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Impact of Knowledge, Tendency and Perceived Threats of Climate Change on Adaptation Strategies: The Case of Tehran Architects

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Abstract

The consequences of climate change are observed in several ways in human settlements, one of which is the threat it poses to the physical elements and infrastructures of cities. To mitigate it, cities apply adaptation strategies. These strategies have proper effectiveness and are adapted according to local characteristics. This study applied the cross-sectional survey method and Structural Equation Modeling (SEM) to assess the possible relations between variables. The study population was the architects of Tehran metropolis with a sample size of 85. The study instrument was a researcher-developed questionnaire consisting of four sections. Five hypotheses were assessed for relations of knowledge, tendency, perceived threats, and the adaptation strategies, all of which were proved by the study results. The results of the study showed that knowledge on the climate change significantly affects the perceived threats, tendency and the adaptation strategies. The adaptation strategies were also dependent on tendency and the perceived threats. The findings of this study can be helpful for planners and decision makers and the Architecture Society of Tehran to address the problem of climate change more adequately.

Keywords: architect, climate change, adaptation strategies, Tehran, Structural Equation Modeling (SEM)

Introduction

Climate change is a critical issue of this modern era (Zhang, et al., 2020) and its consequences are growing more severe (Paterson & Charles, 2019). Climate change and its consequences have implications for flood, drought and dust (Esmailnejad & Pudineh, 2017; Blanco, 2006). The climate change is caused by both natural and human causes. Natural causes can include change in the orbit of the sun in the Milky Way galaxy, the passage of comets, the change in the outputs of the sun, and the change in the orbital parameters of the Earth. On the other hand, human causes can include the excessive emission of greenhouse gases due to fossil fuel overuse, population growth, and the increasing industrial activities (Salahi et al., 2015; Farshchi, 2009; Azizi, 2004).

Climate change is a critical issue confronting almost every city around the world (Filho et al., 2018). It is an important matter for the cities (Choudhary et al., 2019). Cities have to deal with the consequences of climate change, which vary from an increased risk of flood to the discomfort of increased heat, based on the conditions and geographical location of each city (Filho et al., 2019). Cities are implementing more adaptation strategies as a reaction to the challenges of the climate change (Araos et al., 2016). Adaptation strategies are now a necessity for cities worldwide (Eisenack et al., 2014). Adaptation is at the same time one of the most complicated issues for cities (Anguelovski et al., 2014). Adaptation to climate change is more significant in the developing countries. This is because the developing countries feel the consequences of the climate change more deeply. These countries fail on many more fronts than the developed ones (Bhave et al., 2016).

Like many other countries, Iran has been grappling with the consequences and threats of climate change in recent years (Rezayan et al., 2017; Amiri & Eslamian, 2010; Mansouri Daneshvar et al., 2019). Several signs of climate change have been identified in Tehran, the capital (Navazi & Navazi, 2017; Saligheh, 2015; Ghazal et al., 2014; Haghtalab et al., 2013; Saadatabad & Bidokhti, 2011; Rafieian & Sheikhi, 2015).

Regarding architecture and urban development, some factors contribute to climate change. First, the materials used in the buildings have high thermal capacity and create an impenetrable surface which quickly moves precipitation out of the city before it evaporates. This prevents the loss of heat for the evaporation of the water of precipitation. Second, motor vehicles and household use of fuels release huge amounts of heat into cities and the air pollution prevents the radiation of long waves that transfer the heat directly from the earth surface up to the atmosphere. Third, the three-dimensional structure created by tall buildings changes the air flow and forms a complex geometry for heat exchange. Fourth, the high density of pollution including fine particulate matters, steam, and carbon dioxide in cities increases the temperature. Fifth, vertical walls of the buildings block radiation escape in cities, compared to relatively flat rural areas. Lateral sides of these three-dimensional structures emit the stored heat, part of which, instead of moving upward, reflects back on the buildings and slows the heat dissipation process. Sixth, the high roughness of the city surface reduces the wind speed in the urban area, slows down ventilation, and prevents the cold air from entering cities. Finally, the urban concrete and asphalt absorb and store a large amount of solar radiation compared to the vegetation and soil available in rural areas (Farshchi, 2009; Azizi, 2004).

The question of how to adequately address climate change has recently found its way into the academic and technical literature of the field of architecture (Thompson, 2019). This is important because architects should be informed about and try to handle the problem (Rittel & Webber, 1973; Dubois et al., 2015) and because they are pivotal actors in adaptation (Dubois et al., 2015). As architects are major parties involved in urban development, they can launch and speed up the climate change adaptation process (Dubois et al., 2015). In this regard, knowledge about climate change plays an instrumental role in the engagement of individuals in adaptation strategies (Kabir et al., 2016; Sulistyawati et al., 2018; Engels, 2019).

Some strategies for adapting to climate change, as discussed in the literature, are: use of green and domestic material; use of green surfaces such as green roofs, benefitting from natural capacities of the land such as slope and topography; the use of technologies to save energy; surface water management to store rain and snow waters; the use of flexible designs; compatibility of the architecture with the local climate; and use of renewable energies (Altomonte, 2009; Ojo & Baiyegunhi, 2019; Rubio-Bellido et al., 2015; IPCC, 2001; Crawley, 2008; Farshchi, 2009; Azizi, 2004).

This study aimed to investigate the possible relations between knowledge, tendency and perceived threats of climate change and adaptation strategies. The hypotheses of the study were:

- Knowledge of climate change affects adaptation strategies
- Tendency affects adaptation strategies
- Perceived threats of climate change affect adaptation strategies
- Knowledge of climate change affects the perceived threats of climate change
- Knowledge of climate change affects tendency.

2. Methods

This was a quantitative study carried out in 2019 in Tehran, Iran, which applied cross-sectional survey method. This method is a research method which gathers data in a particular time frame to explore a fact (Vaus, 2001).

The location of Tehran in the southern foothills of the Alborz Mountains. It is almost 50 kilometers extended from longitude 51 degrees 2 minutes east to 51 degrees 36 minutes east. In terms of latitude, the city lengths almost 30 kilometers from 35 degrees 34 minutes north to 35 degrees 50 minutes north. Its height from the sea level is 1800 meters in the northern areas and 950 meters in the southern areas (Rahimi et al., 2012).

The study population was composed of Tehran architects with relevant experience to climate change and adaptation. The variables of interest were knowledge on climate change, tendency, perceived threats of climate change, and adaptation strategies. The Structural Equation Modeling (SEM) was used to investigate the possible relations between the variables. The SEM is a causal structure between the latent structures (Schumacker & Lomax, 2015). Since there should be 20 respondents for each variable (Ding et al., 1995; Diamantopoulos & Siguaw, 2000; Jackson, 2003), and since there were four variables in this study, the required sample size for this study was 80 respondents. For any potential dropout, the sample size was raised to 90 respondents.

The study instrument was a researcher-made questionnaire. After our initial contact with the participants and obtaining their verbal consent, the questionnaires were either delivered or sent by email to the participants. When the questionnaires were returned to the research team, five of them were excluded from the study because of the high number of questions left unanswered or the irrelevant answers given to some questions. The analysis was performed on 85 questionnaires.

The questionnaire consisted of 27 items in four dimensions: Knowledge (3 items), Perceived threats (10 items), Adaptation strategies (10 items), and Tendency (4 items). The respondents had been asked to choose an option on a five-point Likert scale that ranged from “totally agree” to “totally disagree”. The face validity of the questionnaire was assessed by five experienced experts in related fields and their comments were applied. The construct validity of the questionnaire was assessed by average variance extracted. This indicator is calculated by dividing the sum of standard regression weighted squares or factor loads of the observed variables by the total number of observed variables (Hair et al., 2014, p. 680). Fornell and Larcker (1981) suggested the threshold of 0.50 and Magner et al. suggested the 0.40 threshold as an accepted value for this indicator. Table 1 shows the average variance extracted for the study variables.

Table 1. Average variance extracted from the study variables

Variables	Average Variance Extracted
Knowledge	0.67
Perceived threats	0.46
Tendency	0.54
Adaptation strategies	0.51

Composite reliability was used in this study to assess the internal compatibility of the items and the compatibility of the items that are representatives of latent factors. This type of reliability is available in the SEM. The composite reliability measures correlation between the items of an indicator for proper fitness. Bagozzi and Yi (1988), Moss et al. (1998), and Hair et al. (2014) considered values above the 0.60 as an acceptable value for composite reliability. Table 2 shows the values of composite reliability for the study indicators. The values are above 0.60 for all indicators, which point to the acceptable reliability of the models and latent variables in the structural models.

Table 2. Composite reliability of the study variables

Variables	Average Variance Extracted
Knowledge	0.72
Perceived threats	0.78
Tendency	0.70
Adaptation strategies	0.75

To examine the theoretical model of the study, the Amos 21 software was used. The main reason for using SEM is that this technique by the Amos software enables the researcher to organize the research from theoretical issues and their statement to analysis of experimental data all into a multivariate framework. This method reveals the complexities of concepts – one-way, two-way, direct and indirect impact of the variables on each other –and the complexities of measuring the latent structures (Ghasemi, 2013). Use of SEM also considers the issues such as collinearity of the independent variables, non-normal distribution of the data, and small sample size (Barroso et al., 2010).

3. Results

Demographic characteristics of the participants showed that 68.8% of the respondents were male and the rest were female. The age of the participants ranged from 27 to 68 years and the mean age was 40.81±11.52 years. The mean age of the female participants (38.27±11.97) was not significantly different from that of their male counterparts (37.30±10.99). Also, 35.29% of the participants had a bachelor’s degree, 31.76% had a master’s degree, and 32.94 had a PhD in architecture. In terms of professional working experience in the field of architecture, 24.70% had an experience of less than 2 years, 40% had 2 to 5 years of experience, and 35.29% had more than 5 years.

To assess the impact of the independent variables of knowledge, tendency, and perceived threats on the dependent variable of adaptation strategies, and to assess the impact of knowledge on perceived threats and tendency, the developed model was tested. Figure 1 shows the developed model based on the responses given by Tehran architects.

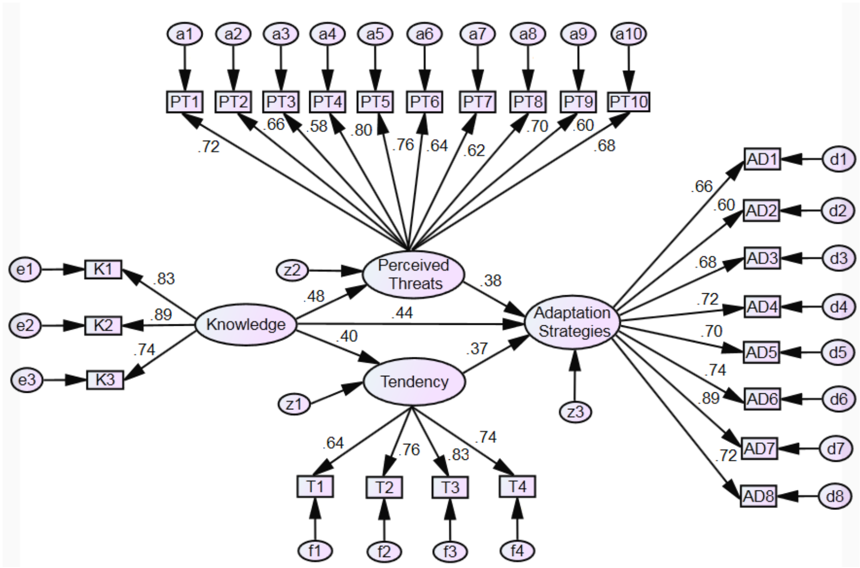

Figure 1. The structural model developed between the study variables

Regarding Figure 1, the impact of study variables on each other is presented in Table 3 based on the study hypotheses. This table indicates that the impact of knowledge, tendency, and perceived threats on adaptation strategies is 0.44, 0.38, and 0.37, respectively. The impact of knowledge on perceived threats and tendency was 0.48 and 0.40, respectively. Thus, all hypotheses of the study were supported by data.

Table 3. Regression paths of the SEM analysis

Hypothesis	Regression paths coefficients	Standard path	Critical ratio	P-value	Results
H1	Knowledge → Adaption Strategies	0.44	4.433	< 0.001	Supported
H2	Tendency → Adaption Strategies	0.38	3.124	< 0.001	Supported
H3	Perceived Threats → Adaption Strategies	0.37	3.091	< 0.001	Supported
H4	Knowledge → Perceived Threats	0.48	5.241	< 0.001	Supported
H5	Knowledge → Tendency	0.40	3.914	< 0.001	Supported

To assess whether the tested model has a proper fitness, the fitness indices of the SEM were examined. Table 4 shows the fitness indices of the used SEM in this study. This table indicates that all indices had a fitness of an acceptable level, which means that the experimental data from the participants proves the theoretical model developed based on the literature.

Table 4. Fitness indices of the structural equation model

Model	CMIN/DF	RMSEA	GFI	CFI	PNFI	NFI	PGFI	PRATIO
SEM	2.85	0.04	0.93	0.91	0.51	0.94	0.59	0.91

4. Discussion and Conclusion

As stated, climate change has direct and indirect negative impact in various forms on the cities worldwide (Filho et al., 2019; Liang et al., 2020; Lee et al., 2020). Considering the variability of the climate in recent decades it is inevitable to apply adaptation strategies for overcoming the challenges of the climate change (Esfandiari et al., 2020). Adaptation strategies for climate change can help reduce the impact of these consequences (Watson et al., 2013; Lindley et al., 2006). The strategies include a wide variety of short - term and long - term actions. These actions usually seek some goals further to climate change and may or may not be successful in moderating the damages or benefiting from the available opportunities (Cortekar et al., 2016). This strategy is considered as a procedure with proper effectiveness and response to local characteristics.

The findings of this study proved all five hypotheses. As mentioned in the first hypothesis of the study, knowledge had a significant relation with adaptation strategies such that the higher the knowledge, the more the adaptation strategies. Thus, adaptation strategies for climate change can be accelerated by increasing architects' knowledge about the issue. Previous studies also have depicted that the more knowledge on climate change, the more attention and application of that knowledge (Loupis et al., 2015; Council, Education, & Education, 1900; Chopra et al., 2019).

The perceived threats had a direct relation with adaptation strategies, meaning that as perceived threats increase, so do adaptation strategies. Previous studies also reported the correlation of perceived threats and application of adaptation strategies (Drummond et al., 2018; Davydova et al., 2018).

Just like knowledge and perceived threats, the tendency variable also had a direct relation with adaptation strategies. Another finding of the study was that architects' knowledge about climate change had a relation with tendency and perceived threats. Findings of the study can be beneficiary for policy makers, planners and decision makers of the fields of urban planning, urban designing, and architecture.

The following suggestions are made based on the study findings:

- Scaffolding the concept of climate change into the academic curriculum of architecture at all levels;
- Holding an architectural design competition to identify new adaptation strategies;
- Holding professional courses on climate change and adaptation strategies for architects;
- Formulation and adoption of an instruction by Tehran municipality regarding adaptation strategies;
- Holding joint meetings of climate change experts and architects;
- Holding congresses on architects' role in adaptation strategies.

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