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A STRUCTURAL EQUATION MODEL OF FACTORS RELATING TO SMART CITIES THAT AFFECT THE MANAGEMENT OF THE WORLD HERITAGE SITE AS WELL AS THE QUALITY OF LIFE OF TOURISTS AND VILLAGERS IN AYUTTHAYA, THAILAND

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ABSTRACT

This research aims to analyse the structural equation model (SEM) of variables associated with smart cities which affect the global management of world heritage sites as well as quality of life for Thai tourists and people in Ayutthaya province. The concept behind the study is the smart city and how the management of world heritage sites has affected the quality of life of the Thai people. This research used quantitative methods. A sample was composed of 404 individuals located in the world heritage site within the surroundings of Ayutthaya. SEM was used to perform the data analysis. The results indicate that the single and multiple group model provided a satisfactory fit with the empirical data. Furthermore, the research paper identified that the variables associated with smart cities strongly affected both the management of the world heritage site as well as the quality of life for tourists and villagers in the historic city of Ayutthaya. This research recommends three key measures: 1) Smart mobility policies: The Ministry of Transport and Ministry of Pollution Control should collaborate on pursuing smart mobility policies. 2) Education policies: The Ministry of Education needs to emphasise knowledge about the world heritage site and the principles of smart cities in the school curriculum. 3) Policies concerning the development of the historic city of Ayutthaya: The Department of Historical Parks should amalgamate the principles of smart cities into its strategic plan for developing the historic city of Ayutthaya.

Keywords: Smart cities; world heritage management; quality of life; structural equation model

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1. INTRODUCTION

Contemporary technological changes are significant in human life; specifically, online communication systems play varied roles in society. Ultimately, online information systems are crucial for human contact. The government has adopted an online database system for developing national policies because database systems are effective for accessing information in any location and at any point in time. Advanced technology strengthens the activities of human beings, for example in the crucial field of national economics. It is essential to have a technological system in place that can connect data between government and business owners and managers in cities. Access to government information must be swift and convenient for residents, tourists and business owners in the area. Moreover, clean energy is an innovative means through which the government can make budgetary savings; it also enables the reduction of urban transport-related air pollution. Ultimately, these are dynamics of a smart city strategy (Brohi et al., 2018).

Thailand has prepared plans for developing smart cities through key agencies, for example, the Ministry of Transport, the Ministry of Energy and the Ministry of Digital Economy and Society, by preparing a draft strategic plan for Smart Cities in Thailand (The Ministry of Digital Economy and Society, 2018). These core agencies have developed six major aspects including the smart economy, smart mobility, smart energy and environment, smart governance, smart people and smart living. The initial stage of the Smart City Development Plan involves the government focussing on seven provinces, namely Bangkok, Phuket, Chiang Mai, Khon Kaen, Chonburi, Rayong and Chachoengsao. These provinces are the main target of the smart city development given their position as economic hubs for Thailand. The Thailand Smart City Development Plan has mostly focused beyond cultural tourist attractions, although there has been some focus on the ancient cultural site known as the historic city of Ayutthaya in Phra Nakhon Si Ayutthaya province close to Bangkok. In 1991, this area was recognized as a UNESCO cultural heritage site (UNESCO, 2020).

Smart city development is able to nurture new services in an area, for example, through the creation of urban employment opportunities, the use of resources to attain maximum value, and alongside opportunities for entrepreneurs to engage in business and bring tax revenue for the government (The Ministry of Information and Communications Technology, 2014). Accordingly, there are benefits for a normal city. Given that this research focussed on studying world heritage sites, through undertaking a case study of the historic city of Ayutthaya, the following research question was formulated: Does the development of smart cities affect the quality of life and the management of the world heritage site for tourists and people in Ayutthaya province?

2. RESEARCH OBJECTIVE

To utilise the structural equation modelling (SEM) to analyse how variables associated with smart cities affect the management of world heritage sites and the quality of life among tourists and residents of Ayutthaya province.

3. THEORETICAL BACKGROUND

3.1 Smart cities

Human need for convenience in daily life leads to issues within growing cities such as the pollution of urban communities that arises from human activity. The smart city concept aims to develop cities by using technological systems. Along with protecting the environment to create a pleasant community, smart city technology can be used to reduce pollution in cities. Using sophisticated ICT systems, the smart city seeks current issues in cities and aims to solve them through local cooperation. Various stakeholders have indicated that smart cities should have the following components: smart governance, smart economy, smart mobility, smart environment, smart people, and smart living (Manville et al., 2014). Smart cities use ICT and innovation to maintain a balance between the social economy and the environment. The smart city features 8 important dimensions, namely: smart infrastructure, smart transportation, smart environment, smart services, smart governance, smart people, smart living, and the smart economy (Anthopoulos, 2017). Researchers have concluded that the concept of the smart city delivers modern technological concepts to communities to solve community-based problems by allowing citizens to obtain maximum benefits for their city. Smart cities are concerned with issues related to smart governance, smart economy, smart mobility, smart environment, smart people, and smart living.

3.2 Quality of life

The concept of the quality of life involves the relationship between the individual and the continuation of life events; life activities consist of freedom, knowledge, economics, health, safety, social relationships, spirituality, environment and recreation (Ferriss, 2010). Therefore, the quality of life is the satisfaction, or happiness, gained from the environment and conditions of life (Knopman et al., 2015). Eurostat (2019) indicated that quality of life has the following components: material living conditions, productive or main activities, health, education, leisure and social interactions, economic and physical safety, governance and basic rights, natural and living environment, and overall experience of life. Yonk and Smith (2018) note that quality of life includes education, public safety, health, infrastructure, and the economic environment. The researchers created a synthesis of ideas and found that assessments of quality of life should cover of the following five issues: education, public safety, health, infrastructure, and economic environment.

3.3 World heritage management

The management of World Heritage Cities is considered part of maintaining the culture of countries. The development and management of world heritage cities in various countries requires a specially adapted approach. UNESCO (2013) describes the process of managing World Heritage Cities in the following way, splitting the approach into three main categories and nine elements:

Section One consists of legal frameworks, institutional frameworks, and resources. Section Two concerns planning, implementation, and monitoring. Section Three is about the results; these consist of outcomes, outputs and improvements to the management system. These are the three main categories which are used when managing world heritage cities on a macro level.

Finally, the researcher conducted a literature review concentrating on three latent variables for this study, namely: smart cities, world heritage management and quality of life, as well as investigating a further 14 observed variables: smart mobility; smart economy; smart environment; smart people; smart living; smart governance (Giffinger et al., 2007; Manville et al., 2014); planning; implementation; monitoring (UNESCO, 2013); public safety; health, infrastructure; education; and the economic environment (Yonk and Smith, 2018).

4. RESEARCH METHODOLOGY

4.1 Population and sample size

This research aimed to investigate two groups, namely villagers and tourists, in the Phra Nakhon Si Ayutthaya World Heritage site area. A sample size was calculated that would allow analysis through structural equation modelling (SEM), which requires a sample size between 10 and 20 per single parameter (Kline, 2016). This research was composed of 3 latent variables and 14 observed variables; therefore, this research used 17 variables, thus necessitating a sample size of $20 \times 7 = 340$. The researcher calculated the reserve rate for incomplete query events as being 20%. The questionnaire calculation was incomplete - as follows: $340 \times 20/100 = 64$. Accordingly, the research target group produced a sample size of 404. Quota sampling was applied to the villagers and tourist groups because the researcher needed to calculate the difference in the results between villagers and tourist groups; this provided a sample size of 202 respectively per group and used an accidental sampling technique.

4.2 Validity and reliability of the research instrument

The researcher applied two methods for checking validity and reliability. The initial stage entailed the evaluation of the Index Objective Congruence (IOC) by three experts, one each from the fields of Public Policy, Public Administration and World Heritage Site Management. The results indicated that all questions exceeded the value of 0.5, meaning that the IOC was passed. The subsequent stage checked reliability using the Cronbach's Alpha method in Table 1, with the questionnaire score being 0.83. As this was greater than 0.80, this may be considered a better score (George and Mallery, 2010).

Table 1: The Reliability of Data

Factors	Reliability Statistics (Cronbach's alpha score)	Index
Smart cities	0.83	Better
World heritage management	0.65	Acceptable
Quality of life	0.72	Acceptable

Table 2 shows the Skewness and Kurtosis check. Data are distributed in normal criteria. The skew values are in the range -0.27 to -0.83 and the high values are in the range -0.66 to 0.91. Finally, in Table 3 a check to Tolerance and VIF found that all variables were normal criteria.

Table 2: The Skewness and Kurtosis Check

Factors	$\bar{X}$	SD	SKEW	KUR
S1	4.44	0.46	-0.68	0.24
S2	4.43	0.49	-0.46	-0.66
S3	4.38	0.41	-0.27	-0.43
S4	4.41	0.50	-0.38	-0.62
S5	4.44	0.44	-0.62	-0.09
S6	4.35	0.56	-0.74	0.09
H1	4.34	0.58	-0.54	-0.47
H2	4.35	0.55	-0.55	-0.38
H3	4.46	0.47	-0.41	-0.62
Q1	4.40	0.44	-0.31	-0.39
Q2	4.41	0.49	-0.46	-0.37
Q3	4.46	0.49	-0.83	0.91
Q4	4.46	0.43	-0.61	-0.08
Q5	4.46	0.47	-0.78	0.18

Table 3: Tolerance and VIF Check

Factors	Collinearity Statistics	
Model 1	Tolerance	VIF
S1	.507	1.972
S2	.503	1.989
S3	.461	2.169
S4	.564	1.772
S5	.536	1.867
S6	.556	1.799
H1	.612	1.633
H2	.579	1.727
H3	.633	1.581
Q1	.595	1.680
Q2	.666	1.501
Q3	.701	1.426
Q4	.604	1.655
Q5	.656	1.524

Representations of meaning in Table 2 and Table 3.

S1	mean	Smart Economy
S2	mean	Smart Mobility
S3	mean	Smart Environment
S4	mean	Smart People
S5	mean	Smart Living
S6	mean	Smart Governance
H1	mean	Planning
H2	mean	Implementation
H3	mean	Monitoring
Q1	mean	Education
Q2	mean	Public Safety
Q3	mean	Health
Q4	mean	Infrastructure
Q5	mean	Economic Environment

4.3 Data collection

The questionnaire was distributed by the researcher to villagers and tourists in the world heritage site area, specifically in Phra Nakhon Si Ayutthaya province. The researcher waited for the respondents to fill in the required information and to return the completed questionnaire.

4.4 Data analysis

The independent factors in the research were the smart city and the management of world heritage cities. The dependent factor was quality of life. This study adopted multiple group SEM analysis (Multiple-SEM) to ascertain if the criteria of the test model were fit for purpose. This required: a Chi-Square index above 0.05; Normal chi-square/DF below 2; SRMR index below 0.10; RMSEA index less than 0.05; TLI index exceeding 0.95, as well as a CFI index above 0.95 (Schumacker and Lomax, 2010; Wang and Wang, 2012; Kline, 2016; Brown, 2015; Finch and Bolin, 2017).

5. RESULTS

The findings have been divided into two parts, pertaining to the single group model and multiple group model results for villagers and tourists.

5.1 Single group model

The results indicate that the single model was a perfect fit with empirical data. All criteria were passed, for example: X^2at 0.08; X^2/df at 1.27; SRMR at 0.02; RMSEA at 0.02; TLI at 0.99 and CFI at 0.98.

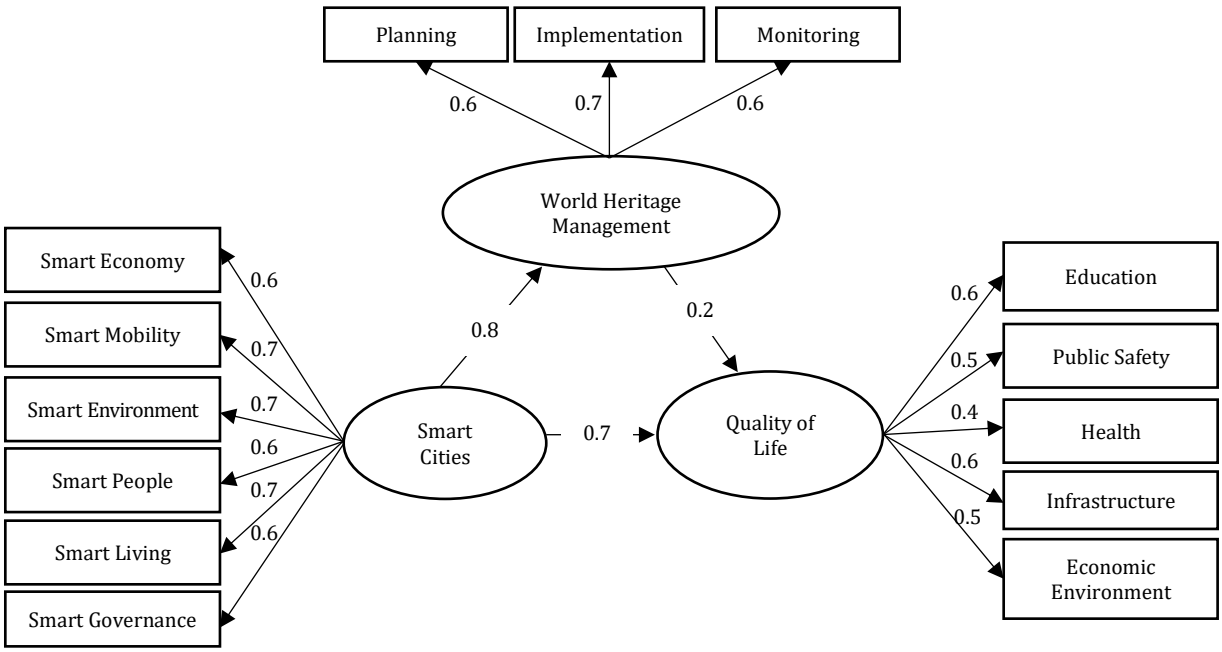


Figure 1: SEM for the Variables Associated with Smart Cities and Their Effects on the Management of the World Heritage Site and Quality of Life

Table 4: Direct-Indirect-Total Effect from The SEM in Terms of How Smart City Variables Affect the Management of World Heritage Sites and Quality of Life

Variables / Influencing variables	World heritage management (WH) (R^2 = 0.64)	Quality of life (QL) (R^2 = 0.82)		
	Direct effect	Direct effect	Indirect effect	Total effect
Smart cities (SM)	0.80	0.70	0.19	0.89
World heritage management (WH)	-	0.24	-	0.24

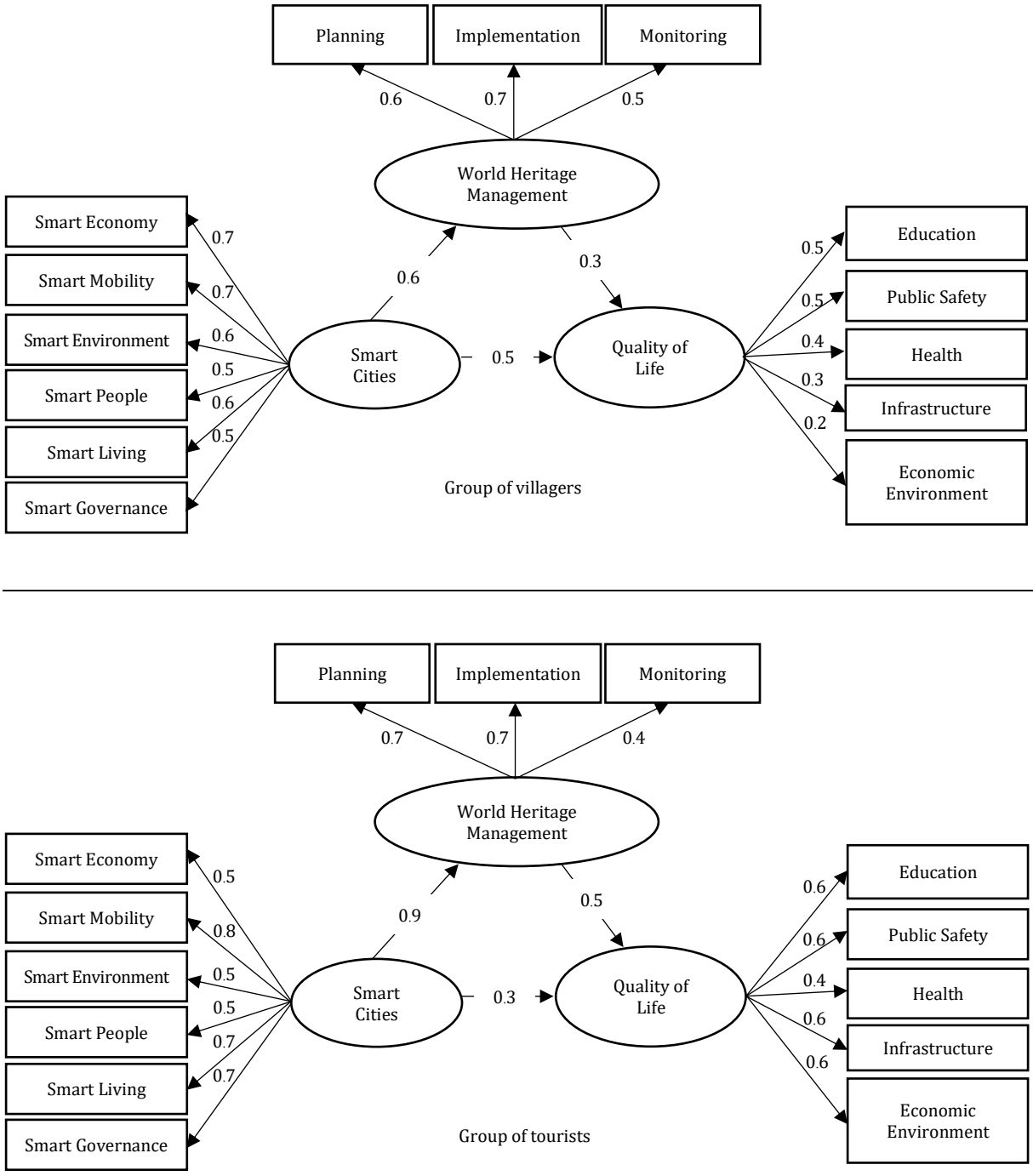
Figure 1 illustrates that the variables associated with smart cities have a strong impact on both world heritage management variables and quality of life variables. However, Table 4 shows that world heritage management variables have little effect on the quality of life variables.

5.2 Multiple group model

This model applied multiple group analysis, dividing the two groups between villagers and tourists. The results indicated that the multiple group model was a close fit with the empirical data. All criteria were passed apart from the chi-square index for significance, given that the research method adopted a substantial sample size exceeding the 200 - 300 sample size range. Accordingly, it was difficult to achieve a perfect model fit (Schumacker and Lomax, 2010; Wang and Wang, 2012; Hair, 2014; Brown, 2015; Kline, 2016). Nevertheless, the test achieved X^2 at 0.00, X^2/df at 1.46, SRMR at 0.05, RMSEA at 0.04, TLI at 0.96 and CFI at 0.98.

Figure 2 shows evidence that the tourist group and villagers group show scant difference in terms of the SEM for the impact of variables associated with smart cities on the management of the world heritage site and on the quality of life for tourists and villagers in Ayutthaya province. Furthermore, Table 5 shows that smart city variables were found to have a greater effect on the management of the world heritage site among

the tourists compared to the villagers. Moreover, variables associated with smart cities were found to have a greater impact on the quality of life experienced by villagers rather than that experienced by tourists.



Chi-Square = 128.88, Chi-Square/df = 1.46, df = 88, p-value = 0.00, RMSEA = 0.04, CFI = 0.98, TLI = 0.96, SRMR = 0.05 (Group of Villagers WH R2= 0.46, QL R2=0.62) (Group of Tourist WH R2= 0.81, QL R2=0.81)

Figure 2: The Multiple-Group SEM for the Impact of Variables Associated with Smart Cities on the Management of the World Heritage Site and on the Quality of Life for Tourists and Villagers in Ayutthaya Province

Table 5: Direct and Indirect Effects from The Multiple Group SEM in Terms of How the Variable Associated with Smart Cities Affect the Management of the World Heritage Site and the Quality of Life for Tourists and Villagers in Ayutthaya Province

Variables / Influencing variables	World heritage management (WH)		Quality of life (QL)					
	Villagers	Tourist	Villagers	Tourist	Villagers	Tourist	Villagers	Tourist
	Direct effect		Direct effect		Indirect effect		Total effect	
Smart cities (SM)	0.68	0.90	0.53	0.39	0.22	0.47	0.75	0.87
World heritage management (WH)	-	-	0.32	0.53	-	-	0.32	0.53

6. CONCLUSION AND DISCUSSION

It is evident from the research that the management of world heritage sites and quality of life are directly impacted by smart cities. However, the research has identified similarities and minimal disparities between thought processes, and perspectives, in two different groups: villagers and tourists. Developing an ancient city into a smart city is essential if society wishes to integrate new technology to improve daily life. Simplicity is pivotal in order to apply this to the life of an individual citizen. The role of the Thai government must ensure that developing a policy on Ayutthaya, the world heritage site, must include smart mobility and smart living. This can improve the local economy, living standards and transportation around Ayutthaya city. The latter is highly relevant as there is a requirement in the city to improve transportation, and convenience whilst also making a more robust effort to limit air pollution. Therefore, there is potential for the Ayutthaya World Heritage site to introduce a tram system that would run around the city and which would thus improve the current public transportation system. Additionally, the management team of the world heritage site should seek to incorporate the variables associated with smart cities with a strategic plan for improving the historic city of Ayutthaya. This result is supported by Borda and Bowen (2017) who state that cultural heritage plays an essential role in the development of the fabric of smart cities. Akram et al. (2016) cite the case of Évora City where Portugal's conservative system was the main driver in the city's smartization and management process. This enabled the city to achieve sustainable development by focusing on the smart city; this was significant for the wider community. Rapid global development has allowed world heritage sites to receive protection as well as improvement through the introduction of new technology for the next generation. Finally, this research has demonstrated that the variables associated with smart cities have a strong effect on the management of the world heritage site and on the quality of life in Ayutthaya.

7. RECOMMENDATIONS

The policy recommendations, based on the research findings detailed above:

7.1 Smart mobility policies

Thailand's government is recommended to pursue the development of Ayutthaya province in accordance with smart city principles. The Ministry of Transport and Ministry of Pollution Control should collaborate on pursuing smart mobility policies, for example, through the introduction of an electric tram system and electric vehicles to help save energy. Such a strategy would improve both the environment and the health of its citizens.

7.2 Education policies

The Ministry of Education should integrate knowledge of the world heritage site and smart city principles into the curriculum in order to support the future development of students.

7.3 Policies concerning the development of the historic city of Ayutthaya

The Department of Historical Parks should amalgamate smart city principles into its strategic plan for developing the historic city of Ayutthaya. Such a policy would enhance the quality of life for the people in Ayutthaya province.

7.4 Future study

The study should be added to the body of literature on World Heritage Sites within Thailand to assist in exploring the different factors that affect the transition of World Heritage cities to smart cities, and to assist in identifying whether there are any new factors involved, or not.

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