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Usefulness of a Civic Engagement Scale for Research on Smart Cities: Measuring Attitudes and Behavior

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Abstract: Civic engagement plays a critical role in smart city innovation and urban development by encouraging active participation in civic activities such as volunteering, voting, community organizing, or advocacy, all of which contribute to the development of local communities. This study highlights the need to assess civic engagement in smart cities in order to improve the interactions between technology and society. The study assessed the reliability and validity of the Civic Engagement Scale (CES) in the Czech context. The results presented are based on a representative sample of 1366 respondents from the general population aged 15–74. The study included univariate statistics, tests of internal consistency, and principal component analysis. In addition, the study presents the results of confirmatory factor analysis (CFA) that was conducted to examine the fit of the proposed model to empirical data. The results indicate that the CES has excellent psychometric properties, including high internal consistency and favorable absolute and incremental indices. The Czech version of the CES can be considered a valid and reliable instrument. The findings suggest using CES to research and evaluate policy interventions aimed at developing digital platforms that enable citizens to easily participate in urban planning and smart city projects, community-driven smart city projects that ensure local needs and preferences are addressed, or implementing incentive programs for citizens.

Keywords: civic engagement; smart cities; psychometrics; cross-sectional research; participation; local communities

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1. Introduction

Civic engagement involves the active participation of individuals in a range of civic activities that contribute to the overall consolidation of society. These activities include volunteering, donating, voting, and organizing community initiatives [1,2]. At the individual level, civic engagement stems from a commitment to give back to the community and embodies a set of values, knowledge, skills, and actions that generate political and social benefits for the local community [3]. Adler and Goggin [4] defined civic engagement as the way citizens participate in improving the conditions of their (local) communities. Similarly, Ehrlich [5] emphasized that civic engagement involves individual and collective actions aimed at improving the conditions of life within a given community, including support for democratic and political initiatives volunteering and donation [6,7]. In summary, civic engagement serves as a manifestation of social belonging [8], active participation [9], and the practice of active citizenship [10].

The importance of civic engagement is reflected in the growing interest of researchers and policymakers in understanding its nature, determinants, and outcomes. Deng and Fei [11] suggested that civic engagement, in addition to other constructs such as community engagement or public participation, refers to activities within social and political processes designed to enhance the learning and understanding of social issues, facilitate communication, and empower participants. This study draws attention to the need to assess civic engagement in smart cities in order to improve the interplay between technology and

society. Given the objectives of this study, the focus on smart cities concerns perceptions of renewable energy, sustainable transportation, and smart public services [12].

Civic engagement is central to the successful development and functioning of modern urban environments, including smart cities. The concept of smart cities, first used in 1994 [13], depends on the interaction between citizens and urban systems, where civic engagement plays a central role in planning, decision-making, and innovation processes. Smart cities have emerged as a response to accelerating urbanization processes [12]. However, rapid urban development supported by modern information and communication technologies can lead to gaps in civic engagement and participation. Therefore, the continuous monitoring and support of civic engagement is essential to create citizen-centered smart cities, successfully implement modernization projects, and ensure the sustainability of their positive impacts [14]. In addition, interventions aimed at improving residents' quality of life through information and communication technologies can be more effective if they are developed and implemented in collaboration with citizens [1]. Smart cities aim to create environments that are responsive to the needs of residents [11]; civic engagement is the linchpin that enables this interaction and participation.

2. Literature Review

Given the importance of analyzing and measuring civic engagement, there has been a need to develop appropriate research tools. Traditionally, such efforts have involved asking respondents about their participation in various community initiatives, e.g., environmental, religious, recreational, and cultural programs [15,16]. However, given the complexity of the issue, the development of sophisticated and reliable tools in the form of scales with established reliability and assessed validity has become increasingly important [3]. The reason is that a well-designed scale can add value to both theoretical and practical knowledge about civic engagement and provide stakeholders with a conceptual framework [1,7]. A validated tool for measuring civic engagement can also help to create participatory and responsive smart cities with the capacity to transform urban life. Appropriate scales that have been developed to date fall into three main categories: the first assesses civic behavior, quantifying specific activities related to civic engagement, such as volunteering, attending public meetings, or voting [10]; the second category assesses attitudes associated with civic engagement, including altruism, interest in social issues, or a sense of social justice [1,4,8]; and the third category combines these two components by examining the relationship between attitudes and corresponding behaviors. An example of this approach is represented by the Civic Engagement Scale (CES).

Exactly a decade ago, in 2013, the CES developed by Doolittle and Faul [3] was introduced. Despite the initial lack of psychometric testing, numerous research initiatives to validate the scale and to implement it in local settings have emerged over the past decade [17,18]. However, despite the increased attention, the knowledge gap has remained regarding the psychometric characteristics of the scale, especially with respect to specific populations and framing topics (e.g., smart cities).

Therefore, the primary objective of this study was to validate the CES with respect to smart cities. Special emphasis was put on presenting the psychometric characteristics, including the reliability and convergent validity of the scale. In addition, this study investigated the applicability of CES to the adult population in Czechia. It is worth mentioning that the population studied in the original study performed by Doolittle and Faul [3] consisted of students within a reported age range of 17–63 years, with a mean age of 28.42 years. However, the data used in this study were from a representative sample of the Czech population aged 15–74, enabling the analysis of civic engagement across different segments of the population. This study aimed to deepen the understanding of civic engagement in the context of smart cities and to provide other researchers, policymakers, participation practitioners, and urban planners with a reliable tool for researching, measuring, and evaluating this critical construct. The study had three main objectives: (a) to explore the underlying dimensions (factor structures) of civic engagement with exploratory

factor analysis; (b) to confirm these factor structures through confirmatory factor analysis; and (c) to assess the convergent validity of the scale.

3. Materials and Methods

3.1. Participants and Procedures

The population was defined as the general population of Czechia aged 15 to 74. In order to obtain a representative sample, an address-based sampling technique was used. First, a total of 179 sampling units were identified, and then interviewers contacted 2704 households preselected within the given sampling units. Altogether, 1391 face-to-face interviews were conducted (i.e., the response rate was 51.4%). A dataset of 1366 cases was used for analysis, as some cases had to be excluded due to incompleteness. The resulting sample described in Table 1 demonstrated a proportionate representation of the theoretical population with respect to gender, age, size of place of residence, and type of dwelling. Data collection took place in September 2022.

Table 1. Selected socio-demographic characteristics.

Variables		Theoretical Population *	Sample
Gender	Male	49.9%	49.3%
	Female	50.1%	50.7%
	Total	100.0%	100.0%
Age	15–29 years	20.1%	19.9%
	30–49 years	39.5%	39.4%
	50–74 years	40.4%	40.7%
	Total	100.0%	100.0%
Size of the place of residence	Fewer than 10,000 inhabitants	46.1%	46.3%
	10,000 to 49,999 inhabitants	22.0%	21.6%
	50,000 inhabitants and more	31.9%	32.1%
	Total	100.0%	100.0%
Type of dwelling	Family house	46.2%	46.7%
	Condominium	53.8%	53.3%
	Total	100.0%	100.0%

Note: n = 1366; * Data about the theoretical population comes from the Czech statistical office.

3.2. Ethical Considerations and Quality Assurance

Considerable attention was paid to ethical and data quality assurance issues. Several steps were taken to protect the rights of respondents, ensure their anonymity, and adhere to ethical standards. In this regard, informed consent was obtained from respondents prior to the start of each interview; this ensured that respondents were fully aware of the objectives of the study, the research process, and how the data provided would be used. When gathering data from adolescent respondents (15–18 years), the procedures were introduced and explained not only to the respondents themselves, but also to at least one parent or guardian. In addition, informed consent was obtained from both the adolescent and the guardian who was present throughout the interview process to ensure a supportive and ethical environment.

The responses obtained were rigorously anonymized, i.e., all data were processed in such a way that no specific individual could be identified. Aggregate data were presented in a way assuring that no individual could be identified. This ensured that respondents' privacy and confidentiality were fully protected. As part of data quality assurance, 35% of all interviews conducted were back-checked.

3.3. Translation of the Scale

In the first stage of the translation process, two independent translations of the original English instrument into Czech were carried out, following the procedures recommended by Sousa and Rojjanasrirat [19]. The two Czech versions were compared to identify and resolve any differences and ambiguities. Finally, a back-translation was performed to check the equivalence between the English and Czech versions [20].

Another step in the process of scale translation was a pilot test conducted with a sample of 26 respondents. The aim of this phase was to test the comprehensibility of the items for the intended population and to identify possible sources of misunderstanding. The pilot testing did not reveal any comprehension issues; therefore, the translated instrument was considered adequate and usable for the Czech population.

3.4. Measures

3.4.1. Civic Engagement Scale (CES)

The Civic Engagement Scale (CES) contains a total of 14 items rated on a seven-point Likert-type scale. Given the hypothesized gap between attitudes and behaviors [21,22], when individuals' attitudes may not directly correspond to their actions due to situational circumstances, the original study presented attitudes and behavioral patterns as two components of the scale [3]. Eight items comprised the first component focused on the attitudinal aspect of civic engagement (e.g., "I believe I should make a difference in my community."), while the remaining six items formed a second component reflecting specific behavioral patterns (e.g., "I help members of my community."). Attitudinal items were rated with the use of agreement scale ranging from definitely agree (7) to definitely disagree (1), whereas the behavioral scale was assessed by the frequency scale ranging from always (7) to never (1). This was the same format as that used by Doolittle and Faul [3] in their original study from 2013. Total scores for each component of the scale ranged from 8 to 56 for the attitudinal component and from 6 to 42 for the behavioral component, with higher scores indicating higher levels of civic engagement. This particular design of the scale has been used in other studies as well [14,17,18], and has also been carefully evaluated for reliability and validity.

3.4.2. Independent Questions

Assessing the convergent validity of a scale is an essential step in validating a research instrument because it examines whether the scale actually measures the intended construct [23]. For this reason, four specific questions were included in the research instrument. In order to decrease the response bias and minimize the burden on respondents, these indicators took the form of independent questions.

First, the belongingness to the local community was assessed by the question "I feel that I am part of the community where I live.", focusing attention on identification with the community spirit and involvement in decision-making processes. This question is relevant from the perspective of smart cities, which seeks to connect citizens within a city and encourage their active participation in social and community activities [13]. Respondents who perceive themselves as part of their community might be highly motivated to engage for the benefit of the given community, city development, and the implementation of smart city principles.

Second, the examination of the attachment to a place was another key element of civic engagement that was identified. The appropriate question "What are your feelings about the place where you currently live?" reflected the respondent's affective relationship with the place of residence and reflected the respondent's subjective perception and attachment to the place [16]. Place attachment has been linked to civic engagement by many researchers, both directly and indirectly [24–27]. Therefore, an indicator regarding the respondent's relationship with the place of residence was included to examine the convergent validity of the CES. Hereinafter, this question is reported as "place attachment".

Third, the inclusion of the question differentiating between respondents living in family houses and condominiums was important for testing the scale validity. This question was asked under the assumption that people living in family houses may have a greater need for control over their property and close environment (and therefore, a greater motivation to be active members of the community) than those living in condominiums.

Fourth, in addition to testing the convergent validity per se, a question was included to test the hypothesized relationship between CES and respondents' attitudes toward smart cities. As mentioned in the introductory session, the issue of attitudes toward smart cities was indicated by a question aimed at identifying the key areas that respondents considered desirable with respect to smart cities. These areas were renewable energy, sustainable transportation, and intelligent public services [12,13]. The corresponding multiple-choice question was "I wish my place of residence would use renewable energy, has sustainable transportation, and has intelligent public services.". The answers were transformed to an indicator of interest in smart cities as follows: high interest (all three areas checked); moderate interest (two areas checked); low interest (one area checked); no interest (no areas checked).

On top of that, standard socio-demographic indicators were also monitored. In this study, particular attention was paid to the association of CES scores with gender, age, and the size of the respondents' place of residence.

3.5. Data Analysis

Sample statistics and the characteristics of the respondents who participated in the study were analyzed in SPSS. Means (M), standard deviations (SD), skewness, and kurtosis were calculated to provide a basic description of the data distribution. The strength and direction of the relationship between variables were indicated by Pearson's correlation coefficient; the means of different subgroups were compared using analysis of variance (ANOVA). *T*-tests were used for comparison of means between two groups, whereas ANOVA was used to compare means among more than two groups. The internal consistency of the scale was assessed not only by Cronbach's alpha [28,29] but, because of correlated errors, also by McDonald's omega [30,31], and AVE along with CR [32], which were also used to inform about convergent validity.

The dimensionality of the scale was tested using exploratory factor analysis based on principal component analysis [33]. In accordance with classical test theory, the psychometric properties of the scale were examined using confirmatory factor analysis (CFA), performed in AMOS 24. Given the need to follow explorative and confirmative strategies simultaneously, the total dataset of 1366 cases was randomly divided into two equivalent subsets. The first subset was used for exploratory factor analysis, while the latter was used for confirmatory factor analysis. Similar procedures have also been used successfully in previous studies [34,35]. The sample size was sufficient even after this split [36].

Missing data were assumed to be missing at random [37]. For no variable did the proportion of missing values exceed 3%. In the case of EFA and CFA, the listwise method was used; thus, the analyses in question were performed only with complete datasets; on the other hand, the independent questions and their analyses may have different numbers of valid cases.

4. Results

4.1. Descriptive Statistics

All items had similar mean scores, with attitudinal components ranging from 4.04 to 5.19 (with standard deviations in a relatively narrow range from 1.437 to 1.710) and behavioral components ranging from 2.91 to 3.87 (with standard deviations in a range from 1.720 to 1.923). Table 2 also shows the skewness of the individual items, which range from −0.119 to −0.555 for the attitude items and from 0.004 to 0.611 for the behavior items. Moreover, the kurtosis of these items ranged from −0.165 to −0.732 or −0.659 to −1.017, respectively. Skewness and kurtosis for both scale components ranged from −1.5 to +1.5,

indicating a normal distribution [38]. Additionally, the floor and ceiling effects reached acceptable values (1.2% for the floor, 3.2% for the ceiling in the case of attitude items; 9.6% for the floor and 1.2% for the ceiling for behavior items), which is consistent with the recommendation of Cain et al. [39] that these values should be less than 50%.

Table 2. Descriptive statistics of the Civic Engagement Scale (CES).

	Attitude Items	***n***	**Mean**	**SD**	**Skewness**	**Kurtosis**	**ITC**
1	I feel responsible for my community.	683	4.54	1.679	−0.367	−0.669	0.799
2	I believe I should make a difference in my community.	683	4.64	1.590	−0.428	−0.427	0.845
3	I believe that I have a responsibility to help the poor and the hungry.	683	4.83	1.437	−0.420	−0.165	0.757
4	I am committed to serve in my community.	683	4.50	1.592	−0.280	−0.557	0.861
5	I believe that all citizens have a responsibility to their community.	683	4.89	1.574	−0.484	−0.325	0.812
6	I believe that it is important to be informed of community issues.	683	5.19	1.479	−0.555	−0.238	0.759
7	I believe that it is important to volunteer.	683	4.04	1.694	−0.172	−0.712	0.739
8	I believe that it is important to financially support charitable organizations.	683	4.15	1.710	−0.119	−0.732	0.726
	The whole attitude component	683	36.78	10.715	−0.349	−0.187	
	Behavior Items						
1	I am involved in structured volunteer position(s) in the community.	683	2.91	1.811	0.611	−0.774	0.789
2	When working with others, I make positive changes in the community.	683	3.23	1.766	0.300	−0.963	0.856
3	I help members of my community.	683	3.40	1.720	0.251	−0.831	0.794
4	I stay informed of events in my community.	683	3.87	1.792	0.004	−0.971	0.805
5	I participate in discussions that raise issues of social responsibility.	683	3.28	1.923	0.410	−1.017	0.817
6	I contribute to charitable organizations within the community.	683	2.97	1.763	0.523	−0.659	0.777
	The whole behavior component	683	19.66	9.356	0.347	−0.648	

Table 2 also shows the summary data for the two components of the CES; the mean score for the attitudinal component of the scale was 36.87, with a standard deviation of 10.715, while the mean score for the behavioral component was 19.66, with a standard deviation of 9.356.

4.2. Internal Consistency

Cronbach's alpha coefficient was calculated to assess the internal consistency of the scale. Its value reached significant values of 0.940 (attitude component) and 0.934 (behavioral component), indicating that the items consistently measured the same construct. These values not only confirmed the internal consistency of the present form of the scale; they even exceeded the original scores reported by Doolittle and Faul [3], of 0.91 and 0.85. In this context, the McDonald's omega coefficient was also calculated, which reached a value of 0.940 for the attitude component and 0.935 for the behavioral component.

Internal consistency was also tested by the item-total correlations (ITCs) [40]. These coefficients ranged from 0.726 to 0.861 for the attitudinal component and from 0.777 to 0.856 for the behavioral component. All values were significantly higher than the critical value of 0.4 recommended by Furr [41]. Such results supported the hypothesis of a unidimensional structure of civic engagement attitudes and civic engagement behaviors, as measured by this scale [42].

4.3. Dimensionality of the CES

Exploratory factor analysis was conducted to assess the structure of the scale [33]. The results showed that both components were unidimensional when the principal component analysis for each part of the scale showed only one factor with an eigenvalue greater than 1. This result was further confirmed by the scree plots, which showed that the optimal number of factors for each component is one. According to Henson and Roberts [43], higher factor loadings indicate a greater contribution of the items to a given factor, with factor loadings greater than 0.4 indicating a significant contribution. Table 3 shows the factor loadings of the items to the extracted factor; it is obvious that all items achieved factor loadings greater than 0.4. Table 3 also shows the obtained communalities (h^2), which ranged from 0.62 to 0.82 across both components being above the critical value recommended by Velicer and Fava [44].

Table 3. Exploratory factor analysis.

		n	FL	h^2
CES—attitude items				
1	I am committed to serve in my community.	683	0.901	0.81
2	I believe I should make a difference in my community.	683	0.888	0.79
3	I believe that all citizens have a responsibility to their community.	683	0.863	0.74
4	I feel responsible for my community.	683	0.852	0.73
5	I believe that it is important to be informed of community issues.	683	0.819	0.67
6	I believe that I have a responsibility to help the poor and the hungry.	683	0.818	0.67
7	I believe that it is important to volunteer.	683	0.797	0.64
8	I believe that it is important to financially support charitable organizations.	683	0.785	0.62
CES—behavior items				
1	When working with others, I make positive changes in the community.	683	0.905	0.82
2	I participate in discussions that raise issues of social responsibility.	683	0.876	0.77
3	I stay informed of events in my community.	683	0.868	0.75
4	I help members of my community.	683	0.860	0.74
5	I am involved in structured volunteer position(s) in the community.	683	0.855	0.73
6	I contribute to charitable organizations within the community.	683	0.846	0.72

Exploratory factor analysis also brought some other important results: the coefficient of determination, i.e., the proportion of variance in the identified factor explained by the items, was 70.8% for the attitudinal component and 75.4% for the behavioral component. For the attitudinal component, the KMO reached 0.932 and Bartlett's test of sphericity showed a result of $\chi^2 = 4417.764$ (df = 28, $p < 0.001$). Similarly, for the behavioral component, the KMO was 0.920 and Bartlett's test was $\chi^2 = 3232.478$ (df = 15, $p < 0.001$). These results supported the hypothesis of a unidimensional structure of each of the CES components [36].

4.4. Confirmatory Factor Analysis (CFA)

The psychometric properties of the CES were assessed using confirmatory factor analysis (CFA) with maximum likelihood estimation [45]. Given $\chi^2 = 27.397$ with df = 13, $p < 0.05$, for the attitude component and $\chi^2 = 11.411$ with df = 6, $p < 0.05$, for the behavior component, other indices such as the root mean square error of approximation (RMSEA), standardized root mean square residuals (SRMR), comparative fit index (CFI), Tucker–Lewis index (TLI), and goodness of fit index (GFI) were used to evaluate the model fit. Results for both components of the CES are shown in Figure 1, which depicts the tested models together with standardized coefficients (factor leadings) and communalities.

The values of absolute and incremental indices along with their critical values are presented in Table 4, which also presents the results of the initial and improved models.

Table 4. Absolute and incremental indices.

	RMSEA	SRMR	GFI	CFI	TLI	NFI
CES—attitude component						
Original model	0.139	0.0393	0.911	0.940	0.916	0.936
Improved model	0.040	0.0149	0.990	0.997	0.993	0.994
CES—behavior component						
Original model	0.120	0.0261	0.956	0.971	0.952	0.968
Improved model	0.036	0.0098	0.994	0.998	0.996	0.996
Critical values	<0.07 [45]	<0.08 [46]	>0.95 [45]	>0.90 [45]	>0.95 [45]	>0.95 [46]

The process of assessing the fit of the proposed model to the data involved several iterations, during which the model was refined to reflect errors that include unobserved variables and capturing variance not included in the latent construct.

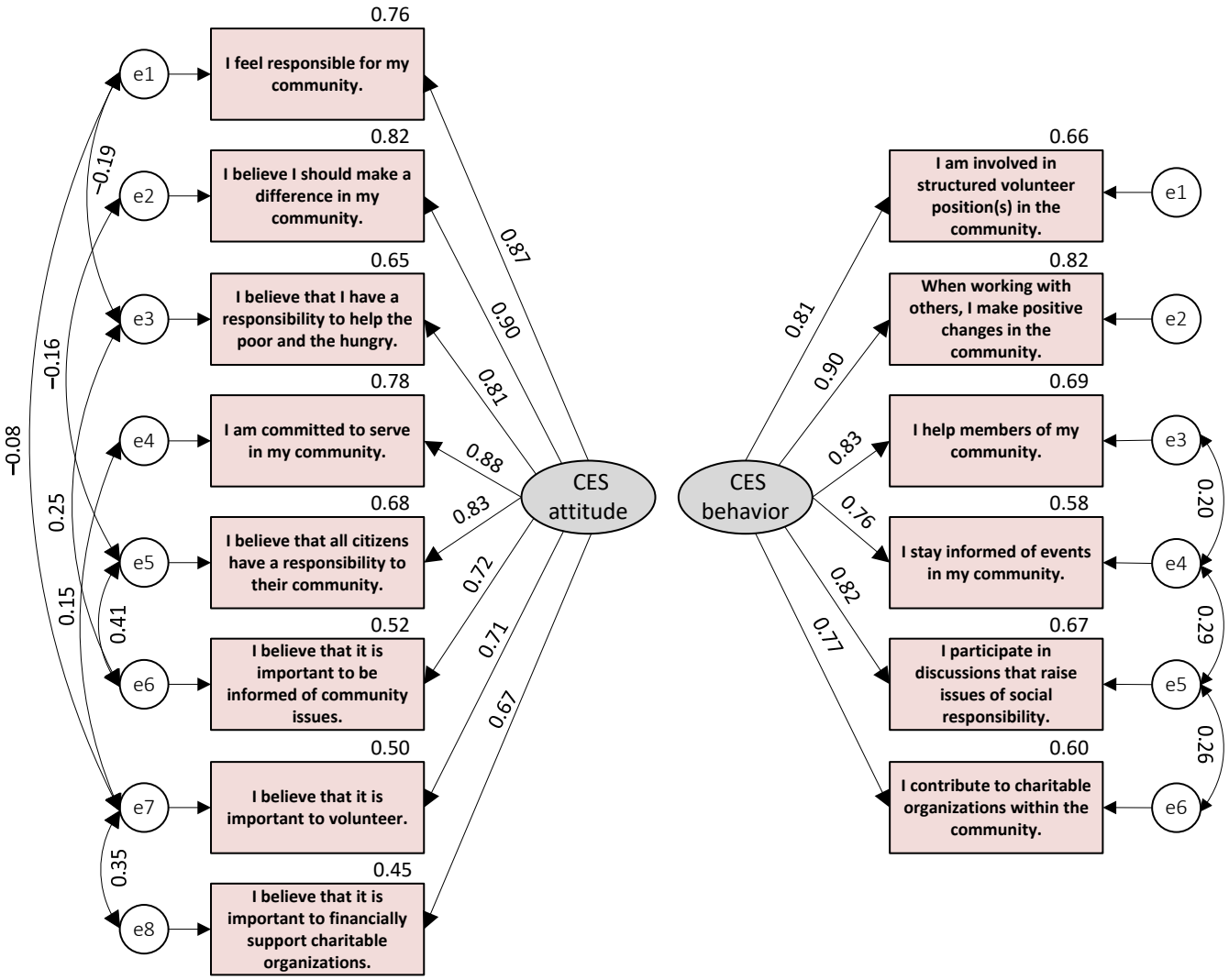

Figure 1. Confirmatory factor analysis of the improved CES models.

4.5. Construct Convergent Validity

Convergent validity of the Czech version of the CES was assessed through average variance extracted (AVE) and composite reliability (CR) [32,47]. The scale achieved an AVE of 0.71 for the attitudinal component and 0.75 for the behavioral component, which means that, on average, 71% and 75% of the indicators' variance was explained by the latent variable. Therefore, the results suggested that the latent variable was a fairly accurate representation of the construct being measured. Composite reliability (CR) for the Czech data was 0.95 for both components, supporting the assumption that the CES adequately measured the civic engagement.

More evidence with respect to the construct validity is the extent to which the scale items are correlated with each other [48]. This is because high correlation can be interpreted as a consistent way of measuring the same construct. The correlation matrix in Table 5 provides strong evidence of such construct validity, as it shows significant associations between all items.

Differences in mean scores on the attitudinal component of the scale between different subgroups were examined. Table 6 shows that older respondents scored more highly on the CES than younger respondents. Additionally, significantly higher CES scores were observed among respondents living in single-family homes compared with those living in condominiums. In addition, respondents with higher place attachment achieved significantly higher CES scores.

Table 5. Correlational matrix.

Attitude Items		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	I feel responsible for my community.	1.000							
2	I believe I should make a difference in my community.	0.693 **	1.000						
3	I believe that I have a responsibility to help the poor and the hungry.	0.529 **	0.581 **	1.000					
4	I am committed to serve in my community.	0.683 **	0.705 **	0.616 **	1.000				
5	I believe that all citizens have a responsibility to their community.	0.624 **	0.617 **	0.549 **	0.678 **	1.000			
6	I believe that it is important to be informed of community issues.	0.511 **	0.577 **	0.570 **	0.555 **	0.631 **	1.000		
7	I believe that it is important to volunteer.	0.509 **	0.531 **	0.471 **	0.574 **	0.503 **	0.471 **	1.000	
8	I believe that it is important to financially support charitable organizations.	0.504 **	0.528 **	0.454 **	0.527 **	0.491 **	0.460 **	0.607 **	1.000
Behavior Items		**1**	**2**	**3**	**4**		**5**	**6**	
1	I am involved in structured volunteer position(s) in the community.	1.000							
2	When working with others, I make positive changes in the community.	0.656 **	1.000						
3	I help members of my community.	0.567 **	0.645 **	1.000					
4	I stay informed of events in my community.	0.529 **	0.633 **	0.603 **	1.000				
5	I participate in discussions that raise issues of social responsibility.	0.596 **	0.640 **	0.557 **	0.637 **		1.000		
6	I contribute to charitable organizations within the community.	0.604 **	0.611 **	0.550 **	0.524 **		0.614 **	1.000	

** Correlation is significant at the 0.01 level (2-tailed); n = 683; Kendall's tau_b.

As hypothesized, civic engagement, as measured by the CES, was found to be significantly related to belongingness. In this regard, Table 6 shows that among respondents with a low feeling of belongingness (i.e., those who did not identify with their local community, and therefore strongly disagreed with the statement "I feel that I am part of the community where I live."), the CES score reached a low value of 22.73. In contrast, individuals who strongly identified with their local community had a significantly higher CES score (43.04). A similar pattern was observed in the case of place attachment. In this regard, respondents who indicated that they could hardly imagine living anywhere else achieved a CES score of 39.88, while those who had planned to move away because they did not like their place of residence had a CES score of 23.42. Thus, the CES appears to be a sensitive indicator in this regard. In addition, respondents who attributed more importance to smart city innovations showed higher CES scores (41.36), followed by 37.59 among those with moderate perceived importance, and 29.73 among respondents for whom the smart cities innovations had low importance.

Table 6. Associations of CES—attitude with independent questions.

		CES Mean	**SD**	**F/t**	**df**	***p*-Value ***	**Eta**
Gender							
	Male	36.18	10.936	−1.434	684	0.152 **	0.055
	Female	37.35	10.485				
Age							
	15–29 years	34.13	11.845	8.500	2	<0.001	0.156
	30–49 years	36.98	10.032				
	50–74 years	38.52	10.293				
Size of the place of residence							
	Fewer than 10,000 inhabitants	35.85	11.890	1.489	2	0.226	0.066
	10,000 to 49,999 inhabitants	36.79	8.946				
	50,000 inhabitants and more	37.57	11.079				

Table 6. *Cont.*

	CES Mean	SD	F/t	df	*p*-Value *	Eta
I feel that I am part of the community where I live (belongingness).						
Definitely agree	43.04	8.818				
Agree	38.24	8.461	87.902	3	<0.001	0.532
Disagree	28.69	10.099				
Definitely disagree	22.73	10.003				
Place attachment						
I can hardly imagine living anywhere else.	39.88	9.197				
There are some other places where I could live.	35.01	10.681	35.137	3	<0.001	0.366
It is nothing special here, I can live elsewhere as well.	28.31	11.207				
I plan to move away because I do not like this place.	23.42	11.843				
Type of dwelling						
Family house	38.31	10.22	3.081	684	0.002 **	0.117
Condominium	35.76	10.93				
Importance of smart cities innovations						
High	41.36	9.236				
Moderate	37.59	9.435	43.990	3	<0.001	0.409
Low	29.73	10.638				
None	32.73	10.725				

* ANOVA; ** *t*-test.

Table 7 shows the results for the behavioral component of the CES. There were statistically significant associations of CES scores with belongingness: the CES score for respondents who strongly disagreed with the statement "I feel that I am part of the community where I live" was 14.27, while the CES score for those who strongly agreed with this statement was 22.76. There were also statistically significant associations with age, with CES scores being highest for respondents aged 50 or older. However, unlike the attitudinal component, the differences based on type of dwelling were not statistically significant. In addition, the results summarized in Table 7 show that there were no statistically significant differences based on the size of the place of residence, and gender.

Differences reflecting the sensitivity of the CES to place attachment are evident. In this regard, Table 7 shows that people who strongly identified with their place of living (i.e., those who said they could not imagine living anywhere else) had a CES score of 21.10, compared with 11.17 for respondents who planned to move away because they disliked their place of living. As expected, there were statistically significant differences between respondents from family houses and those living in condominiums on the attitudinal component (38.31 versus 35.76); however, no such association was demonstrated in the case of the behavioral component, where the CES scores were 20.36 and 19.19, respectively. Finally, the results showed a statistically significant positive relationship between behavioral components of the CES and the importance of smart city innovations.

Table 7. Associations of CES—behavior with other indicators.

	CES Mean	SD	F/t	df	*p*-Value *	Eta
Gender						
Male	19.85	9.779	0.504	660	0.614 **	0.019
Female	19.49	8.946				
Age						
15–29 years	16.52	8.982	14.338	2	<0.001	0.201
30–49 years	20.22	9.231				
50–74 years	21.32	9.260				
Size of the place of residence						
Fewer than 10,000 inhabitants	19.77	9.858	1.084	2	0.339	0.056
10,000 to 49,999 inhabitants	18.95	8.786				
50,000 inhabitants and more	20.21	9.405				

Table 7. *Cont.*

	CES Mean	SD	F/t	df	*p*-Value *	Eta
I feel that I am part of the community where I live (belongingness).						
Definitely agree	22.76	10.226				
Agree	20.51	8.459	21.344	3	<0.001	0.296
Disagree	15.56	8.085				
Definitely disagree	14.27	8.972				
Place attachment						
I can hardly imagine living anywhere else.	21.10	9.303				
There are some other places where I could live.	18.86	9.128	9.783	3	<0.001	0.203
It is nothing special here, I can live elsewhere as well.	16.19	9.301				
I plan to move away because I do not like this place.	11.17	5.167				
Type of dwelling						
Family house	20.36	9.568	1.601	684	0.110 **	0.061
Condominium	19.19	9.193				
Importance of smart cities innovations						
High	21.73	9.911				
Moderate	20.43	8.708	12.243	3	<0.001	0.230
Low	16.01	8.456				
None	18.05	8.400				

* ANOVA; ** *t*-test.

5. Discussion

The purpose of this study was to evaluate the psychometric properties of the CES. A combination of several analytical approaches was used, including internal consistency testing, principal component analysis, and confirmatory factor analysis. Based on data from a sample representative of the Czech population, the results showed that the CES performed well. The scale had a mean score of 36.78 for the attitudinal component and 19.66 for the behavioral component; it had acceptable values of skewness and kurtosis [38]. Each of the scale components showed a high degree of internal consistency when the correlation between the items and the total score ranged from 0.633 to 0.847 (attitudinal component) and from 0.586 to 0.826 (behavioral component), meeting the criteria for acceptability [48].

Scale validation results further demonstrated a good fit of the proposed model to the Czech data. The RMSEA reached 0.040 for the attitudinal component and 0.036 for the behavioral component; the SRMR values were 0.0149 and 0.0098, respectively; and the GFI reached excellent values of 0.990 and 0.994 [45–47]. Similarly satisfactory results were obtained for the CFI (0.997/0.998), TLI (0.993/0.996), and NFI (0.994/0.996).

Convergent validity, as expressed by the average variance extracted (AVE) and composite reliability (CR), exceeded the recommended thresholds of 0.5 and 0.6, respectively [32,47,49], and showed significant associations with all independent questions in this study. CR usually provides a more accurate estimate of internal consistency than Cronbach's alpha, but in this case, the results were similar due to the fact that most of the statistical assumptions of Cronbach's alpha were met.

The results obtained are consistent with other studies indicating that civic engagement does not show statistically significant differences based on gender [50,51]. Some studies have also concluded that civic engagement does not differ by age [2,3,50,52]; however, this study showed the opposite result for both the attitudinal and behavioral components. This opposite finding can largely be explained by the fact that the other studies focused primarily on student populations, while this study considers a much broader range of ages.

It is important to note that due to the cross-sectional nature of this study, the direction of the relationship between civic engagement and self-reported attitudes cannot be clearly established [53]. It is unclear whether higher levels of civic engagement influenced respondents' place attachment or whether, instead, civic engagement in local communities was based on these feelings. Both perspectives have merit, but a different research design would be needed to determine the direction of causality. Similarly, it remains unclear whether attitudes within the CES can be considered predictors of behavior (engagement practices)

or whether the two components are of equal importance. The reliance on self-reported data is also a limitation of this study [53]. Although the study confirmed statistically significant associations between variables, it is important to note the limitations associated with using self-reported data rather than independently validated objective indicators.

The CES can help identify potential barriers to active participation in smart city initiatives [50,54] and can provide early warning of potential problems, allowing decision makers to improve their mitigation strategies [55]. However, some interventions may bring additional risks, such as widening the digital divide [11,14,56]. Therefore, it would be useful to consider ICT literacy, perceptions of smart services, and the specificities of urban versus rural populations [14,55–57]. From a practical point of view, it seems that the CES can contribute positively to the development of smart cities by providing useful evidence to measure the impact of appropriate policies and interventions to stimulate civic engagement. Using CES, civic engagement can be tracked consistently over time or compared across cities, regions [15,27,51], and target groups [58].

6. Conclusions

The implications of this study for smart city research and practice are at least twofold. First, it is a novel contribution to validation of the CES, which aims to provide a standardized tool for thorough examinations of civic engagement. In this regard, the study highlights the importance of civic engagement attitudes and behaviors as two key components related to smart cities and shaping the urban environment. The results confirmed the good psychometric properties of the CES and suggested that this scale could be a valuable tool for measuring civic engagement in the context of smart cities. Future research could aim to use the CES for detailed case studies or comparative analyses of different smart city projects to understand how civic engagement varies and what factors influence it. In addition, researchers could use the CES to examine the impact of civic engagement on the effectiveness of particular smart city initiatives, including exploring the relationship between civic participation and outcomes in terms of improved city services, sustainability, or even quality of life. Second, policymakers and smart city practitioners can use the results of this study to measure the level of civic engagement and design targeted interventions that can encourage citizens to participate in smart city initiatives. Based on the CES findings, they could develop targeted interventions to increase civic engagement, including community workshops, digital platforms for citizen feedback, and educational programs on smart city technologies. In addition, policymakers and smart city practitioners could foster partnerships between city governments, academic institutions, and technology companies to develop innovative solutions that promote civic engagement and address urban challenges.

Future research could examine the invariance of the CES and assess its performance within specific smart city initiatives and interventions around the world. This would provide a comprehensive perspective on how civic engagement translates into different urban settings and how it supports the innovation and development of smart cities.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki of 1975 (https://www.wma.net/what-we-do/medical-ethics/declaration-of-helsinki/, accessed on 20 September 2023) and followed the AAPOR ethical code (https://www.aapor.org/Standards-Ethics/AAPOR-Code-of-Ethics.aspx, accessed on 20 September 2023). The research design and the research instrument (the questionnaire) were approved in INESAN by the Research Ethics Board (IREBA/2022/923). The institute holds an HRS4R HR Excellence in Research award (https://inesan.eu/en/hrs4r-2/, accessed on 20 September 2023), which acknowledges the highest standard of ethics adhered to by researchers at this institute (https://www.euraxess.cz/jobs/hrs4r, accessed on 21 March 2023).

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study. This study involved data collected from anonymous respondents. All subjects gave their informed consent for inclusion before their participation in the survey.

Data Availability Statement: The data used to support the findings of this study will be available from the corresponding author upon reasonable request.

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References

1. Talò, C.; Mannarini, T.; Rochira, A. Sense of community and community participation: A meta-analytic review. *Soc. Indic. Res.* **2014**, *117*, 1–28. [CrossRef]
2. Jacoby, B. Civic engagement in today's higher education: An overview. In *Civic Engagement in Higher Education: Concepts and Practices*; Jacoby, B., Ed.; Jossey-Bass: San Francisco, CA, USA, 2009; pp. 5–30.
3. Doolittle, A.; Faul, A.C. Civic Engagement Scale: A Validation Study. *SAGE Open* **2013**, *3*, 1–7. [CrossRef]
4. Adler, R.P.; Goggin, J. What Do We Mean By "Civic Engagement"? *J. Transform. Educ.* **2005**, *3*, 236–253. [CrossRef]
5. Ehrlich, T. Civic learning: Democracy and education revisited. *Educ. Rec.* **1997**, *78*, 57–65.
6. Sherrod, L.R.; Lauckhardt, J. The development of citizenship. In *Handbook of Adolescent Psychology: Contextual Influences on Adolescent Development*, 3rd ed.; Lerner, R.M., Steinberg, L., Eds.; Wiley: Hoboken, NJ, USA, 2009; Volume 2, pp. 372–408.
7. Barrett, M.; Zani, B. *Political and Civic Engagement: Multidisciplinary Perspectives*; Routledge: London, UK, 2014.
8. Lasker, R.D.; Weiss, E.S. Broadening participation in community problem solving: A multidisciplinary model to support collaborative practice and research. *J. Urban Health* **2003**, *80*, 14–47. [CrossRef] [PubMed]
9. Grillo, M.C.; Teixeira, M.A.; Wilson, D.C. Residential Satisfaction and Civic Engagement: Understanding the Causes of Community Participation. *Soc. Indic. Res.* **2010**, *97*, 451–466. [CrossRef]
10. Andolina, M.; Jenkins, K.; Keeter, S.; Delli Carpini, M.X.; Zukin, C. *A New Engagement? Political Participation, Civic Life, and the Changing American Citizen*; Oxford University Press: Oxford, UK, 2006.
11. Deng, G.; Fei, S. Exploring the factors influencing online civic engagement in a smart city: The mediating roles of ICT self-efficacy and commitment to community. *Comput. Hum. Behav.* **2023**, *143*, 107682. [CrossRef]
12. Albino, V.; Berardi, U.; Dangelico, R.M. Smart cities: Definitions, dimensions, performance, and initiatives. *J. Urban Technol.* **2015**, *22*, 3–21. [CrossRef]
13. Senior, C.; Temeljotov Salaj, A.; Johansen, A.; Lohne, J. Evaluating the Impact of Public Participation Processes on Participants in Smart City Development: A Scoping Review. *Buildings* **2023**, *13*, 1484. [CrossRef]
14. Zait, A.; Andrei, A.G. Civic Engagement at the Crossroads of Online and Offline Spaces: A PLS-SEM Assessment. *Sci. Ann. Econ. Bus.* **2019**, *66*, 559–572. [CrossRef]
15. Hoskins, B.L.; Mascherini, M. Measuring Active Citizenship through the Development of a Composite Indicator. *Soc. Indic. Res.* **2009**, *90*, 459–488. [CrossRef]
16. Irani, M.; Aghdam, S.R.; Ghasemzadeh, B. Investigating the link between place attachment, civic engagement, and pro-environmental behaviors. *Environ. Dev.* **2023**, *47*, 100897. [CrossRef]
17. Belay, A.; Tefera, B. Validation of Adolescent Civic Engagement Scale in the Ethiopian Context. *J. Posit. Sch. Psychol.* **2022**, *6*, 8306–8320.
18. Akin, A.; Fatih, U.; Umran, A. The Validity And Reliability of Turkish Version of the Civic Engagement Scale. *J. Educ. Instr. Stud. World* **2014**, *4*, 55–59.
19. Sousa, V.D.; Rojjanasrirat, W. Translation, adaptation and validation of instruments or scales for use in cross-cultural health care research: A clear and user-friendly guideline. *J. Eval. Clin. Pract.* **2011**, *2011*, 268–274. [CrossRef] [PubMed]
20. Yu, D.S.; Lee, D.T.; Woo, J. Issues and challenges of instrument translation. *West. J. Nurs. Res.* **2004**, *26*, 307–320. [CrossRef] [PubMed]
21. Padel, S.; Foster, C. Exploring the gap between attitudes and behaviour: Understanding why consumers buy or do not buy organic food. *Br. Food J.* **2005**, *107*, 606–625. [CrossRef]
22. Terlau, W.; Hirsch, D. Sustainable consumption and the attitude-behaviour-gap phenomenon-causes and measurements towards a sustainable development. *Proc. Food Syst. Dyn.* **2015**, *6*, 199–214.
23. Flake, J.K.; Fried, E.I. Measurement schmeasurement: Questionable measurement practices and how to avoid them. *Adv. Methods Pract. Psychol. Sci.* **2020**, *3*, 456–465. [CrossRef]
24. Forsyth, D.R.; van Vugt, M.; Schlein, G.; Story, P.A. Identity and sustainability: Localized sense of community increases environmental engagement. *Anal. Soc. Issues Public Policy* **2015**, *15*, 233–252. [CrossRef]

25. Scannell, L.; Gifford, R. Defining place attachment: A tripartite organizing framework. *J. Environ. Psychol.* **2010**, *30*, 1–10. [CrossRef]
26. Anton, C.E.; Lawrence, C. Home is where the heart is: The effect of place of residence on place attachment and community participation. *J. Environ. Psychol.* **2014**, *40*, 451–461. [CrossRef]
27. Hesari, E.; Moosavy, S.M.; Rohani, A.; Besharati Kivi, S.; Ghafourian, M.; Saleh, S.; Pour, B. Investigation the relationship between place attachment and community participation in residential areas: A structural equation modelling approach. *Soc. Indic. Res.* **2020**, *151*, 921–941. [CrossRef]
28. Tavakol, M.; Dennick, R. Making sense of Cronbach's alpha. *Int. J. Med. Educ.* **2011**, *2*, 53–55. [CrossRef] [PubMed]
29. Raykov, T. Scale reliability, Cronbach's coefficient alpha, and violations of essential tau-equivalence with fixed congeneric components. *Multivar. Behav. Res.* **1997**, *1997*, 329–353. [CrossRef] [PubMed]
30. Revelle, W.; Zinbarg, R. Coefficients alpha, beta, omega, and the GLB: Comments on Sijtma. *Psychometrika* **2009**, *74*, 145–154. [CrossRef]
31. Hayes, A.F.; Coutts, J.J. Use omega rather than Cronbach's alpha for estimating reliability. But. . .. *Commun. Methods Meas.* **2020**, *14*, 1–24. [CrossRef]
32. Kalkbrenner, M.T. Alpha, omega, and H internal consistency reliability estimates: Reviewing these options and when to use them. *Couns. Outcome Res. Eval.* **2023**, *14*, 77–88. [CrossRef]
33. Comrey, A.L.; Lee, H.B. *A First Course in Factor Analysis*; Psychology Press: London, UK, 2013.
34. Remr, J. Validation of the Health Consciousness Scale among the Czech Population. *Healthcare* **2023**, *11*, 1628. [CrossRef]
35. Remr, J. Assessing System Justification in Czech Population Using the System Justification Scale. *Eur. J. Investig. Health Psychol. Educ.* **2023**, *13*, 1801–1814. [CrossRef]
36. Hogarty, K.Y.; Hines, C.V.; Kromrey, J.D.; Ferron, J.M.; Mumford, K.R. The Quality of Factor Solutions in Exploratory Factor Analysis: The Influence of Sample Size, Communality, and Overdetermination. *Educ. Psychol. Meas.* **2005**, *65*, 202–226. [CrossRef]
37. Graham, J.W. Missing data analysis: Making it work in the real world. *Annu. Rev. Psychol.* **2009**, *60*, 549–576. [CrossRef] [PubMed]
38. Ho, A.D.; Yu, C.C. Descriptive statistics for modern test score distributions: Skewness, kurtosis, discreteness, and ceiling effects. *Educ. Psychol. Meas.* **2015**, *75*, 365–388. [CrossRef] [PubMed]
39. Cain, M.K.; Zhang, Z.; Yuan, K.H. Univariate and multivariate skewness and kurtosis for measuring nonnormality: Prevalence, influence and estimation. *Behav. Res. Methods* **2017**, *49*, 1716–1735. [CrossRef] [PubMed]
40. Wieland, A.; Durach, C.F.; Kembro, J.; Treiblmaier, H. Statistical and judgmental criteria for scale purification. *Supply Chain. Manag. Int. J.* **2017**, *22*, 321–328. [CrossRef]
41. Furr, R.M. *Scale Construction and Psychometrics for Social and Personality Psychology*; Sage Publications: London, UK, 2011.
42. Kline, R.B. *Principles and Practice of Structural Equation Modeling*; Guilford Publications: New York, NY, USA, 2023.
43. Henson, R.K.; Roberts, J.K. Use of exploratory factor analysis in published research: Common errors and some comment on improved practice. *Educ. Psychol. Meas.* **2006**, *66*, 393–416. [CrossRef]
44. Velicer, W.F.; Fava, J.L. Affects of variable and subject sampling on factor pattern recovery. *Psychol. Methods* **1998**, *3*, 231. [CrossRef]
45. Schreiber, J.B.; Nora, A.; Stage, F.K.; Barlow, E.A.; King, J. Reporting structural equation modeling and confirmatory factor analysis results: A review. *J. Educ. Res.* **2006**, *99*, 323–338. [CrossRef]
46. Hu, L.; Bentler, P.M. Fit indices in covariance structure modeling: Sensitivity to underparameterized model misspecification. *Psychol. Methods* **1998**, *3*, 424–453. [CrossRef]
47. Byrne, B.M. Structural Equation Modeling with AMOS. In *Basic Concepts, Applications, and Programming*, 2nd ed.; Routledge: New York, NY, USA, 2001.
48. Nunnally, J.C.; Bernstein, I.H. Validity. *Psychom. Theory* **1994**, *3*, 99–132.
49. Field, A. *Discovering Statistics Using SPSS*, 5th ed.; Sage Publications: London, UK, 2017.
50. Barnason, S.; Li, C.J.; Hall, D.M.; Wilhelm Stanis, S.A.; Schulz, J.H. Environmental Action Programs Using Positive Youth Development May Increase Civic Engagement. *Sustainability* **2022**, *14*, 6781. [CrossRef]
51. Choudhary, R.; Gupta, D.S. Civic Engagement a Precursor to Well-being. *Indian J. Health Wellbeing* **2017**, *8*, 152–156.
52. Zaff, J.; Boyd, M.; Li, Y.; Lerner, J.V.; Lerner, R.M. Active and engaged citizenship: Multi-group and longitudinal factorial analysis of an integrated construct of civic engagement. *J. Youth Adolesc.* **2010**, *39*, 736–750. [CrossRef] [PubMed]
53. DeVellis, R.F. *Scale Development: Theory and Applications*, 4th ed.; SAGE: London, UK, 2016.
54. Baccarne, B.; Evens, T.; De Marez, L. Understanding civic crowdfunding as a mechanism for leveraging civic engagement and urban innovation. *Technol. Innov. Manag. Rev.* **2020**, *10*, 51–66. [CrossRef]
55. Park, J.; Fujii, S. Civic Engagement in a Citizen-Led Living Lab for Smart Cities: Evidence From South Korea. *Urban Plan.* **2023**, *8*, 93–107. [CrossRef]
56. Albalá Genol, M.Á.; Etchezahar, E.; Maldonado Rico, A.; Gómez Yepes, T. Representations of Social Justice and Digital Civic Engagement: The Influence of Psychosocial Variables in Teacher Training. *Sustainability* **2022**, *14*, 7096. [CrossRef]

57. Fung, A. Varieties of participation in complex governance. *Public Adm. Rev.* **2006**, *66*, 66–75. [CrossRef]
58. Veeh, C.A.; Plassmeyer, M.; Nicotera, N.; Brewer, S.E. A combined measure of civic engagement for use among emerging adults. *J. Soc. Soc. Work Res.* **2019**, *10*, 13–34. [CrossRef]