Local Government and Innovation for Sustainable mobility

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Abstract

This paper traces the interdependent development cycle of institutions and technology concerning sustainable mobility by analyzing the relationship between innovation and transportation policy in local governments. This paper spells out local government solutions to mobility problems using Sustainable Innovative Mobility Means (SIMM). Throughout the world, there are many SIMM projects that were implemented by local governments. Therefore, this paper focuses on local government as a main driver of SIMM. This research investigates optimal policies and the role and instruments of local governments in sustainable mobility innovation. This paper uses European and Japanese case studies and theoretical assumptions. Five roles and five instruments of local government in transportation policy have been analyzed in this paper. Actually, the importance of these roles and instruments varies by municipality, depending on factors such as the size and level of the local government and its relationship with the state. Innovative urban rail project cases in Japan and France gave us many indications of the role of local transport policy in innovating mobility technology. Some failed rail projects also have provided important suggestions about the responsibility and governance of local government, especially about the establishment of transportation planning. In the Mobility as a Service (MaaS) application case in Helsinki, a successful partnership between a local government and an app developer was the key to success. In the case of the autonomous minibus of Sion and ridesharing in Nakatonbetsu, local government provided the environment to develop step-by-step to SIMM developers. In the integrative framework, regionality is important. SIMM develops in regional society. Thus, efficient local mobility governance is the incubator for SIMM.

Keywords

Mobility innovation, Local Government, LRT, AGT, Autonomous vehicle, Ridesharing service, Mobility as a Service (MaaS), France, Japan, Spain, Switzerland.

JEL Classification: O31, Q55, Q58, R42, R51

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1. The Purpose of the Research

The purpose of this paper is to identify the policies, roles, and instruments of local governments in solving mobility problems in their regions through Sustainable Innovative Mobility Means (SIMM). This process includes innovations, autonomous drive, new sharing services, a comprehensive information system (called MaaS), and improvements in existing public transportation and passenger service with automobiles.

Transport policy issues include the following:

- Environmental Issues: climate change, air and noise pollution, and urban amenities.
- Transportation Rights: securing access to mobility for all people, especially in rural areas and for low-income persons.
- Normalization: ensuring access to all mobility service for all persons, especially PRM (persons with reduced mobility, like elderly and disabled persons).

These mobility problems can be solved through SIMM by promoting a ridesharing service, autonomous mini-buses, and innovative mobility information systems by information and communications technology (ICT), for example. However, much remains unknown and uncertain in SIMM concerning security, stability, economic rationality, and effects on existing transportation systems. Undetermined legal and regulatory issues are also problems. Therefore, many challenges must be solved in realizing the successful implementation of SIMM.

This paper focuses on the role and objectives of local governments because regionality is a key factor in SIMM. Regionality means that mobility system construction suits for social, environment and economic context in each region. Most innovations must be implemented as regional mobility solutions that focus on regionality.

2. Background for This Research

2.1 Social Background: Policy and Institutional Reform

Motorization causes serious problems, including environmental problems, car accidents, and traffic congestion. Many researchers criticize motorization. In economics, E. J. Mishan and K. Uzawa pointed out the problem of the social cost of automobiles from the viewpoint of pollution, traffic accidents, and infringement of amenity rights[1]. They insisted on reducing private transportation, especially private cars, and rehabilitating public transport for sustainability. Recently, many cities and regions have implemented projects to reduce private cars and enhance public transport and other alternative modes all over the world[2].

Sustainable Transport is defined by the European Commission in the following ways[3].

- allows the basic access needs and development of individuals, companies and societies to be met safely and in a manner consistent with human and ecosystem health, and promotes equity within and between generations;

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1 Mishan (1967), Mishan (1969), Uzawa (1974).

2 WCTRS (2004).

3 European Commission (2000), p.11

- is affordable, operates efficiently, offers choice of transport mode, and supports a vibrant economy, and regional development;
- limits emissions and waste within the planet's ability to absorb them, uses renewable resources at or below their rates of generation, and, uses non-renewable resources at or below the rates of development of renewable substitutes and minimizes the use of land and the generation of noise"

The definition of sustainable mobility or transportation consists not only of environmental sustainability but also of social and economic sustainability. Innovative technologies for sustainable mobility or transportation means three things: First, reducing greenhouse gases (GHG) and saving energy; eliminating air pollution, vibrations, and noise nuisances; nature conservation and improved amenities. Second, guaranteed transportation rights; secure access to transportation services for all persons, including PRM, the young, and low-income earners to fight social exclusion problems caused by the lack of transportation; Third, contributing to secure employment (commuter transportation services), promotion of entrepreneurship, and rationality and efficiency in logistics by diminishing traffic congestion.

Many countries reformed their institutional transportation policies in favor of sustainability. Some countries established transportation acts that include sustainability standards, for example, the Transportation Codes (ex. LOTI) in France (2010, LOTI Revised Edition of 1996), the Transport Act 2000 in the UK (2000), and the Basic Act on Transportation Policy in Japan (2013). Several international organizations, such as the EU and the OECD, have worked on promoting sustainable transportation. Decentralization of transportation policy has been contemporaneously promoted. Local governments have been given the responsibility for sustainable transportation policy.

Transportation rights is a new social right. Its origin is in the French Transportation Law "LOTI" (Orientation Law of Domestic Transport) of 1982. Since 2010, the Transportation Codes (*Code des transports*) have regulated transportation rights. Important provisions are as follows:

- The transport system must satisfy the needs of its users; guarantee the transportation rights of all persons, including persons whose mobility is reduced or handicapped; the user's freedom to choose the ways of transportation for the user's goods to carry himself or to entrust it to the organization or enterprise that the user chooses (Article L1111-1, Code des Transports).
- The progressive implementation of transportation rights allows the user reasonable conditions of access, quality, price, and costs—in particular, regarding the use of transportation means that are open to the public (Article L1111-2, id.).
- Transportation rights include the right of users to be informed about what kind of transportation system exists and how they can use it (Article L1111-4, id.).

Transportation rights induce that all persons — not only residents but also visitors or tourists — have access to transportation system and information.

The policies and institutional reforms for sustainable transport promotes technological and service innovation. However, various new mobility technologies conflict with existing transportation regulations. Regulations need to be reformed to integrate the new technology. Finland provides a pioneering case. Finland has reformed transportation laws to suit advanced ICT, like a MaaS, in recent years (See subsection 6-1).

2.2 Social Background: Technical Innovation

Transport or mobility policy faces rapid change in terms of both institutions and technology. Recently, rapid mobility technology innovation has created various SIMM. In this research, the author has defined the following five elements as SIMM.

- **New driving service using new technology:** Autonomous cars are attracting attention all over the world. Public autonomous car services (Autonomous minibuses) could be useful, especially for transportation service in underpopulated areas. Electric vehicles and fuel cell vehicles are also defined as these types of SIMM. On the other hands, automated driving system for rail transport has been important SIMM since 1980s.
- **Innovative sharing services:** These new services have been created by ICT innovation, for example, smartphone applications. Ridesharing services like Uber are a efficient solution to problem s in regions where transportation services are not enough. Car-sharing and bicycle-sharing systems (*vélos en libre-service*) have also spread rapidly in recent years.
- **Innovation of public transportation creating new social value:** Traditional public transport system has become another type of SIMM through new technology. For example, technology of low floor vehicle has developed antique tramways into modern urban rail system called light rail systems (LRT). Low-floor LRT innovation has created new social value, called “transportation barrier-free” in Japan, that all transportation must meet access for disabled persons. Nowadays, transportation barrier-free is one of important mobility element for social sustainability.
- **Customer service innovation by ICT revolution:** The ICT revolution, for example, smartphone applications, can provide new travel information services, paperless tickets, and bus location systems. These innovations are important because they can improve customer or passenger satisfaction. Nowadays, these SIMM are known as MaaS (Mobility as a Service).
- **Social technology innovation for Comprehensive and systematic local transport networks:** In order for the transportation system to meet sustainability, all modes need to be integrated into one transport service. Because a single means of transportation cannot fulfill our transportation demands, even if it is innovative. However, it is not possible to realize comprehensive transport service only by technological innovation of vehicles, infrastructure, and information. Realization of comprehensive transport service requires the initiative of public authority that has efficient policy instruments as a social technology. Therefor the author focusses on social technology for integration of all mobility service as an element of SIMM.

2.3 Academic Background

This research analyzes local government as a main driver of innovative sustainable mobility and interdependent development of institutions and technology. However, there are three problems with the existing research on this issue.

First, the research area is divided between policy research and technical research about mobility. There are two main disciplines: transport economics and mobility study on management of technology. Main scopes of transport economics research and analysis are investment of various transportation infrastructure, regulation of public transport and

fare policy, operating company management, and road congestion problems. Technological development and innovation are outside the main scopes of transport economics research and analysis.[4] On the other hand, mobility study on management of technology means technical development of the automobile.[5] Management of technology has continually conducted productivity comparisons and processes regarding the production and development of automobiles, which is only one means of mobility. However, management of technology has always treated social and institutional issues or infrastructure as data.[6] Inter-disciplinary work between transport economics and management of technology has never been done.

Second, there is a lack of co-research on mobility and environmental economics. There is little exchange in the relationship between transport economics and environmental economics; rather there is confrontation.[7] Lately, inter-disciplinary work between management of technology and environmental economics has begun. It is called "Green Innovation Research". Many research has been developed on environmental technology innovation about the automobile industry.[8] Environmental economics hypothesizes that appropriate environmental regulations encourage corporate efficiency and innovation and enhances corporate competitiveness. Green innovation research was launched;[9] however, it is still only a sprout. In addition, current range on mobility of green innovation research is only environmental sustainability, like climate change and air pollution. It does not include social sustainability, for example, transportation rights for PRM.

Third, mobility innovation has not been made a priority issue in existing sustainable transportation study. The first reason is the enormous social cost of automobiles, especially environmental cost like a climate change and air pollution. Environmental cost with current number of vehicles could not be compensated by technological innovation of vehicle. Thus, many researchers have ever analyzed the way for reducing car-use and enhancing exiting alternative means. Economists have researched regulations and economical means of reducing automobile traffic, including congestion charges, environmental taxes, and so on, and investing in infrastructure for public transportation and walking.[10] The second reason is that conventional automobile technology development does not help person who cannot drive, like PRM and low-income earners. Various mobility services for the elderly persons in rural area have developed all over the world, but those services have long used only traditional technology, before the inception of autonomous vehicles and ridesharing applications.[11] Only tramway and bus low-floor vehicles have been developed for disabled persons (see subsection 4.3). Because

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4 For example, in English: Powell (2001a), Powell (2001b), in Japanese: Okuno et al. (1989), Yamauchi & Takeuchi (2002).

5 Clark & Fujimoto, 1991; Holweg & Pil, 2004; Womack et al., 1990.

6 About mobility study on management of technology, the suggestion came from discussions with Prof. H. Higashi, researcher of management of technology.

7 Koyama (2014).

8 Shu (2008).

9 Ueta & Shimamoto, eds. (2017).

10 Mishan (1969), Uzawa (1974), Koyama (2014).

11 Akiyama & Yoshida, eds. (2009), Okubo, ed. (2016).

innovative automobiles are inferior to old technology public transportation in terms of environmental efficiency and improving right of PRM.

Fourth, there is a lack of literature on sustainable mobility from the point of view of local governments. Purpose of this research is to contribute to the promotion of inter-disciplinary research on innovative sustainable mobility.

3. Local Government's Role and Policy Instruments in the Social Implementation of Sustainable Innovative Mobility Means

3.1 The Brief

Local government's role in and policy instruments of social implementation of SIMM are discussed. Despite SIMM's usefulness in solving various mobility problems and improving the quality of life of less-mobility persons, there are many hurdles to overcome in order to realize social implementation. Because IMM is one type of disruptive innovation that has not yet been diffused and implemented, there are some risks and uncertainties concerning safety and social conflict. Many of these hurdles should be overcome by the regional society. It is hoped that local government can play a leading role in solving these problems and realizing social implementation.

3.2 Definitions from the Theoretical Assumptions

3.2.1 The Role of Local Government

Successful innovative transport service or technology involves local governments playing five roles to implement various innovations for sustainable transport. These roles in the development of new technology and services are vision maker, launch customer, collaborator of technological development, observer, and successor.

1. **Vision Maker:** Common goals are necessary for sustainable transport and transportation rights. As these goals need to reflect the potential needs within social challenges, the public sector needs to set those goals. No private sector, especially private enterprises, will develop or implement SIMM without them. A vision maker must define transportation rights and the goals of sustainable transportation. Local government can find the possible need for sustainable transportation within its region by evaluating other policy sectors like the environment, land use and housing, economic development, education, medical and welfare needs, tourism, and other public utilities. Local government must define common goals for sustainable mobility in a transportation strategy or a comprehensive local transportation plan.
2. **Launch Customer:** If there are few demands, the private sector will not develop innovative technology, products, and services. Therefore, investment decisions by local governments are important for SIMM development and social implementation. Local Government must be the customer that launches of innovative transportation products or services, for example, new vehicles, substructure technology, information utilities, smart phone applications, power supply systems, etc. Local governments can

either be operators themselves or outsource to private organizations. If local government becomes the launch customer, many private enterprises and organizations may be incentivized to develop innovative technology, products, and services.

3. **Collaborator of Technological Development:** Successful development of new transportation technology or services will involve experimental demonstrations or trial runs with passengers, including paid passengers. Local government must provide developers the field for the experiments and must cooperate with them. In some cases, local government may join development groups whose objectives are desired by the local government itself. For example, local governments may partner with ridesharing to carry out experimental demonstrations or trial runs.
4. **Observer:** Local government must assess and monitor the effects and impacts on sustainability of various IMM and technologies for sustainable transportation. Local government has an obligation to assess or monitor environment policy or transportation policy under each law. Local government is a qualified observer of innovative technologies for a sustainable transportation.
5. **Successor:** Local government's role is to establish and sustain IMM technologies for sustainable transportation. Local government must reflect the results of innovation in its transportation institutions, by-laws, and future strategies in transportation planning. In Japan, the national law has adapted new means or rules that had been implemented and succeeded in local governments. Local governments, therefore, are successors to innovative technologies for sustainable transportation.

3.2.2 Local Government Policy Instruments

To make an innovative mobility service contribute to the security of transportation rights, local governments must develop five policy objectives. They are a comprehensive local transportation plan, a public finance system, development of transportation infrastructure, the authority of transportation services, and public participation and collaboration with various stakeholders.

1. **Comprehensive Local Transportation Plan:** A comprehensive local transportation plan is defined as a legally binding goals to supply a mobility service, to invest in transportation infrastructure, and to allocate transportation usage as social common capital in that region. It must fulfill the criteria for environmental, social, and economic sustainability defined in planning or goals in each sector. It must be agreed upon through public participation procedures. Examples of these plans are the Urban Mobility Plan—or *Plan de Déplacements Urbain* (PDU) — in France and the Local Transport Plan (LTP) in the United Kingdom.[12] In both of France and the UK, local governments must establish these plans under the terms of their transportation acts. Also, a comprehensive local transportation plan includes a strategy to introduce innovative technologies for sustainable transportation.

[12] Certu (2002), Minami (2009).

A comprehensive local transportation plan can be defined at any mobility service level. It could be the basis for regulations of private transportation operators, and it must include consensus-building and public participation procedures. This plan is a vision for sustainable transportation in that region. Local government must define its comprehensive and systematic local transport network using this plan.

Public Finance System

2. **:** The most important role of local government is managing the public finance system for local sustainable transportation. Local government determines the total budget both in terms of taxes and fares. This includes collecting transportation taxes or other taxes, defining fare levels and fare collection, and deciding the amount of subsidies and the grant rules.

Development Transport Infrastructure

3. **:** Local government is the most important player in developing transportation infrastructure. This includes infrastructure and equipment for new sustainable transportation technologies.

Authority of Transport Service

4. **:** Local government must have authority over all transport services in its region. There are three ways to have authority: the first is to have authority over any private transport operator including NGOs or community associations operating non-profit traffic services; the second is local government becoming an operator itself; the third is through a Public-Private Partnership where local government is responsible for the operation and delegates it to a private operator.

Public Participation and Collaboration with Stakeholders

5. **:** This means building a social consensus, including acceptance of new technologies and services. Local government can use various public participation procedures, for example, procedures in environmental policy or development of local transportation plans. Another method is a stakeholder council consisting of local officers; transportation service operators; representatives of residents and consumers; chamber of commerce, industry, and tourist associations; educational and medical stakeholders; labor unions; environmental NGOs; and academic researchers.

   For example, if there are social conflicts or problems related to ridesharing services, which can be conflicts with taxi companies or public transportation operators, or drivers' turnover problems, local government and the regional society can solve these problems through a public participation process. Public participation is needed to develop a comprehensive local transportation plan. Therefore, problems can be solved by involving stakeholders in the participation process that develops a plan.

3.3 Level and Scale Differences among Local Governments

3.3.1 Level of Local Government

In this empirical analysis, we conducted the analysis with respect to differing levels of local government. In many countries, local administrative institutes are multi-leveled. For example: Japan has two levels: Municipalities (*Shi-Cho-Son*, City, Town or Village) and Prefectures (*To-Do-Fu-Ken*); France has three levels: Municipality (*Commune*), Prefecture (*Préfecture*), and Region (*Région*); Spain has three levels: Municipality (*Municipio*), Prefecture (*Provincia*), and Region (*Comunidad Autónoma*); England has four levels (Parish, District, County, and Region). In federal states (for example: the United States of America, Germany, and Canada), the laws or institutions among the states or the role of the states must be take into account.

First, there is the concept of subsidiarity. This principal means that municipalities should do what is within their power to do; the next highest level of local government does what the municipality cannot do; and the central government or the federal government should do only what the local governments cannot do. Therefore, municipalities should develop policies for innovative mobility. However, we should pay attention to differences in institutions of transportation policy. In some countries, high-level local governments are subject to transportation policy by law. In France, municipalities have the authority for local transportation (Almost of cities or towns creates cooperate body among municipalities, as the local transportation area is composed of multiple basic municipalities). In the United States, there are many special administrative bodies for transportation policy Independent from municipalities. In Japan, municipalities do not have the authority over local transportation because all fundamental authority goes to the central government, but there are some policy instruments which municipalities can implement voluntarily in some transportation law. In England, the county—which is a high-level local government has authority for local transportation.

If transportation law gives the authority for local transportation policy to one of the local governments, that local government should be subject to SIMM policies. If the country does not decentralize transportation policy, local governments must be subject to SIMM.

3.3.2 Scale of Local Government

The scale of local governments is an important element that determines the capacity for transportation policy. Among high-level local governments, even a small-sized government has suitable capacity. Among municipalities, however, there is a big disparity in capacity for IMM. Large municipalities can establish a special department for each policy or technical matter; they can even install a research laboratory. In the market aspect, large municipalities are economic superpowers that can purchase rolling stock and other transport instruments and investing infrastructure. Large municipalities alone can become a launching customer.

If a municipality or cooperating municipalities have a population of more than 700,000,[13] it is a superpower in mobility innovation for sustainability. In France, Paris and Lyon are leading cities in IMM. Middle-sized municipalities (100,000–700,000

[13] This is basis of the Japanese metropolitan municipality that is called "*SEIREI-SHITEI-TOSHI*" (Cities designated by government ordinance).

population) have suitable resources for IMM. Small-sized cities or rural municipalities (under 100,000 population) have only a small capacity and limited knowledge of technology and have limited economic power. Support by central governments or other local governments must be accounted for when considering small-sized municipalities.

3.4 Cooperation among Local Governments and Support from the Central Government

3.4.1 Cases Not Possible Through Municipality Alone

In actuality, small municipalities find it difficult to play a role in IMM and to implement policies. Small-sized municipalities must be supported by central governments or other local governments. Otherwise, they can only use the IMM that other municipalities provide. Popular means have economic rationality due to scale. In this section, direct and indirect support for small-sized municipalities is analyzed.

3.4.2 Support from Central Government

Support from the central or federal government is a basic resource for small-sized municipalities. If a municipality does not have a large enough budget for transportation, the central government can subsidize it. In technological matters, not only governments but also national research institutes can offer support. Support from a central government has some disadvantages, however. The standards are strict; the procedures are complicated; and there is no flexibility. Small-sized municipalities do not have the capacity to receive support from the central governments. It is more rational to seek support among other local governments than support from central governments.

Another important role of the central government is defining a national mobility minimum through laws, ordinances, and plans. If a national mobility minimum is established, the markets for mobility technology and service in rural areas will have been created, and many private innovators will start development.

3.4.3 Cooperation between Different Levels of Local Government

Support from a high-level local government is rational. In Japan, prefectures support small municipalities in not only transportation policy but also in any other kind of policy. Nara Prefecture established a Public Transportation by Law and a Public Transportation Council that makes the prefecture and all municipality policies consistent.[14] Because the prefecture has more detailed information about the regional mobility situation than the central government, support from high-level local governments can be sensible. If transportation law or institutions are an independent authority between different levels of local government, this support cannot be applied (for example, France). High-level local governments can only provide support by indirect means or voluntary approaches as in Section 3.4.4.

3.4.4 Inter-Regional Cooperation among Local Governments

The last type of support comes from large- or middle-sized municipalities to small-sized municipalities. If there are both large and small municipalities in same region, large cities can help direct small municipalities. One way is to establish a greater inter-municipality

[14] Minami (2015)

body. For example, there are many Inter-Communes Transportation policy bodies (AOM, *autorité organisatrice de la mobilité*) in France.[15]

Other way to cooperate is to establish a national inter-municipalities organization for cooperation in transportation policy. National organizations have advisory roles as research centers and information exchanges. In France, GART (*Groupement des autorités responsables de transport*) is a national organization for the cooperation of transportation policy.[16] GART is consistent with the transportation policy sections of prefectures and municipalities (and AOM). GART has published many reports of transportation policies, including IMM. It also holds an exhibition event (s*alon de transport public)* every two years with UTP (*L'Union des Transports Publics et ferroviaires*), a cooperating public transportation operator organization.[17] The event includes rolling stock, traffic equipment, infrastructure and information equipment, and other transportation-related manufacturer booths in an exhibition hall. This event includes a program of seminars and conferences and supports small-sized municipalities looking for inter-regional cooperation.

4. Innovation in Urban Rail Transport Projects

4.1 Social Context Before and After the 1980s—A Comparison Between France and Japan

After WWII, Tokyo, and Paris made major innovations to their metros (underground rapid transit systems) by making direct connections between their suburban railway lines and their metro lines. In 1960, the TOEI Subway's (Tokyo Metropolitan Bureau of Transportation) Asakusa line (Line No.1) opened a third line direct to the Keisei Railway, one of Japan's major private railway companies. In 1962, Tokyo Metro's (ex-Eidan) Hibiya line started a direct connection to Tobu railway. Now 10 Metro lines out of 13 lines in Tokyo run directly to suburban commuter rail lines.[18]

Paris studied Tokyo and decided to construct a Réseau Express Régional (RER) or Regional Express network. In 1971, the western part of the RER-A opened. This is the first suburban train service direct to the city center. The RER project was under the national governments initiative.[19] In Tokyo, the Metro project was also under the national government's initiative. There are two Metro operators in Tokyo. The first is TOEI Subway (Tokyo Metropolitan Bureau of Transportation in the Tokyo metropolitan government). It has only four metro lines. The other is Tokyo Metro with nine lines. Tokyo Metro was established in 2004 by privatizing the Teito Rapid Transit Authority (it's called Eidan), a public enterprise co-owned by the central government and the Tokyo metropolitan governments. Direct access between suburban rail networks and Metro was a result of the guidance and recommendation of the central government.

Beginning in the 1980s, there were increasing cases in both Japan and France where SIMM concerning rail systems were introduced as local government initiatives. Urban rail projects in provincial cities increased both in countries after the 1980s. Because there

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15 Minami (2009).

16 GART website.

17 Website of transport public 2018.

18 Minami (2019).

19 Passalacqua (2018).

is little intervention by the central government in cities other than in the capital, local government initiatives are important for urban rail projects. The important technical topic was the active development of a medium-capacity rail system. In a provincial city, buses cannot meet the demand and the metro is over capacity. Medium-capacity railways can be divided into two categories. The first category is a grade-separation system were all tracks are laid as overpasses or undergrounds, and there are no railroad crossings. This applies to monorails and AGT (Automated Guideway Transit), and the introduction of automatic driving technology is being actively pursued. The second type is a road surface system. This applies to modern tramways called LRT (Light Rail Transit), BRT (Bus Rapid Transit, buses that occupy lanes operating like a tramway) and rubber-tire trams. Bus Rapid Transit is not a rail system from the aspect of technology, but it is from the aspect of urban planning. It is closer to a tramway than a bus, so BRT is included as a broad rail system. The concept of TCSP (*Transports Collectifs en Site Propre*, public transport on a proper site) in French transport policy definition includes the metro and commuter railways, AGT, monorail, tramways, rubber-tire tramways, and BRT with proper bus lanes.

Beginning in 1980, many cities in both Japan and France preferred the grade separation system over the road surface system because a grade separation system can secure road capacity and can contribute to relieving congested roads. Therefore, Japan and France developed various systems of grade separation. Japan succeeded in developing three types of monorails (the Japanese Straddle type, the SAFEGE type, and the mini-monorail cable drive) and two types of AGT (Japan standard AGT, VONA) as commuter rail services. These systems are suitable for elevated rail systems. France succeeded to developing an AGT system called VAL, suitable for underground rail systems.

LRT is a modern tramway that is improved by the latest technology. The merits of LRT are as follows: LRT is suitable for environmental sustainability because of its low CO_2 emissions and its air pollution reduction; its infrastructure cost is lower than metro or AGT systems and monorails; It is barrier free (suitable for elderly and disabled persons); and It is efficient (punctuality, higher capacity than buses). In other words, LRT is an improvement on tramways as a SIMM innovation.

When tramways began to modernize, Western Germany drove innovation. However, France developed various new tramway technologies when the first LRT opened at Nantes in 1985 and has been driving innovation recently. Since 1985, 30 French cities have introduced modern tramways. The new technology includes many good practices. Some innovations are very useful to sustainable transport. The innovation of French LRT is not only a technical innovation but also a service and a political innovation. Japan, on the other hand, introduced monorail and AGT and has rarely considered LRT.

4.2 The Relationship of Japanese Innovative Urban Rail Projects with Local Government

4.2.1 The World's First AGT in Kobe City

Kobe City introduced the world's first AGT (Automated Guideway Transit) as a permanent commercial service on February 5, 1981. This is also the world's first automated rail system (Fig. 1). AGT is a railway system that uses small vehicles with rubber tires. Following Kobe, various AGT systems have been introduced as urban rail

services or shuttle services at airports around the world. The first line was called Port Liner, and it opened 6.4 km from the Sannomiya Station (which connects with five railway lines in downtown Kobe) to the northern area of Port-Island (a new city built on a landfill in 1981). When Kobe Airport on the southern island of Port-Island was opened in 2006, Port Liner was extended 5.4 km to Kobe Airport Station and connected with high-speed ship service to Kasai International Airport.

Figure 1 - AGT train in Kobe, August 12, 2020.

In 1990, the second line, called Rokko Liner, was opened in the eastern part of Kobe City, running 4.5 km from Sumiyoshi Station (connecting with suburban rail service) to Marine Park Station (in Rokko-Ilsland, eastern landfill). Both AGT lines are operated by Kobe New Transit Company, Ltd.–a joint public-private enterprise. (The Japanese name is DAISAN-Sector). Kobe City holds about 80% of the stock. The object of the Kobe New Transit Company is to secure convenient citizens' transportation by playing a part in the comprehensive transportation system in the Kobe City Basic Plan.[20]

Kobe City is the seventh largest city in Japan, with a population of 1.5 million. It has a large international trading port. However, it is a long, narrow city surrounded by the sea and mountains. Lack of land for housing and businesses was an obstacle to urban development. So, Kobe City adapted a comprehensive urban plan for increasing the land needed for urban development. Kobe City opened a mountain to create a residential area and built a landfill in the sea with soil taken from the mountain. The city planned to create new railway lines in the developing area. For the mountainous area without a railway, Kobe City built the Metro line using traditional rail technology. Because it was predicted that the landfill would not have a high traffic demand, Kobe City decided to introduce a medium-capacity rail system. Kobe City is good at urban management and made profit by developing landfill sites and managing AGT.[21]

The case of Kobe City was successful due to the integration of new technology and comprehensive transportation planning. The success of Kobe City triggered the spread of AGT in Japan.

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[20] Website of Kobe New Transit.

[21] Takayose (2000).

4.2.2 Innovation for Metro by the Osaka Municipal Transportation Bureau

The Osaka Municipal Transportation Bureau (OMTB, which was reorganized into Osaka Metro Co., Ltd., in 2018) has contributed to the development of Japanese railway technology. The OMTB has an urban rail system consisting of eight metro (underground rapid transit system) lines and one AGT line.

The OMTB introduced the second Japanese AGT system in the western landfill area. It was opened just one month after Kobe City's, and Osaka and Kobe City both promoted AGTs at the same time. Osaka's AGT was driven autonomously, but for over 10 years it had a security staff of drivers onboard. (Kobe City's AGT was unmanned after the first short period.) In 1984, OMTB introduced vehicle Type 20 for the Metro. This was the first Japanese variable-frequency drive train (VFD, *VVVF* in Japanese) for heavy rail (the first vehicle was tramway, see 4.2.3 in Japan).[22]

In 1990, Tsurumiryokuchi Line (now named Nagahori-Tsurumiryokuchi Line) opened as the seventh metro line in time for the International Garden and Greenery Exposition (Fig. 2). This is the second linear motor rapid transit line in the world and the first constructed in Japan. The first one was for Metro Vancouver, Canada. Metro by linear motor train is now used in six cities (Osaka, Tokyo, Fukuoka, Kobe, Yokohama, and Sendai).[23]

Figure 2 - Linear motor Metro in Osaka, August 12, 2020.

4.2.3 Kumamoto—A Leading Tramway City

As a result of the problems caused by motorization, many Japanese cities had closed tramway networks in the 1960s and 1970s. Now, 20 tramway networks remain. In the 1980s, tramway renovation was launched. Kumamoto City first introduced many innovative technologies. These technologies were tested in Kumamoto, were mass-produced in Hiroshima, and have spread nationwide.

Kumamoto is the third city in the Kyushu Region with a population of 750,000. Kumamoto's tramway is operated by the Kumamoto Municipal Transportation Bureau. When motorization began, tramway ridership decreased. Kumamoto City decided to close

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22 Yoshitani et al. (1986).

23 Japan Subway Association (2005).

all tramway lines at once and replace them with monorails. In fact, half the lines were closed. (These were lines with small demand.) However, Kumamoto City changed its transportation policy maintaining and modernizing the tramways when an oil shock occurred. In 1978, Kumamoto City introduced the first Japanese air-conditioned vehicle for tramways (a modification of existing vehicles). In 1982, vehicle Type 8200 was introduced. This was the Japanese first VFD car not only designed for tramways but also for any rail system.[24] Because the VFD is noisier than the conventional motor drive, it may cause signal system malfunctions. The tramway has a simple signal system selected for the first test run in commercial operation. Type 8200 made an important contribution to the technical aspects of Japanese railways.

In 1997, Tramway of Kumamoto introduced the first Japanese low-floor vehicle—Type 9700, imported from Germany (Fig. 3). Type 9700 triggered the re-evaluation of the tramway as a barrier-free LRT suited for Japan.[25] As the Transport Barrier-Free Act was enacted in 2000, low-floor vehicles were introduced in Japanese tramways. Toyama City constructed a new LRT system with same type of vehicle (a renovation of the JR branch line) in 2006. On the other hand, the Japanese government decided to aid the technical vehicle development for the modern LRT system. Japanese rail vehicle manufacture did not have low-floor vehicle technology.[26] These vehicles were introduced in Hiroshima after 2004 (Fig. 4).

Figure 3 - Tramway Kumamoto's Type 9700 made in Germany, November 24, 2001.

[24] Tsuru (1996).

[25] Nakamura (1997).

[26] Minami (2001).

Figure 4 - Hiroshima low-floor tramway vehicle made in Japan, August 10, 2016.

4.3 French LRT Projects in Urban Municipalities

4.3.1 Low-Floor Vehicle Tramway Innovation in Grenoble

The most important innovation of LRT is the low-floor vehicle for barrier-free transportation. The epoch-making case was Grenoble (1987). Grenoble City introduced LRT as a solution to automobile air pollution. Disabled residents demanded barrier-free vehicles to secure their transportation rights. So, the Grenoble transport authority introduced the TFS Vehicle (*Tramway Français Standard*), which has a low floor area of 70% (Fig. 5, Fig. 6, and Fig. 7). The disabled person can ride a tramway without the assistance of another person (Fig. 8). In this way, disabled residents in Grenoble gained mobility. The local government's decision to realize innovative tramways improved their quality of life. In 1994, LRT of Strasbourg was opened. Strasbourg introduced the 100% low-floor "Eurotram" vehicle (Fig. 9).[27]

Following Grenoble and Strasbourg, low-floor vehicles have become the standard for LRT. The impact of the Grenoble tram was huge; the vehicle standard of not only tramways but also of city buses changed. The market for vehicles for urban public transportation has changed dramatically. Only enterprises with low-floor technology can survive.

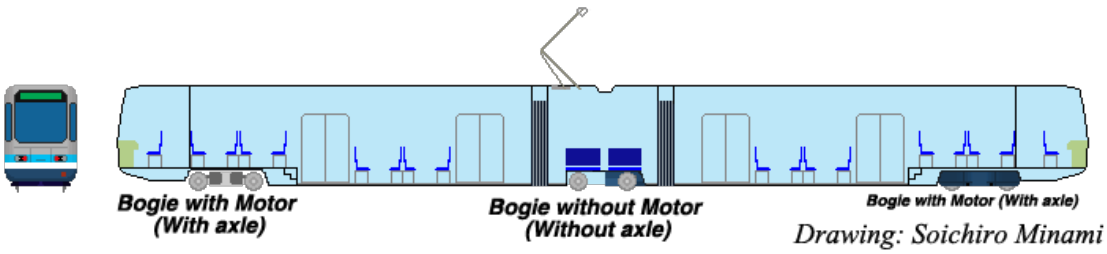

Figure 5 - Components of a low-floor vehicle (TFS).

[27] Meneteau (2005).

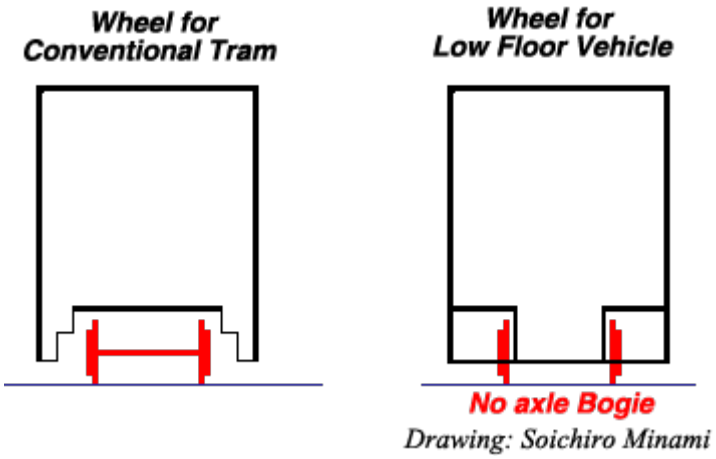

Figure 6 - Component of a low-floor vehicle.

Figure 7 - TFS in Grenoble, November 23, 2016.

Figure 8 - Barrier-free door of TFS in Grenoble, December 2, 2001.

4.3.2 Urban Transport Policy Innovation in Strasbourg

Grenoble and Strasbourg are leading cases not only of barrier-free but also of comprehensive an urban mobility project.[28] The Grenoble LRT project is a model of a new urban transportation system, including re-organization of urban traffic and car use regulation, extension of the pedestrian priority zone in the urban center, introduction of a Park & Ride system, and so on. Grenoble was modeled after the Fribourg City example in Germany.

After Grenoble's success, the Strasbourg project set a new standard of urban transportation policy in France. The LRT project is a create city suits for tramway with urban redevelopment. Strasbourg implemented the re-organization policies for road traffic, car control, and extension of the pedestrian zone as in Grenoble. The Strasbourg project's breakthrough was the integration between Mobility infrastructure and landscape policy and urban design strategy. Strasbourg introduced a modern design vehicle, called the Eurotram, and adopted an elaborate infrastructure design at stops (Fig. 9). Strasbourg changed LRT from a means of transportation into a symbol of the city. After Strasbourg, LRT became more popular than the metro. Some cities, like Bordeaux, have changed their rail projects from the metro to LRT.

Elaborate infrastructure design is expensive, but the new standard of LRT is a very inexpensive urban rail project. The total cost of an LRT project is much cheaper than a metro project or an AGT project, even if infrastructure design is expensive. In other words, urban rail as a status symbol for a city became cheaper after the Strasbourg LRT project.

Public participation is also innovative part of an LRT project. In Strasbourg, there was strong opposition to a tramway. The Strasbourg urban community opened up a public consultation (*Concertation publique* in French) more than 500 times.[29] In the United States, tramway projects have been decided by initiative and referendum.[30] So, tramways and LRT projects are developed democratically in local governments.

Figure 9 - Eurotram in Strasbourg, July 16, 2004.

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28 Meneteau, id.

29 Trautmann (2003), Trautmann (2016).

30 Nishimura (1998), Yarita (2002), Tsukamoto ed. (2019).

4.3.3 No Overhead Wire Technology in Bordeaux

The Bordeaux LRT runs through the old city center, which is a World Heritage Site (Fig. 10). Overhead wires would present a problem in the landscape. The Bordeaux Urban Community (CUB is the transport authority) decided on a new wireless tram system called Alimentation Par le Sol (APS) by Alstom. The APS system has a third-rail power supply. The third rail on the road surface is divided into an insulation section and a conduction section. It has a method that identifies the section to feed power to by detecting the passing of the train with a relay box for the security of pedestrians (Fig. 11).[31]

At first, there were many technical troubles and a lot of suspended tram service. Abolition of the APS system was even considered. However, CUB and Alstom solved the problem through cooperation. So, the APS technology was completed. Other French cities had introduced APS systems: Reims (2011), Angers (2011), Orleans Second Line (2012), and Tours (2013). Dubai (UAE) and Rio de Janeiro (Brazil) also adopted APS.[32]

In the Bordeaux case, CUB had a strategy for urban landscaping. Therefore, CUB became visionary in no overhead wire technology. When technical trouble occurred, CUB worked as a collaborator of technological development.

Figure 10 - Bordeaux LRT passing the World Heritage Cathedral, June 26, 2018.

[31] Tukamoto, Minami et al. (2016), Tukamoto ed. (2019).

[32] Minami (2018).

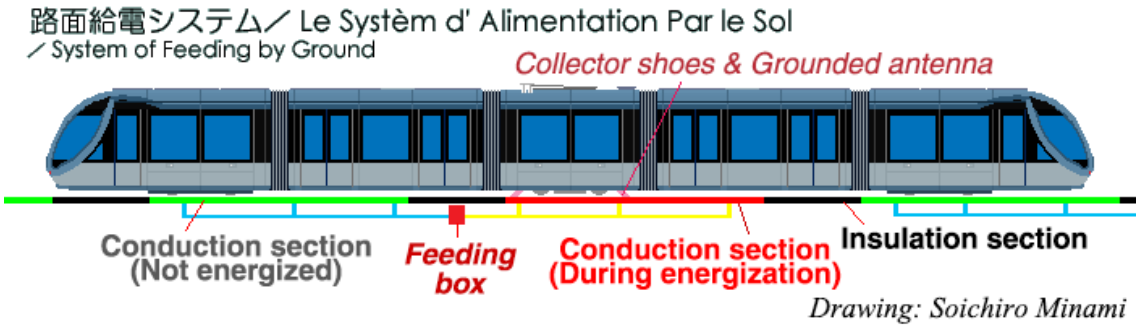

Figure 11 - APS (Alimentation Par le Sol) System

4.4 Urban Rail Project Failure in Europe and Japan

4.4.1 Technical Failure on a Rubber-Tire Tramway in France

After the opening of Strasbourg's LRT, many cities have wanted to introduce LRT. But it is a difficult undertaking for small- or medium-sized cities because LRT is more expensive than BRT or an advanced bus system. Rubber-Tire Tramway (*Tramway sur Pneumatiques*) was developed as an economical LRT system. In Europe, four systems were developed and commercialized. The first was a TVR (*Transport sur Voie Réservée*) system developed by Bombardier. Monorail is laid at the center of the track. The vehicle is guided by pulley wheels. TVR can be driven as a bus in the section without the guide rail (Fig. 12). The TVR vehicle is like a trolleybus. The second system was Translohr, developed by Lohr Industry, a French company based in Strasbourg. (Now Translohr, it is sold by Alstom.) Monorail is laid at the center of the track. The vehicle is guided by two diagonal wheels that sandwich the rail. Translohr cannot be driven as a bus. The Translohr vehicle is like a tramway. The third system was Civis, developed by Siemens and Iveco Bus (ex-Renault Bus). This is an optically guided system for BRT. At first, Renault developed special bus vehicles like a tram that was called a "Civis," and Siemens developed an optical guidance system. However, the Civis vehicle did not sell well. Now Siemens sells an optical guide system for any bus-type vehicle. The fourth system was Phileas, developed by APTS, a branch of VDL, a Dutch bus company. Phileas is a level-1 autonomous articulated bus with a magnetic guide. Each wheel moves independently by an autonomous system, and there is no inner wheel difference when negotiating a curve. Phileas can also be driven as a traditional bus with a manual mode and no guide. In France, all systems were introduced and operated commercially.[33] However, the TVR and Phileas systems both failed, and local governments payed the cost of these failures.

TVR systems were introduced at Nancy (2000, Fig 12) and Caen (2002, Fig 13). TVR of Nancy had many technical troubles and was suspended for more than a year. After improvements, the service resumed in 2002. All stakeholders litigated Nancy's TVR. In 2010, the French government recommended the Nancy and Caen urban transportation authority to remove TVR and to replace it with an LRT (normal tramway), Translohr, or a BRT.[34] The reason for this recommendation is because TVR is not safe. Both urban

[33] Mori & Minami (2011).

[34] CGEDO (2010).

authorities decided to replace TVR by with tramways. Caen's TVR was abolished at the end of 2017, and a new tramway opened in 2019. However, the new Caen tramway was laid on the old TVR track (Fig. 14). So, there were not any noticeable TVR remnants in Caen.

Figure 12 - Transport sur Voie Réservée (TVR) in Nancy at the mode-change point from Tram to Trolleybus, September 11, 2006.

Figure 13 - TVR in Caen, October 19, 2005.

Figure 14 - Caen tramway TVR replacement, running on the same TVR track (See Fig. 13), January 11, 2020.

Phileas technology development was not completed by APTS. Douai City decided to introduce Phileas. Infrastructure for Phileas was constructed until 2009. However, the French government did not authorize operation of Phileas. The government judged that Phileas' autonomous technology was incomplete. Phileas tramway service opened in Douai in 2010 (Fig. 15), but Phileas can only be driven in only manual mode, which makes it a BRT.[35]

It was too expensive to renovate the system to the level required by the French government, and APTS went bankrupt in 2014. The Douai urban transport authority replaced Phileas with a normal BRT at the end of 2014. Most Phileas lanes and stations switched to BRT lanes. Some stops could not be used because Phileas vehicles have access doors on both sides (Fig. 15, Fig. 16).

Figure 15 - Phileas of Douai: vehicle has access doors on both sides, June 12, 2010.

35 Mori & Minami, id.

Figure 16 - BRT of Douai, which replaced Phileas. Normal vehicles can't use left lane at Stop, March 16, 2019.

4.4.2 Ruins of LRT in Andalusia, Spain

Many Spanish cities have introduced tramways, but there have been failure cases that quickly closed the tramway. In Andalusia State, there were two modern tramway failures. The first case was Tramway of Belez-Malaga City. The tramway opened in 2006. But the tramway lost the competition with the bus, and there were few passengers. In 2013, tram service was suspended. The second case was Tramway of Jaen City. The tram operated for only two weeks. As a result of an election, the new mayor decided to cancel tramway operation.[36]

Two cities made Ruins of Tramway (Fig. 17, Fig. 18). The Andalusia's tramway fiscal burden was divided between the region and the municipalities. Andalusia Region paid for all tramway infrastructure. The municipalities paid for the operation of the tramway. The municipalities had to subsidize the operation costs of the tramway. The region actively invested in the tram, but there was a discrepancy in communication between the region and the municipality. Of course, there are also successes in Spain, for example, Seville, Granada, and Malaga in Andalusia.

[36] Tsukamoto et al. (2013).

Figure 17 - Abandoned and destroyed tram stop in Jaen, September 18, 2018.

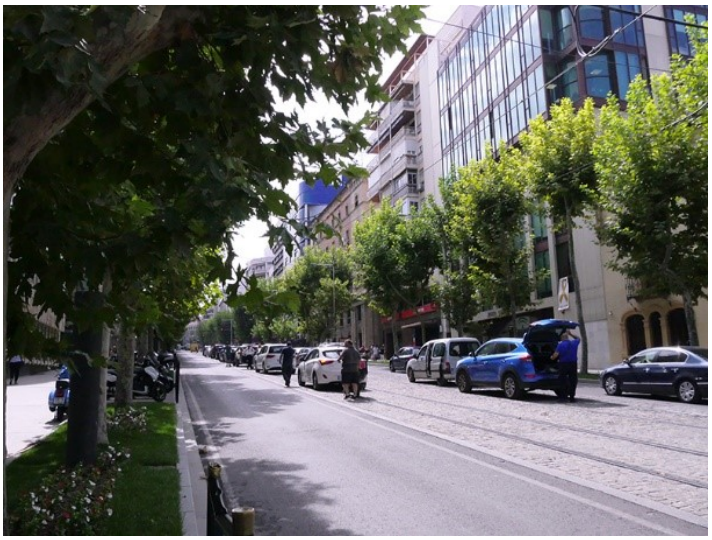

Figure 18 - Unused tram track in Jaen. The track is used as a car park, September 18, 2018.

4.4.3 Ruins of AGT in Komaki, Japan

Komaki's AGT called the Peach Liner is the only AGT and monorail line commuter rail service that was closed in Japan (Fig. 19, 20). The Peach Liner failed in terms of both technology and transportation planning. Tokadai Newtown is located in Komaki, 15 km from the center of Nagoya. The Peach Liner operated between Newtown and the Komaki Station and connected with Meitetsu Komaki Line, a commuter rail service between Kamiiida Station in Nagoya City and Inuyama Station. The Peach Liner opened in 1991, but it AGT was closed in 2006 due to a low passenger count.

Figure 19 - AGT rolling stock in Komaki, March 7, 2006.

Figure 20 - Loop at terminal of AGT in Komaki. This viaduct is being removed in 2020, March 7, 2006.

The primary cause of failure of the AGT is an actual user count that is much smaller than the planning estimate. Initially, the system was used by only 2,100 people per day for two reasons. The first was that the number of actual residents made up half of the plan, but the number of residents in Newtown was too small to fulfill the demand of the AGT service. The second reason was that as a connected rail service, the Komaki line was not convenient. Thus, the Peach Liner and the Komaki line lost out to competition with another commuter rail service run by JR Central. Kamiiida Station was an isolated terminal. Passengers had to walk or take a bus to nearest Metro Station. In 2003, the Komaki line was extended to the Heiandori station as a new metro line and connected with Metro line. The number of passengers on the Peach Liner increased, but it did not reach a profitable level. It was abolished in 2006. According to verification by Morikawa et al.,[37] there was a problem in demand forecasting. At the time of planning, the estimate was 30,000 people per day, a 15-fold difference from the actual results. Commuter train service on the JR Chuo Line in the neighborhood was not considered at all in this demand

[37] Morikawa et al. (2004).

forecast. It was estimated that all users from Newtown to Nagoya would use the Peach Liner. In reality, 80% of the railway users were already using JR. Many residents used JR with park and ride.

The Peach Liner also had technical problems. First, Peach Liner adopted a system called VONA, which has a guide rail in the center of the track. However, VONA was incompatible and expensive because it was different from the Japanese AGT standard. The committee established by the prefecture and Komaki proposed to switch the Peach Liner into a system that could be operated at low cost. The committee proposed IMTS (an autonomous bus system with a magnetic guide that operated in platoons, which was operated at EXPO 2005 AICHI, Fig. 21). It was developed by Toyota by modifying the AGT track and seemed reasonably priced.[38] However, the cost of renovating VONA's orbital facility was higher than expected, and the track of VONA did not correspond with the inner ring difference of bus vehicles. Eventually, the city decided to abolish the AGT and switch to a bus.[39]

Figure 21 - IMTS operating at EXPO 2005 AICHI, August 18, 2005.

4.4.4 Lessons from Failure Cases

Implication from the French cases is the difficulty of mode choice. Innovative means have risks and uncertainties. It is difficult to know whether that means succeeding or failing to complete the technology. It is difficult for local governments in small and medium cities to have knowledge about the technology perspective of SIMM. In fact, those three cities made their choices in the early stages. Autonomous Operator of Parisian Transports (RATP) did demonstration experiments of TVR, Translohr, and Civis at the BRT line in a Paris suburban area. After this experiment, Île-de-France Mobilité decided to choose Translohr, not TVR. Nancy and Caen decided before the results of this experiment. When considering innovations, demonstration experiments are especially important.

Implications from the Spanish cases was governance in using SIMM. By dividing responsibility between the region and the municipality, two tramways were destroyed.

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38 Committee for future of Peach Liner (2005).

39 Document for public participation about abolish of Peach Liner by Komaki City (2006).

Therefore, SIMM investment infrastructure must be considered. Local governments must establish a long-term strategy of how to operate the service through SIMM.

In the case of Komaki, the AGT system failed both in terms of technology and transportation planning. This case had failure points similar to France and Spain. The question is which planning and technical failures is more serious. In the French case, the driving lane and track site SIMM failures could be converted to a new system. In the Spanish and Japanese cases, the unused infrastructure of the SIMM failure remains abandoned property. The cost of removal is also high. Therefore, planning failure is more serious than technical failure. Even with SIMM, local governments need to carefully formulate a transportation plan and management strategy.

4.5 Implications from Urban Rail Projects

In Japanese innovative rail projects, many were implemented by large municipalities, cities designated by government ordinance (*Seire-Shitei-Toshi*) in the Japanese local government system. French innovative rail projects were implemented not only by large municipalities but also by small- and middle-sized municipalities. The reason for the size difference between French and Japanese cities is the room for choice of rail transport systems, including financial aspects. French cities introduced both a grade-separation system and a road surface system, while Japanese cities mainly introduced only a grade-separation system. In Japan, only large cites could introduce an innovative medium-capacity rail system like a monorail and an AGT. On the other hand, in France, small- and middle-sized municipalities could choose a road surface system as an innovative medium-capacity rail system.

The difference in the choice of systems depends largely on finances. At first, there is a difference in subsidies from the central government. In France, the subsidy system for TCSP infrastructure includes any system.[40] In Japan, there are many subsidies for rail infrastructure for each mode. For example, there is a subsidy for metro, a subsidy for AGT, and so on. In addition, there were two ministries that issued subsidies before 2001. The Ministry of Transport was in charge of subsidy for metros, and the Ministry of Construction was in charge of subsidies for monorails and AGT (these two ministries combined in 2001 to become the Ministry of Land, Infrastructure, Transport, and Tourism).[41] Subsidies for tramways did not exist until 1998 in Japan.[42] Second, there is a difference in the degree of local finance's contribution. France has a special tax system for urban public transport called *Versement Transport* that is collected by the urban municipality or their union (AOM, Urban Mobility Authority). The French AOM has enough fiscal resources to invest in innovative urban rail or BRT projects.[43] In Japan, local governments do not have enough fiscal resources to support public transportation. Japanese rail systems have always been operated on a self-supporting basis. In Japanese middle-sized cities, it is difficult to implement innovative urban rail projects because public transportation is not profitable. From the analysis of the difference in city sizes between France and Japan, it can be stated that for SIMM success it is necessary to

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40 Certu2002, p.41.

41 Shoji (2001), pp.86-96.

42 Minami (2001).

43 Minami (2012).

establish the choice of transportation mode for local government, focusing on the financial aspects.

The analysis of successful and unsuccessful cases provides important implications for the success of SIMM. For French rubber-tire tramway cases, the networks were replaced by other means as they were. In Caen, TVR was converted into a tram as in the same place, and in Doue, the Phileas lanes became bus lanes without any reconstruction. These cities established solid transportation plans, they succeeded in securing the demand of LRT or BRT. On the other hand, in the Spanish LRT cases and for AGT in the Komaki case, poor transport planning and strategy was fatal. By comparing the Japanese AGT cases of Komaki and Kobe, we can learn the importance of city planning and transportation management strategies in the introduction of SIMM.

There are two important implications from the study of innovative urban rail projects. The first implication is the need for a choice in transportation modes for local governments. If local governments can choose only expensive means like a metro or AGT, then middle- and small-sized cities cannot introduce innovative means. National transport policy systems need to expand the choice to inexpensive systems such as LRT or BRT. The second implication is that the planning or management matter more than technical matters. Any innovative means that has no support from transportation plans and related city plans or management strategy finds it hard to succeed.

5. Innovation in Road Public Transport Projects

5.1 Social Context of Mobility Innovation Policy of Road Public Transport

In rural areas, public transport services are not profitable because the demand is small. Conventional bus service is not rational. The last mile problem is important all over the world. Road transport SIMM is expected to solve problems in rural areas. In the Europe, especially in France, local governments are responsible for ensuring the mobility of rural people who cannot drive.

Since the year 2000, mobility conditions in Japanese provincial and rural areas have a serious crisis. As a result of deregulation in public transportation, many private operators have ever discontinued bus lines and some rail lines in the provinces. Municipalities have begun to operate substitutional mobility services, for example, Community Bus (a new type of minibus service), DAITAI-Bus (bus service by vehicles that not authorized as a public transportation), New demand responsive transport (DRT), demand-bus or taxi, etc., and so on. Municipalities have also introduced school buses or pickup services for medical and nursing-care instead of a bus system. To cope with the crisis, the Japanese government enacted new transportation laws such as the Act on Revitalization and Rehabilitation of Local Public Transportation Systems (2007, revised in 2014 and 2020) and the Basic Act on Transportation Policy (2013). Under the new laws, municipalities are required to play a subjective role in local mobility policy. Under the new laws, local public transport network plans made by municipalities are introduced, but unlike French and British law, the establishment of a plan is voluntary.

5.2 Autonomous Minibuses in France and Switzerland

Recently a demonstration experiment of autonomous minibuses is popular in Europe. France has two leading autonomous vehicle transportation companies, NAVYA and EZ

Mile. The three demonstration cities are Sion (Switzerland), Paris (France), and Lyon (France).

Sion was the first city to have an autonomous minibus as a permanent service. The service, called Smart Shuttle, opened in 2016. The vehicle is a low-speed autonomous bus (Autonomous Driving level 4) by NAVYA (Fig. 22).

Figure 22 - Smart Shuttle in Sion, September 8, 2017.

There are two routes of daily operation. Route 1 circulates around the old city, and Route 2 circulates between the old city and the train station (mixed transportation). The vehicle has a capacity of 11 people, an average speed of 10 km/h, 20 km/h maximum. The long-term experiment enables continuous vehicle and software updates. The aim of Smart Shuttle is to improve resident mobility. In Sion, residents can use Smart Shuttle for daily use, shopping, hospital visits, and so on.[44]

Lyon was the first city in France and the second city in the world to have an autonomous minibus permanent service. Grand Lyon Metropole has done a demonstration experiment of autonomous minibuses in a re-development area south of the city center (Fig. 23). It is free of charge and does not require reservations. It operates from Monday to Saturday. The service hours are every 30 minutes on Monday to Friday from 7:30 to 19:00 with a frequency of 15 minutes during peak hours). On Saturdays, the buses run every 30 minutes with a frequency of 15 minutes in the afternoon from 10:00 to 19:30. The service carried 22,000 passengers from September 2016 to October 2017.[45]

In the Paris metropolitan area, there are two experiments. The one is a service in Vincennes Forest Park for picnic visitors. The organizers are RATP (Autonomous Operator of Parisian Transports), Ile-de-France Mobilité (Metropolitan Transportation Authority), and the city of Paris. The operator is RATP. Vehicle is the EZ10 by EZ Mile (Fig. 24). It runs only on Friday, Saturday, and Sunday, from 10:00 to 20:00. There is service for less mobile persons, and it is free of charge.[46] The other is service in La

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44 Lecture in Study Tour by Tourist Office of Sion. "Sion, voyage au coeur du Smartshuttle ". 8th September 2017.

45 Inteview to Mr. Keroum SLIMANI, Chef of Mobility Projet at Grand Lyon Metropole. 14th September 2017.

46 Île-de-France Mobilité Web.

Defense Area, in the western business center. The organizer is Île-de-France Mobilité. Operator is Keolis. The vehicle is an Arma by Navia. The Northern Line runs from Monday to Friday, 9:00–20:00, every 10 minutes. The Southern Line runs every day, 10:00–20:00 (weekdays from 9:00), every 10 minutes. It is free of charge and serves everybody.[47]

These demonstrations are long term and give opportunities to many residents and visitors. There are three main objectives of the demonstrations. The first is Technical Inspection; the second is to investigate how to improve people's lives; and the third is impact assessments on regional societies and economies.

Figure 23 - Arma Vehicle in Lyon, March 14, 2019.

Figure 24 - EZ10 vehicle in Paris, April 15, 2018.

47 Navya Web.

5.3 Demonstration Experiments of Autonomous Minibuses in Japan

The Japanese government proposes the solution of rural mobility problems by innovative means. The favored means is an autonomous minibus. The government has promoted the demonstration experience of autonomous minibuses. On the other hand, the sharing economy is also an important way. Ridesharing services have been recommended by the Ministry of Internal Affairs and Communications (MIC). In a white paper on ICT, MIC discusses the development of ridesharing services like Uber. There are not any regulations or definitions of ridesharing services in Japanese transportation law. Therefore, ridesharing services is difficult for the Ministry of Land, Infrastructure, Transport and Tourism (MLIT) to deal with. Ridesharing services is outside the legal institutions. If Japanese municipalities want to introduce ridesharing services to solve a mobility problem, there are many hurdles to overcome in order to realize the implementation.

The MLIT implements some demonstration experiment projects. The largest project is based on Michi-no-Eki and other public facilities in the Chusankan rural area.[48] This project started in 2017. In FY2017, only a few persons acting as monitors could take the minibus. The aim of project is to use by autonomous technology to ensure passenger and logistics mobility in areas where depopulation is occurring. The experiment's time period was short, one or two weeks (Table 1). From October to December 2018, new experiments were done as projects FY 2018. The experiments covered six locations. The time periods were approximately 2 months. Everybody could ride and needed to make a reservation like a DRT.

Japanese Government launched permanent autonomous minibus service in 2019. From November 30, 2019, the Japanese first permanent autonomous minibus lines opened in Kamikoani village in Akita prefecture which was one of municipalities demonstration experiments at Michi-no-Eki by MLIT. This system is same to demonstration experiments (see Table 1). The autonomous minibus in Kamikoani is implemented by State (CAO and MLIT).[49] From November 26, 2020, Sakai Town in Ibaraki prefecture introduced autonomous minibus service by ARMA, Navya.[50] This service is Japanese first autonomous minibus service operated by Local Government.

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48 MLIT web site http://www.mlit.go.jp/road/ITS/j-html/automated-driving-FOT/index.html Accessed October 30, 2018.

49 Press release in MLIT web site https://www.mlit.go.jp/report/press/road01_hh_001258.html Accessed February 19, 2021.

50 Sakai Town web site.

Table 1 List of demonstration experiments at *Michi-no-Eki* by MLIT in 2017(FY)

Name of Municipality	Name of Prefecture	Type	Period (mm/dd)	Vehicle Type	Service Length	Number of Monitors
Taiki Town	Hokkaido	App	12/10–12/17	AS	7.6km	120
Kamikoani Village	Akita	Des	12/3–12/10	YM	3.2km	100
Takahata Town	Yamagata	App	2/25–3/4	AI	20km	90
Hitachiota City	Ibaraki	App	11/18–11/25	YA	3.2km	160
Tochigi City	Tochigi	Des	9/2–9/7	EZ	2.0km	70
Nagaoka City	Niigata	FS				
Nanto City	Toyama	App	11/26–11/30	AI	16km	70
Ina City	Nagano	App	2/10–2/16	AS	5km	160
Gujo City	Gifu	FS				
Toyota City	Aichi	FS				
Higashiomi City	Shiga	Des	11/11–11/17	AS	4.6km	120
Otsu City	Shiga	FS				
Iinan Town	Shimane	Des	11/11–11/17	AI	5.7km	60
Niimi City	Okayama	App	3/3–3/16	YM	2.2	200
Ube City*	Yamaguchi	FS				
Miyoshi City	Tokushima	App	12/3–12/9	AI	7.2km	80
Miyama City*	Fukuoka	App	2/17–2/24	YA	10km	80
Ashikita Town	Kumamoto	Des	9/30–10/7	YA	6.3km	100

[Type] Des: Designation, App: Application, FS: Feasibility Study
[Vehicle Type] AS: AS-Mobi (Lv2&4), AI: AISAN (Lv2&4), YM: YAMAHA (Lv2&4), EZ: DeNA EZ10 (Lv4)
* Bases of Ube city and Miyama City are not *Michi-no-Eki.*
Source: MLIT

5.4 Ridesharing Demonstration Experiments at Nakatonbetsu Town

Nakatonbetsu is located approximately 100 km south of Wakkanai, which is the northern city of Hokkaido. The population was 1,777 in February 2017, 38.3% of the population is elderly. It is estimated that the population of the town will decline to 946 by 2040. The national railway line abandoned in it 1989 and replaced with a bus line operated by Soya Bus Company. In May 2018, the bus operated only four times per day. People who do not drive cars must depend on taxi services, but there are only two taxis in Nakatonbetsu Town. Nakatonbetsu has a loss of mobility chances.

The town concluded a cooperative agreement with Uber Japan to introduce a Naktonbetsu ridesharing social experiment, voluntary ridesharing services do not violate current Japanese regulations. The mission of the demonstration experiment is to introduce and realize a sharing economy. Through this experiment, Nakatonbetsu expects to increase inbound visitors, better life satisfaction, and rejuvenation of human and social capital. At first, the Nakatonbetsu distributed flyers to introduce the launch of the ridesharing service and to enlist volunteer drivers for the service. The town organized a committee, the Nakatonbetsu Local Transportation Group that held a monthly meeting to prepare and coordinate the ride sharing service. The committee conducted seminars on safe driving, created a safety map of Nakatonbetsu Town, and advertised to increase users and drivers.[51]

During the seven months of the experiment, 206 rides given, and the accumulated mileage was 2,396 km. More than half of the rides were over 3 km. Around 30% of rides

[51] Minami, Akiyama & Higashi (2018).

were longer than 10 km. The average distance was 12.95 km, and the median was 2.26 km.[52]

Implication from the Nakatonbetsu case provided four implications. First, it is important is to gather the evidence. The town was surveyed using questionnaires and interviews with residents. The town conducted the ridesharing experiment after understanding the situation and the challenges to mobility. The town feeds back the results of the additional survey in the experiment progressing. Example, fare system changed to the charge equivalent to actual cost from free charge.

Second, it helps to take a step-by-step approach. The town gradually developed a system of ridesharing through trial and error. Third, it is necessary to clarify the town's responsibility and authority. Uber drivers in Nakatonbetsu must take attend a course conducted by the town in driving school. This rule effectively acts as a town licensing system for the drivers. Fourth, it is important to build a partnership with an innovator (Uber), academic researchers, and consulting agency by establishing of the survey committee for sharing. Nakatonbetsu developed a mobility policy cycle for IMM as shown in Fig. 25.

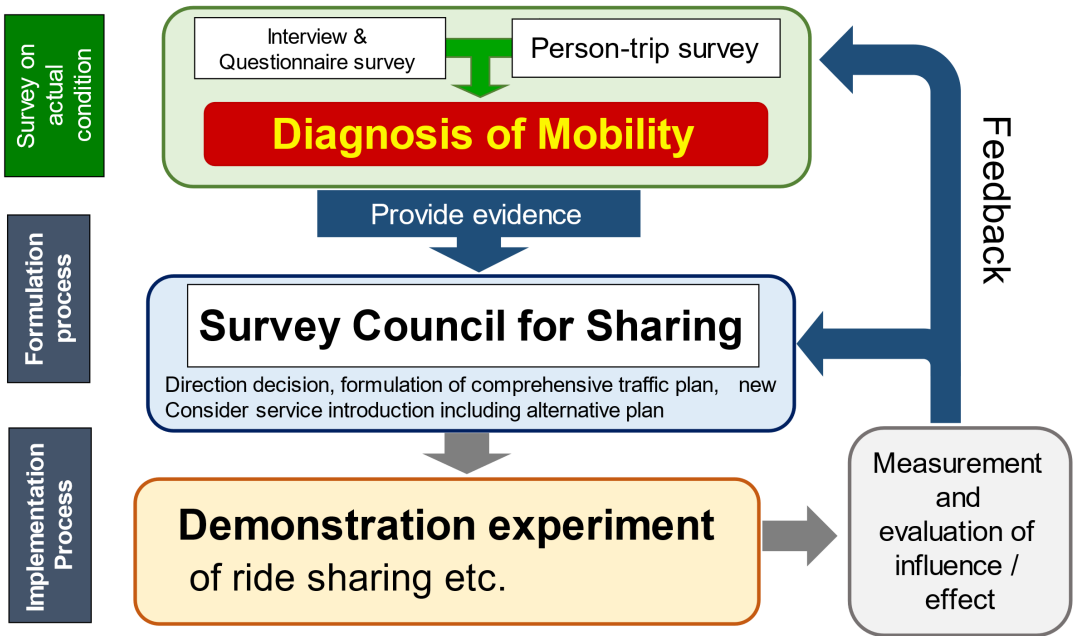

Figure 25 - Mobility policy cycle for IMM in Nakatonbetsu.

5.5 Implications from Road Public Transport Projects

There are three implications for local governments hoping to implement demonstration experiments on innovative road transportation means. First, it is desirable that the experiment period be long, over one year. If the experimental period is short, less than 1 month, it will merely become a transient event, and the residents would only take test drive as a leisure activity. Second, experiments must be designed to measure the impact on the quality of residents' lives. It must determine that residents can use the innovative means for necessary trips in daily life—shopping and going to the hospital, etc. Third, the experiment should have a strategy of gradual expansion and development. For example,

[52] Nakatonbetsu Town (2017).

in Sion, the experiment implemented only one line, but after one or two years it could expand to other lines. Higashi (2018) found that the role of local transportation policy was an incubator for innovations in the Sion and Nakatonbetsu cases. Local government gave environment to develop step-by-step to SIMM developers.[53] Therefore, Incubator is another important role of local government.

6. MaaS (Mobility as a Service) and Local Government

6.1 MaaS in Helsinki and the Role of Local Government

Mobility as a Service (MaaS) originated in Helsinki. The first MaaS smartphone application—Whim—was developed by the Finnish venture company MaaS Global. The background of MaaS is the latest Finnish transportation policy. Finland established The Act on Transport Service (July 2018) to re-organize transport regulations to suit ICT, especially by using Big-Data by Transportation Operators and other agencies concerned with mobility. Under the new Transport Act, ticket sales procedures by a third party were liberalized to encourage venture companies to develop ticket applications. Also, the taxi license system was reformed to offer easy access to new operators. Under the new license, ridesharing companies like Uber could make inroads as taxi companies.[54]

The Whim application has been in service since November 2017. The Whim app was designed as one complete application to deal with all mobility issues for all people. The Whim app not only includes functions that perform traffic information searches about timetables and walking routes but also about fare payments by credit or debit cards, e-tickets for public transportation, taxi dispatches and rental car or bicycle reservations. With Whim, one can use public transport services (Metro, Tram, Bus, Ferry and Commuter Rail), taxies, walking, bicycling, and rental cars in the Helsinki metropolitan area. The Whim app can show several options through a search. If the choice is public transport, the app will show a timetable and a walking route to stations or bus stops and destinations with the purchase of an e-ticket in the app. If one chooses a taxi or rental car, one can reserve a taxi or rental car. There are three fare options for using mobility services with the Whim app. The first is the plan to confirm each order with a usage fee for a taxi or a rental car. The second a free plan for all public transportation and a flat rate fare for taxies and rental cars (49 Euros per month). The third is a subscription plan of unlimited use not only for public transportation but also for taxis and rental cars, (499 euros per month). The Whim app is characterized by actually roaming with a system of applications provided by each transportation agency. Therefore, existing apps are not in competition but in collaboration with each other. The ultimate goal of Whim is realizing a mobility service so that all people have no need for a private car.[55]

Whim application development is based on national policy, especially regulation reform to liberalize ticket selling. In other words, development of the Whim app was not developed according to the Helsinki government's mobility policy. However, without Helsinki's mobility policy, Whim app might not have been developed. In Helsinki

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[53] Higashi (2018).

[54] Interview with Mr. A. Tiskola and Ms. E Immonen, Ministry of Transport and Communications of Finland, September 26, 2018.

[55] Interview to Mr. S. Hietanen, CEO of MaaS Grobal, and Ms. K. Huhtala-Jenks, MaaS Global, 25th September 2018.

metropolitan region, users pay only 50% of the operation cost (Fig. 26). The rest of the cost is covered by tax revenues from the state and the city. The transport authority in the Helsinki metropolitan area is called HLS and one of special local governmental body.[56] Whim's price system is managed by local government's transportation financial system. In addition, HSL offers a convenient application service for public transportation with search capabilities and e-tickets. Helsinki has the best MaaS Global partnership.

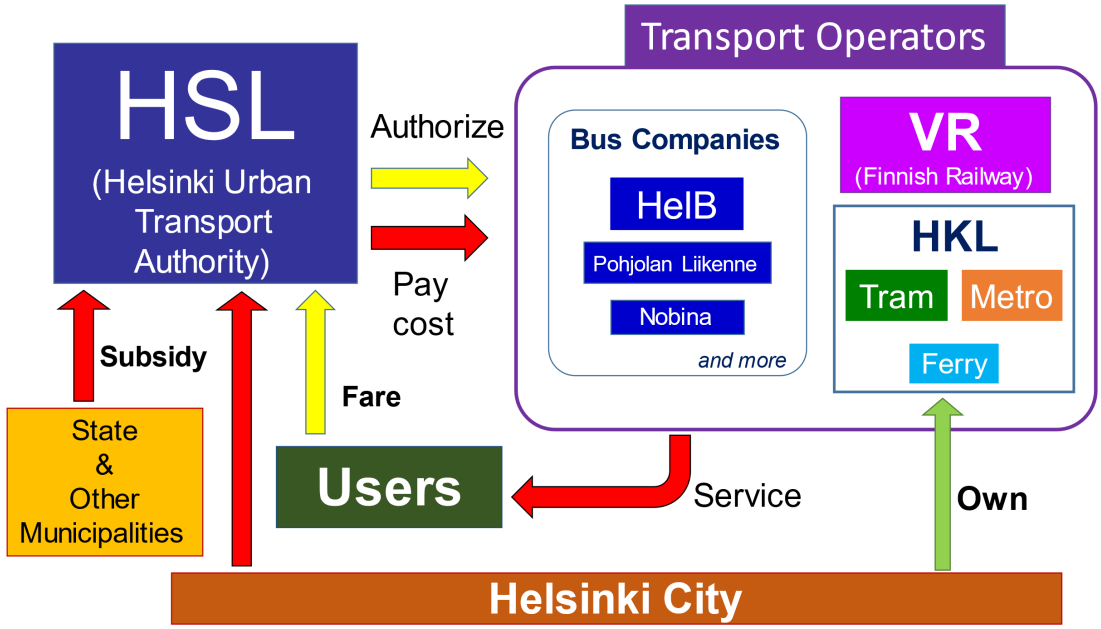

Figure 26 - Finance system for Public Transportation in the Helsinki Metropolitan Area.

6.2 Role of Local Government in MaaS

The objective of MaaS is to create an alternative to the private car by integrating all transportation means. One means of transportation cannot fulfill all transportation demands, even if it is new and innovative. Only private cars can meet all travel needs. In fact, people know how to use single transportation methods, for example, taking a bus, taking a taxi, etc., but they do not know how to use them in combination. Information technology has enabled people to use a combination of transportation means. People can get information on both primary transportation means and secondary transportation means available for their trip through MaaS applications. Importantly, MaaS is just a means of information, not a means of transportation. If the only transportation means in the region are poor, a MaaS application is just the means to informing people that a private car is the most convenient way to travel.

The most important role of the local government for MaaS is to provide sufficient transportation service and infrastructure or to create an environment where private companies can supply innovative means and to arrange appropriate transportation by establishing a comprehensive local transportation plan. MaaS is useful only when there is an optimal supply of transportation.

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[56] Akiyama Labo. (2018).

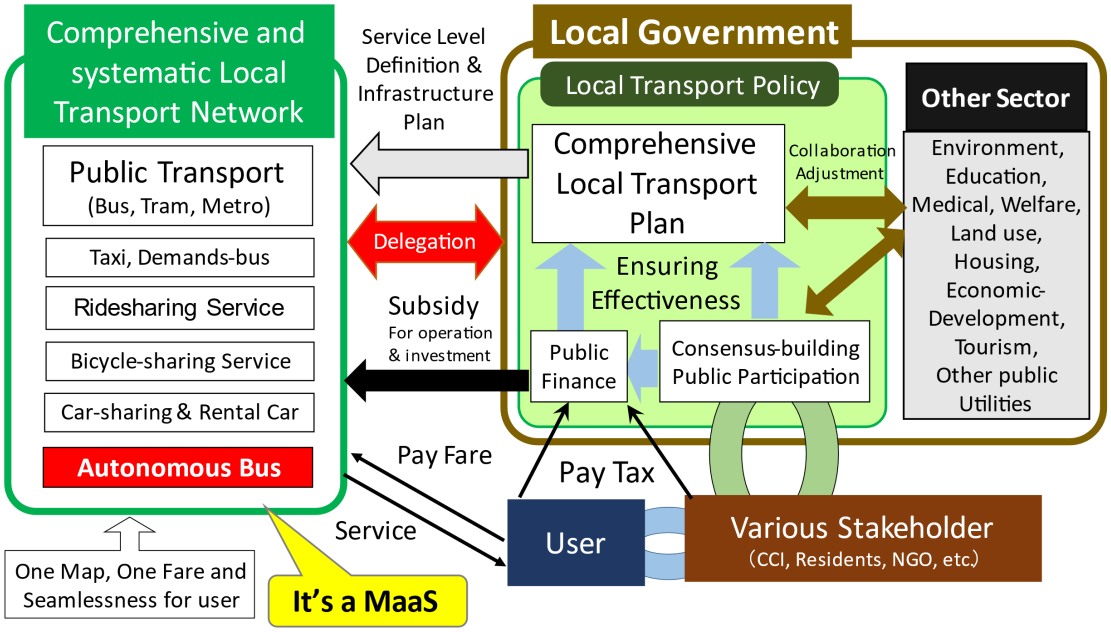

Figure 27 - MaaS in Comprehensive Local Transport Policy

Therefore, local governments must necessarily realize the comprehensive and systematic nature of regional transportation networks, including all traffic services, not only traditional public transportation but also ridesharing, bicycle sharing, and public autonomous car services. To realize a comprehensive transportation network, local governments must define the service levels of all transportation services in a comprehensive LTP, must set up contracts with all transport operators—including ridesharing services, and must establish a finance system and a stakeholder council as a decision-making system. This perspective is shown in Figure 27.

7. Conclusion

The goal of this paper is to determine what steps local governments must implement to solve the mobility problem by SIMM. Five roles and five instruments of local governments on transportation policy were analyzed as theoretical assumptions. The significance of these roles and means varies by municipality depending on factors such as the size and level of local government and its relationship with other levels of government.

From the case study we get the following implications. The lesson learned from the innovative urban rail projects is that local governments must be able to choose among all systems, whether expensive or cheap, and they must establish an optimal transportation plan. If the planning is adequate, it is possible to recover from technical failure. If the technology is good but the plan is wrong, the failure will be fatal. In the case of the experiments with autonomous vehicles and ridesharing, it was desirable to carry out the experiment for a long period of time to measure the impact on the quality of life of the residents and to gradually expand and develop the experiments. In the case of MaaS, the most important role of local government was to supply and arrange the transportation means by establishing a comprehensive local transportation plan.

There are three key points about the role of local government for the implementation of SIMM. The first key point is comprehensiveness. Mobility is a comprehensive concept. Local governments must take account of various elements about mobility and other factors, including the population and generations of people, the economic and geographic situation, environmental regulations, and tourism. The successful experiment has a scenario or strategy based on the social background of the area. The second key point is regionality. The characteristics of mobility are different among regions or areas. “What are the best methods?” is the wrong question. “What methods are suitable for our region?” is the correct question. Therefore, local governments must understand the characteristics of their areas before choosing a means of transportation. The third key point is the cycle of transportation policy and the implementation of SIMM. This means that the role of the local government is to be an incubator for innovation.

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