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Recognition Changes of the Concept of Urban Resilience: Moderating Effects of COVID-19 Pandemic

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Abstract: Urban resilience, which has emerged as an important concept in cities since sustainability became a 21st-century urban paradigm, reflects the needs of the times to change and bring about a shift in existing national landscape architecture and social policies. To explore the characteristics of recognition of college students majoring in landscape architecture towards the concept of urban resilience before and after the beginning of COVID-19, this study aims to answer three research questions: to analyzes recognitions of landscape architecture majoring students on urban resilience (research question 1); to compare the differences that emerge from before and after the beginning of the COVID-19 pandemic (research question 2); and to explore latent classes according to the education pattern (research question 3). The results of this study are as follows: First, before the beginning of COVID-19, four latent classes were drawn up in relation to awareness of the concept of urban resilience, while three latent classes were examined after the start of the pandemic. Before the beginning of COVID-19, students of landscape architecture accepted the concept of urban resilience as a physical and environmental approach to overcome risk factors by creating landscape architecture and infrastructure or applying the concept of resilience in urban development and redevelopment. However, after the beginning of COVID-19, they mostly have been recognized urban resilience as a concept related to technological ability. Thirdly, the grades and educational experiences of the students were found to have a significant effect on the probability of their belonging to a specific latent class.

Keywords: urban resilience; sustainability; landscape architecture; recognition; COVID-19

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1. Introduction

As the media and scholars have already pointed out, there has been widespread recognition that COVID-19 pandemic would demand a "New Normal" lifestyle and will completely change the flow of global civilization. During the ongoing COVID-19 outbreak, many measures or practices helped to make cities and communities more resilient [1]. In this context, promoting urban resilience in relation to environmental, socioeconomic and political domains has increasingly attracted the attention of researchers and local authorities [1–3].

The term 'resilience', which traces its etymology back to the Latin word 'resilio', carries the meaning of 'to jump back', 'to rebound', and 'to recoil', so its meaning as found in the dictionary can be defined as a system's ability to respond to change. The idea of resilience was first discussed in the field of physics, whereby the concept of elasticity and material against external shock was considered [4], but it was in the field of ecology that the academically systematic concept of resilience emerged.

The definition of resilience is a very abstract and complex concept and has been defined in various ways in various studies. Holling [5], an ecologist, argued that the social ecosystem had an 'adaptive Renewal Cycle' consisting of four levels of systems: R-Phase, K-Phase, Ω-Phase, and A-Phase. Since then, it has been defined in various manners by different fields and researchers. In education, psychology and medicine, the concept of resilience is used to mean an individual level of resilience [6–8], i.e., the individual's ability to overcome crises and adversity and return to their previous state. In the field of management, the concept of resilience is defined as the ability to anticipate and adapt to environmental trends that could seriously harm companies beyond overcoming crises and failures [9]. In the field of disaster prevention, resilience is usually characterized as the ability to absorb and recover from disasters [10]. Walker and Salt [11] defined resilience as the ability of a system to absorb confusion and maintain basic functions and structures. Folke [12] defined resilience in the fields of engineering, ecology and social ecology. Engineering resilience means restoring a construction to its previous growth path in pursuit of a stable balance, while ecological resilience is a phenomenon that deviates from the path of all stages after the impact and has a low level of long-term balance or improved growth path. The concept of social–ecological resilience refers to a composite adaptation by feedback and interaction with an integrated system of people, society and nature.

Before the concept of urban resilience gained attention among scholars, since the 1970s, the concept of sustainability had been focused mainly on the extent to which environmental pollution concerns require changes in landscape and policy factors. However, since the 2000s, the level at which environmental destruction threatens the global risk limit has reached a point where systemwide change is required [13]. In the process of discussing specific ways to pursue sustainability, researchers began to study the concept of urban resilience, which has mainly been used in the fields of ecology and medicine, economics and urban areas. The urban-related resilience research was conducted in the fields of urban ecology [5,14], disaster prevention and policy areas [15–18], regional development areas [19–22], and urban regeneration [23–25]. On the other hand, new urban theories such as Urban Metabolism, Agropolis, City for Adaptation to Climate Change, Transition Town and Biophilic City are emerging. Although the term 'regional and urban resilience' began to be used in the early 2000s, it is still undergoing changes in its application and stages of adaptation, as the research fields to which it relates are still expanding [26].

In particular, in the field of landscape architecture, the concept of urban resilience has not received much attention compared to in other related fields, such as urban planning and environmental planning. The field of landscape architecture is closely related to improving the health and welfare of the people, revitalizing the city and improving the urban living environment. Despite the fact that discussions of landscape architecture academia require education on urban resilience, related research has not been actively carried out. Moreover, in the landscape architecture field, the definition of urban resilience, as well as specific educational goals and pedagogies are unclear.

At this point in time, when the concept of urban resilience is being emphasized due to the COVID-19 pandemic, it is time to prepare a clear urban resilience education policy for each field. In the case of education for sustainable development (ESD), there are precise guidelines. ESD started in earnest after the definition of sustainable development was established by the United Nations in 1987 as an education to improve problem-solving ability on various topics of sustainable development, to form a positive attitude, and to lead eco-friendly actions. In 1992, 'Agenda 21', which emphasized the implementation of sustainable development at the global level, emphasized the need for ESD, and in 2002, the 'World Summit for Sustainable Development (WSSD)' held the 'ESD Decade' (Decade of ESD, 2005–2014) was declared and the practice of sustainable development through education was specified. Countries around the world have developed and implemented educational courses related to the subject of sustainable development for students and the general public. ESD emphasizes practical actions along with improvement of related knowledge and changes in attitude, viewing human beings as being the key actors in achieving sustainable development. In order to achieve this educational purpose, a study was conducted on the knowledge level, attitude, and behavior of students and teachers of various majors on various topics related to sustainable development. Based on this, a plan to effectively implement education for sustainable development was proposed [27–29]. Thus, to grasp the current pedagogical situation and the directions that might be taken in future, research on students' attitudes and awareness is most significant. However, no research related to the attitudes towards the concept of the urban resilience has been conducted.

How do college students who major in landscape architecture understand the concept of urban resilience? How has it changed since the start of the COVID-19 pandemic? How are the characteristics of latent classes different according to educational patterns? These questions are of great social significance in that they can serve as a basis for predicting the direction of decision making and policy decisions related to the environmental industry, as well as academic needs, to address educational curiosity after the beginning of COVID-19 pandemic.

To answer this question, this study used a Latent Class Analysis (LCA) method. This is an analytical method of discovering potential classes based on individuals' response types to a series of observations. The awareness and attitudes of a group is related to successful collaboration [30]. Awareness and attitudes include cognitive, emotional, and behavioral factors, and are acquired through the repetition of direct experiences or learning. By comparing results from before and after the beginning of the COVID-19 pandemic, this study aims to explore how the pandemic has influenced the recognition of the concept of urban resilience by students majoring in landscape architecture.

2. Urban Sustainability and Resilience

The concept of resilience is closely related to sustainability, but it does not have an exact meaning and is often used as an additional label attached to existing research [31,32]. It is often said that the city is comparable to an organism, as each element has its own functions and roles, and changes by adapting to internal and external changes in the course of its creation, development and extinction. In terms of urban ecology, the city's survival lies moving, responding to change and adapting, and in order for the city to last, there must be resilience. Recently, the U.N. Sustainable Development Goals [33], the UN Human Settlements Conference (Habitat III) [34], and the UN Disaster Relief International Strategic Organization [35] have also adopted the concept of the city's resilience. OECD [36] defined resilience as "the ability to absorb, recover and adapt to the effects of economic, environmental, social shock or chronic pressure for sustainable development and welfare and comprehensive growth". It disproves the need for resilience as part of its guiding role and efforts regarding what the city should continue to maintain and provide on its current basis. In order to understand and respond to various environments and variables surrounding modern cities, various measures are needed to introduce internal and external changes and crises, along with various concepts that used to make up existing cities and to link these to the concept of resilience [37–40].

Sievers [41] understood resilience at the characteristic level and said, "resilience is considered part of sustainability, but even so, sustainability is not necessarily on the premise of resilience". This is because the needs of current and future generations cannot be guaranteed unless there is a productive balance between the goals of each component of sustainability, with the basic condition that the core of sustainability exists within a limited space or resource. The term "resilience" first appeared in urban-related research when the city's sustainability was discussed is Vale and Campanella [42]'s presentation of a colloquium held in MIT. Since then, related research has continued in Australia and Germany, drawing attention as a future urban model, and follow-up research is now underway. Already used in the engineering, medical and disaster prevention fields, the concept of resilience is being applied to cities to understand how they expand and develop. The purpose of research aiming to apply the concept of resilience to cities is to find ways to protect the urban ecology system according to urbanization, link the ecological system with the urban system, and restore resilience.

The concept of urban resilience, due to frequent and extended weather and disasters worldwide, should comprehensively consider regional capabilities, including not only physical but also social and economic factors [17,43], and the concept of urban resilience in consideration of prevention and response recovery capabilities should be applied to landscape architecture [44]. The study on studies of resilience began with Holling [5] and attempts that were made by Walker and Salt [11] to specify how to apply it to real cities, while Kegler (2014) developed the resilience theory in the spatial domain. In addition, research on the concepts of resilience, development and the evaluation of indicators is being conducted at ARUP [45], UNISDR [44], ADB [46], and the Stockholm Resilience Center [47].

Resilience research is conducted on a wide range of subjects within the fields of urban, landscape and ecology. Among them, most of the research is being conducted in the fields of disaster, ecology, and crisis management [48–51]. Research related to urban resilience has been actively conducted in recent years on a range of subjects including urban sustainability and resilience studies [52–54], urban regeneration projects and urban resilience diagnosis [55,56], regional resilience diagnosis studies applying the concept of resilience [49,57], studies on the resilience of communities through the application of theory [58,59], development of evaluation criteria for the introduction of the resilient city model, and analysis of applicability [60–62]. The existing research mainly focuses on diagnosing the resilience construction process of urban regeneration projects, regional resilience, and low-rise residential communities through the concept of resilience.

Urban resilience during the COVID-19 pandemic has been primarily impacted by five factors: (1) medical services and essential facilities; (2) mobility and transportation networks, which have greatly contributed to the spread of diseases between communities and cities; (3) immediate and continuous health and socioeconomic impacts; (4) social services to maintain welfare of poor and low-income families; (5) lack of preparedness and late attempts to control the outbreak [1]. Moglia et al. [63] identified seven lessons for accelerating a green recovery of cites from the COVID-19 pandemic: (1) the need to transform urban mobility; (2) the need to provide an urban form that promotes public benefits; (3) the provision of more green commons/public land; (4) the need to build resilient supply chains and greater resource efficiency; (5) the need for improved ICT infrastructure; (6) the need for multilevel and coordinated governance; and (7) considerations of equity and vulnerabilities.

In case of the concept of sustainability, to achieve educational goals, studies on the level of knowledge, attitudes, and behaviors on various topics of sustainable development were conducted to assess various groups' recognitions of the concept of sustainable development [64,65]; in addition, studies on attitudes to the relationship between the environment and the economy [65–67], and research on the awareness of sustainable development [23] are continuously being conducted. Comparing the study of Choi et al. [65] who surveyed the attitudes of prospective teachers on sustainable development and a study of Jaegal et al. [66], who studied the attitudes of citizens to sustainable development, these two studies used different methods, but they similarly examined sustainable development through the relationship of 'economic' and 'environment' variables. On the other hand, there has been no research on students' attitudes or perceptions of education relating to urban resilience. Education about urban resilience regards human beings as the key actors in achieving sustainable development, and emphasizes practical action along with the improvement of related knowledge and attitudinal change.

3. Methods

3.1. Latent Class Analysis (LCA)

Decision-making related to the planning process should be viewed as part of a larger socio-economic system and the resulting economic, social and environmental impacts should be analyzed in an integrated manner. Therefore, when it is necessary to make a decision to select an optimal alternative, there are many studies that have adopted a Multiple-Criteria Decision Analysis method (MCDA) [68–70]. This is a method of selecting an alternative through a compromise between the conflicting criteria when a plurality of conflicting criteria exists. Among them, Analytic Hierarchy Process (AHP) is the most widely applied method among MCDA. This is because the analysis process is simple and it is easy to obtain the preference information of the decision maker by making a pairwise comparison in the process of evaluating the importance of factors or alternatives [71–73]. However, this method has difficulty in categorizing the types of recognition for a specific concept, as there are limitations to the understanding that can be gained about the overall recognition type through the analysis of an individual questionnaire. LCA can be used as an alternative method to compensate for these limitations. The latent group analysis method is an analysis method that discovers latent classes based on individual response types to a set of observation variables.

LCA is a type of potential variable model that assumes that the observed distribution consists of a mixture of two or more underlying distributions, and is a method of discovering potential classes based on individuals' response types to a series of observations [74]. Although subclasses, types, and categories exist within the group to be studied, the latent class distinguished by the latent variable unique to each individual is not revealed because it cannot be directly observed. In this context, the analysis method designed to discover and classify the potential group is the latent class analysis [75–77]. LCA has the advantage of being an observational-centric method of analysis that does not simply verify relationships between observations, but rather identifies combinations of relationships found within individuals or classes based on similar patterns between characteristics that people have.

LCA estimates the class membership probability of the class and the conditional question-specific response probability according to the class membership. The membership probability of a potential class means the probability of belonging to a latent class, and the probability of a conditional question-by-question response by class membership indicates the degree of agreement between the observed item and the potential type. Uncertain estimates of potential collective analysis use a maximum likelihood verification method using EM (extraction-maximization), during which missing values are assumed to be MAR (missing at random) [75].

3.2. Participant

In order to analyze the latent class of landscape architecture college students on the concept of the urban resilience, students from seven universities located in Seoul, Korea, were selected for the survey. In South Korea, most of major universities are located in Seoul. Among them, students from the universities which have landscape architecture department were chosen. Table 1 illustrates the distribution of gender, grade, contact experience with urban resilience terms, and whether or not resilience education has been experienced in the universities.

In the case of before the beginning of COVID-19 pandemic, of the 523 questionnaires, only 511 copies were selected for analysis, excluding those that responded insincerely. The survey was conducted for four weeks from October to November 2018. The study included 300 male and 211 female students. By age, 19 people were under 19 years of age, 459 between 20 and 24 years of age, 30 between 25 and 29 years of age and three over 30 years of age, with the largest proportion being those aged between 20 and 24. By university grade, the first grade participated the most, with 168 in the first grade, 115 in the second grade, 121 in the third grade and 107 in the fourth grade. Comparing experiences encountered with the term "Urban Resilience", 38.6 percent said they had "experience", while 61.4 percent said they had "no experience". A survey of respondents who responded that they had been in contact with terminology on the contact path was also conducted. As a result, there was a high rate of contact during regular classes, such as middle and high school class (7.1%) and university lectures (48.2%), and 40.1% of experienced respondents had encountered the term through media such as newspapers, broadcasting, the internet, and books. In addition, about 29.5% of all respondents had experience in EUR (Education for Urban Resilience) at universities.

Table 1. Distributions of participants.

		Before the Beginning of COVID-19		After the Beginning of COVID-19	
	Sortation	**Frequency (Number)**	**Percentage (%)**	**Frequency (Number)**	**Percentage (%)**
Gender	Male	300	58.7	384	66.3
	Female	211	41.3	177	33.7
Age	~19	19	3.7	50	9.5
	20~24	459	89.8	467	89.0
	25~29	30	5.8	50	9.5
	Over 30	3	0.6	4	0.8
Grade	1 (Freshman)	168	32.9	123	23.4
	2 (Sophomore)	115	22.5	128	24.4
	3 (Junior)	121	23.7	176	33.5
	4 (Senior)	107	21	98	18.7
Learning about Resilience Terminology	Exist	197	38.6	424	80.8
	None	314	61.4	95	19.1
Route to Learning Resilience Terminology	Middle and High School Class	14	7.1	17	4.0
	University lecture	95	48.2	323	76.1
	Media (newspapers and broadcasting)	30	15.2	22	5.2
	Internet	41	21.3	31	7.1
	Books	7	3.6	20	4.7
	Etc.	10	5.1	11	
Experience of EUR	Exist	151	29.5	350	66.7
	None	360	70.5	175	33.3

In the case of students' attitudes after the beginning of the COVID-19 pandemic, the survey was conducted over two weeks from 14 September to 28 September 2020, and a total of 640 sheets were distributed for each grade level, and a total of 532 sheets (83.1%) were collected. Excluding seven questionnaires which did not provide complete answers to each question, a total of 525 copies were used for analysis.

3.3. Variables

This study analyzes the types of latent class on the concept of urban resilience for sustainable cities of college students majoring in landscape architecture, and reveals the differences in the probability of a student belonging to potential class types depending on their grade and experience in urban resilience education. This study analyzes the influence of types of potential classes on the concept of resilience for sustainable cities of college students majoring in landscape architecture, and reveals the differences in the probability of belonging to potential class types depending on grade and experience of sustainable development education. Accordingly, a framework for urban resilience was established as a dependent variable for this study.

If we consider urban areas to function as organisms that operate through their own metabolism, we must then consider that all of the elements within the system are strongly connected. These characteristics are complex, adaptive and emergent ecosystem systems with governance networks, networked material and energy flows, urban infrastructure and form, and socio-economic dynamics as subsystems [14,26]. First, a governance network is responsible for problem solving, adaptation and re-organization of various activity entities and institutions, including governments, NGOs, industries, universities and research centers, and a city where good governance is formed by their smooth network can improve its resiliency. Second, networked materials and energy flows relate the processes of production and consumption taking place in cities to urban metabolism, and the flow of resources and consumption needed for urban residents to lead their lives is associated with the functions of cities and the quality of life of citizens. Third, urban infrastructure and forms include green areas, parks and dry environments such as buildings, transportation networks, and water grids [78]. Fourth, social dynamics consisting of definitions and equality, such as financial capital, demographics and inequality, play a role in determining the livelihood and status of urbanites [14].

This complex and multidimensional urban resilience requires the sharing and interaction of functions and roles between each component and system. As a condition for implementing urban resilience with complex spatiotemporal systems, ARUP [45] illustrated conditions that could provide ways to meet the health, environment, social harmony and wealth requirements of urban citizens, and they presented 4 categories, 12 requirements and 52 resilience indicators. O'Rourke [79] presented the R4 Framework for resilience components and systems, while Jung et al., ref. [80] outlined four categories of redundancy, durability, resourcefulness, and rapidity, considering the redundancy of the concept of urban resilience and the suitability of the landscape architecture. Based on the study of O'Rourke [79], this study summarizes concepts related to urban resilience components and systems and uses them as a dependent variable (Table 2). We formulated 16 questions to measure the dependent variables, and the reliability of the measuring tool was high with a Cronbach's α value of 0.802.

Table 2. Dependent variables.

Variables		Measurement Variables
Redundancy	A variety of infrastructure and resource networks for functional execution	Urban resilience is related to capacity for technical substitutions and "workarounds".
		Urban resilience is related to ability to substitute and conserve needed inputs.
		Urban resilience is related to availability of housing options for disaster victims.
		Urban resilience is related to alternate sites for managing disaster operations.
Robustness	Strength and buffering of the external impact	Urban resilience is related to building codes and construction procedures for new and retrofitted structures.
		Urban resilience is related to extent of regional economic diversification.
		Urban resilience is related to social vulnerability and degree of community preparedness.
		Urban resilience is related to emergency operations planning and private–public cooperation.
Resourcefulness	Ability to mobilize resources and efficient management	Urban resilience is related to availability of equipment and materials for restoration and repair.
		Urban resilience is related to business and industry capacity to improvise and to converge with knowledge-based industries.
		Urban resilience is related to capacity to address human needs and social trust relationship.
		Urban resilience is related to capacity to improvise, innovate, and expand operations.
Rapidity	Ability to recover in quick time	Urban resilience is related to system downtime, restoration time.
		Urban resilience is related to time to regain capacity, lost revenue.
		Urban resilience is related to time to restore lifeline services.
		Urban resilience is related to time between impact and early recovery.

The independent variables selected in this study are academic year and experience of EUR. In order to identify the differences between the class variables corresponding to the categorical variables and the latent class, the multi-logistic regression analysis was conducted, and the grade variables were converted to variable numbers Y1, Y2, Y3. In addition, a class with educational experience was set at 1, and a class with no educational experience was set at 0. The variables selected in this study are summarized in Table 3.

Table 3. Independent variables.

Variables		Measurement Variables
Grade (Variable number of grades, Y1, Y2, Y3 set)	Freshman (1st grade)	1: Y1 = 0, Y2 = 0, Y3 = 0
	Sophomore (2nd grade)	2: Y1 = 1, Y2 = 0, Y3 = 0
	Junior (3rd grade)	3: Y1 = 0, Y2 = 1, Y3 = 0
	Senior (4th grade)	4: Y1 = 0, Y2 = 0, Y3 = 1
Experience of Education for Urban Resilience (EUR)	Exist	Exist: 0
	None	None: 1

3.4. Research Models and Analysis

Latent Class Analysis (LCA) was used as an analysis method to identify the hierarchical type of the class according to the response of the target variables. Potential layer analysis is a non-variable, human-centered approach analysis that classifies homogeneous subclasses based on the response patterns of categorical variables and uses them to analyze differences between classes. The four variables, Redundancy, Robustness, Resourcefulness, and Rapidity, among the urban resilience composition requirements were classified and analyzed by classifying them according to the mean. Using the Archike Information Index (AIC), the Bayesian Information Index (BIC), and the Modified Bayesian Information Index (ABIC), bootstrap likelihood ratio verification (BLRT) and the Ro-Mendel-Ruby likelihood ratio verification (LMR-LRT), the appropriate model fit was determined.

The characteristics of each class, such as post-affiliated probability and response probability, were analyzed and named for the latent class selected through the above process. In addition, in order to identify whether there are differences in the types of perceptions of urban resilience based on educational experience, multi-logistic regression analysis was performed after converting them to a variable number.

Technical statistics to determine the optimal model were used by Likelihood-Ratio G2, Akaike's Information Criticism (AIC), ABIC (Adjusted Bayesian Information Criticism), Entropy, etc. AIC and ABIC are suitable models for lower numbers [75] and are good classifications if the entropy value is close to or exceeds 0.8 [81]. Rather than judging the model fit only for technical statistics, the overall assessment should consider whether the characteristics can be clearly distinguished between the proportions of the classes belonging to each model [75].

4. Results

4.1. Before the Beginning of COVID-19 Pandemic

In case of the prior to the beginning of the COVID-19 pandemic, in order to classify students' attitudes towards the concept of urban resilience, starting from an independent model (one class), the class number was increased one by one, and estimated through the fit of the model. The goodness-of-fit index of each group analyzed is shown in Table 4 below. AIC, BIC, SSA AIC tended to decrease by more than a certain index as the number of classes increased, leading to the three-class model, and the BIC index slightly increased in the four-class model. On the other hand, in the case of the Entropy index, which reflects the accuracy of group classification, the fit of the four-class model is high as it is the closest to 0.8 in the four-class model.

Table 4. Goodness-of-fit analysis of latent class model.

Number of Classes	1 Class Model	2 Class Model	3 Class Model	4 Class Model	5 Class Model
Log-likelihood	−1811.88	−1771.25	−1736.53	−1713.52	−1699.19
AIC	3643.76	3584.51	3537.07	3513.05	3506.38
BIC	3683.11	3667.14	3662.99	3672.25	3718.87
SSA BIC	3651.38	3600.51	3561.46	3545.82	3547.54
Entropy	-	0.55	0.65	0.83	0.72
BLRT (*p*)	-	−1811.88(.00)	−1771.25(.00)	−1736.53(.00)	−1715.53(.01)

saBIC: sample size adjusted Bayesian information criterion, LRT: Lo–Mendell–Rubin test; BLRT.

The probability of class membership and the probability of response by question are shown in Table 5. The names are given by type, considering the characteristics of the probability of response by question according to each class membership.

Table 5. Probability of class membership and item-response for four-classes model.

		Class I	Class II	Class III	Class IV
Probability of latent class membership within class		0.35	0.24	0.22	0.19
Item–response probabilities within each class					
Redundancy	Urban resilience is related to capacity for technical substitutions and "workarounds".	0.96	0.49	0.04	0.54
	Urban resilience is related to ability to substitute and conserve needed inputs.	0.17	0.91	0.68	0.2
	Urban resilience is related to availability of housing options for disaster victims.	0.31	0.25	1.00	0.83
	Urban resilience is related to alternate sites for managing disaster operations.	0.23	0.31	0.88	0.97
Robustness	Urban resilience is related to building codes and construction procedures for new and retrofitted structures.	0.97	1.00	0.76	0.25
	Urban resilience is related to extent of regional economic diversification.	0.35	0.58	0.32	0.02
	Urban resilience is related to social vulnerability and degree of community preparedness.	0.48	0.88	0.76	0.70
	Urban resilience is related to emergency operations planning and private–public cooperation.	0.78	0.66	0.34	0.84
Resourcefulness	Urban resilience is related to availability of equipment and materials for restoration and repair.	1.00	0.94	0.15	0.67
	Urban resilience is related to business and industry capacity to improvise and to converge with knowledge-based industries.	0.73	0.83	0.28	0.59
	Urban resilience is related to capacity to address human needs and social trust relationship.	0.32	0.06	0.35	0.02
	Urban resilience is related to capacity to improvise, innovate, and expand operations.	0.19	0.25	0.10	0.82
Rapidity	Urban resilience is related to system downtime, restoration time.	0.98	0.89	0.18	0.80
	Urban resilience is related to time to regain capacity, lost revenue.	0.83	1.00	0.09	0.58
	Urban resilience is related to time to restore lifeline services.	0.01	0.20	0.23	0.17
	Urban resilience is related to time between impact and early recovery.	0.14	0.25	0.62	1.00

'Class I' had a 100% chance of responding positively to the statement "Urban resilience is related to availability of equipment and materials for restoration and repair". Additionally, 'Class I' showed a higher probability of responding that the concepts of urban resilience were embraced by definitions related to the ability of the physical system, the system's own capabilities, and the linkages and interactions between system components (more than 0.90). Reflecting these characteristics, the type of perception of class I towards the concept of urban resilience was named 'physical and environmental approach-centered'.

'Class II' showed high response rates to questions related to economic capabilities that could mitigate and prevent direct or indirect losses. It is similar to class I in that it has a positive view of landscape architecture and architectural resiliency, with a 100% positive response rate to the item "Urban resilience is dependent to building codes and construction structures". However, it is distinct from class I in that it has a high response rate to questions related to financial support for risk factors and resource allocation. Reflecting this characteristic, Class II was named 'economic perspective-centered'.

'Class III' is interested in questionnaires related to the ability of governments and communities to recover, mitigate and prevent damages. This class has a 100% chance of responding positively to the statement "Urban resiliency is relative to availability of housing options for disaster". Reflecting these characteristics, it was named 'social perspective-centered'.

'Class IV', unlike the previous three classes, accept the concept of urban resilience as functional performance-related systems and organizations, such as key facility management, decision-making and measures. This class has a 100% chance of responding positively to the item of "Urban resilience is relative to time between impact and early recovery" and has an active positive attitude toward items related to the improvement of damage and recovery systems. Although the response rate was low on items related to improvement of local economic vulnerabilities and capacity building, Class III has a distinct characteristic in that it shows interest in improving damage and recovery-related systems. Reflecting these characteristics, Class IV was named as a group with an 'institutional and organizational perspective-centered'.

Comparing the ratios belonging to four types of classes, Class I showed a 35% probability of belonging, Class II showed a 24% probability of belonging. On the other hand, Class III and Class IV were likely to belong to 22% and 19%, respectively (Table 5).

In order to analyze the characteristics of each latent class according to the grade and urban resilience education experience, multiple logistic regression analysis was performed using the grade and sustainable development education experiences as independent variables. Table 6 shows the results of performing multilogistic regression analysis by setting Class IV (system/organization-oriented) as the reference class for analysis. Y1, Y3, and educational experiences corresponding to grade variable were found to have a significant effect on the probability of belonging to a potential class at the $p < 0.001$ level, respectively.

Table 6. Logistic regression coefficient (β) and odds ratio (OR) by variable.

	Class I		**Class II**		**Class III**		**Class IV**	
Variables	β	OR	β	OR	β	OR	β	OR
Y1 ** (Second graders)	−0.41	0.91	1.29	3.64	0.42	1.52	-	OR
Y2 * (Third graders)	1.19	3.29	−0.22	0.81	−3.32	0.04	-	1.00
Y3 ** (Forth Graders)	0.94	2.57	1.78	5.93	6.13	457.50	-	1.00
Experience of EUR **	1.36	4.82	0.47	1.92	3.23	72.49	-	1.00

OR: Odds Ratio, -: reference class * $p < 0.001$ ** $p < 0.0001$.

Comparing the differences between grades, the probability of second graders (Y1 = 1, Y2 = 0, Y3 = 0 and Y3 = 0) belonging to class I is 0.91 times higher than that of first graders

(Y1 = 0, Y2 = 0, Y3 = 0); they are 3.64 times more likely to belong to class II, and 1.52 times more likely to belong to class III. Fourth graders (Y1 = 0, Y2 = 0, Y3 = 1) were more likely to belong to each class than first and second graders. Compared to the first grade, the probability of belonging to class I is 2.57 times higher, class II 5.93 times higher, and class III is 457.50 times higher. Compared to the second grade, class I is 2.82 times higher, class II is 1.63 times higher, and class III is 300.99 times higher.

4.2. After the Beginning of COVID-19 Pandemic

Table 7 shows the goodness-of-fit indices from the independent model to the five-class model. First, the AIC, BIC, and SSA BIC values decreased to the three-class model, and then the BIC value increased in the four-class model, and other goodness-of-fit values also decreased.

Table 7. Goodness-of-fit analysis of latent class model.

Number of Classes	1 Class Model	2 Class Model	3 Class Model	4 Class Model	5 Class Model
Log-likelihood	−1977.19	−1878.59	−1835.34	−1809.42	−1785.96
AIC	3974.39	3799.18	3734.69	3704.84	3679.92
BIC	4013.73	3881.81	3860.61	3874.04	3892.41
SSA BIC	3982.01	3815.18	3759.08	3737.61	3721.080
Entropy	-	0.69	0.75	0.76	0.76
BLRT (*p*)	-	−1977.19(.00)	−1878.59(.00)	−1835.35(.00)	−1804.14(.00)

AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; SSA BIC: adjusted BIC; BLRT: bootstrapped parametric likelihood ratio test.

The entropy value was 0.76 in the four-class model, closer to 0.8 than in the three-class model, so the classification accuracy of the four classes was higher. The tendency of BIC, which is a goodness-of-fit index, shows a tendency to rise again from the four-class model in a pattern that decreases to the three-class model, so it can be judged that the suitability of the three class model is higher on the fitness index.

The probability of class membership and the probability of response by question are shown in Table 8. Comparing the ratios belonging to three types of classes, Class I showed a 49% probability of belonging, Class II showed a 27% probability of belonging. On the other hand, Class III were likely to belong to 22% (Table 8).

'Class I' shows a high response rate for recovery capability, technology, industry, and system readiness. The difference from 'Class I' of before the pandemic started, 'physical and environmental approach-centered', is that this has a high response chance of 92% to 'Urban resilience is related to capacity to address human needs and social trust relationship'. In other words, it can be seen as a class that values social trust as well as technological prowess in the concept of urban resilience. Therefore, this class was named 'Techno-centrism based on social bond', and the proportion was the highest at 49% of the total.

'Class II' is also focused on resourcefulness aspects of the concept of urban resilience overall, while this class recognizes that 'urban resilience is related to emergency operations planning and private–public cooperation', with 98% positive response rate. Reflecting these characteristics, 'Class II' was named 'Techno-centrism based on institutional system'.

'Class III' emphasizes the rapid capability of urban resilience. Members of this class also show high response rates to questionnaire related to readiness such as 'Urban resilience is related to capacity for technical substitutions and 'workarounds' and 'Urban resilience is related to time to restore lifeline services'. In order to reflect these characteristics, 'Class III' was named as 'Techno-centrism based on readiness'.

Table 8. Probability of class membership and item-response for three-class model.

		Class I	Class II	Class III
	Probability of latent class membership within class	0.49	0.27	0.22
	Item–response probabilities within each class			
Redundancy	Urban resilience is related to capacity for technical substitutions and “workarounds”.	0.26	0.18	0.88
	Urban resilience is related to ability to substitute and conserve needed inputs.	0.30	0.08	0.40
	Urban resilience is related to availability of housing options for disaster victims.	0.23	0.27	0.33
	Urban resilience is related to alternate sites for managing disaster operations.	0.26	0.29	0.36
Robustness	Urban resilience is related to building codes and construction procedures for new and retrofitted structures.	0.19	0.28	0.28
	Urban resilience is related to extent of regional economic diversification.	0.18	0.29	0.32
	Urban resilience is related to social vulnerability and degree of community preparedness.	0.73	0.63	0.54
	Urban resilience is related to emergency operations planning and private–public cooperation.	0.35	0.98	0.45
Resourcefulness	Urban resilience is related to availability of equipment and materials for restoration and repair.	0.93	0.94	0.73
	Urban resilience is related to business and industry capacity to improvise and to converge with knowledge-based industries.	0.98	0.86	0.88
	Urban resilience is related to capacity to address human needs and social trust relationship.	0.92	0.06	0.35
	Urban resilience is related to capacity to improvise, innovate, and expand operations.	0.51	0.39	0.45
Rapidity	Urban resilience is related to system downtime, restoration time.	0.91	0.45	0.16
	Urban resilience is related to time to regain capacity, lost revenue.	0.42	0.41	0.89
	Urban resilience is related to time to restore lifeline services.	0.83	0.61	0.95
	Urban resilience is related to time between impact and early recovery.	0.42	0.77	0.54

In case of characteristics by type of class according to grade and EUR, ‘Class III’ was set as a reference group for the analysis. Comparing the differences by grade, the probability that the second grade (Y1 = 1, Y2 = 0, Y3 = 0) belonged to Class I was 2.72 times higher than that of the first grade (Y1 = 0, Y2 = 0, Y3 = 0). The probability of belonging to Class II was 2.15 times higher (Table 9).

Table 9. Logistic regression coefficient (β) and odds ratio (OR) by variable.

	Class I		Class II		Class III	
Variables	β	OR	β	OR	β	OR
Y1 ** (Second graders)	0.99	2.72	0.77	2.151.7	-	OR
Y2 * (Third graders)	−0.65	0.52	0.58	1.78	-	1.00
Y3 ** (Fourth Graders)	5.78	324.05	1.45	5.91	-	1.00
Experience of EUR **	1.60	4.97	0.53	1.70	-	1.00

OR: Odds Ratio, -: reference class * $p < 001$ ** $p < 0001$.

5. Discussion

Urban resilience and sustainability have different starting points from the background of the emergence of concepts. Sustainability originally meant continuity that could be replenished and continued on its own without artificial input, which originated from the concept of the balance and continuity of nature. Sustainability is intended to improve the continuation of a system and the functioning of the components from the emergence of the operating system until it is discarded. On the other hand, urban resilience means the ability to recover from natural and artificial shocks, pursuing disaster prevention and minimizing negative impacts and ultimately pursuing sustainability, but it may not finally realize sustainability.

The overall results show that both before and after the onset of COVID-19, students' attitudes to the concept of urban resilience were similar to those toward sustainable development [82]. Urban resilience is at the heart of sustainability [11], and if there is a high level of urban resilience in the face of unpredictable changes, the system can be said to be sustainable [83]; otherwise, the sustainability of the system cannot be guaranteed. Therefore, it is necessary to solidify the concept of urban resilience in the landscape architecture field and educate students' about how it differs from sustainable development.

Before beginning of the COVID-19 pandemic, comparing the overall characteristics of the four classes shown in Table 4, it was possible to distinguish between short-term and long-term measures in relation to the priority countermeasures. On the concept of urban resilience, class I and class II tended to mostly recognize short-term response strategies such as physical and economic responses. The probability of belonging to a class with this view was around 59%. Class III and class IV tended to accept the concept of resilience as a long-term countermeasure as part of a social response system, and the probability of belonging to a class taking this view was around 41%. After the beginning of the pandemic, all three classes showed mostly high response rates for the resourcefulness and rapidity sections of the questionnaire compared to the redundancy and robustness factors. It seems that even though the respondents are landscape students, they accepted the urban resilience concept as medical resilience rather than related to the physical infrastructure of buildings and cities throughout the pandemic.

Before the beginning of the COVID-19 pandemic, all four classes related to the common perceptions held by landscape architecture students about the concept of sustainable development [82]. Class I and II are classes that view sustainable development in three dimensions: 'environmental', 'technical' and 'economy', which can be seen as the view of ecological environmentalism and technical environmentalism in prior research. After the beginning of the pandemic, all three classes considered technological capability as an important factor in the concept of urban resilience. This seems to be because most of them shared the need for medical supplies and the development of vaccines during the pandemic.

In case of EUR, grade and educational experience were found to be variables that had a significant effect on the probability of belonging to a latent class for the concept of urban resilience. Based on the results of this study, our suggestions in terms of EUR are as follows. First of all, it was found that all classes with educational experience related to the concept of urban resilience were more likely to belong to classes (social perspective centered) that viewed urban resilience from a "social system" perspective than those with no educational experience. This presupposes that there is a possibility of a change in perception through education. Comparing the differences between grades shows that students in their fourth year of university are more likely to belong to class III than first- and second-grade students.

It is also assumed that the landscape architecture curriculum is emphasizing urban resilience as a 'physical solution through engineering access' given that the 'physical and advanced' class accounts for the largest proportion. Given the academic nature of 'engineering', which values changes through technology and engineering, such a result may be a natural phenomenon. However, if the urban resilience concept is pursued without consideration for the socially disadvantaged or for human rights, it can lead to a sense of incompatibility between classes. Krasny and Tidball [84] pointed out that civic ecology and related environmental education practices contribute to attributes of resilient social–ecological system. As part of environmental education, the EUR should be a model that integrates social and ecological problems, including behavioral factors such as problem identification, analysis and practice [85]. Therefore, we suggest a plan to organize interdisciplinary courses to provide comprehensive access to the 'environment, society, and system' areas in the curriculum from the lower grades. Additionally, it is important to develop pedagogy for students about the in-depth concept of urban resilience not in relation to the COVID-19 pandemic but also in relation to aspects of urban physical infrastructure.

6. Conclusions

So far, research on sustainability education has been conducted in various ways at different stages, but there has been no research on urban resilience education. In this context, studies on attitudes toward the concepts of sustainability and sustainable development have been steadily conducted for various groups, such as preservice teachers, college students, and citizens, but this has not been studied in the specific context of urban resilience either [82]. With the outbreak of the COVID-19, research on urban resilience is growing in most urban related fields; however, in the case of landscape architecture, an important field of environmental design and planning, research on this area is not active compared to other adjacent fields.

Thus, this study aimed to grasp and examine how students majoring in landscape architecture perceive the concept of urban resilience and how their views have changed throughout the COVID-19 pandemic. In addition, to explore the role of EUR in landscape architecture departments, we analyzed whether there were differences in the types of perception of urban resilience depending on the educational experience and grade of the students.

Overall, the results are as follows: First, before the beginning of COVID-19, four latent classes were extracted on the concept of urban resilience; 'physical and environmental approach-centered', 'economic perspective-centered', 'social perspective-centered', and 'institutional and organizational perspective-centered'. These classes tended to overlap with the perceived types of sustainable development at the level of 'environment, economy, and social development', and among them, there were also types of attitudes that approached them from institutional and organizational perspectives. In case of after the beginning of COVID-19, three latent classes were examined; 'Techno-centrism based on social bond', 'Techno-centrism based on institutional system', and 'Techno-centrism based on institutional system'.

Second, before the beginning of COVID-19, students accepted the concept of urban resilience as a physical and environmental approach to overcome risk factors by creating landscape architecture and infrastructure or applying the resilience concept in urban development and redevelopment. However, after the beginning of COVID-19, they have mostly recognized urban resilience as a concept related to technological ability. Third, grade and educational experience have been shown as variables that significantly affect the probability of belonging to a latent class of urban resilience concept.

This study has limitations in generalizing the results of this study in that our data were collected through convenience sampling. Another limitation is that we used an already-developed framework to measure the knowledge, attitudes and behaviors of students in the specific field of landscape architecture on urban resilience. If a questionnaire tool is developed focusing on the topic of urban resilience as applied to each field in the future, it will be possible to derive more implications for our situation along with a more accurate diagnosis.

Nevertheless, this study may provide us with an opportunity to understand the perception patterns of college students majoring in landscape architecture before and after COVID-19 outbreak in relation to the concept of urban resilience. In addition, it is important to carry out the concept education of urban resilience, but it is significant that it has revealed that the contents of education should also be discussed in depth.

On the other hand, in future studies, it will be necessary to find concrete ways to strengthen EUR through the current curriculum. There is a need to study ways to introduce new subjects, internships, group projects, and ways to implement EUR through comparative subjects, such as field training.

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References

1. Cheshmehzangi, A. Reflection on Early Lessons for Urban Resilience and Public Health Enhancement during the COVID-19. *Health* **2020**, *12*, 1390. [CrossRef]
2. Fouda, A.; Mahmoudi, N.; Moy, N.; Paolucci, F. The COVID-19 Pandemic in Greece, Iceland, New Zealand, and Singapore: Health Policies and Lessons Learned. *Health Policy Technol.* **2020**, *9*, 510–524. [CrossRef]
3. Kang, D.; Choi, H.; Kim, J.-H.; Choi, J. Spatial Epidemic Dynamics of the COVID-19 Outbreak in China. *Int. J. Infect. Dis.* **2020**, *94*, 96–102. [CrossRef]
4. Davoudi, S.; Shaw, K.; Haider, L.J.; Quinlan, A.E.; Peterson, G.D.; Wilkinson, C.; Fünfgeld, H.; McEvoy, D.; Porter, L.; Davoudi, S. Resilience: A Bridging Concept or a Dead End? "Reframing" Resilience: Challenges for Planning Theory and Practice Interacting Traps: Resilience Assessment of a Pasture Management System in Northern Afghanistan Urban Resilience: What Does It Mean in Planning Practice? Resilience as a Useful Concept for Climate Change Adaptation? The Politics of Resilience for Planning: A Cautionary Note: Edited by Simin Davoudi and Libby Porter. *Plan. Theory Pract.* **2012**, *13*, 299–333.
5. Holling, C.S. Resilience and Stability of Ecological Systems. *Annu. Rev. Ecol. Syst.* **1973**, *4*, 1–23. [CrossRef]
6. Hyun, E. Adjustment of Single Parent Family—The Bufferin Effect of Family Resilience. *J. Korean Home Manag. Assoc.* **2007**, *25*, 107–126.
7. Kim, H.K.; Lee, M.H. Factors Influencing Resilience of Adult Children of Alcoholics among College Students. *J. Korean Acad. Nurs.* **2011**, *41*, 642–651. [CrossRef]
8. Cicchetti, D. Resilience under Conditions of Extreme Stress: A Multilevel Perspective. *World Psychiatry* **2010**, *9*, 145–154. [CrossRef] [PubMed]
9. Gholami, A.; Shekari, T.; Aminifar, F.; Shahidehpour, M. Microgrid Scheduling with Uncertainty: The Quest for Resilience. *IEEE Trans. Smart Grid* **2016**, *7*, 2849–2858. [CrossRef]
10. Timmermann, P. Vulnerability, Resilience and the Collapse of Society. *Environ. Monogr.* **1981**, *1*, 1–42.
11. Walker, B.; Salt, D. *Resilience Thinking: Sustaining Ecosystems and People in a Changing World*; Island Press: Washington, DC, USA; p. 2012.
12. Folke, C. Resilience: The Emergence of a Perspective for Social–Ecological Systems Analyses. *Glob. Environ. Chang.* **2006**, *16*, 253–267. [CrossRef]
13. Steffen, W.; Richardson, K.; Rockström, J.; Cornell, S.E.; Fetzer, I.; Bennett, E.M.; Biggs, R.; Carpenter, S.R.; De Vries, W.; De Wit, C.A.; et al. Planetary Boundaries: Guiding Human Development on a Changing Planet. *Science* **2015**, *347*, 1259855. [CrossRef]
14. Olsson, P.; Galaz, V.; Boonstra, W.J. Sustainability Transformations: A Resilience Perspective. *Ecol. Soc.* **2014**, *19*. [CrossRef]
15. Papadopoulos, T.; Gunasekaran, A.; Dubey, R.; Altay, N.; Childe, S.J.; Fosso-Wamba, S. The Role of Big Data in Explaining Disaster Resilience in Supply Chains for Sustainability. *J. Clean. Prod.* **2017**, *142*, 1108–1118. [CrossRef]
16. Chang, S.E.; Shinozuka, M. Measuring Improvements in the Disaster Resilience of Communities. *Earthq. Spectra* **2004**, *20*, 739–755. [CrossRef]
17. Cutter, S.L.; Barnes, L.; Berry, M.; Burton, C.; Evans, E.; Tate, E.; Webb, J. A Place-Based Model for Understanding Community Resilience to Natural Disasters. *Glob. Environ. Chang.* **2008**, *18*, 598–606. [CrossRef]
18. Grove, K. Agency, Affect, and the Immunological Politics of Disaster Resilience. *Environ. Plan. D Soc. Space* **2014**, *32*, 240–256. [CrossRef]
19. Hudson, R. Material Matters and the Search for Resilience: Rethinking Regional and Urban Development Strategies in the Context of Global Environmental Change. *Int. J. Innov. Sustain. Dev.* **2008**, *3*, 166–184. [CrossRef]

20. Yamamoto, D. Regional Resilience: Prospects for Regional Development Research. *Geogr. Compass* **2011**, *5*, 723–736. [CrossRef]
21. Pike, A.; Dawley, S.; Tomaney, J. Resilience, Adaptation and Adaptability. *Camb. J. Reg. Econ. Soc.* **2010**, *3*, 59–70. [CrossRef]
22. Swanstrom, T. *Regional Resilience: A Critical Examination of the Ecological Framework*; Working Paper; Institute of Urban and Regional Development (IURD), University of California Berkeley: Berkeley, CA, USA, 2008.
23. Chelleri, L.; Schuetze, T.; Salvati, L. Integrating Resilience with Urban Sustainability in Neglected Neighborhoods: Challenges and Opportunities of Transitioning to Decentralized Water Management in Mexico City. *Habitat Int.* **2015**, *48*, 122–130. [CrossRef]
24. Hale, J.D.; Sadler, J. Resilient Ecological Solutions for Urban Regeneration. *Proc. Inst. Civil Eng.-Eng. Sustain.* **2012**, *165*, 59–68. [CrossRef]
25. Feliciotti, A.; Romice, O.; Porta, S. Urban Regeneration, Masterplans and Resilience: The Case of the Gorbals in Glasgow. *Urban Morphol.* **2017**, *21*, 61–79.
26. Meerow, S.; Newell, J.P.; Stults, M. Defining Urban Resilience: A Review. *Landsc. Urban Plan.* **2016**, *147*, 38–49. [CrossRef]
27. Bradley, P. Integrating Sustainable Development into Economics Curriculum: A Case Study Analysis and Sector Wide Survey of Barriers. *J. Clean. Prod.* **2019**, *209*, 333–352. [CrossRef]
28. Estrada-Vidal, L.I.; Tójar-Hurtado, J.-C. College Student Knowledge and Attitudes Related to Sustainability Education and Environmental Health. *Procedia-Soc. Behav. Sci.* **2017**, *237*, 386–392. [CrossRef]
29. Tuncer, G. University Students' Perception on Sustainable Development: A Case Study from Turkey. *Int. Res. Geogr. Environ. Educ.* **2008**, *17*, 212–226. [CrossRef]
30. Dourish, P.; Bellotti, V. Awareness and Coordination in Shared Workspaces. In Proceedings of the CSCW, Toronto, ON, Canada, 1–4 November 1992; Volume 92, pp. 107–114.
31. Timon, M. The Rise of Resilience: Linking Resilience and Sustainability in City Planning. *Urban Ecol. New Sch. N. Y. City N. Y.* **2014**.
32. Zhang, X.; Li, H. Urban Resilience and Urban Sustainability: What We Know and What Do Not Know? *Cities* **2018**, *72*, 141–148. [CrossRef]
33. SDGs, U. United Nations Sustainable Development Goals. *UN. Org.* **2015**.
34. Evans, B.; Elisei, P.; Rosenfeld, O.; Roll, G.; Figueiredo, A.; Keiner, M. HABITAT III–Toward a New Urban Agenda. *Disp.-Plan. Rev.* **2016**, *52*, 86–91. [CrossRef]
35. Carabine, E. Revitalising Evidence-Based Policy for the Sendai Framework for Disaster Risk Reduction 2015–2030: Lessons from Existing International Science Partnerships. *PLoS Curr.* **2015**, *7*. [CrossRef]
36. OECD. *Reviews of Risk Management Policies Boosting Resilience Through Innovative Risk Governance*; OECD: Paris, France, 2014.
37. Shen, L.-Y.; Ochoa, J.J.; Shah, M.N.; Zhang, X. The Application of Urban Sustainability Indicators—A Comparison between Various Practices. *Habitat Int.* **2011**, *35*, 17–29. [CrossRef]
38. Alberti, M. Measuring Urban Sustainability. *Environ. Impact. Assess. Rev.* **1996**, *16*, 381–424. [CrossRef]
39. Turcu, C. Re-Thinking Sustainability Indicators: Local Perspectives of Urban Sustainability. *J. Environ. Plan. Manag.* **2013**, *56*, 695–719. [CrossRef]
40. Brundtland, G.H. Our Common Future—Call for Action. *Environ. Conserv.* **1987**, *14*, 291–294. [CrossRef]
41. Sieverts, T. Am Beginn Einer Stadtentwicklungsepoche Der Resilienz? Folgen Für Architektur, Städtebau Und Politik. *Inf. Raumentwickl.* **2013**, *4*, 315–323.
42. Vale, L.; Campanella, T. *The Resilient City: Trauma, Recovery, and Remembrance*; MIT: Cambridge, MA, USA, 2002.
43. Shaw, K.; Maythorne, L. Managing for Local Resilience: Towards a Strategic Approach. *Public Policy Adm.* **2013**, *28*, 43–65. [CrossRef]
44. Johnson, C.; Blackburn, S. Making Cities Resilient Report 2012. In *My City Is Getting Ready! A Global Snapshot of How Local Governments Reduce Disaster Risk*; United Nation Office for Risk Reduction: Geneva, Switzerland, 2012.
45. ARUP. *City Resilience Framework*; Ove Arup & Partners International Limited: New York, NY, USA, 2014.
46. ADB. *Urban Climate Change Resilience: A Synopsis*; Asian Development Bank: Manila, Philippines, 2014.
47. Stockholm Resilience Centre What Is Resilience? Available online: https://www.stockholmresilience.org/research/research-news/2015-02-19-what-is-resilience.html (accessed on 18 April 2020).
48. Leichenko, R. Climate Change and Urban Resilience. *Curr. Opin. Environ. Sustain.* **2011**, *3*, 164–168. [CrossRef]
49. Campanella, T.J. Urban Resilience and the Recovery of New Orleans. *J. Am. Plan. Assoc.* **2006**, *72*, 141–146. [CrossRef]
50. Takewaki, I.; Fujita, K.; Yamamoto, K.; Takabatake, H. Smart Passive Damper Control for Greater Building Earthquake Resilience in Sustainable Cities. *Sustain. Cities* **2011**, *1*, 3–15. [CrossRef]
51. Tyler, S.; Moench, M. A Framework for Urban Climate Resilience. *Clim. Dev.* **2012**, *4*, 311–326. [CrossRef]
52. Elmqvist, T.; Barnett, G.; Wilkinson, C. Exploring Urban Sustainability and Resilience. In *Resilient Sustainable Cities*; Routledge: New York, NY, USA, 2014; pp. 31–40.
53. Romero-Lankao, P.; Gnatz, D.M.; Wilhelmi, O.; Hayden, M. Urban Sustainability and Resilience: From Theory to Practice. *Sustainability* **2016**, *8*, 1224. [CrossRef]
54. Kalantari, Z. *Enlivening Our Cities: Towards Urban Sustainability and Resilience*; Springer Science & Business Media: Berlin, Germany, 2021.
55. Toubin, M.; Laganier, R.; Diab, Y.; Serre, D. Improving the Conditions for Urban Resilience through Collaborative Learning of Parisian Urban Services. *J. Urban Plan. Dev.* **2015**, *141*, 05014021. [CrossRef]

56. LopezDeAsiain, M.; Díaz-García, V. The Importance of the Participatory Dimension in Urban Resilience Improvement Processes. *Sustainability* **2020**, *12*, 7305. [CrossRef]
57. Wardekker, A.; Wilk, B.; Brown, V.; Uittenbroek, C.; Mees, H.; Driessen, P.; Wassen, M.; Molenaar, A.; Walda, J.; Runhaar, H. A Diagnostic Tool for Supporting Policymaking on Urban Resilience. *Cities* **2020**, *101*, 102691. [CrossRef]
58. Fabbricatti, K.; Boissenin, L.; Citoni, M. Heritage Community Resilience: Towards New Approaches for Urban Resilience and Sustainability. *City Territ. Archit.* **2020**, *7*, 17. [CrossRef]
59. Dobson, S. Community-Driven Pathways for Implementation of Global Urban Resilience Goals in Africa. *Int. J. Disaster Risk Reduct.* **2017**, *26*, 78–84. [CrossRef]
60. Zuniga-Teran, A.A.; Gerlak, A.K.; Mayer, B.; Evans, T.P.; Lansey, K.E. Urban Resilience and Green Infrastructure Systems: Towards a Multidimensional Evaluation. *Curr. Opin. Environ. Sustain.* **2020**, *44*, 42–47. [CrossRef]
61. Arafah, Y.; Winarso, H.; Suroso, D. Towards Smart and Resilient City: A Conceptual Model. In Proceedings of the IOP Conference Series: Earth and Environmental Science, Bandung, Indonesia, 3–5 April 2018; Volume 158, p. 012045.
62. Liang, Z. Assessment of the Construction of a Climate Resilient City: An Empirical Study Based on the Difference in Differences Model. *Int. J. Environ. Res. Public Health* **2021**, *18*, 2082. [CrossRef] [PubMed]
63. Moglia, M.; Frantzeskaki, N.; Newton, P.; Pineda-Pinto, M.; Witheridge, J.; Cook, S.; Glackin, S. Accelerating a Green Recovery of Cities: Lessons from a Scoping Review and a Proposal for Mission-Oriented Recovery towards Post-Pandemic Urban Resilience. *Dev. Built Environ.* **2021**, *7*, 100052. [CrossRef]
64. Lee, S.; Lee, J.; Lee, S.; Lee, Y.; Min, G.; Shin, S.; Kim, N.; Ha, K. The Awareness of Teachers and College Students towards Sustainable Development and Education for Sustainable Development. *Environ. Educ.* **2006**, *19*, 5464.
65. Choi, J.-W.; Lee, E.-W.; Kim, D.-Y. Research on Industrial High Schools Technical Subjects Teachers' Perception and Present Situation and Toward Education for Sustainable Development (ESD). *J. Korean Soc. Ind. Converg.* **2010**, *13*, 183–189.
66. Jaegal, D.; Park, D.; Choi, J. Citizens' Perceptions of Local Government Sustainable Development Policy. *Korean Public Adm. Rev.* **2004**, *38*, 201–220.
67. Evans, B.; Joas, M.; Sundback, S.; Theobald, K. Governing Local Sustainability. *J. Environ. Plan. Manag.* **2006**, *49*, 849–867. [CrossRef]
68. Figueira, J.; Greco, S.; Ehrgott, M. *Multiple Criteria Decision Analysis: State of the Art Surveys*; Springer Science & Business Media: Berlin, Germany, 2005.
69. Greco, S.; Figueira, J.; Ehrgott, M. *Multiple Criteria Decision Analysis*; Springer: Berlin, Germany, 2016; Volume 37.
70. Greene, R.; Devillers, R.; Luther, J.E.; Eddy, B.G. GIS-Based Multiple-Criteria Decision Analysis. *Geogr. Compass* **2011**, *5*, 412–432. [CrossRef]
71. Nesticò, A.; Somma, P. Comparative Analysis of Multi-Criteria Methods for the Enhancement of Historical Buildings. *Sustainability* **2019**, *11*, 4526. [CrossRef]
72. Vaidya, O.S.; Kumar, S. Analytic Hierarchy Process: An Overview of Applications. *Eur. J. Oper. Res.* **2006**, *169*, 1–29. [CrossRef]
73. Saaty, T.L. How to Make a Decision: The Analytic Hierarchy Process. *Eur. J. Oper. Res.* **1990**, *48*, 9–26. [CrossRef]
74. Collins, L.M.; Lanza, S.T. *Latent Class and Latent Transition Analysis: With Applications in the Social, Behavioral, and Health Sciences*; John Wiley & Sons: Hoboken, NJ, USA, 2009; Volume 718.
75. Lanza, S.T.; Collins, L.M.; Lemmon, D.R.; Schafer, J.L. PROC LCA: A SAS Procedure for Latent Class Analysis. *Struct. Equ. Modeling A Multidiscip. J.* **2007**, *14*, 671–694. [CrossRef]
76. Goodman, L.A. Exploratory Latent Structure Analysis Using Both Identifiable and Unidentifiable Models. *Biometrika* **1974**, *61*, 215–231. [CrossRef]
77. Lazarsfeld, P.; Henry, N. Latent Structure Analysis Houghton Mifflin. *NY* **1968**.
78. Wolch, J.R.; Byrne, J.; Newell, J.P. Urban Green Space, Public Health, and Environmental Justice: The Challenge of Making Cities 'Just Green Enough'. *Landsc. Urban Plan.* **2014**, *125*, 234–244. [CrossRef]
79. O'Rourke, T.D. Critical Infrastructure, Interdependencies, and Resilience. *BRIDGE-Wash.-Natl. Acad. Eng.* **2007**, *37*, 22.
80. Jung, E.-J.; Jeong, B.-H.; Na, J.-M. A Study on the Sustainability and Resilience of City. *J. Korean Reg. Dev. Assoc.* **2016**, *28*, 87–108.
81. Celeux, G.; Soromenho, G. An Entropy Criterion for Assessing the Number of Clusters in a Mixture Model. *J. Classif.* **1996**, *13*, 195–212. [CrossRef]
82. Han, S.; Kwon, Y. Awareness and Attitude of College Students Majoring in Landscape Architecture towards the Sustainable Development. *Sustainability* **2019**, *11*, 5464. [CrossRef]
83. Redman, C.L. Should Sustainability and Resilience Be Combined or Remain Distinct Pursuits? *Ecol. Soc.* **2014**, *19*. [CrossRef]
84. Krasny, M.E.; Tidball, K.G. Applying a Resilience Systems Framework to Urban Environmental Education. *Environ. Educ. Res.* **2009**, *15*, 465–482. [CrossRef]
85. Jensen, B.B.; Schnack, K. The Action Competence Approach in Environmental Education. *Environ. Educ. Res.* **1997**, *3*, 163–178. [CrossRef]