human role is redefined by the introduction of connectivity technologies?
2. What are the impacts of these redefinitions on business model of organizations?

By answering these questions, this research aims at understanding how the introduction of Connectivity Technologies changes human roles in value creation process.

3. Methodology

The research takes qualitative and explorative approach to address the research questions. The author conducted an explorative field survey in Japanese cities (Tokyo, Maebashi and Fukuoka) for four weeks (March – April in 2020) to study different types of mobility service projects that integrate newly developed Connectivity Technologies (CTs). The five case projects that the research demonstrates is selected among the use cases (or pilot projects) of CTs in commercial usage in mobility service sector whereas human and machine/system work together. The author identified about ten such projects in Japan and the author could obtain opportunities to conduct interviews with project managers or people who knows well about the projects. To obtain the opportunities, the author had practical supports from Dr. Soichiro Minami of Policy Research Institute for Land Infrastructure, Transport and Tourism (PRILIT), and Dr. Hidetada Higashi, associate professor at Yamanashi Gakuin University. The interviews were conducted with an interview guide with some concrete questions on A) the overview of the projects, B) the technological aspect of the project and C) the aspect on human role change. For the technological aspect and the human aspect, the author principally addressed following three questions:

- What are the new technologies used in the organisation to provide a mobility service?
- What kind of human interventions are still required to provide the mobility service?
- Why do those human interventions remain in the process?

Here is a brief description of five case studies. The detailed descriptions will be given in the next section: case description.

Case 1) The first case is an autonomous bus pilot project in Maebashi city. The author visited the site in March 2020 where two autonomous buses operate to provide a shuttle service for passengers between the central station of Maebashi and a shopping mall: Keyaki street shopping mall. The author interviewed the project manager for about 90 minutes. For the first 30 minutes, the author conducted interview while taking the autonomous bus with the project manager focusing on practical learnings during the pilot project. For the last 60 minutes, the author interviewed the project managers covering wider range of questions in terms of the implementation of autonomous driving technologies and its development.

Case 2) The second case is Uber Japan, focusing on the initial phase of its service development in Japan: the service was initially launched in 2015 in Fukuoka and the diffusion of the service faced different challenges. The interview was conducted on-line for about 2 hours with two other researchers mentioned-above in March 2020. The author used the application six times in Japan so as to better understand its functions and usability.

Case 3) & Case 4) The third case is "on-demand bus"[6] pilot project in Fukuoka and the fourth case is a multimodal itinerary search platform. The third case and the fourth case are implemented by Nishi-Nippon Railroad Company, Ltd also known as Nishitetsu. For the fourth case, Nishitetsu is one of the main actors of the deployment of the platform. The author interviewed a project manager of the on-demand bus project and a strategy manager of the company in March 2020. The author visited the area where the on-demand bus circulates. The author used the on-demand bus three times so as to better understand its functions and usability.

Case 5) The fifth case is a mobile phone-based transport route recommendation system developed by a start-company, Scheme Verge. The author conducted an interview with the CEO of the company in February 2020.

These cases are examined through a mere observation and a few interviews to the managers of the service due to limited research resources (mainly time, budget and human resource) but the field survey and on-site observation, though limited, enables the author to gain much more insights than a mere desktop literature survey and the case descriptions and results are faithful to the facts of the real operation.

4. Case description

4.1. Autonomous bus

In Maebashi city, Nihon-Chuo bus company runs two autonomous buses in corporation with Maebashi city and Maebashi University as a pilot project basis. This is the most recent autonomous bus project in Japan as in March 2020. The operation is principally regulated by police authority: a local police permission is required to run the project since it concerns a new type of vehicle on the public road. The local police permitted this pilot project on condition that a license holder of professional bus driving should keep holding steering wheel during the operation so as to be able to take over the control

[6] The author respects the original name of the project "on-demand bus" while they in fact use 8-passsenger van and it should rather be called as a "on-demand shuttle" service. The name on-demand bus is officially used since "shuttle bus" in Japanese signifies a bus (or a van) that repeats a round-trip between two (or a few) destinations. This projects has more than 10 bus stops and the word "shuttle" does not fit to the local usage of the word.

whenever necessary. In addition to it, the operation of doors is also taken care manually. In this sense, the bus operation is not fully-autonomous. The operational situation is monitored in a control centre in remote place as well and one another staff is monitoring the operation of the two buses. According to the project manager, the operation is expected to be supervised only by this remotely-located personnel in the future.

The novelty of the project lies on the autonomous bus driving itself. According to the project manager, there are less and less bus drivers especially in non-urban areas in Japan due to the aging society. Young people prefer to work in city while there are many elderly people staying in rural and sub-urban area where buses are the only mean of public transport. Reducing the roles of the drivers is an important added value of the autonomous bus driving system since it enables to operate bus service with less human resource. Reduction of operation cost is also expected.

The autonomous bus service connects two places: Maebashi station and a shopping mall. The bus runs relatively slow speed around 30 km/h. During the operation, the human driver visually checks the safety situation of the road. If the human driver finds any issue, the human driver immediately takes over the control of the bus. According to the project manager, turning at a junction requires a most attention while changing lanes is smoothly done by the system most of the time.

4.2. Taxi dispatch online platform

Uber is a mobile-based taxi platform application firstly developed in U.S. then introduced to Japan. The main value propositions of the service are on-line booking, dynamic pricing, ride sharing, traceability of trip route and utilization of non-taxi drivers and non-taxi vehicles.

In Japan, Uber Japan tried to deploy its service firstly in Fukuoka in 2015. However, the launch of the service was not successful due to strategical failure. Uber Japan underestimated the repellence of local actors especially local taxi companies and employees.

As in March 2020 in Japan, taxi on-line booking service is provided by several different companies such as Japan Taxi, Grab, Didi and Kakao taxi. These applications also have traceability as a value proposition while none of them provide other three value proposition of Uber: dynamic pricing, ride sharing and utilization of non-taxi driver and non-taxi vehicle.

For conventional taxi service, users need to locate a taxi stop or need to call a taxi company so as to find a taxi. While waiting for a taxi, the user is not sure when the taxi arrives or who will come as the taxi driver. Uber, and other on-line taxi booking services, remove this anxiety. The users can track the location of the coming taxi visually on the map of his/her smartphone. The price of the service can be verified on the mobile application as well. This ensures the clarity on the price between the driver and the user. Conventional taxi service commonly has a night price that is higher than daytime price. Uber introduces dynamic pricing to determine the taxi service fee. When the demand is high, the price raises up while the price becomes low when then demand is low. With this dynamic pricing system, a sudden rain shower can change the price since the demand towards the taxi service augments, for example. It is possible since the online platform enables to reflects the real-time data to the price by using real-time demand supply data.

4.3. On-demand bus (On-demand shuttle)

Nishitetsu recently started engaging itself into two mobility service projects: on-demand bus service (Know-route) and a mobile-based multimodal itinerary search platform (My-route). This section explains on Know-route. Know-Route is an on-demand bus service in a residential area in Fukuoka city. With a fixed ticket fee and pre-fixed embarkment points (= bus stops), the service offers a mobility service that is similar to ride-sharing taxi: which is currently forbitten by regulation in Japan.

Users select a convenient bus stop and a destination on the mobile-application. The system calculates an optimal route for a bus to pick-up and drop multiple users. Since there are several buses in operation in the area, the system optimally matches buses and users. According to the project manager, the company expects to optimize the number of bus and driver by offering this on-demand bus service in place of conventional scheduled bus service. The bus vehicle used for this service is an 8-passenger van. The flexibility of route choice enables the buses to avoid traffic that eventually benefit each user. The payment is done manually while the company envisages to introduce automatic payment system in the future.

The on-demand bus becomes possible thanks to the mobile-based application that integrate the real-time ride request of users so as to calculate optimal route each time a new request arises. This service is similar to ride-sharing taxi but the price and bus stops are pre-fixed.

4.4. Multimodal itinerary search platform

The other service that Nishitetsu develops in corporation with other mobility actors such as Toyota Motor Company and Japan Railway is My-route. My-Route is a MaaS application that enables users to search multimodal itineraries and daily practical information such as parking availability and shop/restaurant information. The development of the application is mainly led by Toyota and Nishitetsu remains as a local partner. Still, since Nishitetsu owns and operates both train and bus network in the region, it plays an important role on the application platform. The data on the application such as time table and restaurant information are registered manually while the system automatically calculate the itinerary that users search for. The data that are manually put by human and the system are complemental components that constitute the service.

4.5. Tourism route recommendation system

Horaï is a mobile-based application specialized for visiting distributed sightseeing spots in Setouchi region in Japan. This application enables users to search multimodal itineraries and book tickets for the trip. According to the CEO, planning optimal itinerary is a pain for tourists especially when touristic sites are geographically scattered. It was the case in Setouchi region where many touristic places are distributed on small islands of the Setouchi region. This application provides a solution to it. When a user chooses touristic places on the mobile application, the system suggests several possible itineraries taking transport time and visit time into consideration. The user can easily see the trip plan and choose one so as to see the booking details. As in March 2020, users cannot buy ticket directly from the mobile application while the company is trying to have this feature in near future.

The novelty of this service lies on the automation of trip planning taking both transport time and visiting time into consideration. Ordinary search engines only provide transport information and people need to plan the tour schedule dealing with multiple parameters such as transport timing, visit time and price. With this mobile application, the scheduling of a trip in this region become simpler and, according to the author, it increases the touristic attractiveness of the region.

Through the data obtained from the uses' trip information, the company accumulates knowledge on users' point of interest (= where users stay longer). Using this knowledge, the application can now categorize users differently so as to provide personalized recommendations of visit to user, according to the CEO. The identification of different categories is done manually as in March 2020. Also, based on the accumulated data, the company can give a demand forecast of transport service and touristic site. The demand prediction can be much more comprehensive than that of the accumulated data of a single transport service or a single touristic site.

On top of that, since the capability of mobility (number of buses, taxis and ships for example) is limited, controlling demand rather than predicting demand is an important element for the management of local transport, according to the CEO. The application can soon be able to contribute on this aspect by recommending itineraries optimized among tourists.

5. Result

Based on the empirical data from the field survey, this section explains the result of the research. The research question was two folds:

1. How the human role is redefined by the introduction of connectivity technologies?
2. What are the impacts of these redefinitions on the business model of organizations?

In this section, the author gives a primitive answer to these questions based on an explorative survey.

5.1. Changes in human role by the introduction of new technologies and system

The author observed two different types of technological applications where the nature of human role changes is different. The first type is when the technology replaces the role of human that is the core in the business process and human roles become subordinate to the main function of the introduced technology. The case of autonomous bus falls into this type. After installing the autonomous driving system to the bus, the human roles become the ones to support the appropriate function of the system such as safety check on the nearby traffic situation by a bus driving license holder or monitoring the operational situation from remote place. The second type is when the technology is introduced to support the role of human in creating the core value of the business. The case of taxi dispatch online platform is a representative case. The system facilitates the use of taxi service that the core value of taxi service is still left as a principal role of taxi driver.

There is a hybrid case as well where the technology and human are complemental to each other to create a value in the business process. Transport route recommendation system is a representative case. The system uses relevant data to suggest a route recommendation where the practical real-life data is collected and updated regularly by human.

Case of autonomous bus

The first case is an autonomous bus pilot project in Maebashi city. According to the field observation, the application of autonomous bus driving system is a technology-centric introduction. The author perceives that the core value of the service is to carry passengers from a place to another place by moving a bus. This core value of navigating is principally replaced by the introduced technology.

A human role replaced by technology is driving: it is replaced by the autonomous driving system. Conventionally, one of key roles of bus driver is driving: in the sense to move the bus from a starting point to a destination. This role is replaced by the driving system. The driving system operates the bus on the road to move the bus on pre-programmed route so as to go to the destinations. The system takes the main control on the steering while an assistant driver on the driving seat is ready to take over the control whenever unexpected situation occurs. While an assistant driver still sits on the driving seat for the pilot project so as to react to any emergency situation, the project manager envisages replace the assistant driver with a remote supervisor in the future. A remote supervisor is a person located in a control centre where s/he can supervise and control the operation of the bus remotely. The project manager plans to make a system that enables one remote supervisor to take care of more than two buses so as to increase the ratio of vehicle to human.

This implicates that safety control is not completely replaced by the technology. To support the operation of the autonomous bus, human takes a subordinary role in safety control to ensure the safety in driving and the security of passengers. The safety in driving becomes a shared role taken care by both human and system and the monitoring of passengers' security remains as a human role. While the role of human in safety control is subordinary to the system in terms of ratio, it seems necessary for human to take part of and to overtake the control at the situations irregular to the system.

According to the author, apart from daily operation, other backyards work remains as human role such as routing, vehicle maintenance and cleaning. Routing of bus remains as a role of human after the introduction of autonomous bus driving system since it requires to combine different types of parameters to design: the routing, the locations of bus stops, is decided based on the estimated demand for transportation, for example. Vehicle maintenance and cleaning remain since it is a complicated enough as a job to be replaced by robotics or even if it is possible, it would be far more expensive than letting human do the same job.

Case of taxi dispatch online platform

The second case is a taxi dispatch online platform: Uber. According to the author, the application of taxi dispatch online platform is a supportive introduction of technology. The author perceives that the core value of the taxi service is to carry passengers by driving a taxi from a place to another place. This core value of driving is kept by human while the introduced technology facilitates the drivers to offer the service. The human role of driving remains in this case since the introduced system is not designed to replace it but rather to support it.

One of the main roles of the introduced technology is to match users to a taxi via online mobile-application. This is conventionally served as a supplemental service by taxi company or taxi driver by using telephone and wireless radio transceiver, or otherwise, users used to find a taxi on the road or at a taxi stop. However, matching users and taxi is not the core value proposition of the taxi service. Users do not pay money to the matching when using conventional taxi service; users pay money to the taxi service as the taxi move the passenger from one place to the other. In this sense, the introduced technology plays a subordinary role to the core value proposition of the taxi service. The core value of the service is created by human driver. Another role of the introduced system is to decide service price and routing. The application mobilises dynamic pricing to determine the fee based on the real-time balance between the demand and the supply. Dynamic pricing was not provided in Japan by conventional taxi service except for an additional fee during night time. Dynamic price determination is enabled thanks to the online platform that integrates real-time demand supply information and reflects it to the price. The routing is another role taken by the technology. Based on real-time traffic information, an optimal route is suggested by the system to the driver. The driver does not necessarily follow the instructed route. The trajectory is registered to the system and it can be reviewed after the ride. This improves the traceability and the users can verify if the route taken by the driver was optimal or not and if the driver intentionally changed the route so as to increase the service fee.

Case of on-demand bus[7] (on-demand shuttle)

The third case is an on-demand bus service provided by Nishitetsu in Fukuoka. According to the author, the application of on-demand bus system is a supportive introduction of technology. The author perceives that the core value of the on-demand bus service is to carry passengers from one place

[7] The author respects the original name of the project "on-demand bus" while they in fact use 8-passsenger van and it should rather be called as a "on-demand shuttle" service.

to another place. This role is still played by the bus driver. The role of the introduced system is subordinary. Like as the previous case, the human role of driving remains since the introduced system is not designed to replace it but rather to support it.

The role of the system lies on the optimal route calculation based on the real-time demand information. For the conventional bus service, the bus route is pre-determined by the company. The system now uses a new data set, real-time demand information, so as to calculate its route. This enables the bus to avoid doing unnecessary move. It is nevertheless the role of human to pre-determine the location of bus stops. This is not a technological issue. According to the project manager, it is impossible to operate a bus service in Japan without determining bus stops prior to its operation. This is a regulation limit. To be more precise, it is not yet possible in Japan to have a ride-sharing service and if the bus operator provides an on-demand bus service without pre-determining the location of bus stops, the service is considered as a ride-sharing service that is prohibited in Japan, as in March 2020 and still in October 2021. There is an additional role of human due to the introduction of the system: passengers need to use its mobile phone to inform the system about its ride. Each passenger needs to inform the system, via its mobile application, about its itinerary: from where to where the passenger wishes to travel.

Case of multimodal itinerary search platform

The fourth case is a multimodal itinerary search platform. The users can search daily information of the city relevant to the mobility such as train time table, optimal itinerary and parking availability as well as restaurant, shopping and event information. According to the author, the application of multimodal itinerary search platform is a hybrid introduction of technology that human and technology share its roles. The author perceives that the core value of the system is to provide the itinerary information based on the request of users. To achieve this, on one hand, data set relevant to transport such as time tables, parking availability and cycle availability are collected and registered by human. Other information such as local restaurant information and local event information as well are collected and registered by human. On the other hand, the search engine system suggests the itinerary that correspond to the request of users. Both human effort and system are critical for the core value creation process. Since this is a new type of service, there is no human role replaced by the system. However, it is noteworthy that both human role (collecting local data and updating them) and the system's role (searching from data base and suggesting optimal itinerary) are equally important in value creation process.

Case of tourism route recommendation system

The fifth case is a route recommendation service for tourism. The mobile-based application is designed to facilitate the tourism in Setouchi region in Japan where touristic sites are scattered in different islands. The tourists need to use ships and taxis to visit around the area. However, the number of ships connecting different islands are limited and it is bothersome for the tourists to plan itineraries over some days taking the timetable of ships in consideration. The mobile application suggests some optimal tourism plans when the user register the touristic site that s/he wants to visit. The CEO told the author that on-line booking of different modes of transport such as ships, taxis and buses as well as hotels and museums will be possible in future. According to the author, the application of tourism route recommendation system is a hybrid introduction of technology that human and technology share its roles. Like as the fourth case, information on hotels, museums and events are kept up-to-date by human. Also, the system is designed to learn users' preference of tourism, so as to suggest additional touristic site suitable for each user. This algorithm on the preference is maintained by human so as to ensure the quality of the suggestion. The role of the system is also important as the system calculate optimal travel plan considering different parameters. Since this is a new type of service, there is no human role replaced by the system. However, it is noteworthy, like as the fourth case, that both human role (collecting local data and updating them) and the system's role (searching from data base and suggesting optimal itinerary) are equally important in value creation process.

According to the CEO, there is one important mobility issue to tackle that the tourism in this region faces. Since the number of ships that connect islands is limited as well as the taxis in each island, predicting demand is not enough to provide satisfying travel experience to the users. The CEO told to the author that it is critical to develop a system that can control the demand of users so as to flatten the peak demand and distribute the tourists to the days and weeks with less demand. This benefits local tourism site: this reduces opportunity loss and increase the total number of tourists over a year.

Table 2. Changes in human roles in value creation process (5 cases synthesis)

Case	**Human role in value creation become/stay**	**Remaining human roles in value creation**	**Replaced human roles or Newly created human roles in value creation**
1 Autonomous bus	Subordinary	Safety control	Driving is replaced
2 Taxi dispatch online platform	Core	Driving	NA
3 On-demand bus	Core	Driving	NA
4 Multimodal itinerary search platform	Hybrid	NA	Data collection and registration are newly created as human roles
5 Tourism route recommendation system	Hybrid	NA	Data collection and registration, and curating touristic site information are newly created as human roles

5.2 Four human roles expected to remain

The author, based on empirical observation, claims that there are, at least, four roles of human[8] that continue to remain: 1) the designer (of the system or of each technological component), 2) the fine-tuner (of parameters so as to maximize the output value of Connectivity Technology system), 3) supervisor, and 4) the enhanced operator. These are the roles in value creation process that enables the service to be offered to the users and the author does not include users or beneficiaries of the service themselves as roles here.

The designer is a role in designing a service with Connectivity Technologies. Human needs to work to decide how to integrate technologies in the service so that the service functions as a whole. This role cannot be replaced by technologies while it can be enhanced by technologies in future. Similarly, the fine-tuner role cannot be replaced by technologies. The fine-tuner is a role in fine-tuning parameters after the implementation of a service and a system. These parameters are not only quantitative parameters but they include qualitative aspects such as how to improve the security of users and how to improve the service so that it becomes more comfortable etc. Those adjustments are continuous and repetitive works that human needs to take care of and that technologies cannot replace while, again, it can be enhanced by technologies in future. The third role is the role of supervisor. This is more responsive work than the fine-tuner. The supervisor needs to react when any unpredictable situation occurs during the operation. Even after the deployment of autonomous technologies, any unpredictable events can happen at any moment. To deal with the emergency situation, the role of supervising should remain as huma role. The last human role is the enhanced operator. This is a human role that uses the software or hardware technologies to enhance the performance of existing human role. Uber drivers, for example, are enhanced operators: their ability to search users is enhanced by the system. Another example can be a human-worker with a power-suit. The robotics technologies enhance the ability of human but they do not replace the role of human. These are the examples of the human role of enhanced operators.

In addition to above-mentioned four roles, while the introduction of technologies sometimes replaces human role, it also creates new human roles not limited to engineering (= developing and maintain the system): it also creates non-engineering roles that requires the understanding of human. For example, “how to control the demand of tourism in a region by giving tourist the information and incentives via mobile application?” is a question that is not purely engineering since human considers different parameters such as the weather, the colour change of trees in forest, trends on the Internet etc. Since these parameters are linked to human emotion and not strictly dealt with numbers unlike economic

[8] The author does not mention maintenance while he is aware of its importance and it can also be a domain where human role would remain. The author does not mention it since he did not observe it during the field survey.

benefit, knowledge on behavioural psychology, for example, shall be mobilised to design and operate the system.

In addition to this, “how to distribute the vehicle control between human and machine when operating partially automated car?” can re-question the role of human as it has some particularities: taking-over control, partial surveillance and diffed attention.

5.3 Impacts on business model

The introduction of Connectivity Technologies modifies or newly create business models. Based on five observed cases, the author observed three different types of changes in business model when it come to the changes in core value creation process. These three types are not strictly distinctive but each of them has its own characteristics. This part can be an important original conclusion of this paper.

The first one is when **the automated system becomes the source of core value creation by replacing human role**, the second one is when **the human stays as the core value source**, and the third one is **the hybrid**. The author describes them in detail below in sub-sub section (1), (2) and (3).

In either case, it is important to note that the company that develops a new technology does not necessarily become the initiative company of the value offering. For example, the case of autonomous bus tells us that the bus service operator will retain its liberty to choose the vehicle model and therefore the manufacture of the autonomous bus remains as a mere supplier of vehicle. The business model does not change significantly except for the fact that the drivers are replaced by the system.

On the other hand, the case of Uber tells us that the development of supportive technology can be a way to obtain a dominant power that radically change the business model. Here, the author supposes that the scale advantage as well as technological maturity plays an important role.

The message here is that the centrality of a new value creation and the centrality of business initiative that enables the new value creation are two different focuses.

When the system creates the core value and the human plays supportive roles (= role replacement)

The representative example of the case that the system becomes the centre of core value creation is autonomous driving bus. When considering the core value proposition of a bus service is to provide a mean of transport: the vehicle management and the driver management are two core processes for the value creation. By introducing autonomous driving system, the driver management will disappear from the value network of the bus service provider. Moreover, since the role of driving is taken care by the system and therefore by the autonomous bus manufacturer, the driving is now out-sourced. The core added value of bus service provider, providing a mean of transport, is now taken care by the manufacturer. The manufacturer takes the core added value of bus service provider by developing and manufacturing autonomous driving buses.

This does not indicate that the autonomous bus manufacturer, or more precisely the autonomous system developer, takes advantage on bus service. Since the bus service provider possesses its local business right, the provider maintains its business initiative that chooses the best product supplier. And therefore, the business model of the bus provider does not change significantly.

In terms of vehicle management, the daily operation management such as scheduling stays as the principal work of the bus service provider. On the contrary, the autonomous bus developer will engage into the development and the maintenance of autonomous driving system and autonomous vehicles.

As a result, while the system replaces the role of driver (and the source of core value proposition is replaced by the system) the service provider remains as the initiative actor in providing the service backed by the local business right.

When human remains in the centre of value creation and the system plays supportive roles (= slight role modification)

A representative example of the case that the system remains to serve supportive roles is Uber. The system serves to match the taxis (: as pairs of driver and vehicle) and taxi users. If we consider that the core value proposition of a taxi service is to carry passengers from its departure point to the destination, the Uber's system does not replace the core value creation process. The system is introduced to supports the taxi drivers to find users and vice versa. Though the technology plays subordinary role to the core value creation: carrying passengers. Uber is a company independent from the conventional taxi companies and the introduction of the on-line platform changed the business ecosystem of the taxi industry. This situation also applies to the case of on-demand bus service. The new system does not replace the core value proposition of the bus service, carrying passengers from a place to another place. However, it has potential to change the business model of the conventional bus service: unlike conventional bus service, the bus company only needs to provide the service when demanded and it does not need to provide unnecessary trajectory without passenger. Both cases are the case of supportive introduction of technology and the Connectivity Technologies does not replace the human role of providing the core value. However, its impact on the business model is much more significant than the autonomous driving system, for example, that replace the human role in core value creation.

Hybrid case (= role modification)

The research also observed two cases where the system and huma both contribute in creating the core value proposition: the multimodal itinerary search platform and tourism route recommendation system. For those cases, while the system plays important role in searching information and providing an optimal itinerary information to the users, the role of human in updating the database is also critical for the core value creation.

These two cases do not tell much about the impact on the business model since it is rather a new type of service: the author cannot clearly tell the service that is impacted by this new service or that can be considered as a precedent one. However, these two similar hybrid cases demonstrate that the local information can be a source of competitive advantage of a business model after the introduction of new technologies. While previous three cases of autonomous driving system, on-line taxi dispatch platform and on-demand bus demonstrate that the new technologies can be a source of competitive advantage of a company, the last two cases indicate that the possession of local information can be a unique capital that can be a non-technological competitive advantage.

The hybrid case is the case where the role of the system and human are complementary. Beyond that, the hybrid cases tell us that non-technological element, in this research it is a set of local information, can be unique source of value.

6. Analysis and discussion

6.1 Maximizing performance: two different strategies

The autonomous driving system and autonomous bus have potential to totally replace the human role of driving. It is a radical change in terms of the share between human role and the role of technology. However, when it comes to the business model, the autonomous driving system does not change the business model of the conventional bus service radically. It is rather the introduction of on-demand bus platform that has potential to radically change the business model of conventional bus service; it does not radically change the role of human.

The degree of change in human role and the degree of change in business model are two different things and do not necessarily correlate. This is the first analysis on the impact of human role change and value creation change on the existing business models.

Human roles remain, and so does the question of how to integrate the technologies

In addition, even a new technology replaces the human role in core value creation, the entire role cannot be replaced. Based on the observation the autonomous bus, even the autonomous driving system replace the human role of driving, the role of supervision remains. This indicates that even the advanced Connectivity Technologies are integrated into the value network of a company, the new technologies cannot cover the entire value creation process and therefore the integration always remains as a partial phenomenon. The human factors keep existing in the value network of a business model and therefore it is important to keep how to integrate the technologies fitting to the existing value network and existing human resources.

Maximizing performance

If the human roles remain in the value network, it is critical for service providers to think human resource strategy and organisational strategy. In the result, there are three types of changes in business model: 1) system creates the core value and the human plays supportive roles, 2) system creates the core value and the human plays supportive roles, and 3) the hybrid case.

For the first type where the system plays the central role in the core value creation, the role of human is to support the operation of the system. The role of human is to support the system to maximise its performance. For the second type where the human remains to create the core value, it is the role of the system to support the human to perform at his best.

For example, the taxi dispatch on-line platform supports the drivers to perform better by providing the automated system in searching users and in the payment. Because of this, drivers have less work in searching users and s/he can focus on the core value proposition: driving. This is a representative case where the technology maximises the performance of human. On the contrary, the autonomous bus project is a representative case where the human maximises the performance of the system. The project can be seen that the human roles such as supervising and vehicle maintenance are there to support the optimal operation of the autonomous bus.

The author estimates that the best and optimal integration of technologies in the value creation process is when the system maximises the performance of human while the human supports to maximise the performance of the system. If this complementary situation is the ideal state for the social implementation of new technologies, mobility service providers need to formulate the human resource strategy so as to properly prepare its organisation to integrate new technologies optimally. Not only business strategy or technological strategy, human resource strategy and organisational strategy need to be aligned so as to better compete in changing environment.

6.2 Classifying technologies taking human factor into consideration

In the result section, the author demonstrated that there are three types of changes in business model: 1) system creates the core value and the human plays supportive roles, 2) system creates the core value and the human plays supportive roles, and 3) the hybrid case. Based on this, the previous subsection discussed that the degree of change in business model and the degree of change in human role do not necessarily correlate.

Here, in this subsection, the author suggests to have a different perspective on the categorisation of Connectivity Technologies: a categorisation taking human factor into consideration. This conceptual framework is a primitive idea that is inspired by the idea of *human centricity* suggested by the director of the frontier research centre.

The author points out that the use of Connectivity Technologies can be classified in three categories depending on its relationship to the human. The first one is the group of technologies that function when the human orders to the machine. The author labels it as *servant* technology in this discussion. An example of servant technology is an ordinary car. A car drives when the drivers operate it and an ordinary car does not drive by itself. The servant technology is always under the control of human and human always takes decision about the machine. The second one is the group of technologies that function when the system detected that an intervention by the machine is required. An example of this technology group is a Collision Avoidance System (CAS) of a car. The CAS is activated when the system detected a situation where a braking is necessary. The author labelled this type of technology as *guardian* technology. The system stays responsive so that it can take over the control of the machine whenever necessary. In this sense, the technologies in this category **do things in the place of the user**.

The third group of technology is labelled as *God's view.* An example of this technology is a navigation system. A navigation system suggests the users the best route among many possible driving routes. While the navigation system calculates the optimal route considering traffic situation and other parameters such as highway tollgate price, the system executes all these as background task. Another example of this type of technology is dynamic pricing. The system takes demand information, supply information and traffic situation to calculate the price but users do not perceive the calculation process. It is different from guardian technology since the God's view technology aims at overall optimization while guardian technology rather aims at partially optimalisation. In addition to this, God's view technology only **suggests to do something** and the user retains the choice to follow or not to follow the suggestions while the guardian technology takes over control of machine/system.

Below is a possible benefit in categorizing technologies in this way. This hypothesis should be further verified with more empirical researches. By categorizing technologies like this, the author supposes that *the technologies in different categories shall be developed under different principals when developing it*. For example, the servant technology needs to be designed to keep attaining human's attention and the guardian technologies cannot make any mistakes as it may lead to fatal situation while for the God's view technologies, total efficiency is more important against small details.

It should be mentioned that this categorisation is based on the observation done through five case studies. More research should be carried out to address different elements such as activeness and passiveness of the control-takeover by machine/system. The focus of the categorisation given here is more on the logic of local and global.

Figure 1. Classifying Connectivity Technology from Human factor perspective

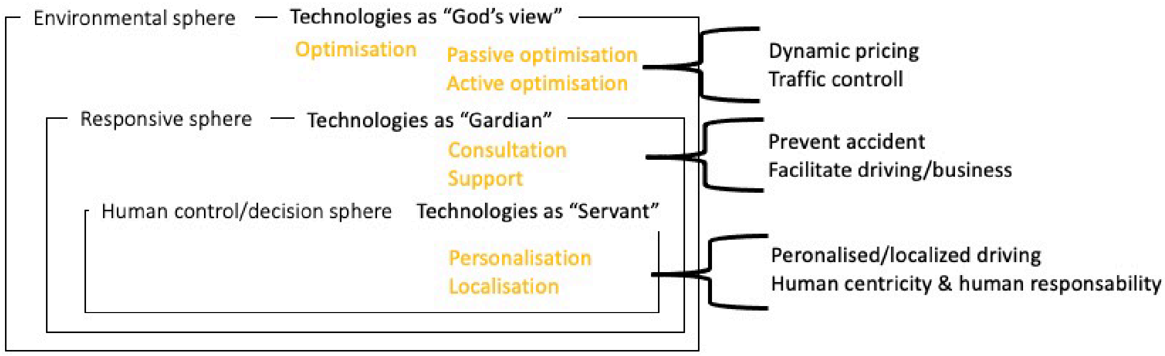

Figure 1 shows a hypothetical classification of Connectivity Technologies (CTs). The outer squire (Environmental sphere): optimization is a function of CTs. Optimization is generally done behind the system and users do not see the process. For users, it looks like an "invisible God" control the environment. The middle squire (Responsive squire): consultation and physical support are functions of CTs. Those are generally decided by the system and users receive the benefits from the system. Since users are not necessarily be conscience about the calculation behind, it looks like a "Guardian" gives consultation and support to users. The inner squire (Human control/decision sphere): there are functions of CTs that only be activated when users command it to do so. For users, the system looks like a "Servant". Still, while users have most control over the system, some personalized and localized actions can be taken by the system.

6.3 Ecosystem-level business model and data management

Apart from the discussion on the business model and human role change, the research gives insights on the value of local information and data. The cases of multimodal itinerary search platform and tourism route recommendation system tell that the location of data (or more concretely "who possesses the local data") can be an important factor that impacts the business model when introducing Connectivity Technologies. Also, the case of on-demand bus service and taxi dispatch on-line platform indicate that the real-time information on "mobility demand and supply balance" can be an important data set to possess.

Four cases out of five studied cases show the importance of local real-time (or up-to-date) information both on mobility and relevant activities such as shopping. However, a mobility service provider does not always have access to the local data to develop a new business model. To develop a new business model with Connectivity Technologies, securing access to the local data can be a challenge. Here, the author claims that, based on the cases of tourism route recommendation system and multimodal itinerary search platform, it is critical to collaborate with different local actors so as to enrich the accessible data. If a mobility service provider wants to develop a competitive advantage in the region, the collaboration with local actors is inevitable not only for political reasons or for technological reason, but also for the reason of data availability. The local data can be a source of competitive advantage when combined with Connectivity Technologies.

For a smooth collaboration with the companies that possess the local data, it is critical for a mobility service provider to propose a business model at the level of ecosystem so as to convince the local actors to provide necessary data.

6.4 Importance of memory for accountability within the value network

Myhre et al. (2019) call for several future research orientations in accountability as is mentioned in the literature review. Myhre et al. (2019) state that one important question is "how accountability should be transferred between humans and autonomous systems, both practically and formally". Furthermore, Myhre et al. (2019) raises following questions: "how accountability should be handled or split between sub-systems from a wide range of suppliers. Also, one might need to consider investigating split accountability between an operator and a system, and how this potentially differs depending on whether the operator or the system holds the initial overall accountability (p. 8)."

Figure 3 Interactions among Connectivity Technologies and humans

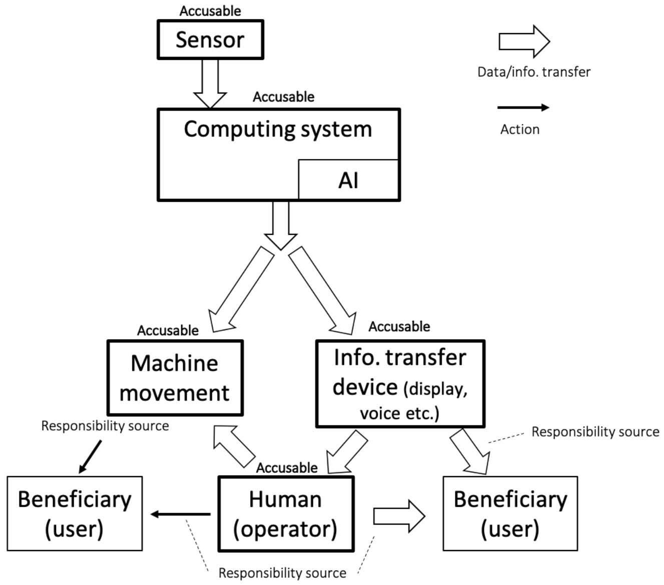

Figure 3 is a simplified model of interactions among Connectivity Technologies and humans. Connectivity Technologies include technologies of sensing, computing, data transfer, human interaction interface and machine controlling, as defined in the introduction. In the figure 3, sensing technology corresponds to sensor, computing technology corresponds to computing system and Artificial Intelligence (AI), data transfer technology corresponds to a large arrow, human interaction interface corresponds to information transfer device and machine controlling technology corresponds to machine movement.

Data collected by the sensor is transferred to computing system. The processed data are used to control a machine for the beneficiary (user, on left bottom) or are used to transfer information to the beneficiary (user, on right bottom). In some cases, the processed data are used to transfer information to human – operator – who operates machine for the beneficiary (user, on left bottom) or directly serve to the beneficiary (user, on right bottom).

If both human and machine are responsible to an action executed, the responsibility of an action can eventually be traced back to either the Connectivity Technologies or to the human - operator.

It was pointed out by Myhre et al. (2019) that the responsibility (or accountability) of technologies can eventually be taken by the designer. Here, the author points out that there can be **multiple designers** since there are multiple technological components (sensor, computing etc.) of Connectivity Technologies. The supplier of each technological component can be different and therefore, it is essential to think how the responsibility or the accountability is transferred from one object to the other and share among the entire process.

And, in order to trace the responsibility, accountable data should be registered at each step of data transfer or action. As a consequence, the author claims that the discussion of accountability is closely related to the implementation of recording devices both for data transfer and actions.

Conclusion

Based on the result and discussion, the author concludes this working paper with five primitive arguments.

Firstly, the empirical study shows that the introduction of new Connectivity Technologies changes human role in organisations, yet does not eliminate human role from value creation process. Even the most advanced autonomous technology only replaces a human role partially and not entirely. This implies that there is still a space to better design the integration of new technologies in the value creation process considering huma factors.

Secondly, the implementation of Connectivity Technologies changes the value creation process of business models. However, replacing the core value proposition does not necessarily result in a radical change in the business model (c.f. case of autonomous bus). Rather, a supportive introduction of technologies has a potential to result in changing the business model radically (c.f. case of taxi dispatch on-line platform). The author claims that it is important for technology developers to clarify if the focal technology addresses the core value creation of a business model or it rather addresses non-core value creation process so as to assess the business potential of the focal technology: even the focal technology is a sort of automation or autonomous technology, it does not directly implicate that the technology replace a core value creation process within the value network.

Thirdly, since the types of change in human role vary according to the way the technology is integrated in the value creation process, the author claims that a classification of technologies based on human-technology relationship can be of use to better understand the nature of the technology in practical application. Rather than classifying Connectivity Technologies from technological perspective, such as sensor technologies, robotics technologies and computing technologies, the author suggests to classify them differently as suggested above (c.f. table 1). The table 1 is a primitive trial of such classification by the author based on the insights from the empirical study. Better conceptualisation may emerge with more empirical studies.

The fourth point is that the integration of Connectivity Technologies into the value network calls the concerning companies to rethink their human resource strategy and organisational strategy beyond business strategy and R&D strategy. Connectivity Technologies change the required roles of human in value creation. While some roles remain, some roles disappear. This paper suggests that there can be two different strategies in Connectivity Technologies integration: one is putting technology at the core of value creation and the other putting human at the core of value creation. For both cases, rethinking HR strategy and organisational strategy is inevitable so as to maximise the business performance.

The last point is on the data possession and local stakeholder management. In order to secure access to the local data that are critical for mobility service providers, developing ecosystem-level business model is one of important action so as to obtain the collaboration of local stakeholders.

Annexes

Annex 1

Here are some notes from empirical observations that the author did not mobilise in the paper. The author expects that this may provide some insights to the readers.

Maebashi autonomous bus project

Some insights obtained from the interview are:

> The vice project manager envisages to increase the number of operational autonomous bus while not increasing the number of monitoring staff. This implies that 10, 100 or 1000 autonomous buses will be operated by one supervisor. (= "1 supervisor for N buses") Still, the number of supervised buses by one person will be limited to certain number due to human capacity or physical limit. The vice project manager evoked the other important point. For him, it is important to think "how to let human take responsibility while the bus is mainly operated by the system". This is because the responsibility of system developer will technically be infinite otherwise. How to distribute newly emerging responsibility? How to measure it?

Uber Japan

The insights obtained from the interview are:

> Local politics and local actors are essential component for the deployment of mobility service. Local actors include ministry of land, infrastructure and land, National police agency, and other existing mobility providers. For example, another mobile-based mobility service provider, Grab, has "Hyper localization" as its company motto. This implies that even next generation vehicles may require the capability to "localize" some of its function according to the geographic condition.

Nishitetsu

The insights obtained from the interview are:

> Technological and social changes lead a mobility service provider to integrate new technologies into its operation. Even a medium/big mobility service provider is not necessarily willing/able to innovate its operation with new available technologies.

How to communicate with this type of actor? How to identify them? How to deal with them?

Quotes from interviews:

> "We are aware of new technologies (Autonomous, ICT) but will not be able to dominate anyway."
>
> "We are now collaborating with another train company that used to be a competitor so as to increase usability of our service."

Horai

The insights obtained from interview are:

Large global companies represented by GAFA (Google, Apple, Facebook, Amazon) cannot yet address the needs of optimization of "local transport".

Data is a key for business performance. MaaS application can identify "cash points" and the optimization of "local transport" can potentially create new cash points.

This kind of strategy is possible in Japan since open data is not yet widely available. (Not like Singapore, for example, where open data is widely available.)

Annex 2 - Discussion with the director of a mobility technology research centre

During the field survey, the author had an opportunity to conduct an interview with the director of a mobility technology research centre: Toyota Frontier Research centre. The discussion with the director of the centre gives the author some insights different from the above-mentioned case studies.

The research centre develops several technological components that can be important for future mobility. One type of technology is robotics. According to the director, robotics technologies can have close contact with human and amplify human movement. For example, a power-suit can enhance the power of human and enables human to carry heavy goods. A power-suit can also reduce the burden of people working in health care services such as hospital and nursing home: they need to help other people to move and it requires strength. According to the director, robotics technologies can be integrated to personal mobility and may open up new forms of individual mobility: smaller than existing cars.

The director points out two important concepts in future mobility when it comes to the integration of robotics technologies. The first one is *Human centricity* and the second one is *Sense of Agency.* Human centricity is to keep human in the centre of a system of robotics. By doing so, the human using the system can have a sense of agency: the feeling that s/he has the control over robotics. Without human centricity in designing a system, the human using the system can lose the sense of agency and the human can feel that s/he is controlled by the system or s/he does not have control over the system. According to the director, robotics should amplify the potential of human but should not replace the potential of human. The distinction between amplifying and replacing is important according to the director.

The director shared another anecdote to the author: non-convenient robot. This is linked to another issue in automation. When a system is automated, the human using the system tends to lose his attention on the movement of the machine. It can cause a big problem when the automated machine moves unpredicted way. To circumvent this issue, the director suggests that a non-convenient robot can be a solution. A non-convenient robot is a robot that makes small but non-serious mistakes during its operation. Like this way, the system is designed to maintain humans' attention on the operation of the machine.

These two insights, one on the human centricity and the other on the non-convenient robot, are important when more automated machines diffuse in the society and when more wide range of people start using such automated machines. The sense of agency concerns the emotion of the users and the recipients of the service using automated machines and it can be an important concept in developing next generation automated machines.

Above is the brief summary of a discussion that the author has with the director of the frontier research centre.

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