Contemporary Integrated Community Planning – Mixed-age, Sustainability, and Disaster Resilient Approaches

Jieh-Jiuh Wang (jjwang@mail.mcu.edu.tw)
Ming Chuan University https://orcid.org/0000-0003-2613-2733
Ning-Yu Tsai
Ming Chuan University

Research Article

Keywords: elderly, sustainability, resilience, community, planning and design, Collective Houses, disaster management

Posted Date: July 13th, 2021

DOI: https://doi.org/10.21203/rs.3.rs-681007/v1

Version of Record: A version of this preprint was published at Natural Hazards on February 25th, 2022. See the published version at https://doi.org/10.1007/s11069-022-05259-1.

Abstract

In recent years, conventional concepts of social reform planning for sustainable, secure, and disaster-resilient communities have continuously driven the thought and practice of community planning and management; furthermore, environmental safety has become the common foundation of these visionary community models. Additionally, low birth rates and aging populations have become common social problems in numerous developed countries. This study integrated the design and planning of sustainable, disaster-resilient, and intergenerational collective communities to develop factors and models of an intergenerational community. Moreover, this study constructed evaluation indicators for intergenerational communities under a safety basis, which were used as the foundation for planning and designing strategies.

1. Introduction

Agenda 21 of the United Nations (UN) proposed employing a culture of safety, disaster warnings, and contingency plans to deal with problems caused by disasters, a plan that integrates safety, disaster resilience, and sustainability. Historical experience and spatial characteristics suggest that the external characteristics potential disaster history, the spatial characteristics of disasters, and the social, political, and economic environment of disaster sites should be clearly understood. Otherwise, even with a considerable amount of money and human power devoted, the core issues would go unaddressed. Communities are the most appropriate unit for understanding all relevant relationships and joint actions. In recent years, concepts with a tradition in social reform planning, such as sustainable, safe, and disaster-resilient communities, have altered the paradigm of community planning and management. Disaster management with survival indicators has become the common foundation of several prospect community models. Reducing the impacts of disasters and losses as well as stable socioeconomic conditions enable people to internalize disaster consciousness into their lives (Lavell, 1994). For sustainable development, constructing a community that has a main framework of the environment, society, and the economy is necessary.

For numerous developed countries, a declining birth rate and aging population have become social problems. For example, in 1993, 7.1% of Taiwan’s population was aged 65 years and above, a percentage considered to indicate an aged society according to the World Health Organization (Department of Statistics, Ministry of the Interior, 2006). Later, this percentage increased from 7.86% in 1996 to 9.9% in 2006. Izuhara (2000) investigated the aged population of each country and estimated that by 2025, Taiwan’s aged population will have increased to 16.6%. The residential trend of the aged population is gradually transforming from care homes, resettlement houses, elderly houses, and elderly communities to intergenerational collective houses. This emphasizes the links between and individual needs of different age groups.

However, relevant case studies and literature have suggested that existing elder communities place more emphasis on health management services and operate in coordination with the declining physical

function of elderly people. Therefore, the planning of barrier-free space has increased considerably. However, the concept of environmental sustainability is not emphasized in communities, and such a concept is rarely incorporated into the building itself or spatial planning (Wang & Tsai, 2015). By contrast, when sustainable communities focus on the resources and rights of the next generation, the needs of the aged population are less emphasized. The rise of intergenerational communities and their corresponding planning and design models are the keys to sustainability in disaster prevention, as well as for satisfying the needs of the aged population.

First, we proposed and verified arguments on the environmental thoughts and practices of sustainable development and eco-friendly spaces, as well as the theoretical and practical development of concepts related to sustainable development. Subsequently, we discussed the current development and focuses of intergenerational communities and reviewed and integrated practices of sustainable and disaster-resilient communities. Moreover, we used the modified Delphi method (MDM) to analyze key planning and design factors for intergenerational communities with disaster resilience.

2. Literature Review

2.1 Concept and Planning of Sustainable Communities

In the mid-1980s, international society gained awareness that unregulated economic development has polluted the air, water, and soil; undermined forest and natural resources; and increased the spread of toxic waste and garbage. Numerous communities have realized that out-of-control economic development have engendered environmental and social problems such as congestion, air pollution, garbage, and resource constraints; these problems have undermined people's quality of life and caused irreversible environmental problems. Discussions on sustainable development in recent years have focused on six basic strategies: (1) the effective use of energy, (2) the effective use of local resources to satisfy local needs, (3) effective infrastructure investment, (4) protection of and improvements to community people's quality of life, (5) support and protection of businesses that provide services or products that facilitate environmental recovery, and (6) the development of a community business ecosystem. Although these six strategies do not fully cover all dimensions of sustainability, the need for communities to create jobs and economic well-being has been proposed. When protecting and restoring the environment, the community is an ideal field for actualizing the goal of sustainability.

A sustainable community is a community development model with the goal of sustainability that guides planners to think at local and regional levels. In addition to energy conservation and waste reduction, sustainable communities focus on the environment, resources, local culture, economy, regional characteristics, and the environment. Additionally, these communities pursue socioeconomic, demographic, technological, and natural growth in a stable state with humans as the starting point. Specifically, social justice, research and development in technology, and economic growth that consider the bearing capacity of the environment are pursued. Sustainable planning methods have also been proposed; Sucher (2003) proposed short-term approaches to improve the existing environment and

emphasized the importance of humanistic scale design and ecological considerations for artificial environments. Layard et al. (2001) suggested that social facilities such as schools, open spaces, health centers, and local shopping places should be closer to people's homes. This can reduce the need for long-distance travel and encourage people to use mass transit systems instead of private transport. Ewing (1996) and Calthrope (1993) proposed introducing nature-friendly designs and models into community design. Ewing (1996) noted that the unlimited expansion of artificial space should be avoided and the refinement of existing space should be prioritized. Calthrope (1993) suggested that urban and rural areas and nature should be considered as one, and that the order of life should be reorganized through nature.

In the United Kingdom, the urban transformation movement initiated by the town of Totnes is a crucial example for sustainable communities. Propositions of plans such as local food, community-supported agriculture, and Good Energy partnerships can awaken local people's awareness of sustainable living, build local ecological resilience for the foreseeable future, encourage communities to reduce their energy consumption according to local conditions, and reduce local dependence on fossil-fuel supply chains. Furthermore, education and training can form a sense of place and sense of ownership in local people and enable them to exceed individual levels and enter the community, support each other, share resources, and exert the power of change. Hopkins (2010) suggested that the key factor in the successful transformation of Totnes town was grasping the production conditions for food and energy. Additionally, the town created opportunities for external funding and built the resilience required for a sustainable community.

The planning of sustainable communities integrates concepts such as ecological design and community empowerment to create living space for humanistic communities. When such living space is being created, several dimensions such as planning and design, architecture, and the ecological environment are considered. However, with the correct concept, community values are created together by residents and planners in the process of community growth. From the concept of sustainable community, Wu (2007) proposed five dimensions of a community construction evaluation system, namely the ecological and environmental landscape, society and culture, economy and industry, living functions, and mechanisms and governance. Chiang and Chang (2014) investigated the governance model of a sustainable community with community as the main body, and its development comprised five major dimensions of community governance evaluation factors: environmental and ecological protection, community economic development, community living network, community culture preservation, and good governance mechanism. Overall, sustainable community development comprises five basic dimensions, namely living, production, ecology, culture, and governance. All five are required to build a sustainable community.

2.2 Characteristics and Development of Disaster-Resilient Communities

In 2005, the UN published "The Hyogo Framework for Action 2005–2015: Building the Resilience of Nations and Communities to Disasters" (HFA), and set the overall resilience of natural disasters as a

crucial goal from countries to communities. Additionally, the UN promoted communities participating in disaster reduction, strengthening their community disaster competence, and forming community disaster resilience based on social risk awareness and education, thereby building a globally linked culture of disaster reduction (UNISDR, 2005). Geis (2000) suggested that disaster-resilient communities should have the ability to resist disasters. Most communities use hardware design and construction to ensure community safety and quality of living. In addition to the aforementioned hardware design and construction methods, FEMA's "Project Impact" emphasized cooperating with other public and private sectors as a community to thoroughly implement disaster-resilient policies with bottom-up public participation. This can effectively reduce disaster impacts and improve the speed of community recovery.

For the sake of increasing the general public's awareness of disaster prevention and integrate such prevention into their lives, communities should focus on the development of basic community systems, together with educations of disaster risk reduction and sustainable development. Thus, disaster-resilient communities rely on the joint efforts of the stakeholders, including governments, professionals, and the community. Based on the disaster awareness and stakeholders' responsibility-sharing, successful factors in confronting with disasters also cover the policy framework and institutions, governments and professional supports, community capacity building as well as community leadership. Besides, most existing communities are limited to tangible community resources and have inadequate intangible resources and organizational ability. Local organizations' self-awareness and responding capability should be enhanced, including their sense of community, trust, participation, as well as community social capitals.

2.3 Development Trends of Elderly-Friendly Intergenerational Collective Communities

2.3.1 From Elderly-Friendly to Intergenerational Collective Houses

In 2002, the WHO proposed its active aging policy framework in response to the continuous growth of aged and urban populations. Specifically, the global population aged 60 years or older was estimated to reach 1.2 billion by 2025, and more than 3/5 of the global population will live in cities by 2030. The WHO's aim was to improve the general public's quality of life in late adulthood. In 2007, the WHO published "Global Age Friendly Cities: A Guide," which covered eight major issues: community support and health services, outdoor spaces and buildings, transportation, housing, social participation, respect and social inclusion, civic participation and employment, and communication and information (WHO, 2007). Aging population has become one of five major global trends, and sustainable development must face this most basic survival problem. Therefore, Wang and Tsai (2015) investigated the sustainable development, eco-friendly environmental thinking, and practical development of elderly communities. Additionally, they incorporated elderly communities into sustainable-community practice and built a sustainable community planning system for elderly people, which included three dimensions: sustainable planning, community planning, and humanistic scale.

Because of aging populations and increasing life expectancy, the revitalization of healthy elderly people and the reuse of human resources are crucial. This is particularly true in modern society because individuals have different lifestyles as well as social and educational backgrounds, and this has resulted in elderly people having different personalities and styles of aging. Such differences make building and urban planning necessary, as well as the provision of diverse housing options, care models, and services for elderly people to meet their changing needs as they age (Epimakhova, 2016). An intergenerational environment encourages older people to be more independent and active and have a stronger tendency to rely on themselves. Additionally, neighbors can offer help to each other, and thus create a sense of safety. Self-support and mutual support among residents are more practical solutions for aging-related problems compared with nursing, which is particularly true during periods of diminishing public capital and support. Under such circumstances, social sustainability depends on the ability of older and younger generations to collaborate and help each other (Black, 2014).

The term “collective houses” originated in Sweden and Denmark and usually refers to 10–15 individual homes with a common space where people perform their daily activities (Jones et al., 2008; Vestbro, 2012). Residents of a collective house may be composed of only elderly people. By contrast, intergenerational communities—which are based on mutual support, cooperation, and the replacement of employment with work sharing—are also feasible. For example, supporting and sharing household tasks such as cleaning, cooking, and childcare are an alternative to living in a single-family home (Sangregorio, 2000). In Japan, intergenerational cohousing models such as “living under the same roof,” “collective housing corporation,” and “after 5 pm villages” have been introduced. Such cohousing models can satisfy the needs of elderly residents, reduce their economic burden, and increase their sense of security, as well as solve the housing problems of underprivileged groups (Chen, 2017).

Because the dependency ratio is increasing annually, care facilities are not long-term plans at the economic and social levels. Rather, informal mutual support between different generations should be employed as a means for enhancing community awareness, establishing a new environment suitable for all individuals, meeting individual and collective needs across generations, and providing a niche for the coexistence of different generations (Epimakhova, 2016). Such a concept has become a global trend, and countries such as the Netherlands, Denmark, and the United Kingdom have transformed from supporting the needs of elderly people to a holistic approach that serves all age groups. Denmark realizes the importance of living with older generations, and in 1987, it stopped building elderly housing (Krings-Heckemeier, 2009).

2.3.2 Promotion and Development of Intergenerational Communities in the United States

In the United States, communities for all ages have been promoted since 2000, and elderly-friendly and child/youth friendly campaigns have been introduced to cope with the needs of demographic changes and community construction. Communities of all ages consciously gather people of different age groups together to solve problems that affect all stages of life. Following more than a decade of promotion,

communities of all ages have clearly engendered health and care, safety, education and lifelong learning, social capital, resident leadership and civic participation, and organization alliances, as well as created new spaces for intergenerational connection and received financial and material support (Henkin et al., 2012). An intergenerational community refers to a place that provides the following three functions: (1) adequate safety, health, education, and basic living needs for all age groups; (2) the promotion of cooperation, interaction, and communication among different generations through plans, policies, and practices; and (3) sharing of the talents and resources of all ages, and support in relationships that benefit individuals and communities (Generations United, 2012).

In the United States, the Best Intergenerational Communities Awards Program was promoted in 2012 on the basis of communities for all ages, and it encourages communities to enhance residents' services and empowerment through intergenerational exchange. An intergenerational community is an intergenerational community housing model. Different generations perform their respective roles in the community, support each other, and promote intergenerational interdependence; furthermore, they build partnerships among local governments, homes for the elderly, schools, businesses, cultural and community organizations and services, families, the elderly, and children. Essentially, intergenerational communities aim to create an environment where individuals of various age groups support and help each other (Generations United, 2012). According to the aforementioned discussion, the key components of an intergenerational community include six main dimensions: housing, transportation and safe neighborhoods, health-care and support services, general retail and services, social integration, and education and employment (Generations United, 2016).

2.3.3 Principles of Intergenerational Community Planning

Humans' physical and cognitive abilities decline gradually with age. A building environment should improve people's living space, provide supportive facilities that serve the elderly, and offer residents opportunities to participate in various activities. Furthermore, cooperation and communication among community residents can compensate for limitations in elderly people's abilities, as well as enable them to be active and capable of living independently for a long time, thereby supporting aging in place of elderly people (Epimakhova, 2016).

Safe residence, affordable housing, quality education, opportunities for lifelong learning and leisure, economic security and belongingness are common needs of different generations (Henkin et al., 2012). Epimakhova (2016) suggested that the construction of intergenerational communities should be enhanced from six dimensions, namely social responsibility, health, accessibility, safety, adaptability, and affordability. To achieve these goals, seven design strategies (density, spatial grading of needs in different fields, internal and external connections, incomplete space, adaptable space, externalization, and efficiency) and five site-selection principles (connection with existing infrastructure, connection with mass public transportation systems, mixed use of the environment, walkability, and connection with nature) can be implemented using different spatial scales (from the living room to communities).

Some scholars have proposed that intergenerational community design is beneficial to brain health from the perspective of neuroscience. Nicholson (1971) studied children's play environments and provided a playground with loose parts such as tires, wood, tools, and plants. The researcher found that these loose parts were more effective at stimulating children to create games compared with the provision of standard playground equipment. Larkin et al. (2010) proposed that the design of the environment of an intergenerational activity should have a certain level of flexibility to respond to a wide range of expected and unexpected changes. Rooms with movable walls should be designed to provide users with more control over the usage of space. With flexibility, the aged population will be more capable of integrating old ideas in new ways; moreover, creativity can inspire young partners to think together as they restructure that space (Cohen, 2005). Additionally, the ability to change spatial characteristics attracts active interaction between adults and children (Haider & Kaplan, 2004). In addition to flexibility, Larkin et al. (2010) proposed guidelines for the design of the environment of an intergenerational community, which included the following: (1) every individual who enters and uses the environment feels welcomed; (2) organized space that resists social isolation but does not invade individuals' privacy; (3) stereotyped clues should not be used to convey negative inferences about an age group; (4) participants should be able to decide the use of space (e.g., having appropriate shared governance and encouraging and valuing employee efforts); and (5) integrating art (e.g., music, drama, and visual arts) and creative games as means of intellectual stimulation and social participation.

2.4 Summary

Current discussions on sustainable communities focus on dimensions such as the efficient use of energy, effective use of local resources to satisfy local needs, promotion of public transportation, mixed use of land, walking instead of driving, maintenance of environmental resources, development of community business ecosystems, and establishment of community living networks. Disaster-resilient communities emphasize the empowerment of the community and residents. Specifically, such communities improve their disaster-resilient knowledge conservation and cohesion; build community awareness and community organizations; and encourage residents to participate in community affairs through an empowerment process, thereby fulfilling community disaster-resilient work. Intergenerational communities emphasize intergenerational connections and their housing designs correspond to the needs of different generations. Additionally, intergenerational communities provide health-care and support services, create an environment with convenient transportation that satisfies daily shopping and safety needs, and provides education and job opportunities.

However, this study found that discussions on sustainable communities and disaster-resilient communities have clearly paid little attention to the daily-life needs of different age groups and the possibility of intergenerational mutual support. How to deal with disasters and balance sustainable development are rarely discussed in intergenerational communities; that is, the existing indicator system is still incomplete for the fundamental elements of the planning, design, and construction of intergenerational disaster-resilient communities.

3. Research Method

We adopted the MDM to identify key factors in planning and design. The Delphi method, also referred to as an expert survey, entails group communication with written questionnaires where a consensus is sought among expert panel members on professional issues through repeated anonymous surveys. During the initial questionnaire stage, each expert can provide personal opinions on the topics being discussed. The questionnaires are revised, condensed, and integrated before returning as anonymous feedback to participating experts in the next questionnaire stage; this process is repeated until the experts reach a consensus (Dhaliwal & Tung, 2000). The MDM simplifies the complicated questionnaire process; structured questionnaires are developed instead of open-ended questionnaires through a literature review, planning, and expert interviews. In the first round of questionnaire surveys, expert members' attention is focused on certain topics to avoid misunderstandings easily caused by open-ended questions and increase the questionnaire return rate (Murry & Hammons, 1995). Steps for implementing the questionnaire include (1) setting goals and needs, compiling discussion topics through a literature review, and designing questionnaires with scales; (2) forming expert groups and explaining the problems in detail; (3) distributing and collecting the questionnaires; (4) compiling expert opinions and conducting quantitative analysis; and (5) ensuring the consistency of the expert questionnaires and completing the modified Delphi questionnaire.

In the analytic hierarchy process (AHP), experts and researchers pair and compare each factor through a nominal scale and construct a positive reciprocal matrix to determine eigen vectors. These vectors indicate the priority or relative weight between each factor, and they are used as the basis for decision-making. The decision-making process of the hierarchical analysis method includes (1) creating a hierarchical structure for evaluation; (2) calculating the factor weight at each level; and (3) calculating the weight of the overall structure (Zahedi, 1986). The Delphi hierarchy process (DHP) integrates the Delphi method with hierarchy analysis and is mainly based on the AHP and the operational logic of hierarchical analysis. We applied the Delphi method to obtain a hierarchical structure before conducting hierarchical analysis of pairwise comparison matrices (Khorramshahgol & Moustakis, 1988).

This research study investigated an emerging and complicated problem and required effective advice from numerous experts. However, group meetings entail considerable costs and time, and thus we adopted the Delphi method. Additionally, we integrated the MDM with hierarchical analysis to investigate the planning and design factors in intergenerational disaster-resilient communities.

4. Indicator System Construction

4.1 Indicator Setting and Selection

This study compiled literature on topics such as sustainable communities, disaster-resilient communities, elderly communities, and intergenerational collective communities. Based on the goals to be achieved in the environment of intergenerational communities proposed by Epimakhov (2016), we set five

dimensions of planning and design factors for collective and resilient disaster-resilient communities: social responsibility, health, accessibility, safety, and adaptability. Under each dimension, the indicator content was compiled according to two scales: community living unit (mainly for the built environment of the community) and the socioeconomic environment (mainly for the surrounding environment of the community and the overall sociocultural and economic level). We constructed the preliminary hierarchical indicators and formed questionnaires that contained five major dimensions and 26 planning and design factors in total, before integrating opinions and making evaluations. Our questionnaire was rated on a 5-point Likert scale, where 5 = extremely unimportant, 4 = unimportant, 3 = acceptable, 2 = important, and 1 = extremely important. Additionally, in the questionnaire, a column was provided under each item for the participating experts to proactively write their thoughts and opinions.

Delbecq et al. (1975) recommend that a homogenous Delphi expert group should consist of 15–30 highly homogenous members, whereas a heterogenous one should consist of 5–10 heterogeneous members. Our interdisciplinary research topic was more heterogenous, and thus we selected eight heterogeneous members. We invited five scholars in the field of social work and three in the field of architectural planning, which meant that eight questionnaires were distributed. The content included the study motivation, purpose, and instructions, as well as explanations of the indicators. The questionnaire was distributed on September 25, 2019 and returned on October 2, 2019. A total of eight valid questionnaires were collected for a return rate of 100%.

Means can be used to determine the importance of an indicator (Holden & Wedman, 1993). We set the importance level as 3.5 points (70% approval rate); therefore, an indicator item with a mean of 3.5 points or more was considered a consensus among all members on the importance of the indicator, and thus the indicator was retained. In the first round of the questionnaire, the experts reached a consensus on the importance of each indicator. Therefore, all indicator items were retained. In the next stage, hierarchy analysis was conducted on the questionnaire, and we only modified parts of the indicator names and descriptions according to the experts' opinions. Based on the MDM results, this study categorized planning and design factors in intergenerational disaster-resilient communities into five dimensions, namely social responsibility, health, accessibility, safety, and adaptability. The five dimensions had 26 indicators, and each dimension is described as follows.

I Social Responsibility: Factors in this dimension are able to prevent social isolation and exclusion as well as intergenerational conflict, and simultaneously promote community aw.areness and encourage social interaction.

II. Health: Factors in this dimension create an accessible public environment and increase residents' awareness and physical health through a carefully designed high-density, mixed-use, and pedestrian-friendly environment.

III. Accessibility: Factors in this dimension achieve access to service facilities through density control and the universal design of paths and spaces. This enables each individual with any physical condition or cognitive status to freely visit or use the services they require within an acceptable distance.

IV. Safety: Factors in this dimension include a universal design that prevents errors and accidents and makes the environment safe for each individual through comprehensive consideration of the capabilities and limitations of all users, as well as a simple and easy-to-use design. Another crucial aspect is protecting the living environment from disturbances to public security and reducing disaster-induced losses. Other factors are establishing community awareness; strengthening land identity; strengthening residents' behaviors and attitudes to protect the community, prevent crime, and provide a sense of security; and strengthening community resilience through activities that encourage certain behavior and attitudes.

V. Adaptability: Factors in this dimension involve adapting to the changing needs of people at different stages of their lives as well as changing needs in the future. This can increase community residents' responsibility to create a friendly environment and encourage them to protect the community.

Table 1
Indicator content for planning intergenerational disaster-resilient communities

Dimension	Scale	Indictor	Conceptualized Explanation
Social responsibility	Community life unit	-1 Spatial classification of public and private areas	Spaces and passages with different definition are clearly classified and sequenced. This enables residents to understand the area of influence and contribute to the cultivation and maintenance of the sense of place and self-identity.
		-2 Spatial design of internal and external spaces	The design interstitial space enables individuals to leave their house and still be separated from public areas. This can provide opportunities for social contact and prevent social isolation and deprivation; however, offensive surveillance should be avoided.
		-3 Externalization of home functions	Moving certain functions from home to shared or community space; externalization not only reduces housing costs but also encourages social integration and interaction in the community. Shared social spaces enable people to participate in community activities and share community work (sharing responsibility), which contributes to community members' social participation and the utilization of their talents and skills.
		-4 Efficient design	Hardware facility reduction and subtraction design principles support the needs of residents with the most streamlined space, thereby making full use of spaces at different times.
	Environmental and social economics	-5 Intergenerational community mutual support	Assisting elderly people to regain their skills, teaching residents/children knowledge or skills through courses or activities, and helping them to solve problems. In the process of mutual help, interpersonal emotions and trust are regained.
		-6 Establishment, preservation, and inheritance of local culture	Discovering traditional local cultures and creating a new intergenerational fusion culture. Through processes such as collection of cultural and historical data, preservation of cultural assets, and development of cultural industries, cultural activities are held and local aesthetics are cultivated. This can reduce stereotypes, encourage respect toward the similarities and differences of different ethnic groups, ages, beliefs, and enhance the community's cohesion and local cultural heritage.

Source: Organized by this study

Dimension	Scale	Indictor	Conceptualized Explanation
		-7 Establishment of partnerships with external parties	Establishing partnerships between communities, government agencies, and nongovernmental organizations to increase community resources and sustainable management capital.
		-8 Provision of educational and job opportunities	Providing quality educational opportunities such as lifelong learning, second speciality, local employment of the elderly, early childhood education, youth employment training, and public service opportunities. Additionally, the community should provide flexible working arrangements for young and elderly people. Making connections and transitions between full-time jobs, part-time jobs, volunteering, and retirement, thereby shortening individuals' idle period without life goals.
Health	Community life unit	-1 Incomplete spatial design with open functions	Providing opportunities for residents to personalize (self-explanatory) space based on their needs (which may change over time). Encouraging community residents to establish senses of space or place, belonging, and identity, which will contribute to their cognitive health.
		-2 Integration of art aesthetics into design	The beautification of public space is integrated into the local culture; semipublic living spaces are encouraged; and local aesthetics are integrated with a pro-natural design.
		-3 Energy conservation/ green energy use	In response to architectural microclimate design, natural ventilation and lighting as well as renewable energy such as solar energy and rainwater are used.
	Environmental and social economics	-4 Communication and information exchange	Elderly people can quickly obtain relevant and accurate information and resources to rapidly integrate into society, meaning they are free from the fear of losing access to information and resources and being marginalized by mainstream society. This prevents them from becoming victims of information technology and Internet fraud.
		-5 Environmental and ecological maintenance and management	A crucial part of the urban environment includes the connection between ecological green networks and nature and the creation and maintenance of ecological habitats. This can provide green care opportunities to reduce residents' anxiety, stress, and depression.

Source: Organized by this study

Dimension	Scale	Indictor	Conceptualized Explanation
		-6 Construction of green consumer chains	Establishing local production and consumption mechanisms, developing community industries, and expanding community employment opportunities.
		-7 Provision of health-care services	Communities require sufficient basic medical facilities, well-trained medical personnel, community education, and health plans. Additionally, supportive services from doctors and experts with professional knowledge are required to satisfy the daily-care needs of community residents of all ages.
Accessibility	Community life unit	-1 Low-rise and high-density neighborhood	Residential density determines the quality of barrier-free community and pedestrian services. Overcrowded communities, overloaded infrastructure, traffic congestion, and a lack of personal space and privacy can be problematic. Communities of low density are functionally isolated, low in mobility, and usually reliant on automobiles for transportation. Residents with a high level of dependence, such as the elderly, physically and mentally disabled, and children, would lose the opportunity to interact with other residents. Low-rise and high-density community designs facilitate creating a compact, accessible, walkable, diverse, or mixed-use environment.
	Environmental and social economics	-2 Proximity to existing public facilities	Communities are built in the vicinity of existing public facilities. Increased access to public facilities and services (e.g., schools, kindergartens, elderly clinics, and even childcare and elderly learning centers can be found on the ground floors of community residences) for different age groups is promoted. This shortens the time required for residents to receive services, provides them with a range of available options, and revitalizes the surrounding environment.
		-3 Mass transit system connections	The connection between the community and the environment relies on an accessible, reliable, and available public transport network, with a walking distance to transport stations of approximately 500 meters.
		-4 Walkability	Convenient sidewalk width, road-crossing safety, climate and terrain design (e.g., shade in tropical areas), and pedestrian network. Access to daily necessities within a walking distance of 500 meters (e.g., grocery stores, cafes, and pharmacies).

Source: Organized by this study

Dimension	Scale	Indictor	Conceptualized Explanation
Safety	Community life unit	-1 Universal design	A universal design integrates products and architectural factors that are suitable for each individual; furthermore, it comprehensively considers the capabilities and limitations of all users. The two aforementioned goals are achieved through simple and easy-to-use designs. The architectural environment and equipment are made as accessible as possible to each individual. This prevents mistakes and accidents and enables each individual to use them safely.
		-2 Emergency notification system	Installing fire safety equipment, an emergency broadcast system, and smoke detectors, which enables residents to quickly learn of and respond to disasters. Specifically, with an emergency rescue system, residents can directly ask for help, or detection systems such as those employing infrared can be used to automatically detect whether residents have fallen or are losing vital signs; subsequently, rescue signals are sent directly outside.
	Environmental and social economics	-3 Effective use of idle space/land	Reusing and revitalizing idle land, such as through creating a shared community garden to grow vegetables and fruit. This provides horticultural therapy for the elderly, creating interactions that are conducive to intergenerational communication and avoiding risks to public security.
		-4 Promotion of community support team plans	Promoting a community support plan and organizing relevant community activities to provide neighbors with opportunities to become more acquainted with each other.
		-5 Construction of community disaster management mechanism	Establishing community disaster-resilient organizations, attracting community safety awareness, and checking community disaster prevention and relief resources. Developing community disaster-resilient plans and building mutual support and care mechanisms. The younger generation assist the elder generation in coping with disasters, which can increase the sense of safety among residents. Organizing community disaster-resilient activities and training of related personnel.
Adaptability	Community life unit	-1 Adaptable space design	The architectural environment can satisfy various preferences and changing needs of different resident groups, as well as cultivate residents' autonomy, control, and local identity.

Source: Organized by this study

Dimension	Scale	Indictor	Conceptualized Explanation
	Environmental and social economics	-2 Shared governance	Residents are able to determine the use and purpose of community public space.
Source: Organized by this study			

4.2 Indicator Weight Calculation

Figure 1 presents the hierarchical structure of factors in our intergenerational disaster-resilient community plan. We conducted pairwise comparisons of various key points and designed expert questionnaires for further pairwise comparisons. Moreover, we conducted expert opinion analysis to obtain the relative weight evaluation of various dimensions and indicators. Our questionnaire adopted pairwise comparisons at the same level, and a 9-point Likert scale was used for evaluation, where 1 = equally strong, 3 = slightly strong, 5 = fairly strong, 7 = extremely strong, and 9 = absolutely strong (Table 2). The left scale indicates that indicators in the left column are more important than indicators in the right column, whereas the right scale indicates that indicators in the right column are more important than indicators in the left column. Numerous factors must be considered when planning the construction of intergenerational disaster-resilient communities. For example, when evaluating two indicators, namely “spatial classification of public and private areas” and “spatial design of internal and external spaces,” if the former is considered more important than the latter, then one should tick the box “(6)” if the importance level is between “fairly strong (5)” and “extremely strong (7)”.

Table 2 Expert questionnaire design for hierarchy analysis

	extreme						equivalent						extreme					
Treatment I	9	8	7	6	5	4	3	2	1	2	3	4	5	6	7	8	9	Treatment II
I-1 Spatial classification of public and private areas				ü														I-2 Spatial design of internal and external spaces

Data source: Organized by this study

During this stage, we distributed the questionnaire to 18 experts comprising six social work scholars (specialized in fields such as elderly life quality, elderly health policy, long-term care, social work, and health-promotion medical care), five architectural planning scholars (specialized in fields such as urban planning, community planning, environmental planning, architectural planning, and environmental

behavior), and seven disaster management scholars (specialized in fields such as disaster management, community disaster prevention, disaster sociology, and environmental management). The questionnaire was distributed on October 7, 2019 and returned on October 22, 2019; a total of 14 questionnaires were collected. The consistency index (C.I.) was calculated for the collected questionnaires to ensure the consistency of evaluations and judgments in pairwise comparisons. A C.I. of 0 indicates complete consistency between interviewees' judgments before and after; furthermore, C.I. $\leq$ 0.1 is usually used as the range of tolerable error, and such a value indicates the questionnaire is valid (Saaty, 1977), whereas C.I. > 0.1 should be removed. Questionnaire consistency analysis revealed that we had 18 valid questionnaires (C.I. $\leq$ 0.1) and a questionnaire return rate of 100%. Subsequently, we used the Expert Choice software package (Expert Choice Inc., Arlington, VA, USA) to make a pairwise comparison matrix as well as to find the maximum eigenvalue and weight vector in this matrix.

4.2.1 Analysis of the Weight of Indicators at Each Level

Table 3 presents the calculation results of each dimension and indicator. In the hierarchy of the main target dimension, "IV Safety" has the highest level of importance (0.374), followed by dimensions with lower weights, which in descending order are "II Health" (0.25), "III Accessibility," (0.139), "V Adaptability" (0.122), and "I Social responsibility" (0.115). This indicated that environmental safety is the top priority of intergenerational communities, and the second priority is health care for community residents. This finding is consistent with the results of Wang and Tsai (2015)—the architectural and community planning of intergenerational sustainable communities should focus on the safety management and health care of the elderly. The priority indicators of the five dimensions are introduced in the following subsections.

1. **Evaluating indicators of the "I Social responsibility" dimension.**

"I-5 Intergenerational community mutual support" (0.245) and "I-8 Provision of educational and job opportunities" (0.145) were employed as the top and second priorities, respectively. Elderly people must increase their opportunities to interact with others (Powell et al., 1976) and maintain a wide range of social activities in which they participate (Peace & Holland, 2001). Intergenerational communities also aim to build intergenerational connections (Generations United, 2016) and create an environment that facilitates people of all age groups helping and supporting each other (Generations United, 2012). Through introducing community elderly people into school curriculum design, elderly people's sense of isolation can be reduced, and furthermore, students' learning motivation and academic achievements can be improved. These positive outcomes have become some of most crucial benefits of promoting intergenerational communities in the United States (Henkin et al., 2012). Therefore, to build an intergenerational community that considers disaster resilience and sustainable development, one should first strengthen intergenerational communication and interaction on the basis of environmental safety and increase educational and job opportunities.

2. **Evaluating indicators of the "II Health" dimension.**

“II-7 Provision of health-care services” (0.351) and “II-5 Environmental and ecological maintenance and management” (0.164) were employed as the top and second priorities, respectively. Most elderly people live in elderly housing for the medical service and life care (Liao, 2008); Handy (2013) observed that intergenerational housing combined with innovative health-care services can reduce social medical costs. For sustainable community development, ecology is not only one of the five main dimensions (Chiang & Chang, 2014); ecology and the environmental landscape play the most crucial roles in the construction of sustainable communities (Wu, 2007). In addition, Ewing (1996) and Calthrope (1993) asserted that design models that respect nature should be introduced to sustainable community design, and ecological corridors and reserved areas should be implemented. Therefore, if an intergenerational community can provide health-care services and strengthen its management of environmental and ecological maintenance, the overall sustainability of the community and society can be improved.

3. **Evaluating indicators of the “III Accessibility” dimension.**

“III-4 Walkability” (0.464) and “III-2 Proximity to existing public facilities” (0.217) were employed as the top and second priorities, respectively. Layard et al. (2001) proposed that the distance between houses and social facilities such as schools, open spaces, health centers, and local shops should be shortened. This could reduce the need for long-distance transportation, encourage people to use mass transit systems, and reduce their possession and use of private vehicles. Scarfo (2011) observed that a mixed-use, pedestrian-friendly, and intergenerational construction environment can promote sustainable and elderly-friendly lifestyles as well as reduce energy consumption and greenhouse gas emissions. This in turn provides the opportunity to preserve local water resources and maintain universal health. Therefore, the community should improve the connectivity between its residents and public facilities through comprehensive planning. Specifically, public facilities and services (e.g., schools, kindergartens, and clinics) that are suitable for different age groups in the community can be added and a walkable environment can be created.

4. **Evaluating indicators of the “IV Safety” dimension.**

“IV-5 Construction of community disaster management mechanisms” (0.342) and “IV-4 Promotion of a community support team plan (0.264)” were employed as the top and second priorities, respectively. In the HFA, disaster resilience at the national and community levels was listed as the top goal of international disaster reduction; furthermore, the promotion of community participation and disaster reduction, strengthening of community disaster-coping capacity, and formation of community disaster resilience were listed as the main points of safety action (UNISDR, 2005). This clearly indicates the importance of creating a community disaster management mechanism. However, effective risk communication that improves the community’s disaster risk awareness and strengthens its ability to prepare and respond should be developed as characteristics of the composition of an intergenerational community. More crucially, intergenerational communication and understanding should be strengthened to build mutual recognition and a consensus. The younger generation, with their stronger physical strength and abilities, can provide assistance to elderly people with declining ability, as well as investigate

appropriate coping plans and methods for potential situations when a disaster occurs. Moreover, factors that result in disasters should be considered in the design, use, and sharing of processes that govern the appropriate spaces of communities.

5. **Evaluating indicators of the “V Adaptability” dimension.**

We employed “V-2 Shared governance” (0.542) and “V-1 Adaptable spatial design” (0.458) as the top and second priorities, but the difference between the two was nonsignificant. The promotion of disaster-resilient communities requires community residents’ participation to strengthen the community’s voluntary willingness; additionally, sufficient training should be provided to motivate people to volunteer for disaster reduction. If the general public participates, then this can increase their awareness and change their attitudes toward public affairs (Macnaghten et al., 1995). As previously mentioned, town transformation actions in the United Kingdom have built residents’ sense of place and sense of ownership through educational training. This encourages residents to develop from an individual level to community level, and thus exert their power to make changes. Therefore, a community’s sustainable development and disaster resilience must be built on the recognition and input of its residents. Shared governance and adaptable space design are achieved through autonomous resident management and architectural design, which enable community residents to determine their use of space and create autonomy, control, and sense of place.

Table 3 Weight and ranking of each indicator

Dimension	Weight	Priority	Scale	Indictor	Weight	Priority
I Social responsibility	0.115	5	Community life unit	I-1 Spatial classification of public and private areas	0.070	8
				I-2 Spatial design of internal and external spaces	0.092	6
				I-3 Externalization of home functions	0.080	7
				I-4 Efficient design	0.127	3
			Environmental and social economics	I-5 Intergenerational community mutual support	0.245	1
				I-6 Establishment, preservation, and inheritance of local culture	0.116	5
				I-7 Establishment of partnerships with external parties	0.125	4
				I-8 Provision of educational and job opportunities	0.145	2
II Health	0.25	2	Community life unit	II-1 Incomplete spatial design with open functions	0.082	6
				II-2 Integration of art aesthetics into design	0.059	7
				II-3 Energy conservation/ green energy use	0.106	5
			Environmental and social economics	II-4 Communication and information exchange	0.131	3
				II-5 Environmental and ecological maintenance and management	0.164	2
				II-6 Construction of green consumer chains	0.107	4
				II-7 Provision of health-care services	0.351	1
III	0.139	3	Community life unit	III-1 Low-rise and high-density neighborhood	0.132	4

Dimension	Weight	Priority	Scale	Indictor	Weight	Priority
Accessibility			Environmental and social economics	III-2 Proximity to existing public facilities	0.217	2
				III-3 Mass transit system connections	0.187	3
				III-4 Walkability	0.464	1
IV Safety	0.374	1	Community life unit	IV-1 Universal design	0.117	4
				IV-2 Emergency notification system	0.206	3
			Environmental and social economics	IV-3 Effective use of idle space/land	0.070	5
				IV-4 Promotion of community support team plans	0.264	2
				IV-5 Construction of community disaster management mechanism	0.342	1
V Adaptability	0.122	4	Community life unit	V-1 Adaptable space design	0.458	2
			Environmental and social economics	V-2 Shared governance	0.542	1

Source: Organized by this study

4.2.2 Weight Analysis of the Overall Structure

Figure 2 shows the absolute weight of each indicator. The weights of the following three indicators were higher than 0.08: “IV-5 Construction of community disaster management mechanisms” (0.128), “IV-4 Promotion of a community support team” (0.099), and “II-7 Provision of health-care services” (0.088). The weights of the following four items were between 0.05 and 0.08: “-2 Emergency reporting system” (0.077), “-2 Shared governance” (0.066), “-4 Walkability” (0.0650), and “-1 Adaptable space design” (0.056). Among the seven aforementioned indicators, three, two, one, and one were in the safety, adaptability, accessibility, and health dimensions, respectively. The adaptability dimension and safety dimension complemented each other. The development of community residents’ sense of identity and attachment can be used as the basis for building a community disaster management mechanism. This finding reveals key factors for constructing an intergenerational collective disaster-resilient community.

The priority is to build communities' resilience to disasters; furthermore, a community living unit scale should be included in the design of adaptable space. Additionally, more emergency reporting systems should be installed in households. In terms of environmental and social economics, the construction of community disaster management systems, promotion of a community support plan, and foundation for creating resilient communities are conducted from a foundation of the shared governance of space. Second, a community health and medical service system should be established to strengthen the construction of the community's overall walking environment to cater for the needs of elderly people.

The indicators with the lowest weight were "I-1 Spatial classification of public and private areas" (0.008), "I-3 Externalization of home functions" (0.009), and "I-2 Spatial design of internal and external spaces" (0.011). The purpose behind the spatial classification of public and private areas and the spatial design of internal and external spaces is to clearly define personal and private space and public areas. Furthermore, the goal is to ensure residents' safety and prevent their isolation as well as the invasion of their privacy. These findings highlight cultural differences between the East and West because privacy is clearly less emphasized in Taiwan. The externalization of home functions is a design concept developed to increase the affordability of housing and strengthen interactions between residents. The major goal behind developing an elderly collective housing model is to provide mutual care and reduce care costs, thereby reducing their economic burden and enhancing community residents' sense of safety. Our results suggested that affordability is relatively unimportant.

5. Conclusion And Recommendations

Low birth rates and aging populations are common social-development trends and problems in developed countries. The housing model of the future is gradually shifting to intergenerational collective housing, which connects different age groups. A literature review revealed that the planning and design factors of an intergenerational collective community mainly emphasize spatial design having to consider the mobility and differing needs of different age groups; however, appropriate planning through community activities is more crucial to an intergenerational community. Appropriate planning can promote intergenerational exchange and satisfy the basic safety, health, education, and living needs of all age groups.

Intergenerational collective communities are still a new topic. This study constructed five major dimensions and 26 indicators for an intergenerational disaster-resilient community planning indicator system. Our results suggested the key factors for an intergenerational disaster-resilient collective community; the most crucial was the construction of community safety mechanisms, followed by care for residents' physical and mental health. Relatively crucial evaluation indicators in each dimension were indicators of environmental and social economics, and are listed as follows: (1) Intergenerational interaction and provision of educational and job opportunities under the social responsibility dimension; (2) provision of health-care services and environmental and ecological maintenance and management under the health dimension; (3) walkability and adjacent existing public facilities under the accessibility dimension; (4) construction of community disaster management mechanisms and promotion of a

community support team plan under the safety dimension; and (5) shared governance under the adaptability dimension. For an intergenerational community, the importance of rebuilding the overall social interaction and economic model, as well as the creation, maintenance, and management of sustainable environment, are significantly more important than the architectural planning and design of community living units. Therefore, a community atmosphere characterized by friendly communication and interactions between people should be created or designed. Through this process, each individuals' psychological, living, and economic needs are satisfied. Under this foundations, only the establishment of community disaster management awareness and mechanisms is sufficient to support the community toward sustainable development.

In this study, the content of the constructed indicators focused on principle indicators, and some were correlated. We recommend that more detailed and specific index levels are developed in the future to enhance the reference value and applicability of the indicator content. Additionally, when calculating the indicator weights, future studies can conduct further analysis by adding the analytic network process, which incorporates feedback and dependence relationships into the matrix. The goal is to more accurately reflect the complicated interactions between indicators. Additionally, researchers can seek to comprehend the development process of the community as well as provide feedback to the indicator structure and content to improve the accuracy and applicability of the indicator system through case analysis.

6. Declarations

Funding (This work was supported by the Ministry of Science and Technology [Grant number MOST 107-2625-M-130 -001], Taiwan)

Conflicts of interest/Competing interests (Not applicable)

Availability of data and material (Not applicable)

Code availability (Not applicable)

Ethics approval (Not applicable)

Consent to participate (Not applicable)

Consent for publication (Not applicable)

Acknowledgements

The author would like to thank the anonymous reviewers and the editor for their comments. Funding: This work was supported by the Ministry of Science and Technology [Grant number MOST 107-2625-M-130 -001], Taiwan

7. References

1. Black, S. (2014). Typological grids - Sustaining the familiar through the full cycle of life. In E. Feddersen & I. Lüdtke (Eds.), *Lost in space* (pp.102-105). Basel, Switzerland: Birkhäuser.
2. Calthrope, P. (1993). *The Next American Metropolis: Ecology, Community and the American Dream*. New York, USA: Princeton Architectural Press Inc.
3. Chen, C.-J. (2017). *The Research of Housing and Nursing Scheme for Taiwanese Senior Citizen – A Case Study of Cohousing Type* (Unpublished Master's thesis). Department of Interior Design, Chung Yuan Christian University, Taoyuan City, Taiwan. (in Chinese)
4. Chiang, T.-S., & Chang, L.-Y. (2014). Sustainable Community Indicators System-Building of Governance Capacity. *Taiwan Democracy Quarterly, 11*(4), 37-83. (in Chinese)
5. Cohen, G. D. (2005). *The mature mind: The positive power of the aging brain*. Cambridge. MA: Basic Books.
6. Delbecq, A. L., Van de Ven, A. H., & Gustafson, D. H. (1975). *Group techniques for program planning: A guide to nominal group and delphi processes*. Chicago, NJ: Scott. Foresman and Company.
7. Department of Statistics, Ministry of the Interior (2006). *Report of the Senior Citizen Condition Survey 2005, Republic of China*. Taipei: Ministry of the Interior, Taiwan. (in Chinese)
8. Dhaliwal, J.S., & Tung, L.L., (2000). Using group support systems for developing a knowledge-based explanation facility. *International Journal of Information Management, 20*(2), 131.
9. Epimakhova, T. (2016). *Designing for Multigenerational Community: Creating a Supportive Environment for Young and Old in the U.S.A.* (Master's thesis). Retrieved from https://tigerprints.clemson.edu/all_theses/2411
10. Ewing, R. (1996). *Best Development Practices*. Chicago, IL: American Planning Association Press.
11. Geis, D.E. (2000). By Design: The Disaster Resistant and Quality-of-Life Community. *Natural Hazards Review, August*, 151-160.
12. Generations United (2012). *America's Best Intergenerational Communities - Building Livable Communities for Children, Youth, Families and Older Adults*. Washington, DC: Generations United.
13. Generations United (2016). *Creating An Age-Advantaged Community: A Toolkit for Building Intergenerational Communities that Recognize, Engage, and Support All Ages.* Washington, DC: Generations United.
14. Haider, J., & Kaplan, M. (2004). Reclaiming open space for the young: An intergenerational perspective on design. In *Proceedings of the Open Space: People Space-an International Conference on Inclusive Environments* (pp. 171–176). Edinburgh, Scotland: Edinburgh College of Art, OPENspace.
15. Handy, J. (2013). What role can senior housing play in care transitions?. *Generations, 36*(4), 102-104.
16. Henkin, N., Brown, C., & Leiderman, S. (2012). *Intergenerational Community Building: Lessons Learned*. Philadelphia, PA: The Intergenerational Center, Temple University.

17. Holden, M. C., & Wedman, J. F. (1993). Future issues of computer-mediated communication: The results of a Delphi study. *Educational Technology Research and Development, 41*(4), 5-24.
18. Hopkins, R. J. (2010). *Localisation and resilience at the local level: the case of Transition Town Totnes* (Devon, U) (Unpublished Doctoral dissertation). University of Plymouth, Plymouth, UK.
19. Izuhara, M. (2000). *Family Change and Housing in Post-War Japanese Society: The Experiences of Older Women*. Aldershot, UK: Ashgate Publishing Ltd.
20. Jones, A., Tilse, C., Bartlett, H., & Stimson, R. (2008). *Integrated housing, support and care for people in later life*. Melbourne, Australia: Australian Housing and Urban Research Institute.
21. Khorramshahgol, R., & Moustakis, V. S. (1988). Delphi hierarchy process (DHP): A method for priority setting derived from the delphi method and analytic hierarchy process. *European Journal of Operational Research, 37*, 347-354.
22. Krings-Heckemeier, M.-T. (2009). New forms of living for the elderly. In E. Feddersen & I. Lüdtke (Eds.), *Living for the Elderly* (pp.22-25). Basel, Switzerland: Birkhäuser.
23. Larkin, E., Kaplan, M. S., & Rushton, S. (2010). Designing Brain Healthy Environments for Intergenerational Programs. *Journal of Intergenerational Relationships, 8*, 161-176.
24. Lavell, A. (ed.) (1994). *Viviendo en Riesgo: Comunidades Vulnerables y Prevencion de Desastres en America Latina [Living at risk: Vulnerable communities and disaster prevention in Latin America]*. Bogota: LA RED/FLACSO.
25. Layard, A., Davoidi, S. & Batty, S. (Eds.) (2001). *Planning for a sustainable future*. New York, NY: Spon Press.
26. Liao, C.-C. (2008). *Public Space Planning for Senior Housing An Example of CHANG GUNG SILVER VILLAGE* (Unpublished Master's thesis). Department of Land Economics, National Chengchi University, Taipei City, Taiwan. (in Chinese)
27. Macnaghten, P., Grove-White, R., Jacobs, M., & Wynne, B. (1995). *Public perceptions and sustainability in Lancashire: indicators, institutions, participation*. Centre for the study of environmental change (Technical Report). Retrieved from https://reurl.cc/yyYdll
28. Murry, J. W., & Hammons, J. O. (1995). Delphi: A versatile methodology for conducting qualitative research. *The Review of Higher Education, 18*(4), 423-436.
29. Nicholson, S. (1971). How not to cheat children: The theory of loose parts. *Landscape Architecture, 62*(1), 30-34.
30. Peace, S. M. & Holland, C. (2001). *Inclusive housing in an ageing society: Innovative approaches*. Bristol, UK: The Policy Press.
31. Powell, L. M., Newcomer, R. J. & Byerts, T. O. (1976). *Community planning for an aging society: Designing services and facilities*. Stroudsburg, PA: Dowden, Hutchington & Ross, Inc.
32. Rowe, G., & Wright, G. (1999). The Delphi technique as a forcasting tool: Issues and analysis. *International Journal of Forecasting, 15*, 353-375.

33. Saaty, T. (1977). A scaling method for priorities in hierarchical structures. *Journal of mathematical psychology, 15*(30), 234-281.
34. Sangregorio, I.-L. (2000). *Collaborative Housing in Sweden*. Stockhholm, Sweden: Byggforskningsradet.
35. Scarfo, B. (2011). Building a more sustainable future for senior living. *Educational Gerontology*, (37), 466-487.
36. Sucher, D. (2003). *City Comforts: How to Build an Urban Village*. Seattle, WA: City Comforts Inc.
37. UNISDR (2005). *Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters*. Retrieved from https://www.unisdr.org/files/1037_finalreportwcdrchinese1.pdf
38. Vestbro, D. U. (2012, September). *Saving by Sharing-Collective Housing for Sustainable Lifestyles in the Swedish Context*. Paper presented at the 3rd International Conference on Degrowth for Ecological Sustainability and Social Equity, Venice, Italy.
39. Wang, J.-J., & Tsai, N.-Y. (2015). Assessment of Sustainable Planning for Elder-Friendly Community-Taking Eight Elderly Communities as an Example. *Journal of Architecture, 90*, 1-21. (in Chinese)
40. World Health Organization (WHO) (2007). Global Age-friendly Cities: A Guide. Geneva, Switzerland: WHO. Retrieved from https://www.who.int/ageing/publications/Global_age_friendly_cities_Guide_English.pdf
41. Wu, K.-L. (2007). Developing an Evaluation Framework for Community Empowerment from the Viewpoint of Sustainable Communities: A Study on the Experiences of Tainan City and Tainan County. *Journal of Housing Studies, 16*(1), 21-55. (in Chinese)
42. Zahedi, F. (1986). The Analytic Hierarchy Process A Survey of the Method and Its Applications. *Interfaces, 16*(4), 96-108.

Figures

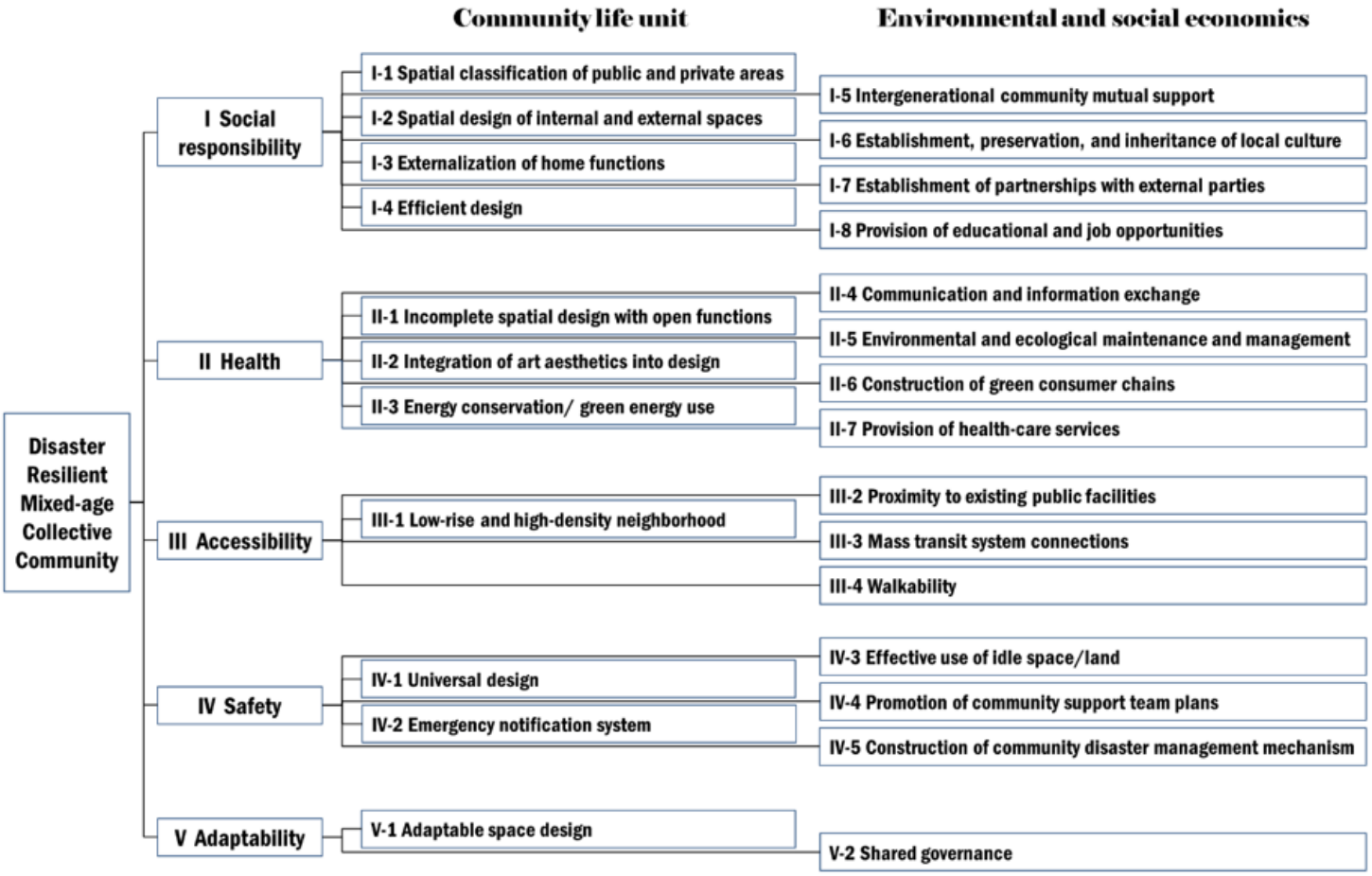

Figure 1

Structure of intergenerational disaster-resilient community planning indicators

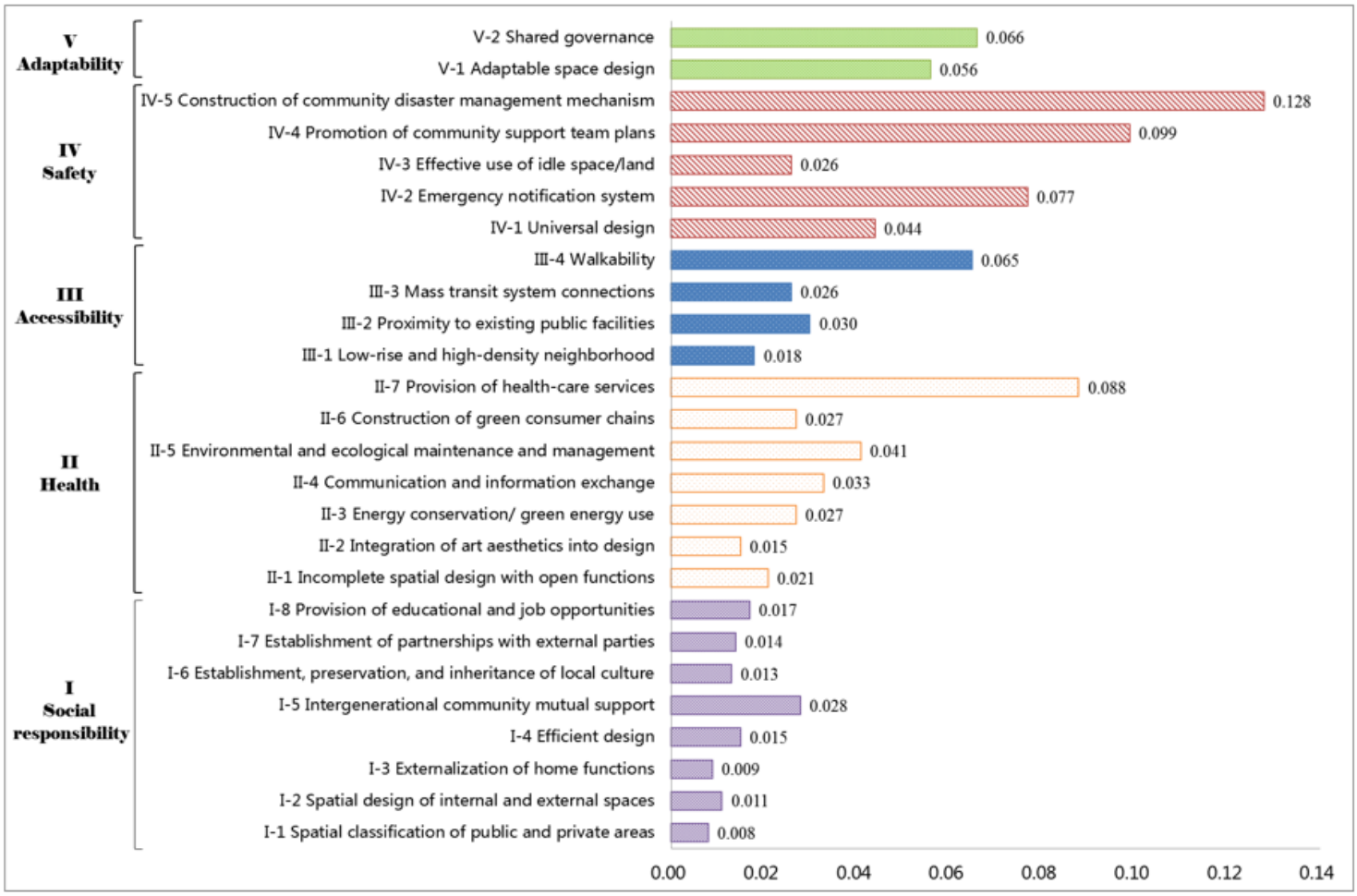

Figure 2

Absolute weight value of each indicator index Data source: Designed by this study