

New Service Model for Railway Business as a 'Social Infrastructure Service': New Service Value Creation Model Using SLA Concept

Masahiko Suzuki, Michitaka Kosaka

School of Knowledge Science, Japan Advanced Institute of Science and Technology, Ishikawa, Japan

Social infrastructures are very popular for many people and are repeatedly used in their daily lives. The discussion on social infrastructures as services is less popular than that as systems. We think that social infrastructures are also services because they provide users with something of value. Customers usually use social infrastructures without considering them thoroughly as services because social infrastructures exist just like air does. Therefore, customers' values for social infrastructures are "invisible" from service providers in social infrastructure services. Many social infrastructures are provided by private companies in Japan. Therefore, providers should identify customers' values to increase their satisfaction. First, we explain the difficulty of applying existing service theories to social infrastructure "services" in this paper. This is because major service theories deal with either enhanced supplementary services or direct interaction between staff and customers, although both situations are rare in social infrastructure services.

Therefore, we propose a new model using a new concept called the Social Infrastructure Service Level Agreement (SISLA) induced from the Service Level Agreement (SLA) to explain "invisible" values. SISLA is different from SLA because SISLA is not a stipulated contract or a promise between service providers and customers. We concluded that: 1) SISLA was a discipline of social infrastructure services used by both service providers and society (groups of customers) and 2) SISLA was an appropriate new service model for social infrastructure services.

This paper focuses on the railway business as a typical social infrastructure. The core service of the railway business is transportation. The service provider can only provide the core service to customers via facilities like rolling stock. Therefore, the staff of the service provider cannot consider customers and their value to be invisible. More concretely, SISLA in the railway business is comprised of safety and punctual train operations.

I. INTRODUCTION

It is known that transport (railways, airlines, highways, ships, buses, and taxis), waterworks and sewers, electric power, gas, communications, earthworks (roads, tunnels, bridges, and buildings) are social infrastructures that form the basis of citizens' lives. "Social infrastructure" in Japan is defined as "The facilities which are basis of industry and social life" [2], [10].

There is a general outline of the social infrastructure in Fig. 1-1.

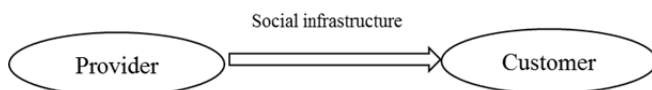


Figure 1-1 Outline of social infrastructure

There are operational and maintenance organizations (national, municipal, and enterprise) around the social infrastructure and users (citizens and industry). The former is considered to be a "provider" and the latter is considered to be a "customer". Almost all the social infrastructure for present citizens has already existed before their birth. Therefore, citizens have used it without any special concerns. Although the Internet has become popular over the last 20 years, it already exists for young people and may last for many years as one of the most important social infrastructures. New kinds of social infrastructures like those on the Internet may increase as time goes by.

It is generally recognized by law that social infrastructures must be naturally constructed and maintained by the nation, municipalities, and enterprises. Some companies also have obligations to supply social infrastructures (e.g., those through road transport vehicle laws, telecommunication business laws, and electricity business laws). Therefore, social infrastructures are positioned as being mandatory rather than derived from the needs of users.

Many social infrastructures in Japan, which were constructed during the period of high economic growth in the 1970s, have greatly deteriorated. Therefore, the necessity for maintenance and renewal has been broadly publicized. The number of customers and staff of providers will decrease because the population of Japan has been decreasing. The crisis in social infrastructures has focused on social infrastructure "systems". We think that "social infrastructure systems" are different from "social infrastructure services". A social infrastructure system generally means a scheme to maintain a usable state for a social infrastructure.

However, Kosaka stated that services were established by the relations between service providers and customers [7]. He also claimed that provider services achieved customer's objectives and satisfaction (Fig. 1-2). Once social infrastructures are recognized as services, it will be customary to apply several service models to social infrastructure services.

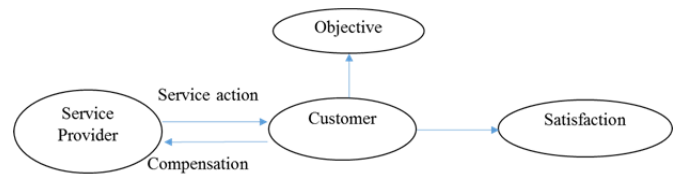


Figure 1-2 Definition of service

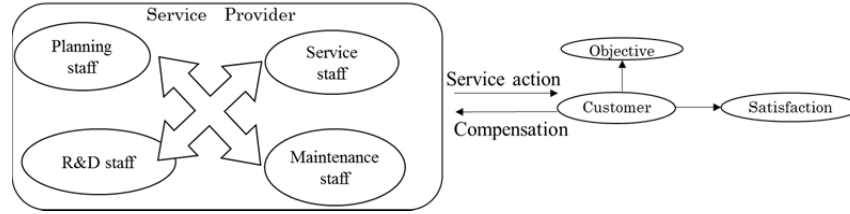


Figure 1-3 Internal structure of social infrastructure of service provider

We should not treat social infrastructures as just a means of conveying services from providers to customers by understanding social infrastructures from the viewpoint of services. Social infrastructures can be treated as services that are changing the value and importance of existence according to relations with customers. Also, there are many departments and systems within service provider organizations and departments to maintain huge social infrastructures that are cooperating and making conciliatory efforts. The relationship between individual departments and customers can clearly be described by including the provider’s internal relationships in the service model (Fig. 1-3).

The results obtained from this study can provide solutions to two main problems.

- 1) How do individual departments of service providers approach customers?
- 2) How do individual departments of service providers conduct themselves to create positive relationships with customers?

Although there has been a great deal of discussion on the motivation for company-internal administrative divisions, we only examined the internal structures of social infrastructure organizations in this study.

Our main question in this research was “How do providers and customers in the railway business co-create service value?” The main objective of this study was to obtain answers to research questions by understanding the characteristics of social infrastructures. Therefore, we established a new service model for a social infrastructure that included service providers, customers, and others by referring to service concepts. We especially selected the railway business as a concrete case. In addition, we focused on maintenance staff and research and development (R&D) departments, which are characteristic organizations in social infrastructure businesses.

Section II first reviews existing service models and explains the difficulty of applying these existing models to social infrastructure services. Section III then proposes a new service model that presents the main characteristics of the social infrastructure. Finally, Section IV explains how we applied the new service model to the railway business as a typical case of a social infrastructure.

II. EXISTING SERVICE MODELS

This section introduces reviews of former research and service models used to investigate the relationships with social

infrastructure services. A brief introduction to Japanese railway businesses is then described, one of which involves social infrastructures from the viewpoints of innovations in technologies and services. Finally, the difficulty of applying existing service models to the social infrastructure services is explained.

A. Former and service models

- 8Ps

Lovelock and Wright’s service 8Ps [9] is a model that divides services into eight elements such as marketing, operations, and human resources. A service’s 8Ps is used to manage the service comprehensively and service providers can distinguish what elements the providers must focus on. The eight elements of the 8Ps are “product”, “place and time”, “price and other user outlays”, “promotion and education”, “physical evidence”, “process”, “people”, and “productivity and quality”.

- Flower of Service

Lovelock and Wirtz [8] explained their “Flower of Service” (Fig. 2-1). This is a model that divides a service into a core product and eight supplementary services.

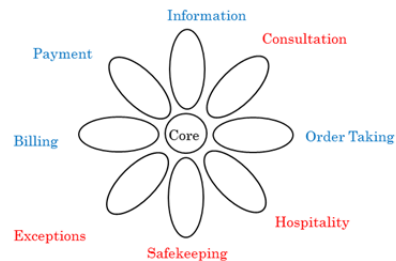


Figure 2-1 Flower of Service

The “Flower of Service” is a model that expresses that there is a core product that is the center of a service and there are eight supplementary services around the core product. As the core product is like the center of a flower and the eight supplementary services are like petals, they can provide excellent services like those provided by a beautiful flower. Eight supplementary services are classified into facilitating services (information, reservations, billing, and payments) and enhancing services (consultations, hospitality, safekeeping, and exceptions).

It is hard to distinguish the core product from other products by only appeal in a mature society where many

tangible products exist all around (e.g., commodity products like electrical products, or where several airline companies provide flight services on the same airline). Providers combine these supplementary services to efficiently increase the value of the core product.

- KANO model

Kano et al. proposed “must-be quality” and “attractive quality” [5]. This concept was based on thinking that the quality of the product must be subjectively and objectively considered. They claimed that physical sufficiency (objective point of view) and satisfaction (subjective point of view) were not necessarily in a linear relation (Fig. 2-2). “Must-be quality” means that the quality element is natural if fulfilled, but causes relative dissatisfaction if not fulfilled. “Attractive quality” means that the quality element causes satisfaction if fulfilled and forces customers to feel they have not been assisted if not fulfilled. For example, “(good) reflected state”, “(no) failure” and “(high) safety” on TV are recognized as “must-be quality. By classifying customers’ quality value for the elements of tangible properties in this way, manufacturers can decide which elements providers must focus on before product development starts.

We can define the concept of “must-be service quality” and “attractive service quality” according to the concept of the KANO model.

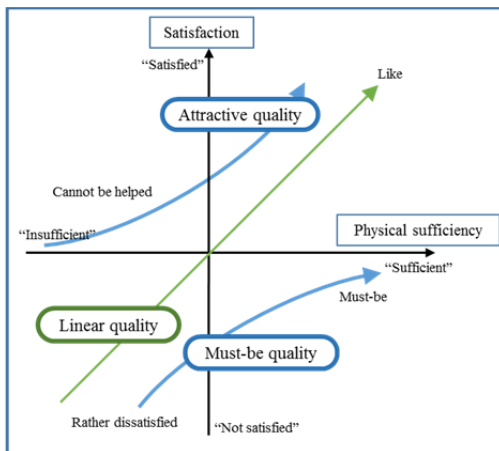


Figure 2-2 KANO model

A social infrastructure service (e.g., electricity) generally creates a strong impression as “must-be service quality”.

Providers can slightly increase customers’ satisfaction when increased service levels are provided. Providers may also decrease customers’ satisfaction fatally when slight decreases in providing service levels occur. If customers’ satisfaction is fatally decreased, it will have worse effects on the other “attractive service quality”, which a provider is carrying out.

- Service encounters

The service encounter in Fig. 2-3 outlines a scenario that a customer and staff encounter [9], [19]. We must take this concept into account as long as we consider that the service is a co-created value process. Needless to say, this scenario is needed when intangible properties are provided, even when the customer receives tangible properties. This is not a simple exchange of tangible properties and fees.

The customer’s viewpoint is that he/she can observe the front stage of the provider. Therefore, communication only occurs at the front stage. Service, on the other hand, is provided as a result of a combination of staff from the front and back stages from the provider’s viewpoint. The encounter scenario for the provider and customer is especially important during the service process. Normann called this the “moment of truth” [12].

We can investigate the state of satisfaction of customers at the moment of service, output from the provider to the customer, and the service process of the provider by using the concept of “service encounters”. Therefore, we can discover what is contributing to improving and maintaining service levels.

- Service profit chain

Heskett et al. [4] presented a service model called the “service profit chain” (Fig. 2-4). This model was induced by the thinking below.

“The service-profit chain establishes relationships between profitability, customer loyalty, and employee satisfaction, loyalty, and productivity. The links in the chain is shown in Fig. 2-4.

Customers, companies, and employees are connected with service profit. Therefore, all elements are important. Locally, customers and employees increase satisfaction with one another via service value.

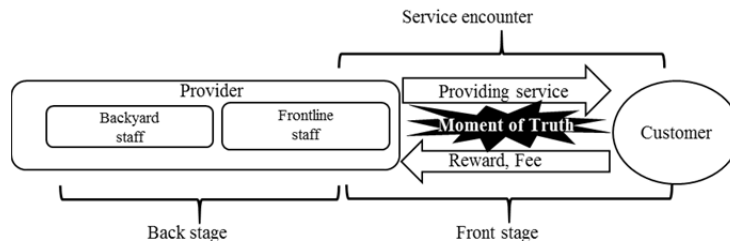


Figure 2-3 Service encounter

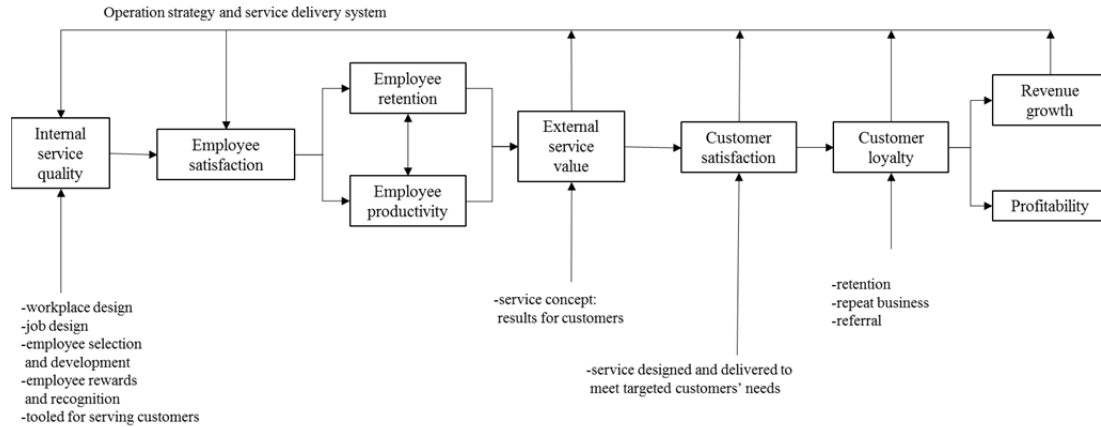


Figure 2-4 Service profit chain

- Public goods

Takigawa defined public goods [17] as goods that had at least one non-rivalness or non-excludability in economics. Non-rivalness has characteristics that no additional cost is needed if users of the goods increase, e.g., movie theaters, pay broadcasts, and club goods. Non-excludability has characteristics that customers who do not pay fees are not excluded, e.g., natural resources and common pool goods. Goods that have both non-rivalness and non-excludability are called pure public goods (free broadcasts and national defense). Goods that have either non-rivalness or non-excludability are called impure public goods. Goods that do not have both characteristics are called private goods (products such as food and clothes).

A part of the social infrastructure is managed by private companies and customers use it through payments. Therefore, the social infrastructure is not pure public goods, although the elements of social infrastructure services can be classified based on the concept of public goods.

B. Brief introduction to Japanese railway business history

Japanese railway construction started in September of 1872 and the first line was constructed from Shimbashi to Yokohama. Japan had changed from the traditional era (Edo) to the modern era (Meiji). Modernization was mainly carried out by the government. Other than modernization of the railways, other modernizations were launched during this period, which included those of a new postal business (1870), telegraph business (1869), issue of yen coinage (1871), issue of yen bills (1873), a national educational system (1872), start of the Gregorian calendar (1872), and many other basic social systems or facilities. Industrial iron mill, silk mill, and occidental agricultural methods started in the 1870s. Therefore, railway lines expanded rapidly to transport these products, coal, and military resources [16].

What was a special issue in early railway history in Japan was that the country had aggressively introduced overseas technology to Japan. Although, engineering, rolling stock, rail, and all other facilities had initially been made in the U.K.,

the first passenger car had been made in Japan by 1874. In addition, the first locomotive was made in Japan in 1893. Subsequently, Japanese engineers took charge of construction of railways from Kyoto to Otsu in 1878. The engineers aimed to maintain railway technology in Japan.

It was also a characteristic event that many private companies were established so soon in that the companies constructed and operated many important railway lines. One of the main reasons was that the government did not have sufficient funds in its budget and had to rely on private investment.

As the Japanese economy was in surplus from the end of the Meiji period to the beginning of the Showa period (around 1925), electrification started from railway lines in the metropolitan area. Long tunnels had also been constructed, which was one of the major means of speeding up construction. Japanese engineers developed high-speed steam locomotives, thereby reducing the traveling time from Tokyo to Osaka to eight hours in 1929.

Other means of transportation such as that by shipping, through ports, cars, and roads had been catastrophically destroyed at the end of World War 2. Therefore, only railways fulfilled the expectation of needs for transportation of daily necessities and soldiers from overseas war zones in Japan. The railways in those days were uniformly administrated all over Japan under the control of the national government. Technology had made progress that corresponded to war efforts and services were provided by the nation.

Railways had flourished during the period of high economic growth. As the number of trains on the main Tokaido line had increased, the line's capacity was exceeded. Subsequently, the construction of the high-speed "Shinkansen" train started in 1955, which was launched in 1964. Transportation by the national railways exceeded demand in the Tokyo metropolitan and Kansai areas because of population convergence. Convenience was improved by private railway companies extending areas to suburbs and by mutually exchanging rolling stocks between private railways

2016 Proceedings of PICMET '16: Technology Management for Social Innovation

and subways in metropolitan areas. In addition, signaling systems were developed to improve transportation.

After that, a modal shift occurred from railways to cars and airplanes due to progress in motorization. This first occurred in freight and then in passengers. Japan National Railways (JNR) fell into deficit in 1964. After several reforms, JNR was divided into six passenger railway companies and one freight railway company.

Demand for railway services has become diversified. Luxury trains like the “Shinkansen Toreiyu Tsubasa” and “Nanatsuboshi in Kyusyu” are in service. The government is leading Japanese railway companies to promote railway technology overseas.

Today, the total length of railways in Japan is over 36000 km (2012) according to the Railway Bureau [14] and the number of passengers is about 23 billion (2013) according to the Policy Bureau [13].

C. Applying existing service model to social infrastructure services

We tried to describe social infrastructure services through existing studies and models described in the previous section. Railway business services were concretely selected as representative social infrastructure services.

First, we classified railway business services and other services according to Lovelock and Wright’s service 8Ps (Table 2-1).

A specific characteristic of the railway business in 8Ps is product. Product in other services is goods or place. Product in the railway business is “moving means for customers”. Tangible properties such as stations and trains that customers use are merely supplemental values of the product “moving means”. Therefore, there are two places (departures and

destinations) in the railway business. The staff of hotels provides services at any time at the customers’ request. However, the railway business has train time tables, which are determined in advance by railway business companies.

Therefore, the staff of railway business companies provide products (moving means) based on train time tables. The price of lodging fees is flexibly determined according to the demands of the market and principles of competition with other providers. Fares in the railway business are regulated by the national authorization system. More concretely, the minister for land, infrastructure, and transportation authorizes the upper limits of fares for railway business companies according to the railway business law. The minister may order railway business companies to make improvements if he/she finds that inappropriate fares interfere with public interests. In terms of costs, railway business companies must make capital investments toward safety, maintenance/renewal of rolling stocks, and ground facilities such as rail, signalling systems, buildings, and many other facilities. The Railway Bureau [15] for railway business companies in Japan stated the ratio of capital investment and repair costs for incomes was 29.4% in 2013. Both railway business companies and overnight stay service providers advertise and promote services by themselves. The main characteristic of the railway business is to provide train status information. This information is rather negative information about providing moving means, which is an important product of the railway business. However, if railway business companies do not announce this information actively and in a timely manner, customers may be increasingly inconvenienced. Incidentally, although customers sometimes tweet on train delays on social networking services (SNSs), this information is not official information issued by railway business companies.

TABLE 2-1 8PS INVESTIGATION (RAILWAY BUSINESS AND OVERNIGHT STAYS)

	Railway business	Other services (Overnight stays)
Products	<u>Moving means</u> , providing information, and providing infrastructure.	Tangible properties (places to stay), intangible properties (hospitality)
Places and times	Stations (departures and destination), rolling stocks, and train time tables	Locations of hotels. 24 hours/During check-ins and check-outs
Prices and other user outlays	<u>Fare (authorization system)</u> Costs: Same as those at right but <u>huge cost is involved to maintain/renew infrastructures</u>	Lodging fees Costs: material, labor, administration, and maintenance costs
Promotions and education	Advertisements in several media but <u>much information is distributed around stations</u> . Dissemination of rules and campaigns to improve manners when using trains/stations	Promotions in several media and word of mouth
Physical evidence	Interior of rolling stocks, automatic ticket machines, and automatic ticket wickets Station facilities, escalators, elevators, and facilities for handicapped people	Layouts/interiors of lobbies, overnight rooms bath amenities, elevators, and facilities for handicapped people
Processes	Departure stations, movements by train, and destination stations	Arrivals at hotels, check-ins (<u>communication/conversations with staff</u>), overnight stays, and check-outs
People	<u>Railway facilities (rolling stocks and stations) provide transportation services</u> . <u>Staff engage in maintenance facilities</u> and also provide guidance to customers at stations	<u>Staff provide services through communication with customers</u>
Productivity and quality	<u>Maintenance of infrastructures</u> during the night between last and first trains.	Levels of service quality and quantity of costs are contrary relations.

TABLE 2-2 ATTRACTIVE/MUST-BE SERVICE QUALITY IN RAILWAY BUSINESS SERVICES

Attractive service quality	Not crowded and announced suspension of operations due to some trouble
Linear service quality	Frequency of trains and express fares
	Cleanliness at stations
Must-be service quality	Safety and air conditioning in trains
	Information announcements (in case of trouble)

Customers in the process of railway businesses do not need to communicate with staff until they accomplish their objectives. In terms of productivity, maintenance staff of railway businesses maintain/renew railway facilities when train operations are suspended, which are mainly during the night. In other words, maintenance schedules are automatically and definitely established by determining train time tables.

In summary, many differences were found by investigating social infrastructures as services with Lovelock and Wright’s service 8Ps compared to other services.

Second, we considered railway businesses using the KANO model by carrying out a survey on customers. There is a classified summary of the survey in Table 2-2.

We found that information announcements (especially in case of trouble) were mostly “must-be service quality”. As the information society, Internet, or SNS are currently widely used, customers tend to think that frequent information announcements are to be expected and lack of information is unacceptable.

Some comments by customers:

- Train delay was unavoidable. As I had no alternative means of travel, I had to wait. However, I wanted to know why the delay had occurred.
- I wanted to receive the latest information to decide whether I should wait for suspended train operations to resume on the regular route or whether I should transfer to another route or use another means of transport.

Because customers usually use a particular train, irregularities such as suspended operations have a major influence on them. Therefore, the most recent and frequent information announcements are important to customers so that they can react to trouble.

Further, air conditioning and safety are must-be service quality. As customers stay longer on the train from departure to destination (when using the core product) than at the station,

they demand comfortable air conditioning on the train, which is more important than the cleanliness of the station or the frequency of trains.

Safety is a fundamental element that guarantees the core product. In extreme cases, the core product is provided even if trains are not frequent and no air conditioning is provided. However without safety, providers cannot provide the core product.

The main difference between the transport infrastructure and other infrastructures is whether or not the infrastructure treats customers themselves. The transport infrastructure supports human life. Therefore, safety is critically important. Customers think that safety is must-be service quality.

Therefore, investment in safety is required without thinking about efficiency to guarantee the service level of the core product. Safety very much contributes to attractive service quality such as frequency of trains and fewer problems. In fact, many railway business companies have said that safety is their top priority. A characteristic of railway business services is that railway companies must invest in safety even if safety makes it hard to increase customers’ satisfaction.

Third, we explained railway businesses based on the flower of service and research [1] on the function of railway stations and classification based on the flower of service. There are many supplementary services, e.g., reservations via smartphones (accepting reservations), automatic ticket machines, contactless IC cards (payment), more advanced trains proposed by station staff (consultation), and waiting rooms (hospitality). In addition, other researchers have used the flower of service to describe the importance of supplementary services. Needless to say, the core product in the railway business is transportation from departure to destination. In addition, the quality of the core product based on safety is a very important issue for providers because it is must-be service quality. However, the flower of service does not focus attention on the core product very well.

Fourth, we considered the railway business based on service encounters (Fig. 2-5).

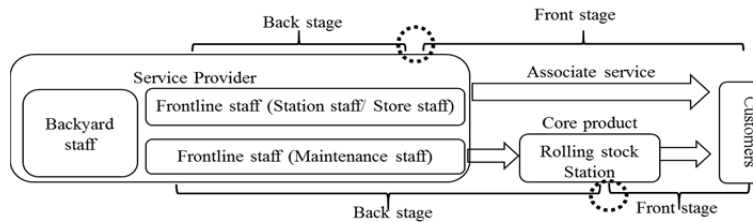


Figure 2-5 Application of service encounter model to railway business

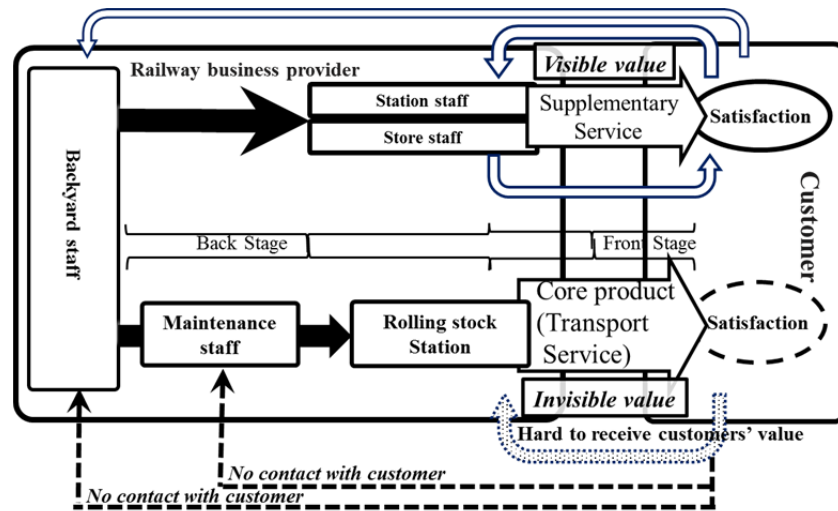


Figure 2-6 Revised model for railway business

Station staff and store staff encounter customers and provide direct services to customers. Direct interaction between staff and customers in these encounters will co-create value. Because staff recognize the service value that customers need, they can provide improved services. However, it is extremely rare for maintenance staff to meet customers. As shown in Fig.2-6, maintenance staff usually provide services to facilities like rolling stock and stations. Customers are provided with the core product (transport service) through railway facilities that the maintenance staff maintain/renew. Therefore, the maintenance staff do not encounter customers although the staff are frontline. The structure of railway business services is more complex than that in the service encounter model.

Finally, let us consider the service profit chain model. We revised Fig. 2-6 to simplify the explanation. We will explain the characteristics of Fig. 2-6 by dividing it into two parts.

The top of Fig. 2-6 represents supplementary services and indicates a direct service encounter between staff and customer that was previously mentioned. There is a service profit chain in this part between the provider and customer.

However, it is hard to find a direct service encounter between staff and customer at the bottom of the figure, although daily services (this is the core product!) are provided. Service value is invisible in this part. Therefore, we cannot find any service profit chain.

Many railway business companies in Japan involve both core product services and supplementary services in their relationships with one another. It is true that the provider's staff make thorough efforts to provide excellent services to customers. However, this model is inconsistent in that maintenance staff who contribute to the core product cannot directly accept customers' value.

III. PROPOSITION FOR NEW SERVICE MODEL: "SISLA"

We propose a new concept to add to the characteristic structure we explained in Section II that is called the social infrastructure service level agreement (SISLA), which is suited to social infrastructure services. The proposal focuses on the service-level agreement (SLA) concept. SLA is the concept mainly used in the IT service field. SLA is recognized as an agreement where service providers and customers agree on the content of services [18]. It is difficult in IT services to define a product's service level. Therefore, it is difficult to distinguish the responsibility for service failures or to confirm the validity of service prices. To avoid these situations, IT service providers and customers mutually confirm details at each stage such as considerations, developments, and operations. Finally, providers and customers fix and stipulate the range of services and prices. Also, activities to maintain and manage SLA, called service-level management (SLM), is carried out.

We incorporated the SISLA model into the railway business that included providers and customers. After investigating the historical background, technological innovations, and business processes between each actor, the validity of the SISLA model was confirmed by demonstrating how each actor achieved value co-creation.

As was explained in the previous section, an appropriate level for the core product in the railway business is provided, although there are few close interactions between staff and customers. To demonstrate this fact, we incorporated the concept of "there is a type of agreement between service providers and customers" from SLA. We defined SISLA as follows.

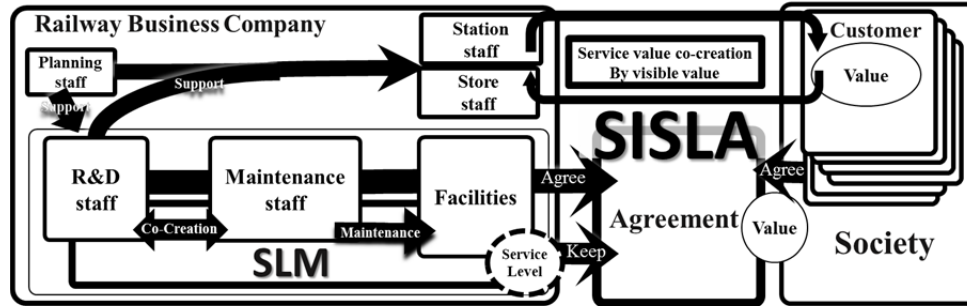


Figure 3-1 New service model: "SISLA"

Social infrastructure service level agreement (SISLA):

The service level agreement for a social infrastructure is agreed between social infrastructure service providers and society (groups of customers). The agreement is gradually changed, not always spelled out, and is built over time and according to culture. The service level to society is recognized as a "must-be" level. There is SLM to maintain SISLA.

The SISLA model of the railway business is outlined in Fig. 3-1. Research and development (R&D) staff and planning staff were added to the model to clarify the internal structure of the provider.

We can even express when direct encounters do not occur between providers and customers and maintain appropriate service levels by using this new "SISLA" model.

Service innovation have been progressed under the customer oriented thinking. For social infrastructure services, the customer oriented thinking is emerged from base service concept "SISLA"

IV. SISLA AND SLM OF RAILWAY BUSINESS

The SISLA of railway business services is divided into individual elements from the standardized items of SLA (JEITA, 2007).

A. Objective of agreement and elements of SISLA

There four main agreements that are explained below.

We found through investigations that the service level of the railway business was in agreement with "society", "law", "other railway business organizations", and "customers" (Fig. 4-1).

- Agreement with society (SISLA):

Safe train operations are not only based on agreement with law, but also maintained by strict railway business restrictions. One of these restrictions involves more frequent inspection periods than those demanded by law. Society demands that safety be recognized as the main foundation of transportation services. Therefore, it goes without saying, that the maintenance of safety is an agreement between railway business companies and society.

In addition, punctual train operations according to time tables reflect the value of transport services. Time tables are determined according to both requests by society (groups of customers) and the operational capabilities of railway business

companies. Railway business companies announce train time tables in advance and guarantee punctual train operations according to the publicized time tables. Society accepts the publicized time tables and individual customers who comprise society establish life patterns according to these tables and ride trains that arrive and depart punctually. Requests by customers regarding time tables reach railway business companies via station staff and other means, and these companies revise the tables each year according to their requests. Railway business companies organize time tables to be as convenient as possible under restrictions such as the number of rolling stock, the ability to carry out maintenance mainly at night, the number of drivers, and maintenance staff to increase customers' value.

- Agreement with law:

Railways are highly popular means of public transport. Therefore, there are regulations in law to protect customers, e.g., upper limits for fares, management for executing maintenance to guarantee safety, and penalties for interruptions to railway operations to ensure stable train operations. These regulations provide agreement by law.

- Agreement with other railway business companies:

There are alternative transportation rules that permit customers to use other railway companies' routes when train services are suspended due to trouble with transportation, physical injury, disasters, and large-scale pre-scheduled construction, mainly in urban areas in Japan, to ensure convenience for customers. In addition, there are through-ticket rules that allow customers to leave one company's station and enter another company's station with one through-ticket, which can be purchased at the first station or with a contactless IC card. The same rail and signaling systems from the viewpoint of facilities achieve train through operations, ticket wickets only for transfer, and cooperative operation of stations by several railway companies to increase convenience for customers.

- Agreement with customers:

Customers pay predetermined fares when using trains. Customers, from the viewpoint of law, agree to contracts that railway business companies determine, and these contracts between railway business companies and customers then become binding. Customers ride trains after agreeing to contractual terms.

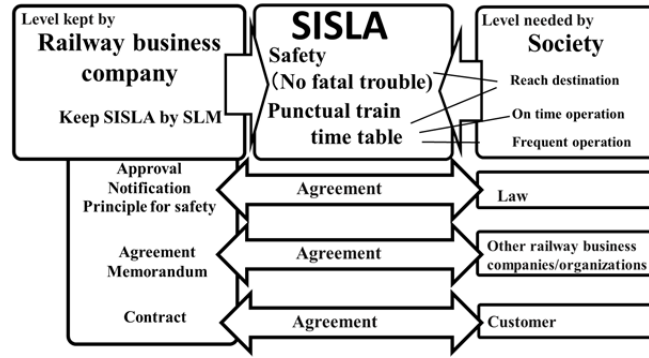


Figure 4-1 Variety of agreements on railway business services

Railway business companies thus agree to several objectives when they carry out railway business services. Agreement with the law is generally recognized as compliance with legal regulations. As the law is established by spokespersons of customers, it represents agreement with society in a broad sense. Agreements with other railway business companies and agreements with customers are recognized as contracts, which both contractors are subject to. The SISLA of railway business services ensures safety and train time tables that are punctually adhered to.

B. Main component of SISLA: Safety

Safety is the most important concept which is a fundamental element of all services from the viewpoint of railway business companies. From the viewpoint of law, there are three norms written in a ministerial ordinance of the Ministry of Land, Infrastructure, Transport and Tourism. That is:

1. Guaranteed safety ensures the continuation of transportation,
2. Compliance with the norms is the basis of safety, and
3. Stringent work regulations need to be adhered to.

All railway business organizations in Japan determine safety principles based on these norms. In addition, the safety

of Japanese railways is recognized by society because of evidence from a white paper on transport safety [3] that shows that death of passengers were zero.

We focused on signalling safety equipment called the automatic train stop (ATS) from the viewpoint of technological innovation. ATS has been improved during the long history of railway safety operations (Fig. 4-2).

Two characteristics were identified by investigating changes to ATS.

- Length of time: It took several decades to complete the installation of these devices. The main reason it took so long for both development and installation to take place was because train operations always focused on safety and it was hard to accelerate the speed of installation. It is somewhat ironic that the speed of installation rapidly increased once fatal accidents occurred. These were destructive conditions for agreements to safety from the viewpoint of the SISLA concept.
- Development: Not all developments started after accidents occurred. “ATS-S” had been a key device until recently in Japan, and installation was accelerated as a result of a fatal accident that happened in 1962, although its development started in 1960. The same situation can be found in the development and installation of “ATS-P”.

1870's -	[Attentive abilities of driver] No backup systems for driver's mistakes
1954 -	[Warning devices] No automatic brakes
1962 -	[ATS-S] Automatic brake commands according to signals. Brake commands can be canceled by driver.
1987 -	[ATS-P] Automatic brakes controlled by braking patterns according to regulated speeds. (Cannot be canceled)
2005 -	[Application to tight curves and other dangerous sections] Automatic braking before sections such as tight curves where maximum speed is regulated. (Avoid fatal accidents due to human error)

Figure 4-2 Changes to ATS functions

Although it is hard for R&D staff to encounter customers, they can improve the level of safety through another trigger, which is SISLA. From the viewpoint of service innovation, innovation of safety, one of important service elements, have been improved slowly but absolutely.

From the viewpoint of society, customers usually think that the safety of train operations is “must-be”. Therefore, customers trust it and do not question it in daily topics.

C. Main component of SISLA: Punctual train time tables

Staff and individual departments, from the viewpoint of railway business companies, act under the objective that they must operate trains according to determined time tables. Mito [11] stated like that “Train time tables is the main product of railway business companies” and Kawabe [6] stated like that “All departments in railway business companies carry out together constructing new rolling stocks, renewing train control systems, constructing of station facilities and many other work in accordance with the timing of revising train time tables.” When trouble occurs, maintenance staff first try to resume train operations after temporary recovery while assuring safety. Next, they complete full recovery at night and resume original train operations the following morning.

Railway business companies use three essentials to achieve these actions and results, which are:

- Time table/train operation systems
The unit in which train time tables are announced at stations is minutes, although the fundamental unit used by railway business companies is five or fifteen seconds. Some railway business companies achieve punctual operations with systems to make train time tables and train operation work in collaboration.
- Operational rules when trouble occurs
It is ideal if train operations are always precisely carried out based on train time tables, but this is impossible because of many causes such as bad weather, disasters, human injury, failure of facilities/rolling stock. Railway business companies make preparations in advance to cope with

these problems. For example, train time tables are designed with sufficient margin compared to the capability of trains to accelerate or brake. Lines with high frequency of use such as the Yamanote line in the Tokyo metropolitan area, sometimes thin out train operations when trouble occurs.

- Maintenance
The maximum cycle for inspection of facilities is determined by law. The cycle of inspection in some railway business companies is shortened to keep facilities in good condition. This is because, once facilities fail, it sometimes creates terrible confusion in society.

These is evidence that all departments and staff in railway business companies act based on an agreement with the objective “to achieve punctual train operation according to determined train time tables”.

As a result, daily punctual train operations are achieved. From viewpoint of service innovation, accuracy level of train operation improved gradually.

Punctual train operations are agreed from the viewpoint of society and recognized as the four “must-be” qualities below.

- Customers in society decide their daily schedules based on the premise that train time tables are punctual.
- Travel agencies make itineraries of travel tours based on punctual train time tables.
- Transfer of trains is guaranteed (usually on last daily train).
- Customers in society sometimes complain about only one minute delays of trains, and train conductors or station staff have to apologize.

D. About SLM

Here, we will briefly explain SLM. There are many activities, culture, and rules in railway business companies to maintain SISLA, as outlined in Fig. 4-3.

E. Detailed service model of railway business services using SISLA

Finally, we will present the service model for social infrastructure for railway business services (Fig. 4-4).

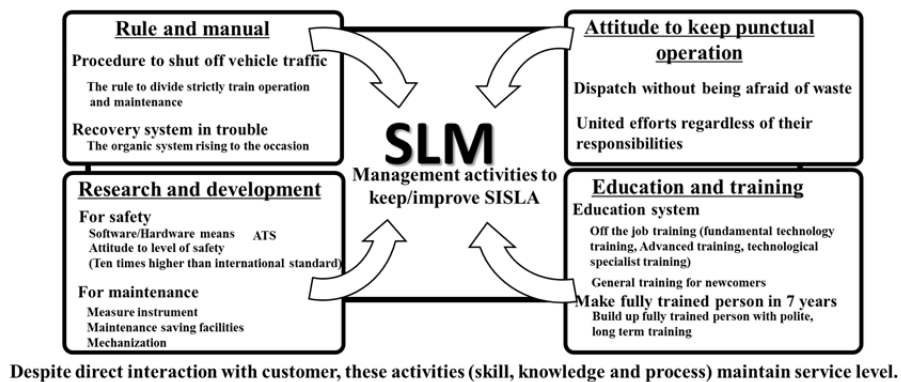


Figure 4-3 Service level management to maintain/improve SISLA

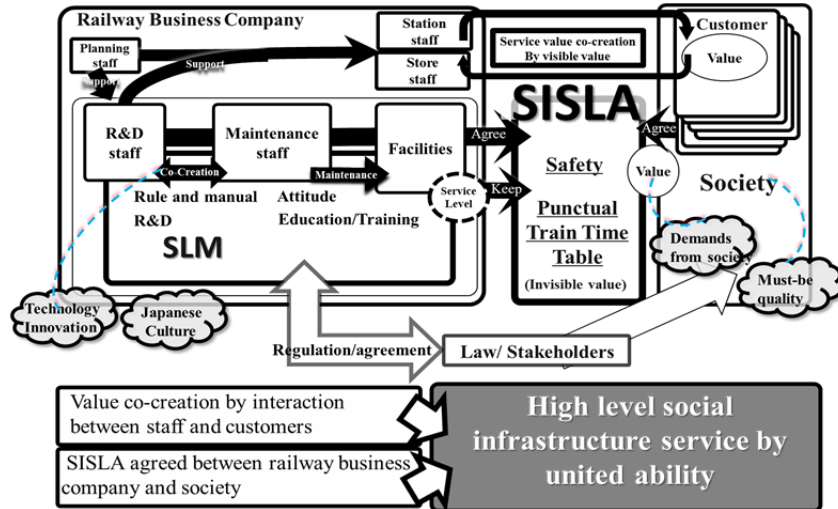


Figure 4-4 Service model for social infrastructure using SISLA

As can be seen from Fig.4-4, social infrastructure services are maintained by totally integrated capabilities. In addition to value co-creation by direct interaction between staff and customers, SISLA maintains the fundamental level of the social infrastructure.

V. CONCLUSION

We proposed a new service model called SISLA in this study, which expressed the services of the social infrastructure that had many characteristics that could not be explained with existing service models or concepts. One of its main characteristics was that the core product of the social infrastructure was not directly provided by the staff of providers. Therefore, the value of customers was blind to providers. No encounters existed between staff and customers when the core product was provided. These situations can be described with the new SISLA model. There is a common-sense agreement with this model between providers and customers. Providers maintain SISLA, society (groups of customers), and recognize SISLA. Therefore, providers and society can use the social infrastructure based on the same recognition. Within the providers, maintenance staff and R&D staff work to maintain SISLA. Many activities that are called SLM are carried out. As the activities around SISLA for the core product and activities for supplementary services are integrated, social infrastructure services are fully provided. We confirmed the validity of the new SISLA model by testing and applying it to railway business services. SISLA involves punctual train time tables and safety in the Japanese railway business.

We intend to thoroughly investigate the differences with SISLA in terms of timelines and countries in our next study. In addition, we intend to expand the validity of SISLA to other social infrastructures such as electricity, highways, airplanes, and telecommunications. Throughout these studies, the SISLA model should change from conceptual to universal and general

models that can be adopted in social infrastructure services. Moreover, we will use SISLA to explain slow and absolute incremental service innovation.

REFERENCES

- [1] Ann, and Afra, and Claire, and Doreen, and Cora, "The Service Quality of Tainan Train Station", Retrieved 1/20/2015 World Wide Web, http://www.j-s.net/ncue_sm/sm_resources/sm_ug_example_2_report.pdf
- [2] Cabinet office of Japan, "Annual Report on the Japanese Economy and Public Finance 2015", pp. 337-344, 2013
- [3] Cabinet office of Japan, "White paper on traffic safety in Japan 2013", Shobi printing co., ltd., p. 98, 2014
- [4] Heskett, J., Jones, T., Loveman, G., Sasser, E. and Schlesinger, L., "Putting the Service-Profit Chain to Work", Harvard Business Review 2008.7, 2008
- [5] Kano, N., Seraku, N., Takahashi, F. and Tsuji, S., "Attractive quality and must-be quality", Hinshitsu Vol. 14, No. 2, pp. 39-48, 1984
- [6] Kawabe, K., "Tokyo general control room -operation commander who support move of 14 million person in Tokyo metropolitan area", Kotsu Shimbunsha, 1984
- [7] Kosaka, M., "Change to service intention", Shakaihyoronsha Co., Ltd., pp. 13-16, 2012
- [8] Lovelock, C. and Wirtz, J., "Services Marketing -People, Technology, Strategy- Sixth edition", Pearson Prentice Hall, pp.77-86, 2007
- [9] Lovelock, C. and Wright, L., "Principle of service marketing", translated by Komiyaji, M., Takahashi, Y. and Fujii, D., Hakuto-shobo, pp. 22-26, p. 58, pp. 67-71, 2002
- [10] Ministry of Land, Infrastructure, Transport and Tourism, Japan, "White paper on land, infrastructure, transport and tourism in japan, 2013", p.1, 2014
- [11] Mito, Y., "Arriving on time - What is the reason why the trains in Japan always arrive on time?", Shinchosya, 2005
- [12] Normann, R. "Service Management: Strategy and Leadership in Service Business", John Wiley & Sons Ltd, 1984
- [13] Policy Bureau, Ministry of Land, Infrastructure, Transport and Tourism, "Annual report of transportation by railway, 2013", 2013
- [14] Railway Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan, "Annual report of railway, 2012", 2012
- [15] Railway Bureau, Ministry of Land, Infrastructure, Transport and Tourism, Japan, "Information about the safety of railway transportation, 2013", Retrieved 7/8/2015 World Wide Web, <http://www.mlit.go.jp/common/001060508.pdf>

2016 Proceedings of PICMET '16: Technology Management for Social Innovation

- [16] Sakata, K., *"Hundred years' history of railway and social culture (Railway, politics, economics, transportation, satire, human life)"*, Kinokuniya company Ltd., 1981
- [17] Takigawa, Y., *"Enjoy learning micro-economics"*, Minerva Publishing, pp. 160-163, 2009
- [18] Uchikawa, K. and Mizuki, M., *"The book for well understanding basics and structures of ISO20000"*, Shuwa System co., ltd., pp. 35-53, pp. 138-144, 2006
- [19] Yamamoto, S., *"Introduction of service marketing"*, Nikkei Inc., pp. 41-49, pp. 99-102, pp. 135-153, p. 160, 2007