Chapter 19
Toward the Social City

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Abstract We have been looking at various research examples and technological schemes as challenges for a new urban development using sensing and information and communication technology (ICT) in "the social city." This chapter further discusses how we grasp the activities of the people in the city. Furthermore, we describe how to enhance the value of the city by effectively supporting individuals' decision-making when they decide on their activities in the real space of the city by innovating customized intelligent communication between people and between people and the city. We also discuss the importance of the social relationships and city formation system with various actors involved in the city. Finally, we envisage the possibility of a new form of city formation system in the social city.

Keywords Town · Urban development · Consumer behavior · ICT · Social city · City formation system · Town management · Decision support system · Consistent estimation · Big data · Town equity

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19.1 Social City and Big Data

19.1.1 Understanding the Real-Time City

As challenges to a new urban development using ICT in the social city, we have been looking at various mechanisms and technologies for collecting information on the behaviors of consumers when they visit the city and the environment of the city they visit. Here we discuss the idea of measuring and estimating the *Kaiyu* behaviors of consumers in the city in real time[1, 2] Consumer shop-around behaviors are referred to as *Kaiyu* in Japanese, a term widely used in several fields such as city planning, marketing, real estate, tourism, and urban development policies.

In Chap. 2, we have estimated the number of visitors who move along the walking path of history in *Dazaifu* City. (Cf. Saito et al. (2022a)) More specifically, we obtained this estimate by applying a simplified consistent estimation method to the on-site *Kaiyu* micro-behavior history data from the *Kaiyu* behavior survey.[3] This procedure proceeds as follows. First, the consistent estimation method enables us to estimate the density of visitors' *Kaiyu* movements or flows among central tourism districts in *Dazaifu* City. Then, we expanded this density by the observed number of visitors to the *Dazaifu Tenmangu* Shrine. In other words, we estimated the number of visitors to *Dazaifu* City as a whole and the number of visitors undertaking *Kaiyu* from one place to another consistently, using the consistent estimation method based only on the *Kaiyu* micro-behavior history data and the actual observed number of visitors at one place.

Figure 19.1 illustrates the algorithm employed in the consistent estimation method.[4]

Let us briefly explain the equation in Fig. 19.1. The equation in Fig. 19.1 looks complicated at first glance but makes sense when looking at it in detail.

Consider the on-site random sampling survey conducted at a city center. Recall that the random sampling survey is carried out by randomly selecting samples from visitors to the city center. The choice-based sampling bias for the on-site random sampling survey occurs because people who visit the city center ten times a month are ten times more likely to be selected as a sample than those who visit once a month. To remove this choice-based sampling bias, we give the inverse of each sample's visit frequency to the city center to each sample as a weight to equalize the probability of being selected as a sample.

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[1] See Saito (2010, 2013) that discussed the idea in more detail. Also refer to Saito et al. (2022c), Chapter 5 in this volume.

[2] Refer to MIT SENSEable Lab and Real Time Rome for the efforts to visualize the activities in the city. Cf. Calabrese and Ratti (2006).

[3] The first Survey of Sightseeing *Kaiyu* Behavior in *Dazaifu* City (May 29, 30, 2010).

[4] As for the consistent estimation for the on-site *Kaiyu* micro-behavior history data, refer to the original papers, Saito et al. (2001) and Saito and Nakashima (2003). Also refer to the Japanese patent granted to this method (Saito 2006).

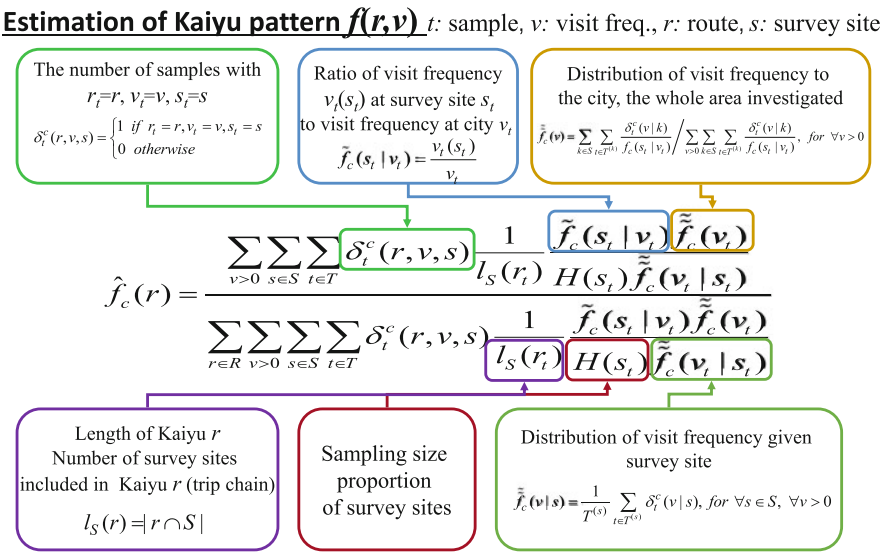

Fig. 19.1 Consistent estimation of the *Kaiyu* pattern from on-site samples. [Cf. Saito (2006) JP3793447]

In this way, we can create a weighting system that works as if we selected the samples randomly from their place of residence, even if we are sampling them randomly at the on-site they visited, by giving them the weights to equalize their likelihood of being selected as a sample, consequently removing the choice-based sampling bias.

We apply this idea to the *Kaiyu* micro-behavior history data collected by the on-site random sampling survey. In the on-site random sampling *Kaiyu* survey, we set up multiple sampling sites or survey points in the city center and randomly select samples from the visitors to those survey points. Note that the visit frequency to the survey points differs sample by sample. Thus, where the samples are selected matters.

Hence, in addition to the visit frequency to the city center by the sample t, i.e., v_t, we must also consider the visit frequency to the survey points where they are sampled, $v_t(s_t)$. Furthermore, the probability of being selected as a sample differs for each sample depending on the number of survey points each sample visited during *Kaiyu*, the length of *Kaiyu*, $l_S(r_t)$, and the size of samples selected at each survey point or the sampling ratio, $H(s_t)$.

The equation in Fig. 19.1 considers all these factors, assigns a weight for each sample t, and performs aggregation.

Next, the graph in Fig. 19.2 shows the fluctuation in the number of visitors per day at several large commercial complexes in the *Tenjin* district, the city center commercial area of Fukuoka City, Japan. The regular peak is the peak in the number of visitors on Saturdays and Sundays. These facilities have people-counting systems that measure the number of visitors in real time. Therefore, while this graph shows

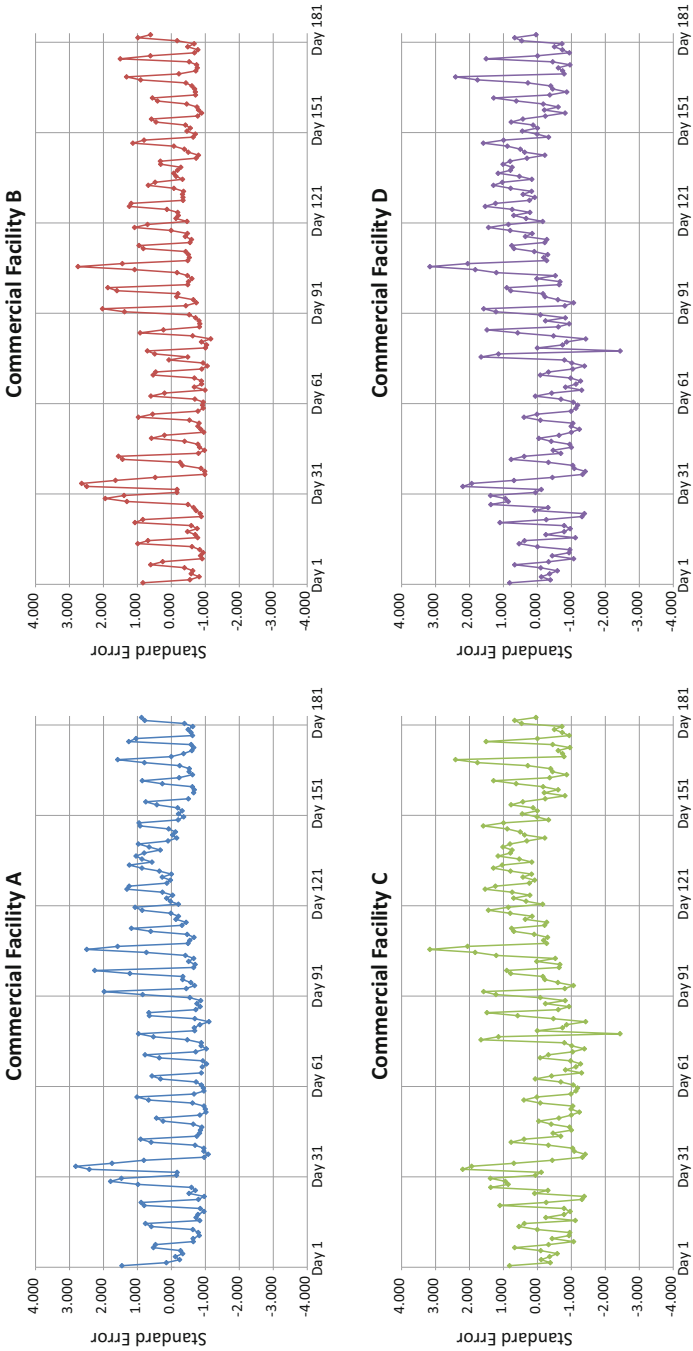

Fig. 19.2 Daily fluctuation in the number of visitors to large commercial complexes in *Tenjin* District, Fukuoka City, Japan (from January to June 2012) (The numbers are normalized by the annual average per day and the annual standard deviation)

the total number of visitors aggregated daily, we can see the fluctuation of the number of visitors in real time, such as over 5 or 10 min if using real-time data,

On the other hand, with the emergence of various methods of measuring location information using smartphones, such as GPS for outdoor use, and Wi-Fi, iBeacon, and Indoor Messaging System (IMES) for indoor use, we now have an environment in which we can obtain microdata on the history of people's indoor and outdoor movements in real time.

By combining these methods, we can understand where people gather in the city and how they move in real time.[5]

Furthermore, if the behavior of individual consumers is modeled using *Kaiyu* micro-behavior history data, we can estimate the current state in real time and predict the *Kaiyu* movements of people 30 min or an hour from now.

19.1.2 Decision Support System to Enhance the Value of the Town: Urban Development Management

A town accepts a variety of visitors and consumers. Therefore, we defined the concept of "town equity" as the value of the intangible asset of the attractiveness of a town fostered in the minds of individual visitors.[6] Thus, it should be noted that the concept of town equity is inherently a disaggregated concept defined at the individual level. Hence, when we refer to the value of a town, we refer to the sum of each individual's valuation of town equity. Therefore, when we consider enhancing the value of a town, we must consider to what extent the town equity is increased for what people and what kind of town equity. When understood in this way, town equity at the individual level can be regarded as the value of a town reflected in the minds of its people and constituting the value of a town.

Furthermore, to enhance the value of a town, we must increase the value of the town as perceived and evaluated by each of the individual visitors. To do this, we must simultaneously respond to the diverse needs of visitors and consumers who visit the town. Hence, it becomes indispensable to have a system or a mechanism that supports the real-time decision-making a variety of visitors make on the spot by providing information customized to each visitor.[7]

[5] Saito (2013) proposes to compose and distribute a town equity index for each city based on the number of incoming and outgoing visitors, which fluctuates in real time.

[6] Saito (2018), Chapter 18 in Saito and Yamashiro (2018), discusses more deeply the concept of town equity and the goals of urban development.

[7] As for the online decision support system on the spot in real space that increases the value of the town, see Saito (2005, 2012a, b, 2014) and Saito et al. (2022c), Chapter 5 in this volume.

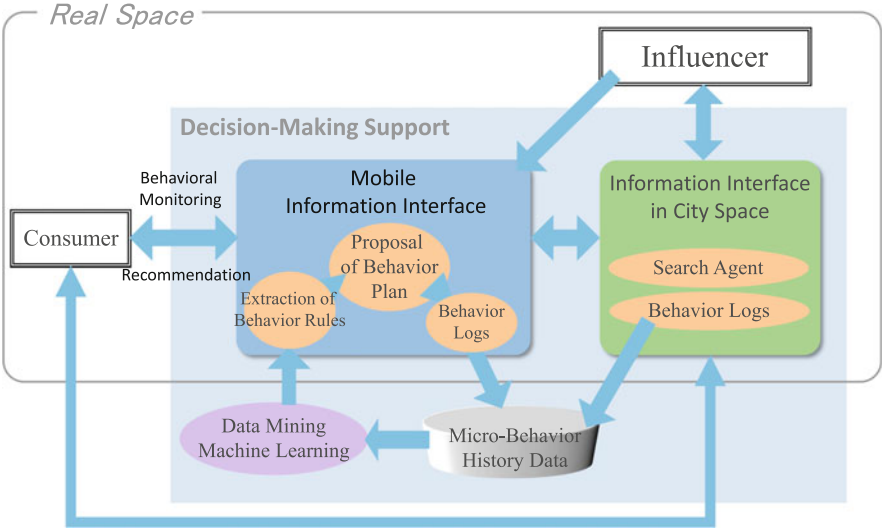

Fig. 19.3 Online decision support system in real space

We conceptualize the mechanism to enhance the value of the town in Fig. 19.3. One method to enhance the town's value is to record the semantic interactions visitors carry out with town information when they make their decisions in the town,[8] as seen in the case of *Tenmonkan*, *Kagoshima* City, Japan, in Chap. 3, and connect them to the on-site decision support through mining and deep learning[9] based on these recorded information processing micro-behavior history data of visitors (Cf. Saito et al. (2022b)).

The other method is to let visitors communicate with others through SNS and influencers to share the town information according to their concerns.

Both methods are strategies to increase the visit values individual consumers perceive and experience when they visit the town by accurately understanding their needs and providing the appropriate on-site decision-support by information and recommendations, consequently raising their town equity.

The challenges of the new urban development utilizing mobile ICT by the social city can also be understood as devices enhancing the value of the town to revitalize the town.

[8] As stated in Chap. 3, the information processing micro-behavior history data easily becomes very big. (See Saito 2012a, b). Also see Imanishi et al. (2018).

[9] As big data becomes usual, concerns with mining big data have shifted to machine learning and AI (artificial intelligence). As for recent remarkable progresses in deep learning, refer to LeCun et al. (2015).

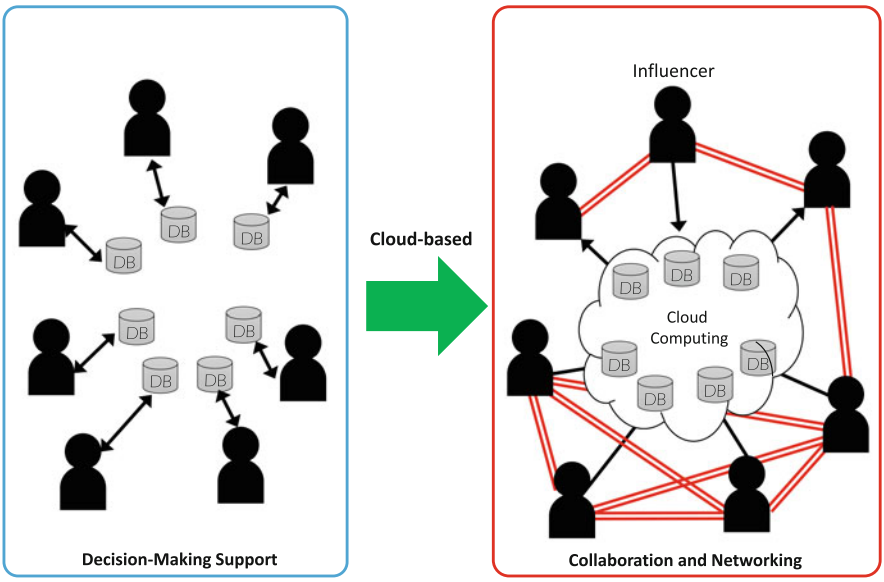

Fig. 19.4 Cloud computing, collaboration, and networking

19.1.3 The Social City and a New City Formation System

We have argued that the challenges of the new urban development using ICT in the social city may bring innovation in evaluating urban development policies. The main point of discussion is the possibility of obtaining micro-behavior history data of consumers visiting the city in real time, which has not been possible before. In particular, the possibility of obtaining data on the micro-decision-making process of how consumers communicate, interact with town information, and make decisions on-site in the real space of the city. If we made this possible, the effects of soft urban development policies such as information provision, marketing, and promotion could be fed back and grasped at the individual level in real time.

Furthermore, as emphasized in this book, the advancement of mobile ICT and informatization and cloud computing of information infrastructure such as social networking services have increased the possibility of more effective communication and collaboration.

While Fig. 19.3 focuses on the on-site decision support customized for individual consumers, Fig. 19.4 illustrates how this decision support, if cloud-based and interconnected, would encourage collaboration among people who share interests and trigger new behaviors by linking people with messages from influencers.

If this is the case, the subsequent development should attempt to organize a new city formation system. The new city formation system should form, maintain, manage, and develop the city by incorporating the individual consumers' real-time

evaluation of urban development policies using their real-time micro-decision-making data into a social decision-making system for urban development.

Various regions and districts have organized TMOs (Town Management Organizations).[10] TMOs aim to carry out strategic town management to determine what strategies towns should take to increase their values by considering themselves as one business entity while bundling various business entities involved in urban development. Thus, their role is a collaborative system for strategic town management. However, almost no TMOs have gone so far in strategic town management. Its partial cause is that currently, no information system exists that is effectively utilized by TMOs to measure and evaluate the effects of their own policies.

Unlike TMOs, the novelty and potential of the social city approach lie in its lightness. In the social city, it is possible to create a collaborative mechanism to increase the value of the town for themselves by creating a small network on the Internet through communication and interaction among the initiators, administrators, visitors, consumers, residents, and influencers of the town who share the same interests, motivations, and preferences. This kind of micro and autonomous city formation system that coexists in a multidimensional and multilayered manner can be said to be a feature of urban development by the social city.

We provided a viewpoint of a city as a city formation system that we regard as a complex autonomous system composed of three systems; the physical, the activity, and the social decision-making system. However, with the advancement of technologies such as ICT, smartphones, and SNS, it is possible to construct a micro-city formation system that can manage a complex system of hardware, activities, and social decision-making in a shorter time, in a smaller area, and by a smaller group, like a microgrid, at a lower cost and according to specific interests.

Thus, the social city should form a mechanism for its urban development where various micro-city formation systems, micro and autonomous collaborative systems for urban development, can coexist in a multidimensional and multilayered manner on the Internet platform and information.

19.2 Information Sharing and Community Formation

We have mentioned that the status of the town and the people in the town can be grasped and managed in real time by the information communication equipment embedded in the town and can be effectively used. For example, it is common that information transmitted through SNS is shared among acquaintances as information

[10]There are TMOs collaborating in a wide area of *Kyushu* Island such as We Love *Tenjin* for Fukuoka City, *SukiTai Kumamoto* for *Kumamoto* City, and We Love *Tenmonkan* for *Kagoshima* City. On the other hand, in Tokyo, *DaiMaruYu* Area Management Council in which three distrcts, *Otemachi, Marunouchi, and Yurakucho* neighboring Tokyo Station collaborate with each other for the area management [Cf. (Urban Renewal Promotion Division, City Bureau, MLIT (Ministry of Land Infrastructure, Transport, and Tourism) 2012)].

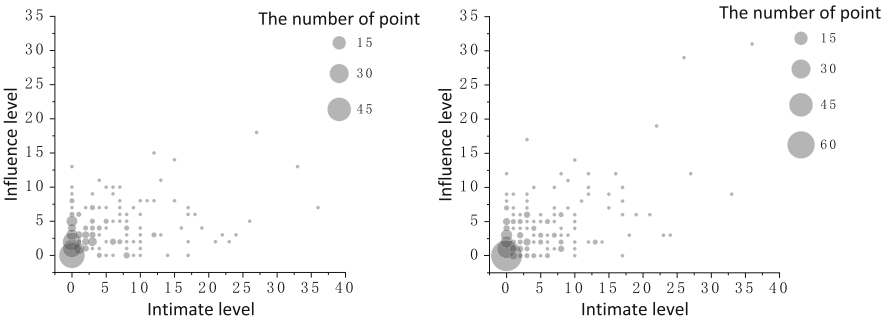

Fig. 19.5 Relation between the ratio of clicking the "Like" button and the closeness of interpersonal relationships (left: relationship between the receiver and the creator of original information, right: relationship between the receiver and direct information transmitter)

about the town, and then the town is utilized based on this information. Moreover, suppose the status of people using the town (e.g., alone or in a hurry) can be grasped based on such information. In that case, the town information system may present information on appropriate facilities to use and generate communication between people at that location.

Here, we introduce the experiment we have carried out using the monitoring method for social behavior. In the experiment, we asked all people in a group of 16 travelers to use a simple SNS app on a smartphone to send and receive information when they were free to do sightseeing.[11] The app recorded three properties for each piece of information received by each traveler: whether the person who received the information clicked the "Like" button, who sent the information, and who created the information,

As a result, we found that there was a relation between the rate of "Like" that the receiver gave to the sender of the received information ("influence level" shown as the vertical axis in Fig. 19.5) and the length of time that the sender met with the receiver ("intimate level" shown as the horizontal axis in Fig. 19.5).

Furthermore, we found that the above relation is more vital for those who sent information directly to the receiver (direct information transmitter) (right chart of Fig. 19.5) than those who created the received information (left chart of Fig. 19.5) (Suzuki et al. 2016).

[11] More specifically, the experiment proceeds as follows: First, a creator, one person in every 16 travelers, created the information and uploaded it to the app. Then, the app transmits this information with the creator's name to a randomly selected one person from the other 15 travelers, excluding the creator. Next, the information receiver, the person who received the information, decides whether to click the "Like" button or not. If the "Like" button is clicked, the app automatically transmits the information with the creator's name and the last transmitter's name to a randomly selected one person from the other remaining 14 travelers, excluding the creator and this information receiver, in this case, the information transmitter. The information transmitting process continues until it ends when some information receiver decides not to click the "Like" button.

From this experiment, if we assume that a person who spends a long time together, which a mobile communication terminal can monitor, is regarded as a "close friend," the above result can be thought of as the information received from a close friend has more social influence and causes more the recipient's behavior of pressing the "Like" button. This experiment also shows that the influence is even more vital when the information is transmitted directly.

Utilizing the social evidence above effectively in the ICT mechanism in the town makes it possible to revitalize the town and promote community formation. For example, getting more people interested in the town will be possible by transmitting information through their close friends. Also, providing information about the city's facilities to people, taking into account their specific interests in visiting the city, will induce them to interact with the facilities. The interaction generated among people through these facilities may grow into an influential information transmission channel among them. Thus, the above mechanism to form people's interactions in a limited space may lead to the town's revitalization and the generation of the community.

19.3 Environmental Information and Behavioral Change in City Space

The town's situation at any given time also affects the decision-making of the visitor to the town. When it is hot, people may want to have a cold drink in a cool place, and when they are tired of the crowd, they may want to rest in a quiet place. Although it is hard to imagine having a long chat with close friends under solid sunshine, we may see people discussing over a cup of hot tea in a chilly space.

We have discussed the use of outdoor space from the angle of the effective use of facilities and the interaction space for people. There have been attempts to promote the use of outdoor spaces by monitoring the visitors and the space (Akagawa et al. 2015).

Compared to indoor spaces, outdoor spaces are affected more significantly by the changes in the environment. Thus, in order for people to use them as comfortable spaces, it is necessary to grasp the environmental information of the space (temperature, solar radiation, wind speed, and loudness) and the state of the people using the space at that time (metabolism and people with whom they are with). Therefore, one effective means is the one that guides people to outdoor spaces according to their needs predicted in real time by monitoring the environmental information of the spaces and the state of the people.

The context of the visitor's behavior and changes in the social situation can be considered criteria for selecting a place to guide. Today, with the development of city infrastructure using ICT, it has become possible for the town to implement algorithms that can anonymously predict such information.

The utilization image of the social environment and the physical environment described here is shown in Fig. 19.6.

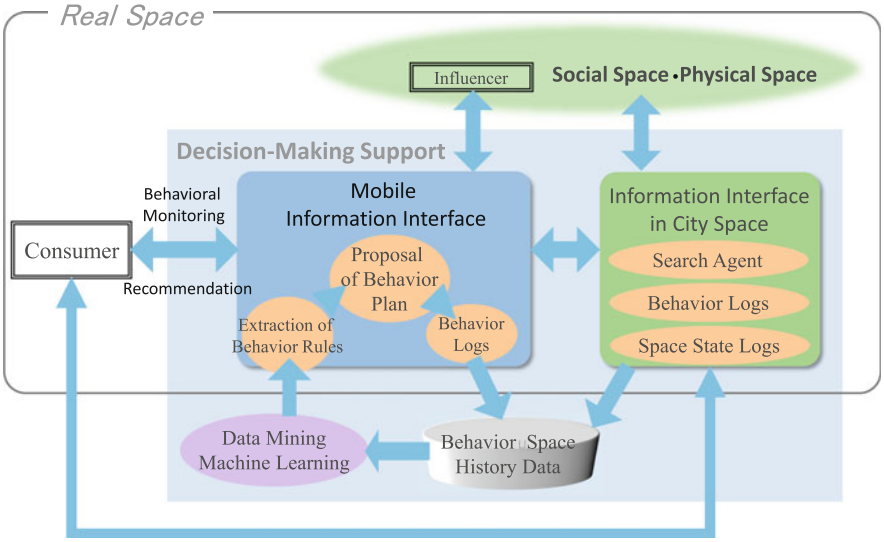

Fig. 19.6 Utilization of social and physical information in the social city

The provision of individually helpful information to visitors of the town and the feedback via SNS through the filter of their use of the actual city space create the interaction between the visitors and between the visitors and the favorite city space in the specific situation and become a social lubricant or intermediary for urban development.

We have discussed the mechanisms, cases, and technologies to realize the social city from various viewpoints. The key to urban development is to share and utilize the information between real and virtual spaces seamlessly while predicting the timing of social decision-making. Soon, more and more cities will be equipped with this kind of system. In the future, it is expected that the number of towns in which such mechanisms are set up will increase, and when one visits a town, one may notice the social mechanisms contained in the town.

We hope that the accumulation of experiences from social events and feedback in the cities will lead to a social city where people vividly communicate with each other and decide by themselves how they enhance the value of their city through a new city formation system.

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