

## **The Main Component of Smart Tourism: A Principal Component Analysis Approach**

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*Received March 23, 2021; Accepted July 20, 2021*

*ISSN: 1735-188X*

*DOI: 10.14704/WEB/V18I2/WEB18322*

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### **Abstract**

**Introduction:** The establishment of a smart tourism model is indispensable for the effectiveness of tourism development and management supported by advances in information and communication technology. The successful implementation of smart tourism is determined by the smart tourism model. Determination of the main components has a significant role in building an effective model. **The purpose of this study:** To determine the main components forming a smart tourism model using Principal Component Analysis (PCA). PCA is used to compress variables by reducing the number of dimensions, without losing much information. **Method:** This research method is a quantitative method using SPSS software version 22. **Result:** The result obtained 9 main components, namely stakeholders, infrastructure, goals, resources, activities, challenges, innovation in various applications, strategies, and use of information and communication technologies. **Conclusion:** Those main components are expected to construct a smart tourism model with components that are comprehensive, interrelated, and adaptable.

### **Keywords**

Principal Component Analysis, Main Component, Model, Smart Tourism.

### **Introduction**

Smart tourism is one of the strategies used to increase the number of tourist visitors and state revenue through the tourism sector with the support of technological advances. The

number of tourist visitors is determined by the quality of services in tourism marketing and management. According to Kalbaska *et al.* (2017), some strategies are carried out to improve service quality such as digitization used to promote tourism. Likewise, Ardito *et al.* (2019) define tourism products according to market needs. Meanwhile, technologies provide a significant role in the analysis of strategies for increasing tourist visitors (Shafiee & Ghatari, 2016). They can be implemented properly with the smart tourism model. The model is a system condition that is described to see the current and future conditions to find out the differences between the two that must be met (Kirikova, 2016; Suryasa, 2019). The model is used as a tool to understand the system. Meanwhile, smart tourism is a complex system (Vargas Sánchez, 2016). The system concept in smart tourism is dynamic, that is, it continues to develop in line with developments in technology, methodology, and science. Smart tourism affects the ability to manage and control destination management by placing the right policies. Smart tourism must also have the ability to adapt, both to the natural environment and the social community.

The way to obtain the main components supporting the model is to use PCA. PCA is a statistical technique that collects some interconnected variables in a collection of variables (Tabachnick & Fidell, 2007). The component is part of the model. The appropriate components are needed to build the right model. Each component of the model needs to be consolidated with the other components through a holistic structure (Khan, Woo, Nam, & Chathoth, 2017). Besides, the role of comprehensive and integrated components is required to meet the challenges of developing an efficient model (Weinreich & Sametinger, 2001). Based on that, the purpose of this research is to find the main components that assist in the construction of the smart tourism model. This study used PCA to process questionnaires distributed online data. The questionnaires contained components of smart tourism that have been previously collected through literature review. The result was obtained the main components of smart tourism which can later be used in the construction of a smart tourism model.

## **Research Methods**

The stages in this research were (1) gather the forming components of smart tourism, (2) distribute the online questionnaire, (3) process data of the online questionnaire using PCA, (4) analyze the PCA results. The following is an explanation of the stages of the research process.

### **Gathering of the Forming Components**

The forming components of smart tourism are taken from the components used in model building, model development, and smart tourism applications. The 55 components have been previously collected through a literature review that selected and analyzed 49 articles from 252 articles on smart tourism. To this aim, we used the qualitative analysis software NVivo. The forming components can be seen in detail in Appendix 1.

### **Distribution of the Online Questionnaires**

The questionnaire was distributed to users that using the digital tourism application at the URL <https://tinyurl.com/y9y2uwsz>. Each of the questions on the questionnaire contains components forming smart tourism. The questionnaire was conducted in July 2020. Questionnaire respondents are users of digital tourism applications, whether they make transportation bookings, tourist accommodation transactions, or are they just looking for information or recommendations for tourist attractions. Besides, there are also users as executors, supervisors, and developers of tourism activities, such as government, academic, owner resort, and software developer. By going through the stages of filtering questionnaire filling data, such as repetition of filling in the questionnaire data or incompleteness of the questionnaire answer, 270 respondents (96,4%) were obtained from a total of 280 participating respondents. Furthermore, 270 respondents will be tested with exploratory factor analysis.

### **Data Processing of the Online Questionnaire**

PCA is used in the data processing of this research because PCA is a technique to get the main component that converts some correlated variables into a small number of variables. As the concept of PCA is to reduce the dimensions of a data set consisting of a large number of interrelated variables and to maintain as much variation as possible in a data set (Tabachnick & Fidell, 2007). It is done by converting some variables into a new set of variables which are the principal variables.

Meanwhile, the Kaiser-Meyer-Olkin (KMO) and Bartlett's Test were carried out which are useful to determine the feasibility of a variable, whether the factor analysis technique can be further processed or not. If the KMO value is greater than 0.5 and Bartlett's Test Significance value is less than 0.05, the factor analysis technique can be continued (Tabachnick & Fidell, 2007).

PCA performs the extraction method, and the output is the commonalities table. The commonalities table shows the value of the variable under study whether it can explain

the factor or not. The variable is considered capable of explaining the factor if the extraction value is greater than 0.5. Furthermore, the total variance is explained to determine the number of factors by looking at the Eigenvalue greater than 1. To find out which components are included in the main component, a rotation is performed using varimax with Kaiser Normalization.

### Analysis of the PCA Results

The results of factor analysis and PCA are analyzed to determine what factors are from some factors that have been determined from the results of the varimax with Kaiser Normalization, which are the main components of the smart tourism model.

### Results and Discussion

The 55 components wrapped in variables were tested by factor analysis. The result was KMO and Bartlett's Test's table that the KMO value is 0.945 and Bartlett's Test Significance value is 0.00. Based on the value of KMO and Bartlett's Test, the test was continued to extraction methods in PCA, namely the communalities' table. Based on that, the extraction value for the CL07 variable is 0.451. It meant less than 0.5 so it was unable to explain the factor. The CL07 variable was not used in this factor analysis.

The test was repeated from the beginning without involving the CL07 variable so that there was a reduction of 1 component. The second repetition that used 54 components showed the KMO value is 0.944 and Bartlett's Test Significance value is 0.00. Because the extraction value of all variables in the communalities' table had more than 0.5, all variables can be used to explain the factors. The test was continued to determine the number of factors by obtaining the eigenvalues as described in Table 1.

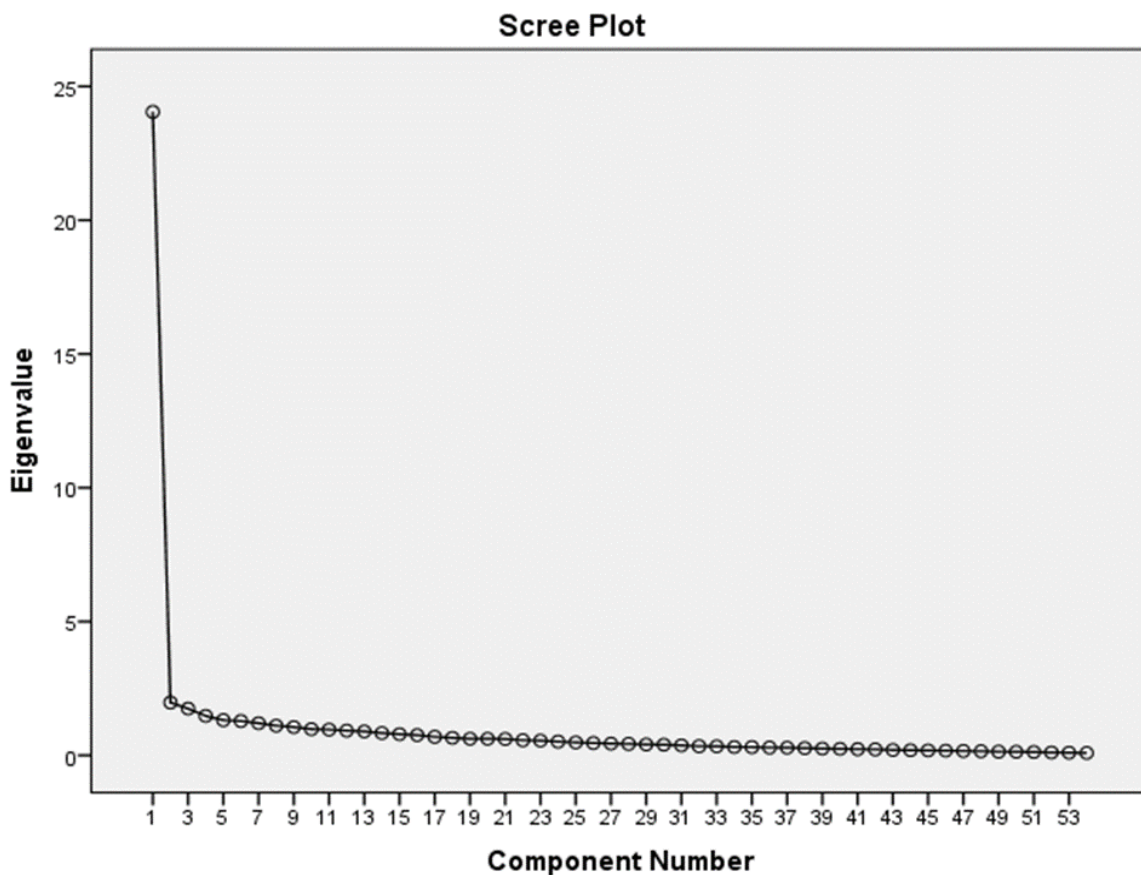
**Table 1 Total variance explained**

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	<b>24.049</b>	44.534	44.534	24.049	44.534	44.534	5.832	10.801	10.801
2	<b>1.973</b>	3.653	48.188	1.973	3.653	48.188	5.182	9.596	20.396
3	<b>1.746</b>	3.234	51.421	1.746	3.234	51.421	4.821	8.927	29.323
4	<b>1.473</b>	2.728	54.150	1.473	2.728	54.150	4.052	7.503	36.827
5	<b>1.315</b>	2.436	56.586	1.315	2.436	56.586	3.922	7.264	44.091
6	<b>1.282</b>	2.375	58.960	1.282	2.375	58.960	3.770	6.981	51.071
7	<b>1.201</b>	2.224	61.184	1.201	2.224	61.184	2.931	5.427	56.498
8	<b>1.109</b>	2.054	63.238	1.109	2.054	63.238	2.592	4.799	61.298
9	<b>1.056</b>	1.956	<b>65.194</b>	1.056	1.956	65.194	2.104	3.896	65.194
10	.978	1.812	67.006						
11	.964	1.785	68.791						
..	...	...	...						
..	...	...	...						
52	.108	.200	99.655						
53	.099	.183	99.838						
54	.087	.162	100.000						

Extraction Method: Principal Component Analysis.

**Table 1** showed the value of each analyzed variable. There were two analyzes to explain the variance, namely the Initial Eigenvalue and the Extraction Sums of Squared Loadings. The requirement to determine the number of factors is if the Eigenvalue greater than one (1). Based on table I, the Total Initial Eigenvalues which are in bold print from the first to the ninth components have an eigenvalue greater than 1. There were nine (9) factors were formed as the principal components. All nine components had a cumulative value is 65.194%. It can be concluded that these factors were able to explain 65.194% of the variation from the data.

**Figure 1** showed the number of factors that were formed. The Scree Plot's figure showed nine components having an eigenvalue of more than 1. It meant 9 principal components can be formed.



**Fig. 1 Scree Plot**

The rotation factor aims to find components that can optimize the correlation between the observed indicators. In this analysis, the varimax rotation factor by Kaiser Normalization was used, as shown in **Table 2**.

**Table 2 Rotated component matrix**

	Component								
	1	2	3	4	5	6	7	8	9
IL01	.112	<b>.670</b>	.177	.177	.160	.084	.180	.117	.145
IL02	.167	<b>.696</b>	.152	.136	.117	.096	.112	.167	.158
IL03	.078	<b>.668</b>	.158	.253	.032	.179	.253	.035	.138
IL04	.111	<b>.648</b>	.143	.234	.059	.223	.275	.252	-.118
RL01	.274	.266	.194	<b>.585</b>	.177	.121	.094	.147	-.076
RL02	.234	.255	.127	<b>.517</b>	.343	.122	.075	.119	.051
RL03	.075	.409	.035	.402	.311	.212	.012	.095	<b>.435</b>
RL04	.124	.240	.229	<b>.608</b>	.235	.170	.128	.107	.075
RL05	.339	.269	.128	<b>.636</b>	.151	.159	-.058	-.009	.084
RL06	.177	.183	.152	<b>.568</b>	.120	.249	.285	.246	.044
RL07	.110	.093	.191	.330	<b>.659</b>	-.075	.157	.171	.062
CL01	.028	.103	.030	.188	.021	.024	.074	<b>.658</b>	.177
CL02	.156	.051	.168	.178	<b>.581</b>	.253	.222	.137	-.020
CL03	.149	-.006	.258	.457	.174	<b>.504</b>	.203	.207	.188
CL04	.340	.229	.174	.290	.043	<b>.634</b>	.158	.152	.016
CL05	.137	.153	.185	.135	.210	<b>.645</b>	.018	.158	.139
CL06	.147	.132	.114	.181	<b>.536</b>	.400	.147	.089	.244
CL08	.334	.262	.144	.260	.146	.172	.187	<b>.445</b>	-.214
CL09	<b>.521</b>	.079	.134	.228	.038	.318	.039	.395	.019
CL10	.237	<b>.492</b>	.072	.182	.404	.225	-.042	-.083	.137
GL01	.234	.361	<b>.453</b>	.216	.010	.388	.168	-.044	.165
GL02	.103	.343	.414	.122	<b>.440</b>	.238	.102	-.146	-.072
GL03	.263	.314	.271	.253	.206	<b>.552</b>	.247	-.134	.058
GL04	.325	.342	<b>.518</b>	.063	.175	.241	-.009	.275	-.074
GL05	.325	.182	<b>.437</b>	.101	.226	.366	.170	.215	.053
GL06	.391	.255	.337	.153	.155	<b>.422</b>	.094	.142	.076
SL01	.253	.195	<b>.377</b>	-.005	.240	.335	.252	.121	.370
SL02	<b>.505</b>	.352	.156	.292	.395	.081	.039	.100	.049
SL03	<b>.653</b>	.016	.183	.284	.180	.285	.120	.144	.090
SL04	<b>.495</b>	.179	.006	.087	.454	.278	.222	.191	.033
SL05	<b>.655</b>	.210	.350	.123	.144	.178	.200	.103	.012
SL06	<b>.676</b>	.133	.123	.175	.094	.088	.267	.055	.267
SL07	<b>.631</b>	.239	.262	.188	.106	.199	.190	.140	.220
SL08	.386	.307	.284	-.046	.307	.277	-.103	<b>.400</b>	.319
SL09	.201	.072	.317	-.024	.262	.156	.109	<b>.630</b>	.093
SL10	<b>.395</b>	.219	.381	.164	.189	.257	.302	.286	.044
AL01	.210	.237	.156	.007	.033	.104	.274	.233	<b>.632</b>
Component	1	2	3	4	5	6	7	8	9
AL02	.287	.302	.243	.051	.199	.208	<b>.605</b>	.237	.266
AL03	.295	.342	.052	.138	.339	.346	<b>.462</b>	.174	.093
AL04	.284	.396	.175	.112	.241	.110	<b>.572</b>	.119	.046
AL05	.229	.323	.336	.232	.121	.120	<b>.574</b>	.014	.215
AL06	.245	.375	.295	.233	.366	.025	<b>.426</b>	.027	.101
AL07	.272	.243	.223	.120	<b>.476</b>	.324	-.062	.337	.252
OL01	<b>.450</b>	.213	.321	.277	.133	.140	.283	.161	.351
OL02	<b>.500</b>	.272	.210	.269	.406	-.052	.143	-.005	.089
OL03	<b>.452</b>	-.022	.332	.322	.284	.134	.090	.001	-.008
OL04	.324	.170	.204	.173	<b>.401</b>	.265	.167	.201	.387
OL05	<b>.421</b>	.451	.268	.115	.086	.155	.077	-.003	.272
OL06	.159	<b>.492</b>	.514	.121	.170	-.030	.179	.241	.130
OL07	.311	.206	<b>.515</b>	.251	.280	.187	-.054	.054	.297
OL08	.196	.141	<b>.587</b>	.367	.116	.086	.349	.015	.109
OL09	.234	.190	<b>.560</b>	.355	.102	.239	.160	.007	.213
OL10	.144	.098	<b>.624</b>	.101	.131	.153	.093	.244	.018
OL11	.218	.188	<b>.500</b>	.306	.125	.166	.258	.183	.223
Extraction Method: Principal Component Analysis.									
Rotation Method: Varimax with Kaiser Normalization.									
a. Rotation converged in 13 iterations.									

To make sure a variable is included in a certain main component so can be seen that the greatest correlation value of the variable against the components formed. In table 2, the greatest value of each variable is bold. The bold variables are grouped into each main component. Collecting the bold variable into the group of each main component as shown in table 3.

Each constituent components' name in table 3 that described the constituent components came from the questionnaire. A description of the constituent components' names can be seen in appendix 1.

**Table 3 Summary grouping of each main component**

<b>Main Component</b>	<b>Constituent components</b>	<b>Name of constituent components</b>
1	CL09, SL02, SL03, SL04, SL05, SL06, SL07, SL10, OL01, OL02, OL03, OL05	crisis management, human empowerment, engagement stakeholder, market competition, policy regulation, integration coordination, collaboration co-creation, innovation creativity, tourism industry, small-medium entrepreneurship, community, academic
2	IL01, IL02, IL03, IL04, CL10, OL06	physical infrastructure, technological infrastructure, data infrastructure, network infrastructure, smart character, visitors
3	GL01, GL04, GL05, SL01, OL07, OL08, OL09, OL10, OL11	economic growth, visitor business transaction, digital technology, citizen, netizen, volunteers, millennials, media
4	RL01, RL02, RL04, RL05, RL06	human resources, IT resources, information resources, social resources, knowledge resources
5	RL07, CL02, CL06, GL02, AL07, OL04	tourism resources, demand and expectation, controlling, satisfaction, entertainment application, government
6	CL03, CL04, CL05, GL03, GL06	collaboration, transformation, digital development, digital services, monitoring sustainability
7	AL02, AL03, AL04, AL05, AL06	application model, information application, a navigation application, recommender application, social media
8	CL01, CL08, SL08, SL09	funding, privacy security, tourism experience, entertainment
9	RL03, AL01	data resources, ICT based applications

Based on table 3 the construction of each main component is analyzed through the constituent components. After that, the names of each main component are given according to the function or activity of the constituent components. Here are the names of the main components:



1. Stakeholders; Stakeholders make strategies and carry out activities related to smart tourism. The stakeholders of tourism that consist of the tourism industry, Small Medium Enterprises (SMEs), communities, and academics play a role in the sustainability of tourism. Strategy, policy, creativity are activities that make stakeholders collaborate and coordinate with each other in tourism management, It then describes the tourism design system as a general framework, followed by a discussion on the nature and role of smart tourism in enhancing this framework. The article then introduces the Curated Series on Tourism Design by identifying a group of articles published in the Journal which address many essential issues shaping the future of the tourism industry (Gretzel et al., 2015; Kalbaska et al., 2017; Polese et al., 2018; Zheng Xiang, 2021).
2. Infrastructures; Infrastructure developments are influenced by developing technologies that are used to make it easier for tourists to visit a tourism destination. Academics provide ideas, especially in IT infrastructure development, consequently rendered infrastructure and amenities along the waterfront obsolete. This dynamic indicates that while ruins often denote the reversal of development, development itself can prompt decay and disintegration, too. (Kontogianni and Alepis, 2020; Mia M. Bennett, 2021).
3. Goals; A smart tourism goal is to increase economic growth and facilitate tourist transactions supported by technological advances (Barile, Ciasullo, et al., 2017). The digital world perpetrators have a vital role in supporting smart tourism's success by participating in using and socializing applications for smart tourism in the wider community.
4. Resources; Various resources are involved in developing smart tourism, such as human resources, IT, social, and others. The smart city/tourism framework while making propositions of how the technology would evolve and influence the industry. Major issues related to the technology as well as challenges are also discussed, including some misconceptions. (Boes et al., 2016; Koo et al., 2016).
5. Activities; Smart tourism activities are carried out by striving to empower tourism destinations and optimize technologies' use (Cai et al., 2019). The government also controls tourism activities and encourages tourism marketing both nationally and internationally.
6. Challenges; The challenge of smart tourism is collaboration, digital transformation, its developers, and digital services in realizing tourism sustainability (Lim et al., 2017).



7. Innovations in various applications; Smart tourism must be rich with innovations that are contained in various applications tailored to tourists' needs (Gretzel et al., 2015).
8. Strategies; Describe strategies to implement smart tourism such as making applications to provide a quality tourism experience, doing tourism innovation in digital services, and having human resources who can innovate (Polese et al., 2018), (Boes, Buhalis, & Inversini, 2015).
9. The use of information and communication technologies (ICT); Various ICT support the development of smart tourism that can be used in a mobile, such as mobile applications, data sources, and many more (Polese et al., 2018).

## **Conclusions**

The result is nine main components from the PCA process, namely stakeholders, infrastructures, destinations, resources, activities, challenges, innovation in various applications, strategies, and the use of information and communication technologies.

The nine main components provide a cumulative diversity proportion of 65.194%, which means that the nine main components according to respondents' perceptions. In this case, users of digital tourism or smart tourism applications can influence the formation of a smart tourism model by 65.194% and the rest can be influenced by other factors that are not revealed in the research model.

The future work is these result as the main components should be validated by a tourism expert. It is done so that the development of a smart tourism model is following the needs of a tourism destination.

## **Acknowledgement**

The authors would like to thank members of the research team for their contribution and resources in this study. The first author also wishes to thank friends of DIK-UI 2016 and friends of E-government Laboratory for their motivation and encouragement.

## **Funding Information**

This research is funded by “Direktorat Riset dan Pengembangan Universitas Indonesia (Risbang UI)” entitled “Hibah Riset UI 2020 dengan skema Publikasi Terindeks Internasional Doktor (PUTI Doktor 2020)” Nomor: NKB-1471/UN2.RST/HKP.05.00/2020.

## Author's Contributions

Ruci Meiyanti: Selected the topic and analyzed the literature along with proposing and implementing the methods. Dana Indra Sensuse: Supervised the research by reviewing the manuscript iteratively, provided encouraging suggestions and recommendations. Yudho Giri Sucahyo: Contributed to the manuscript review, discussed the research, and gave constructive comments.

## Ethics

The participants are informed that their comments will contribute to a research project and all other authors have read and approved the manuscript and no ethical problem.

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**Appendix 1 Smart tourism component results from a literature review**

No.	Initial	Component	Description
1	IL01	physical infrastructure	transportation, market, smart devices such as mobile technologies, data cards, robots, smartphones, RFID, beacon, NFC, smart cards, sensors, etc
2	IL02	technological infrastructure	AR/VR (Augmented Reality/Virtual Reality), AI (Artificial Intelligence), DSS (Decision Support System), UGC (User Generated Content), NFC (Near Field Communication), QR (Quick Response)
3	IL03	data infrastructure	data storage, data structures, and data types
4	IL04	network/internet infrastructure	Digital network infrastructure such as IoT, sensors, wireless, and wi-fi

5	RL01	human resources	tourism experts, tourism officers, tourism advisers, guide, etc
6	RL02	IT resources	IT resources collaborating with stakeholders will support co-creation and co-production to develop smart tourism.
7	RL03	data resources	knowledge or data about profile destination, database, data warehouse
8	RL04	information resources	information related tourism activities
9	RL05	social resources	The existence of relationships in social interactions, social networks, government, and private relations
10	RL06	knowledge resources	Human resources with their knowledge about natural resources and cultural resources
11	RL07	tourism resources	destinations, attractions, amenities, accommodation
12	CL01	funding	financing/ funds to develop tourism facilities, artifacts
13	CL02	demand and expectation	give the best services or other tourism products that fit the tourists needed
14	CL03	collaboration	cooperation between stakeholders, such as the government and the private, community, academic, etc
15	CL04	transformation	It is necessary to transform the ideas and the concepts into a system and application to make creation among stakeholders.
16	CL05	digital developer	the people develop smart tourism applications such as programmers, analysts, etc
17	CL06	controlling	oversee the tourist visits, market segment, etc
18	CL07	empowerment	lack of people who have a capacity in tourism management or tourism activities
19	CL08	privacy security	data security from hacking, phishing, etc
20	CL09	crisis management	overcome the disaster, epidemic, earthquake, demonstration in the area of tourism destination
21	CL10	smart characters	character refer to smart such as useful, interactive, and as a support for decision making
22	GL01	economic growth	to increase GDP, tax from the tourism sector
23	GL02	satisfaction	the visitors have perceived in happy, enjoy, satisfied because of giving the services, attractions, entertainment, and others
24	GL03	digital services	give information, transaction services, banking, and others using digitalization
25	GL04	visitor business transaction	increasing of visitors from foreign tourists or local tourist and their business transactions
26	GL05	social culture value	give insight, income, cooperation, enrichment culture of local residents, etc
27	GL06	monitoring sustainability	sustainable tourism in ecology, economy, and society
28	SL01	digital technology	tourism activity using technology such as browsing the destination, booking, paying, transaction, reporting, etc
29	SL02	human empowerment	the community, local residents, influencers, and others to intensify the activities of tourism marketing
30	SL03	engagement visitors	hold tourists to come again for a visit or even longer in a tourism visit
31	SL04	market competition	branding, festivals, promotion, etc

32	SL05	policy regulation	make and rung the policy and regulation
33	SL06	integration coordination	integration and cooperation both the application system and the work procedures of various stakeholders
34	SL07	collaboration co-creation	a strategy that involves customers to create product innovation
35	SL08	tourism experience	experience in traveling, culinary, services, activities in destination, etc
36	SL09	digital entertainment	games, animation, videos, etc
37	SL10	innovation creativity	creativities, ideas in tourism action, customization
38	AL01	ICT based apps	ICT-based application is used to support the tourism experience and tourism performance in a smart tourism
39	AL02	application model	various applications in the various models such as smart destination, smart tourists, smart applications, smart technology
40	AL03	information apps	applications that can communicate and carry out their functions to meet the needs of real-time information
41	AL04	navigation apps	application to provide traffic information, plan travel routes, and GPS services
42	AL05	recommendation apps	application for tourists in choosing a destination and show the profile of that destination including both of the situation and condition of tourist destinations and transportation that can be used to visit that destination.
43	AL06	social media	Facebook, Twitter, Instagram, and YouTube, etc
44	AL07	entertainment apps	making applications based on function in tourism activity such as to get information, direction, entertainment, etc
45	OL01	tourism industry	business sectors that can produce goods or services within the scope of tourism travel agents, hotels, suppliers, etc
46	OL02	SME	"UMKM" (small-medium entrepreneurship) in tourism sectors
47	OL03	community	group on people that have characteristic/theme in tourism such as genpi (generasi pariwisata Indonesia=Indonesia of tourism generation), etc.
48	OL04	government	leader, officer, staff, and others in government
49	OL05	academic	lecturer, a researcher in the education sectors
50	OL06	visitors	tourists
51	OL07	citizen	the people in the city, nation
52	OL08	netizen	the people who use the internet in their activities in cyberspace
53	OL09	volunteers	the people who are working with geographic information (geotags, photo objects, descriptions, reviews, and discussions of visited tourist destinations) either to create the new content or edit the existed content.
54	OL10	millennials	the digital generation that is born between 1982 - 2002 is an ICT user who is actively seeking information and very enthusiastic about traveling.
55	OL11	media	Corporate (media) information has a role in the promotion of tourism in a destination.