



Research Article

New local design in the new normal: Sustainable city for outbreak risk

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ABSTRACT

There is an urgent need to transform the conventional city into a flexible and sustainable city that can respond to the risks of outbreaks in a broad sense, including global infectious disease pandemics and large-scale disasters. However, today's cities have many trade-off (compatibility) problems related to peacetime-emergency, global-local, and so on, in addition to inertia to change. In this paper, we presented the idea of a new local design in which people's well-being is maintained and improved even in the new normal, based on the idea of "three compatibility problems." As a concrete measure, we developed the concept of milieu that emphasizes local "place" and "innovation," and expresses its socio-economic function after including the void spaces of today's cities. At the same time, we proposed an autonomous and self-sustaining segmented city that can respond to outbreaks by increasing the self-efficacy of citizens. Furthermore, based on an analysis of the implementation cases of integrated transportation machizukuri with railway development in Japan, we reported that the emergence of new local design has already been seen in industry-government-private partnership efforts.

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1. Introduction

1.1. New urban challenges posed by COVID-19 pandemic

The global COVID-19 pandemic has had a significant impact on people's daily lives and socio-economic activities. In particular, restrictions on activities and movement to prevent infections not only cause financial damage but also fuel anxiety and have a negative impact on people's physical and mental health. This mechanism is similar to the so-called global warming problem. Despite the unclear scientific evidence of the truth of global warming and its risk magnitude, a "message of fear" that affects people's lives has been sent, and with the help of political and social sympathetic pressure, daily behavior and lifestyle changes are being urged.

In connection with the occurrence of clusters in workplaces and schools, the risk of infection has increased, especially caused by the overcrowding of public transportation during peak hours. To deal with these issues, it was first necessary to review the work and learning styles, and telework and remote learning without commuting to work or school were recommended. Telework was introduced in Japan with the development of digital technology. However, its introduction was limited to some companies because it did not have any competitive advantage over the conventional way of working. In Tokyo, under the state

of emergency, the percentage share of telework increased from 24.0% in March 2020 to 62.7% in April 2020, 51.4% in December 2020, 57.1% in January 2021, and 64.8% in the first half of February 2021 [1]. However, it has not reached the implementation target of 70% set by the government to control the spread of infection. In addition, the spread of telework was expected to bring about a change in the selection preference of places of residence in terms of commuting time and housing price [2]. However, only 4.1% of the respondents took actions to seek a new place of residence to move in, citing the telework environment and the living environment of the new address as issues [3].

Among the functions of a city such as work, housing, play, commerce, study, rest, culture, and exchange [4], the next major change is to occur in recreation and commerce. Activities and movements such as shopping, dining, and entertainment have been restricted to protect lives from unknown infectious diseases. In some countries, unprecedented restrictions, such as movement restrictions between regions, have been imposed. Although there was no "lockdown" in Japan, all non-essential and non-urgent movements beyond prefectures were restricted. The tourism industry needed to come up with micro-tourism, encouraging people to rediscover the beauty which remains closer to their homes. It was stipulated that customer-drawing events such as sports games and entertainment should be held without spectators to avoid the "Three Cs" of closed spaces, crowded places, and close-contact settings. Furthermore, in commercial facilities, the introduction of non-contact customer service and payment systems have been promoted to avoid close contact even when the risk of infection due to closure or congestion is low.

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The “new normal” brought about by the pandemic is a term that corresponds to changes that do not return to the previous state. Unless the change is consistent with people’s rationality, it is expected that the socio-economic state will return to its original state as people become accustomed to fear and anxiety. In other words, the authors think that the “message of fear” has a short-term impact and does not bring about a fundamental change in people’s behavior. In this paper, with such reversibility in mind, the various new-normal experiences created by the COVID-19 pandemic are positioned as triggers to change the inertia of the conventional city, and it shows the concept and concrete measures of “new local design” in flexibly responding to future outbreaks as well as maintain and improve well-being in normal times.

1.2. Changing demand for a city and its design

In many countries, along with economic growth, urban planning on the premise of separation of work and residence has been promoted. Low-density urban areas have expanded to the surrounding areas in search of houses that are affordable to individuals. However, with this pandemic as an opportunity, the shift from the conventional separation of work and residence to the approach of work and residence or the fusion of work and residence by teleworking at home is progressing. Additionally, the cost of securing a workspace in the living space is added to the purchase requirements. Furthermore, when choosing a residence, in addition to the commercial facilities necessary for daily life, there is an increasing need to improve well-being with various facilities such as culture, entertainment, and health, as well as parks and a comfortable walking environment.

The urban space planned based on the living demands of people defines the activities and movements carried out there. As shown in Fig. 1, changes in people’s lifestyles require changes in their activities and movements as well as transformation in urban space. The new transformation of space composition is expected to bring about further changes in activities and movements. The integration between the city’s physical components, including the spatial environment and human activities, and cyber could reduce the inertia to change. Today, the use of Information and Communication Technology (ICT), Intelligent Transport Systems (ITS), and Mobility as a Service (MaaS) is helping municipalities to connect and improve infrastructure, efficiency, and quality of life for residents and visitors alike. As shown in Fig. 2, a triangular diagram with vertices of “cyber,” “civitas,” and “urbs” is used to show the positioning of some typical urban images that have been discussed in recent years. Here, “cyber” has the Greek meaning of the general steersman or ruler, and “civitas” and “urbs” are Latin words that describe the state of a settlement in which people live together, the city as a vessel, and its facility functions. Although these three words are extremely classic, they can be said to be meta-concepts that should be noted again when reconsidering the state of cities in modern times.

To flexibly respond to unpredictable outbreaks in the future, a city having the functions of a people-centered creative city (which emphasizes “civitas”), an autonomous/independent/segmented compact city

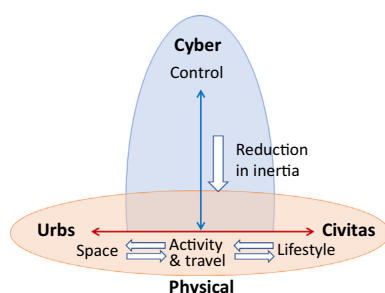


Fig. 1. Components of a city.

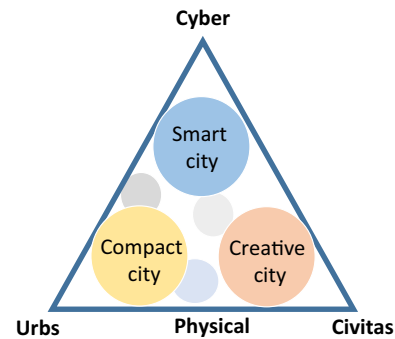


Fig. 2. Recent models of a city.

(urbs) that can respond to lockdown, and a smart city (cyber) that supports risk communication is needed. In particular, risk communication to reduce the risk of the society as a whole is important. Thus, it is essential to share accurate information and make the decision-making process transparent not only among related parties such as governments, experts, companies, and citi-zens but also in the districts and town sections that make up the city. This calls for the formation of a new “field” in which the three elements of “civitas,” “urbs,” and “cyber” are integrated.

The formation of these “fields” also provides clues to solving the following three compatibility problems [Supplementary Note 1]:

1. Balancing the act of protecting each person's life with the act of maintaining the city functions and the societal well-being.
2. Balancing extraordinary systems and everyday systems for outbreaks that are difficult to predict.
3. Balancing global goals such as SDGs and carbon neutral goals with regional development goals that emphasize historic and cultural contexts.

The above compatibility problems are trade-off problems in which it is difficult to find the optimal solutions even if each problem is specifically focused on. However, by considering the structure of the three compatibility problems, a reasonable compatibility solution, that is, a convincing solution, can be derived. In this paper, the solution is referred to as “new local design.” As shown in Fig. 3, in the “new normal,” a series of meta-designs are positioned to connect “civitas,” “urbs,” and “cyber” to enhance people’s happiness and maintain and improve their well-being. To respond to threats to safety and security caused by outbreaks in a broad sense, including infectious diseases, people’s lifestyles including work and mobility must first be changed at the level of “civitas” while there must be transformation into an autonomous, self-sustaining, and segmental urban space at the level of “urbs.” In addition, the leverage of “cyber” innovative technologies could improve the communication skills and facilitate the practice of compassionate mobility.

Compassion is defined as a kind and caring emotional response to share the common experience of imperfection, and desire to help authentically [5]. It is revealed that this kind of feeling state could enhance levels of commitment to the interpersonal relationship and increase social connection [6]. Though compassion has been studied widely in the field such as healthcare, this study lies more on the introduction of compassionate mobility. Compassionate mobility creates alternatives that are daily self-supportive while is designed to be sustainable even in lockdown. Showing as a concept linking transportation service to society and community, it supports a more inclusive and sustainable society by catering to the needs of vulnerable groups [7]. Networking the urban cores while engaging in the pursuit of pleasure in the field of urban milieu, the introduction of compassionate mobility has positive impacts not only on individual health and well-being but also on the overall

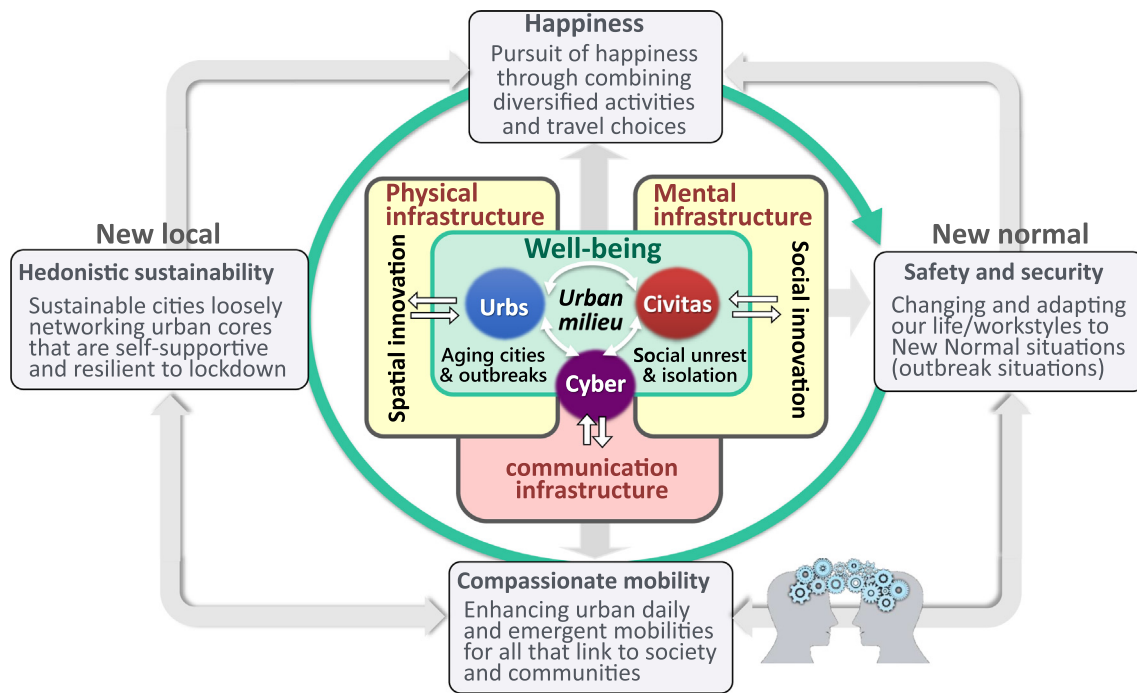


Fig. 3. Meta-design for the pursuit of new local design in the new normal era.

success of the community regarding human resilience under extraordinary suffering.

In Fig. 3, a mental infrastructure is presented in contrast to the physical infrastructure of the city. Markus [8] defines mental infrastructure as an infrastructure that ensures safety and security, protects people's self-esteem, and brings performance, progress, and innovation after organizing the dimensions and functions of various infrastructures.

In the following sections, we attempt to reexamine the concept of milieu [9] placed at the center of Fig. 3 to embody the new local design. Afterward, we propose an autonomous and independent city that can respond to outbreaks by incorporating void spaces in the city, which are regarded as a problem today, to enhance their socio-economic functions and the self-efficacy of the citizens [Supplementary Note 2]. Furthermore, based on two case analyses of new transportation "machizukuri" in Japan [10], the conditions required for a new local design are stated. Machizukuri is a Japanese word that refers to a planning concept, which is composed of "Machi (a small area such as a community)" and "Zukuri (building, creating, and planning)". Emphasizing the collaborative relationships between local residents and government entities, machizukuri aims to create a livable and sustainable city tied to the residents' desires [10]. Integrating transportation planning with urban planning, "transportation machizukuri" emphasizes building a city with walking, cycling, and public transportation as the pillars of urban development.

2. Literature review

2.1. Spatial and temporal redesign of a city

The "15-min city" based on chrono-urbanism advocated by Moreno et al. [11] is once again attracting attention as a city vision that can be adapted during and after the COVID-19 pandemic. The 15-min city comprises a myriad of segments of facilities within a 15-min walk that can serve the purposes necessary for daily life in labor, commerce, medical care, education, and entertainment. The frameworks of the city are proximity, diversity, density, and digital aspects. The city of Paris in France has raised the concept of the 15-min city and is aiming for its

realization by 2024 [11]. In Melbourne, Australia, efforts are being made on a policy to realize a city with access to facilities that meet most of the daily life needs within 20 min by walking, biking, and public transportation [12]. Both policies are based on the spatiotemporal scale of traditional neighborhoods, and they are attracting attention as a vision of a city that can protect the lives of residents and maintain their daily lives even in an emergency such as a pandemic lockdown.

Both of these 15-min and 20-min cities aim to realize a short way city [13] through mixed land use. The four pillars of proximity, diversity, density, and ubiquity that characterize the "15-min city" are interpreted based on the 3D aspects of public transport-oriented development (that is, density, diversity, and design (human-scale design)), with the smart city element of ubiquity added.

Afrin et al. [14] summarized the issues of a pandemic-friendly resilient urban design and planning approach through a literature review, and pointed out the importance of familiar public spaces. Using the idea of disaster risk management, they proposed a three-stage urban strategy of response, mitigation, and preparedness. At the response stage, they focused on smart and resilient urban design and policies to identify the spread of infection. At the mitigation stage, they focused on new technological approaches related to current and future pandemic management. To promote the understanding of health-related and disaster-related risks, they believed that focus should be on non-physical aspects including socio-cultural, political, and economic factors in addition to physical aspects related to urban access, infrastructure, land use, and environment. Furthermore, they stated that it is important to create self-sufficient and decentralized resource-efficient public spaces in familiar places when considering social distancing at the city level [Supplementary Note 3]. At the preparation stage, they stated the importance of proactive measures in people's capacity building for future outbreaks.

Camagni [15,16] and Bramanti and Ratti [17] analyzed the innovation of regions and proposed the concept of "innovative milieu." According to Cambridge Dictionary, "milieu" is broadly defined as "the people, physical, and social conditions and events that provide the environment in which someone acts or lives". In the field of Ecological Psychology, it is identified as a particular layout of the environment regarded as a

composition factor that make up the behavior setting [Supplementary Note 4]. In contrast, the milieu in “innovative milieu” signifies external-ity in a geographically close territorial space. Camagni [15,16] emphasized geographic and spatial proximity in terms of ease of information exchange, similarity of cultural and psychological attitudes, frequency of contact and cooperation among individuals, and density of mobility of elements within a limited local area. They envisioned a local venue, a “local milieu,” that acts as a synergistic collective learning process and a buffer to mitigate uncertainty. They defined innovative milieu as “a complex network of predominantly informal social relationships in a limited geographic area.” Although Camagni [15,16] attached significant importance to “local milieu,” innovation cannot be achieved only by internal relationships, mainly informal and implicit linkage. Therefore, it was maintained that the role of an external network is also important, and that the network also has a cooperative character as well as local relationships.

2.2. Void spaces around transport infrastructures

In transportation planning during the growth stage of a city, the focus has been on providing mobility by connecting the city center and suburbs via express delivery. As a result, except for the corridor area of major urban axes, the urban design of the “interspaces” that connect railway stations and interchanges was neglected, and many scarcely used, or void spaces were created in the city. In recent years, the transportation infrastructure has been made three-dimensional in line with urban redevelopment, and effective use of space is being planned in the immediate vicinity of stations and interchanges. However, there are many cases where the “interspaces,” that are the void spaces, are left untouched. A typical example is a problem of space under railroads in Japan.

Elevated railroad projects have been implemented all over Japan to remove railroad crossings, which are bottlenecks in automobile traffic, by continuously dividing the city area by railroads in addition to preventing railroad crossing accidents. Most of the utilization of the continuous infrastructure space newly created by these continuous three-dimensional crossing projects are entrusted to railway operators. Commercial facilities are being utilized in sections where the ability to attract customers is expected to be high in and around stations. However, the space under elevated railways away from the station is often used as a parking lot or a storage place for materials, and, in some cases, it is partitioned by protective measures as a space that keeps people away. As a result, the elevated railway structure is also a factor that reduces the appeal of the urban area along the railway line. Same as in China, the use of space under overpass has also many problems, and they can be dark, short, unpleasant, and abandoned spaces that are full of girders and include ill-shaped areas in some places [18].

Meanwhile, in Japan, the increase in vacant houses and lots in urban areas because of the increasing full-scale population decline has become an issue for which measures should be taken from the aspects of safety and crime prevention as well as the environment and disaster prevention. The “sponge phenomenon” of increases in vacant stores, shifts to shuttering streets in shopping streets, withdrawal of department stores, increases in old houses, increases in vacant houses in the central city areas, and so on, is also progressing in the area around transportation infrastructure. The sponge phenomenon is characterized by the fact that void space occurs randomly in time and space, making it difficult to respond in a planned manner.

Some previous studies regarded the void space around transportation infrastructure, as described above, as a valuable resource that can bring about innovation in urban areas. Regarding the use of the void space under the elevated railway between JR Motomachi Station and Sannomiya Station in Kobe City, Murakami [19] stated that the citizens originally expected the space to be utilized for residential and commercial purposes; however, the railway operator rejected that because the void space under the elevated railway was legally regarded as a traffic

road. It was revealed that the void space has turned into livable streets where businesses thrive with an increase in the number of visitors after an active discussion among the railway operators, government, and the local shop owners [19]. Doi [20] clarified the transition of the positioning and use of the space under an elevated railway due to the elevated railways of the Ministry of Railways and the entry of Hankyu, using Kobe City as an example like Murakami. In addition, Doi [20] clarified the transition of discussions with the government, railway operators, the under-elevated shopping district, and the role played by the government. Nakamura and Muraki [21] investigated the utilization status of the space under some elevated railways in Tokyo, classified the continuous infrastructure utilization status from the viewpoint of day-time population ratio and land price, and suggested that the development potential for unused sections would increase.

Furthermore, Hirayama and Sasaki [22] suggested that the elevated railway structure has a strong relationship with the block along the railway line from the field surveys of the continuous infrastructure space and the residents’ awareness along the railway line. In addition, Kinoshita et al. [23] analyzed the land use pattern of the space under an elevated railroad in the 23 wards of Tokyo and clarified that the building type has changed to open space use since 1985. Regarding the utilization of void space, it was highlighted that the importance of discussions among railway operators, government, and residents from the perspective of urban development that is integrated with the urban areas along the railway lines. Kido [24] used the Yamanote Line as an example to suggest that a continuous infrastructure space will serve as an attractive facility for the revival of new lifestyle-related communities, the development of stations as gateways, and attractive and functional promenades, thereby creating a new flow of people. Furthermore, it was suggested that a continuous infrastructure space would be beneficial not only for railway operators but also for the local community in order to pursue well-being after experiencing the COVID-19 pandemic. To design the space under the overpass from the perspective of psychological safety, the concerns of users such as safety, territoriality, and identifiability should be focused on, which can effectively improve the sense of safety, identity, comfort, and functionality of the space under the overpass [25].

Momiyama and Soshiroda [26], considering the case of a continuous infrastructure project on the Chuo Line, suggested that the need for brands along the railway lines and the development of sidewalks in a continuous infrastructure space for the development of railway companies under elevated railroads requires relationships among the citizens, government, and railway companies to create a mechanism that creates mobility. Tanaka and Takamizawa [27] indicated that railway companies that are actively working to improve the value along railway lines tend to pay attention to a continuous infrastructure space as potential resources for improving brand power, maintaining and increasing the population along railway lines, and connecting with railway users. To combine the activities with the business conducted at the space, they suggested the necessity of building a cooperative system of railway operators and the government.

3. Methodology: conceptualization of a new local based on milieu

In this paper, under the new normal, the new local is defined as the new norm of community development to enhance people’s self-efficacy and happiness through ingenuity rooted in the community. The sustainability of many cities in Japan is jeopardized by the increasing risk of disasters such as population decline, the progress of super-aging, large-scale earthquakes and tsunamis, and meteorological disasters associated with climate change even before the outbreak of the pandemic. To improve sustainability, it is necessary to design a new living area where people can live happily and their lives protected in both ordinary and extraordinary times. In this paper, the requirements that this new normal should meet are defined as the following three conditions

corresponding to the three compatibility problems (1), (2), and (3) discussed in Section 1.2.

1. Formation of a walkable urban cluster and access to the nexus inside and outside it.
2. Construction of a reversible infrastructure system that can handle ordinary and extraordinary times.
3. Construction of a multi-modal network that connects urban clusters with one another.

The “nexus” in (1) includes three elements of culture, art, and exchange in addition to the conventional water, food, and energy. Culture, art, and exchange are essential elements for the formation of people's self-efficacy, and these are defined as the new nexus [Supplementary Note 5]. Ue [29] focused on the relationship between artistic activity and self-efficacy and clarified that the longer the experience of artistic activities, the higher the general self-efficacy that is not task-specific. (2) is an infrastructure system that enables the mitigation and preparation of disaster risk management. Furthermore, the multi-modal network of (3) is a network that supports the movement of people, goods, and information, as well as risk and communication. It also comprises multiple networks that include the connection between cyberspace and physical space, which enables flexible control of ever-changing situations in response to unpredictable situations, and the spatial and contextual connections of nature, history, and culture.

The new local, which meets the above conditions, is a spatial adaptation of Camagni's local milieu described in Section 2.1, and it encourages the creation of “places” for cluster-based living in cities and the “innovation” of people's lifestyles through multi-modal networks. In this paper, this is referred to as “urban milieu.” The urban milieu has become a dominant area of research in academia and policy. Most studies tend to focus on what makes urban lifestyles in certain areas attractive as hubs for consumption, creativity, and innovation and as residential places. For policymaking, the mainstream spatial planning approaches are based on growth-oriented paradigms developed based on the experiences of successful economic areas. However, as Hooijen [28] recently pointed out, such an approach is questionable in its effectiveness, and an

additional strategy could focus on alternatives to growth-oriented approaches.

In dense urban spaces such as city centers, it is considered effective to utilize the void spaces described in Section 2.2 owing to the lack of nexuses for social distancing and survival during extraordinary times. Figs. 4 and 5 show the image of space and network to illustrate the relationship between the above new local conditions and elements. An urban cluster is a city unit within walking distance having various means of transportation and supports walking. Orbital public transport infrastructure (i.e., rail and LRT presented in Fig. 5) plays the role of connecting the clusters, but movement between clusters is restricted during an outbreak in response to a lockdown request. The left figure in Fig. 5 shows an autonomous, self-sustaining, and segmented urban structure that enhances convenience in normal times and can respond even in emergencies.

Fig. 6 shows the conceptual framework of new local design identified from the perspectives of information, time, space, and environment, and the ways to achieve synergistic effects among them. In Fig. 6, the function of smart cities that support risk communication and dynamic policy interventions is shown across the information and time axes. The functions of the compact city are depicted on the time/space axis, whereas those of the creative city are depicted as functions that straddle the space/environment axis. The new local design includes the functions of these three cities and enables step-by-step risk management of assessment/response and preparation/mitigation.

In the following section, the possibility of securing resource-efficient and decentralized public spaces mentioned by Afrin et al. [14] is considered in the light of Japan's transportation infrastructure development, specifically urban railway projects. The continuous space under the elevated railroad, which was created by the multi-level crossing railway project linked with the urban redevelopment, is a valuable space left in the urban area where the plan is highly feasible. In addition to the continuity of the void space, the symbolism of the structure as well as the easy-to-understand flow lines have the potential to contribute to the enhancement and revitalization of areas along the railway lines. This space is resource-efficient in that it is created along with the development of the upper infrastructure. In addition, since the right holders

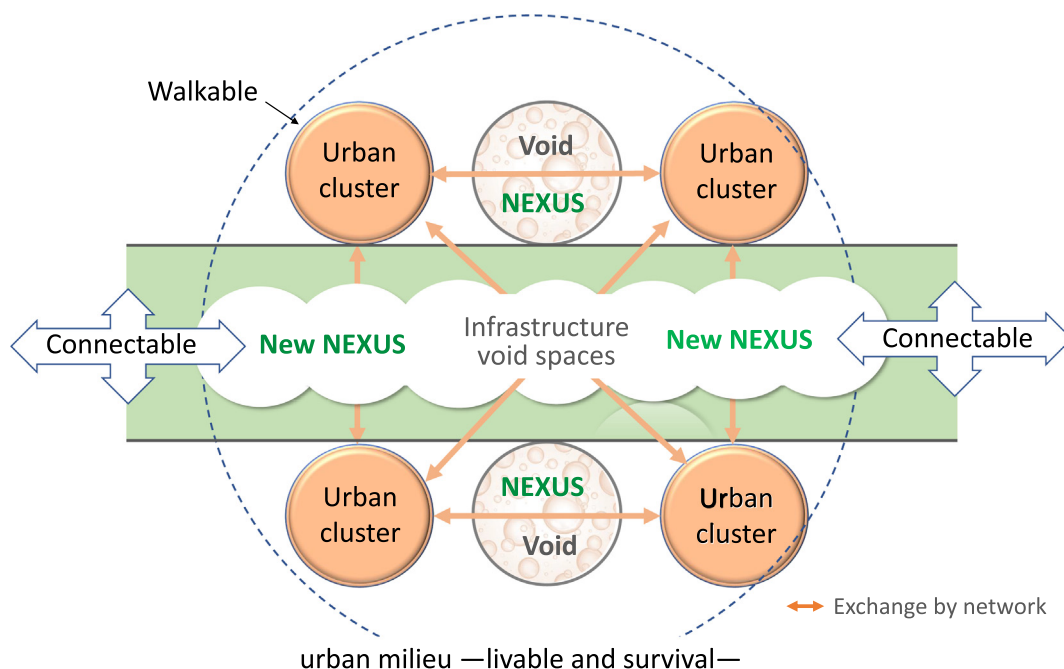


Fig. 4. Spatial image of new local design as “urban milieu”.

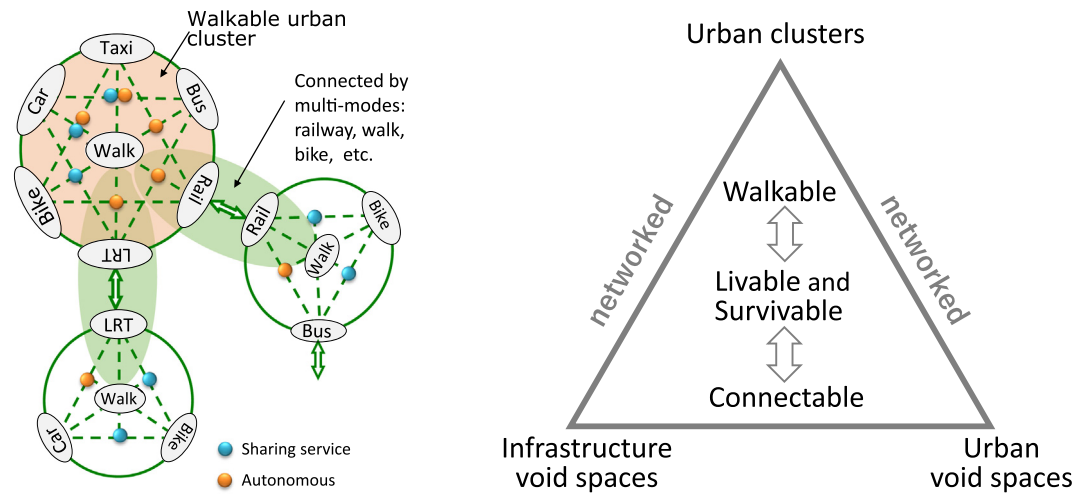


Fig. 5. Networked clusters and spaces.

of the space are limited to railway operators, it is relatively easy to reach a consensus on utilization, and it can be realized in a short period of time.

Elevated railways, which were often seen as “walls” that divide the city, have the potential to become the center of a new city. The continuous void space, which lies between railway stations, brings not vehicles but people in the heart of the city where people walk, touch, and interact with nature, as well as experience shopping, dining, and traveling. It is also expected to be a healthy and resting space with a comfortable walking environment and an axis of a livable urban area.

4. Case studies: utilization of the void spaces of infrastructures along urban railways

In Japan, based on the urban policy slogan called “Compact Plus Network,” efforts have been made to guide urban functions and residences within areas such as stations and bus stops, along with the networking of public transportation, to realize an integrated urban structure. Many local municipalities have formulated location optimization plans to

embody the Compact Plus Network. There are subsidies and tax incentives to guide urban functions and residences, which are the pillars of this plan. However, the realization of the plan is an issue, such as whether it is possible to find economic advantages in acquiring and locating new land and buildings in the guidance area.

Furthermore, today's pandemic has brought to light anxiety about the risk of infection owing to the concentration of people in the city center and the congestion of public transportation when commuting to work or school. Therefore, the ideal way of “compact” that considers not only the spatial density but also the time axis is reconsidered, and the “denseness” of activities and experiences in a timely and spatially high quality environment (cozy place) is attracting attention.

In the following subsections, to demonstrate the realization of the new local design under the new normal in advance, we will take up examples of new transportation machizukuri implemented in Japan. Emphasizing the collaborative partnership among various stakeholders, the case studies present examples of good practices in the realization of 15-min and 20-min cities by utilizing the space under elevated railway stations as a place for dense activities and experiences. Among

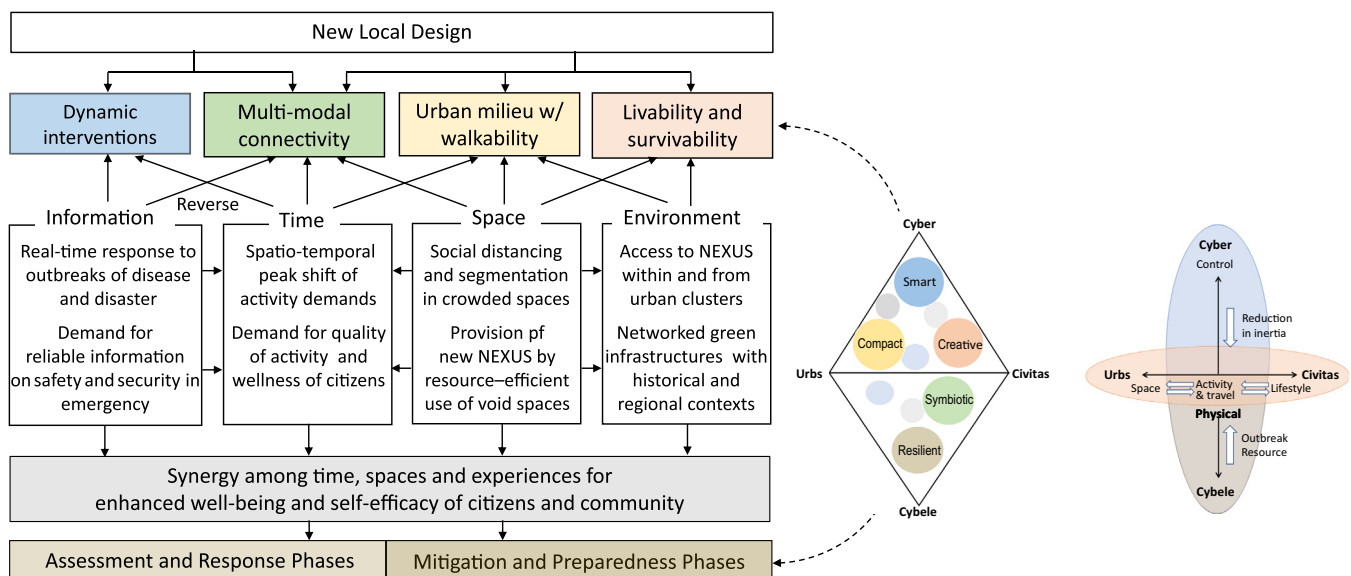


Fig. 6. Conceptual framework of new local design.

the practices that promote the utilization of space under the elevated railroad, this study focuses on the elaboration of the spatial continuity in the surrounding area of railway stations. Furthermore, the selected cases are regarded as concrete examples working on the creation of the “new nexus” proposed in this study.

4.1. SAKUMACHI shopping street in Nagoya: urban milieu with walkability and livability

The Meitetsu Seto Line of Nagoya Railroad Co. Ltd. (third largest operating line in Japan with a total length of 444.2 km; hereinafter referred to as “Meitetsu”) is a 20.6-km railway that starts at Sakaemachi Station in Sakae in the central area of Nagoya City, Aichi Prefecture and ends at Owari Seto Station in Seto City, a commuter town in Nagoya City. The elevation of the line was completed in 1990.

Shimizu Station and Amagasaka Station, where SAKUMACHI shopping street (hereinafter referred to as SAKUMACHI) is located, became unmanned in 2006. In addition, as the public station plaza has not been developed in both stations, the railway station can be accessible by walking and cycling. As a result, the commercial value around and between the stations was low. Moreover, the space under the elevated railway remained underutilized for a long period of time, and it was used mainly as a parking lot [30].

From around 2010, Meitetsu changed the development concept of its railway business site from the conventional focus on profits to community development. As a result, they have begun to investigate the effective use of the space under the railway, which has been unused and has been considered to have low commercial value. In particular, the area along the railway line where SAKUMACHI is located is also a high-class residential area with the highest branding power in Nagoya City, and its high commercial and cultural potential was the main decision factor in determining the development plan.

At the beginning of SAKUMACHI's development plan, Meitetsu did not have a cooperative relationship with the government. However, with the concept of contributing to community development in areas along the railway lines, Meitetsu is making plans in collaboration with the government. In addition, by organizing briefing sessions for local residents and carefully listening to the opinions of residents along the railway line instead of the traditional relationship with only users and businesses involved, they are striving to build new relationships with the government as a partner, which will promote co-creation and enable the influx of residents along the railway lines. By contributing to the improvement of the brand power of the area through the development of the area along the railway line, the corporate strategy is to take on a new role in the region and enhance the branding of the company. In addition, the development goal is to acquire new railway users for the under-elevated shopping district.

Furthermore, in promoting the use of this continuous infrastructure space, cooperation with community-based design offices plays a major role in going beyond the ideas of conventional railway operators, and it is becoming a livable space with the functions necessary for daily life. There were also opinions of residents along the railway line who were concerned that the feeling of openness would be lost owing to the utilization of the continuous space under the elevated space. However, after the opening of the shopping district, there was a change in the opinions of the residents, as people were delighted to see the town become lively.

SAKUMACHI aims to realize mixed land use by utilizing the void space in residential areas. At the same time, it can be regarded as an example of realizing a short way city by changing the flow of people from heading toward the city center of Nagoya to facilities around the nearest station. In addition, as the local people experience the charm of a new space, disseminate that experience, and gain more sympathy, the space will be recognized by more people as a new local attraction, thereby confirming the spatial dynamics of the milieu as a “place” that can be sympathized with. Moreover, the area is also famous for the

rows of cherry blossom trees planted on the sidewalks of the elevated paths, and it is also an area that has the potential to be crowded with many people during the cherry blossom season. Hence, it is considered a good example of enhancing the branding of the region by utilizing its existing potential.

4.2. Onojo “inter-station” urban development: urban milieu with walkability, livability, and connectivity

Onojo City, Fukuoka Prefecture, which has developed as a commuter town in Fukuoka City, focused on the continuous space newly created in the center of the city because of the elevated railway project of Nishitetsu Nippon Railroad Co. Ltd. (hereinafter, Nishitetsu) Tenjin Omuta Line. From the initial stage of the project, the utilization of continuous railway infrastructure space was set as an important policy of the city, and efforts not yet seen nationwide to formulate an overall utilization plan for all sections, including the scope of businesses [31].

The city has set five concepts as its planning policy, which are Nishitetsu's community, wellness, and mobility concepts, as well as communication and culture. Furthermore, by linking the utilization of the continuous elevated railway structure located in the center of the city with the machizukuri, they aimed to create a centripetal space that will be remembered by the citizens as a new symbol of the city and lead to an increase in the population of people living along the railway line.

As shown in Fig. 7, a plaza and pedestrian space were secured under and around the elevated railway. By integrating the sidewalks on the elevated frontage road and integrating the blocks along the railway lines, the plan includes reducing the total time for activities and movements, increasing opportunities for relaxation, shopping, and exchange, and increasing the population along the railway lines. In addition, the elevated space and elevated frontage road are linked to formulating a plan that takes advantage of the continuity of the railway.

This plan to secure a continuous walking environment is consistent with the city's comprehensive plan. The space under the elevated railway is a part of the “Park Line” that connects the “Mizuki Castle Ruins,” which are a historical resource in Onojo City. In addition, by connecting the network of route buses, community buses, and railways, they are trying to diversify the selectivity of movement, including walking, and strengthen the functions of continuous infrastructure space. Furthermore, they are building a network with cross-sectional walking lines to urban areas along the railway lines, centering on the continuous infrastructure exchange plaza. This walking network connects the continuous infrastructure space with new hubs of the city, spots for community exchange along the railway lines, and historical heritage of the area, with the aim of increasing the value of the city as a whole from the ripple effect on the urban areas along the railway lines. Furthermore, in addition to mobility, community, and wellness, the utilization of the continuous infrastructure space with new nexus of culture, art, and exchange is being promoted. To meet the diverse needs of transportation along the railway lines, they are also considering the introduction of next-generation mobility with a view to MaaS, as well as reorganizing community buses, renting bicycles, car sharing, and improving bicycle parking lots. By increasing the mobility options and strengthening the connection among the transportation modes around these stations as well as improving the walkability, the diverse mobility needs can be fulfilled [29].

Onojo City's plan has a major feature in that it can induce an autonomous, self-sustaining, and segmental urban structure that can respond even in an emergency. In the event of an outbreak such as an infectious disease or disaster, it is possible to restrict movement beyond the walking area (cluster) by stopping the connection between railway stations. Meanwhile, owing to the multi-layered mobility function, walking and low-speed movement in the space under the elevated railway can be maintained. In particular, the transportation of water and food

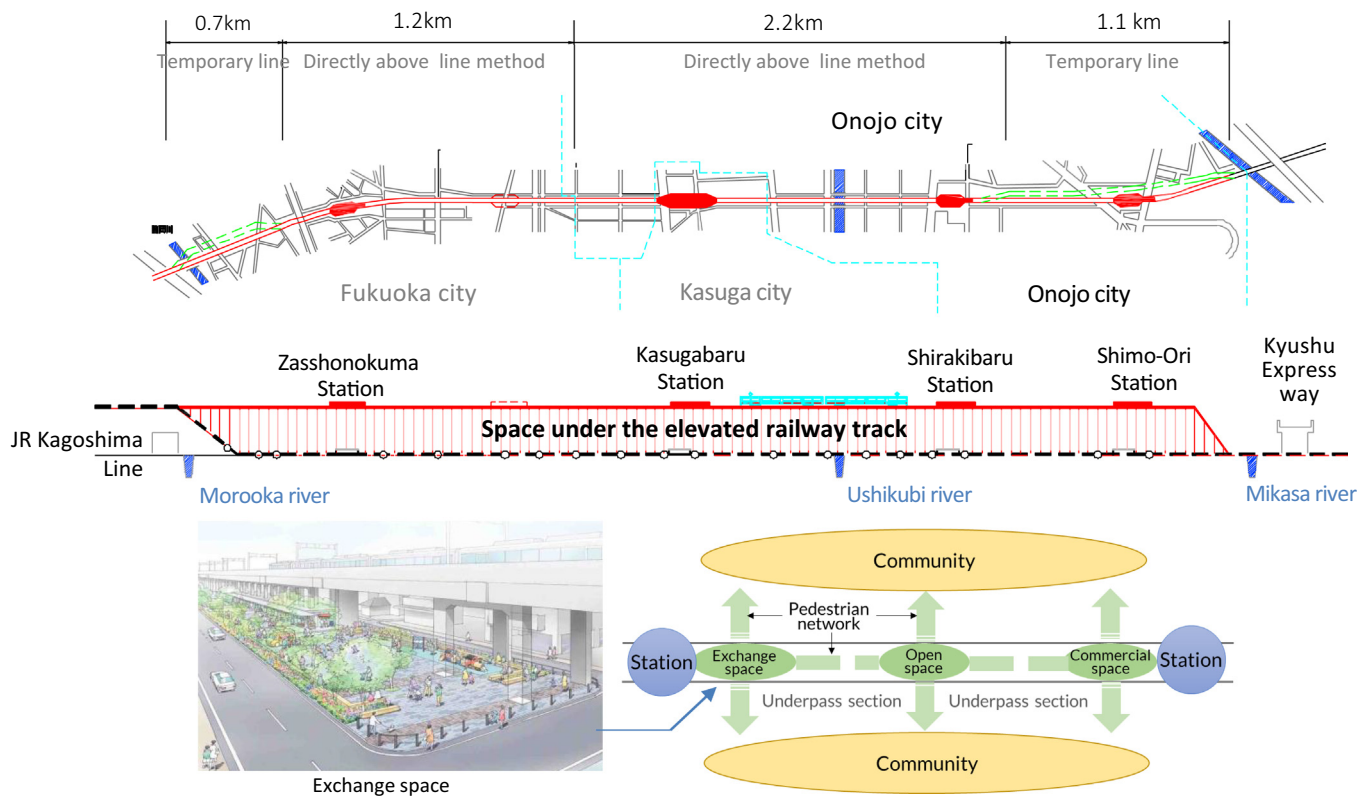


Fig. 7. Outline of Onojo "inter-station" urban development.

(nexus), human interaction, and cultural activities (new nexus) can be maintained.

Of the cases taken up above, Meitetsu's SAKUMACHI infrastructure space utilization [31] is limited to "livable" as shown in Fig. 8. However, in the case of Onojo City, which works in collaboration with various stakeholders from the planning stage, a new local design that includes "walkable" and "connectable" is promoted. In the former case, which preceded in time, there were initial oppositions to the commercial use of the space under the elevated space. However, with the visualization of the plan that emphasizes well-being, there is a significant change in perception among the residents

along the railway line. Onojo City has learned from this success story of SAKUMACHI and is focusing on "preliminary empathy formation" with various stakeholders, including citizens. Furthermore, the railway operators fully understand that the regional revitalization along the railway line and the increase in users in the Onojo area, where the population continues to increase, will affect the success or failure of urban redevelopment around the terminal station in the city center where commuting and school users are concentrated. This has resulted in the establishment of a strong win-win relationship between local municipalities, citizens, and businesses. A comparison of the two given case studies is shown in Fig. 9.

	Category of use	No. of places		Category of use	Quantity and scale
Livability	Entertainment	1	Livability	Square	4 places 3,770m ²
	Sports	1		Multipurpose facility	3 places 1,660m ²
	Beauty	2	Walkability	Promenade	800m, 3,000m ²
	Culture	1		Walking shelter	2 places 2,000m
	Grocery	4	Connectability	Bicycle parking lot	4 places 2,714 vehs
	Eating and drinking	7		Station square	1place 2,700m ²
	Clothing	1		Bus shelter	1place 580m ²
	Work spaces	1	Survivability	NEXUS, Agriculture Small delivery depot	To be Secured in the future
	Education	2			
	Total	20			
Meitetsu Seto Line: SAKUMACHI			Nishitetsu - Omuta Line : Onojo City		

Fig. 8. Prioritized functions in two pioneering cases of new local design and practice.

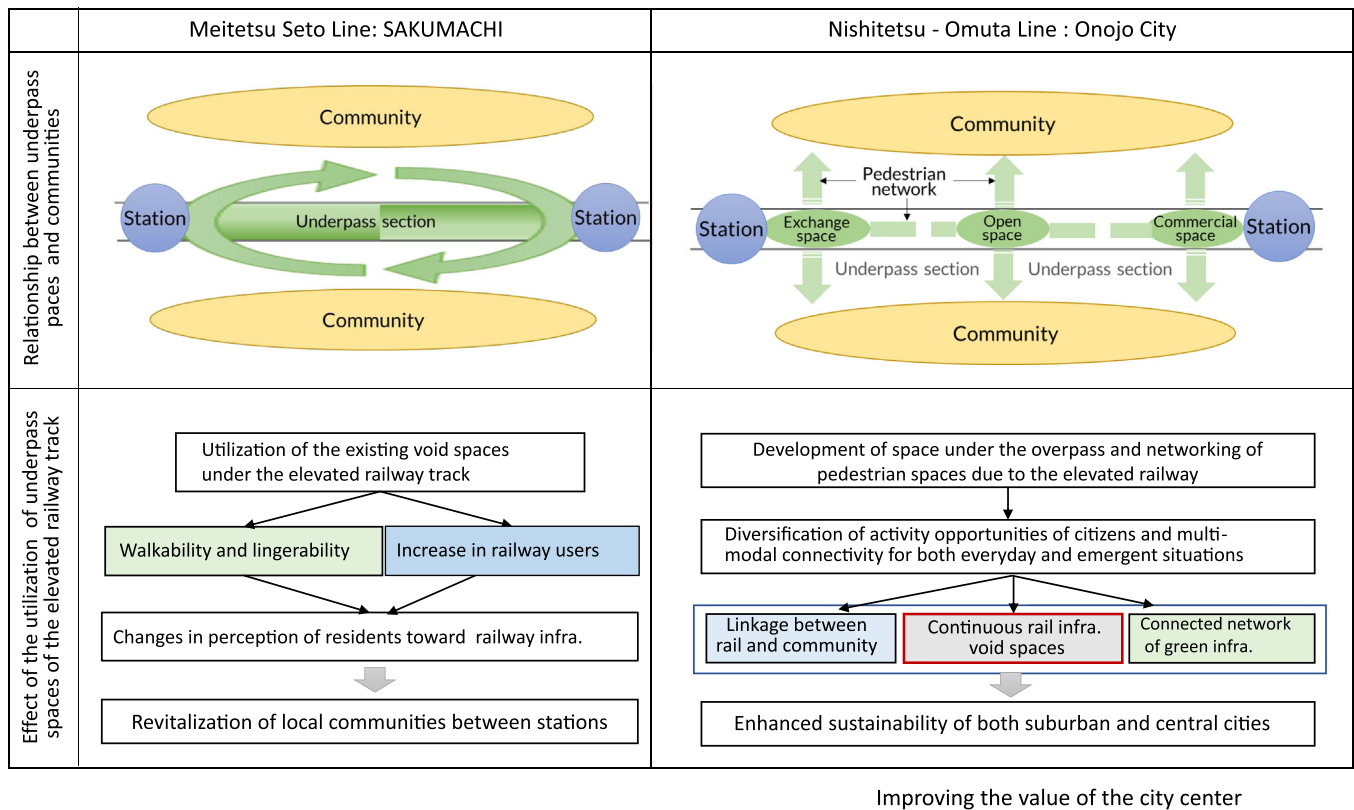


Fig. 9. Comparison of two pioneering cases of new local design and practice.

5. Conclusions

To realize a sustainable city in the new normal, there is an increasing need to realize a city that can become independent and autonomous in an emergency while improving well-being in peacetime. In this paper, we proposed a new local design to achieve this purpose by collaborating with various stakeholders. New local design is the pursuit of the establishment of the “three compatibility problems” of (1) balancing the act of protecting each person’s life with the act of maintaining the urban functions and societal well-being, (2) balancing extraordinary and everyday systems for unpredictable outbreaks, and (3) balancing global goals such as SDGs and carbon neutral goals with regional development goals that emphasize historical and cultural contexts. To obtain this solution, it is indispensable to secure the nexus, which is often neglected in our daily lives, and to utilize resource-efficient space for that purpose. In this paper, we clarified the significance of utilizing void spaces and constructing a networked urban milieu based on them.

Accordingly, this study suggested the need for reversible systems in everyday and extraordinary times, the synergistic effects of information, time, space, and environment on new local designs, and compassion among various stakeholders. In addition, a direction of urban reconstruction was proposed that both density and livability can be achieved through multi-layered and multi-modal movements in continuous social infrastructure spaces such as railways so as to connect city clusters.

Furthermore, by clarifying the innovations of urban clusters and the spatial dynamics of void spaces, securing the nexus in the “sponge” sections of the urban area and securing the new nexus in the continuous social infrastructure facility space will lead to the expansion of the utilization range of the social infrastructure facility space.

To illustrate, two cases were given to demonstrate the practices of new transportation machizukuri in Japan which utilized the void spaces existing in transportation infrastructure for adopting the new normal conditions. In the case of SAKUMACHI, the unused space under the elevated

railway has been successfully transformed into commercial purposes. Emphasizing the collaborative partnership with local municipalities and valuing residents’ opinions, the success was brought by residents’ experience of the charm of new space design. Through forming empathy, SAKUMACHI has gained more attention and been recognized by more people as a new local attraction. This intensified the functions of recreation and culture, thereby confirming the spatial dynamics of the milieu.

In Onojo City’s case, the project was in collaboration with various stakeholders from the planning stage, focusing on the “preliminary empathy formation” especially with the citizens. Promoting the concept of “walkable” and “connectable”, the new local design induced an autonomous, self-sustaining, and segmental urban structure that can respond even in an extraordinary time. Given the two implementations cases, the new local design responding to the new normal has already been seen in industry-government-private partnership efforts.

Supplementary notes

[1] The problem of the COVID-19 pandemic has often been approached from a perspective of a trilemma. Specifically, it is a problem of how to balance inflection prevention, resumption of economic activities, and financial soundness; how to balance inflection prevention, resumption of economic activities, and privacy protection, as well as a balance of freedom of movement and activities, safety, and security, and social and economic vitality. A trilemma is a state in which three conditions cannot be satisfied at the same time, while many of the above examples intentionally bring in elements of different levels to make it look like an unsolvable trilemma. In contrast, the structure of the “three compatibility problems” proposed by this study is rather a problem setting for obtaining a solution.

[2] Studies exploring the effects of the COVID-19 pandemic, especially lockdown, on people’s self-efficacy and well-being are attracting attention in various countries [32–45].

[3] Resource efficiency was highlighted in the New Urban Agenda (NUA, 2016) of SDG Habitat III as well as the G20 Resource Efficiency Dialogue (2017) [36, 37]. In terms of transportation, it was mentioned in NUA Vision 13.(f) that “Promote age-and gender-responsive planning and investment for sustainable, safe, and accessible urban mobility for all and resource-efficient transport systems for passengers and freight, effectively linking people, places, goods, services and economic opportunities”.

[4] A behavior setting consists of a milieu (a particular layout of the environment), a standing pattern of behavior (a recurrent activity), and a synomorphy (a congruent relationship between the two) [39–42]. The greater the congruent relationship between the particular layout of the environment and the activity, the better the behavior setting is able to afford human behaviors and needs [38].

[5] In an emergency, it is important to secure a new nexus of culture, art, and exchange opportunities to maintain the well-being of mind and body, in addition to food, water, and energy necessary to maintain life.

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Declaration of Competing Interest

The authors declare no conflicts of interest associated with this manuscript.

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