

Smart Islands: A Systematic Review on Urban Policies and Smart Governance

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Abstract. The purpose of the article is to identify a key analysis able to combine smart governance with urban and place-based dynamics in island contexts. To this end, authors schematize types, classifications, levels of smart performance and also the most common issues and resolutions in island contexts, starting from a systematic review of the terminology studied in the last 11 years. This literature review proposes a systematic approach by analyzing the most well-known databases in scientific research (Google Scholar, Scopus and Science Direct) in order to catalog and systematize the most optimal methodologies and approaches in the study of island contexts. This article shows a first phase of a broader research, and it provides a bibliographic basis to understand how the Smart paradigm can change the normal management perspective of the island territory.

Keywords: Smart island · Systematic literature review · Smart Island definitions · Smart Cities

1 Introduction

Although today the attention to smart island is growing [1–4], the features of island territories need a deepening in urban planning and place-based governance field. Starting from the analysis of smart island definitions, this article wants to understand how urban policy and smart governance are applied and studied in the island territories, in order to find useful guidelines for the definition of optimal standards for the development of the same island contexts. This need emerged because during this study, authors found difficult to find a single definition of the term smart island. In addition, "*the island regions suffer from structural handicaps linked to their island status, the permanence of which impairs their economic and social development*" [5:136]. However, it must be underlined that, although the literature has not yet defined a common criterion for the analysis of a smart island, the European Union has introduced

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in the EU legislation two fundamental indications reserved to the island regions, as highlighted by Garau and Desogus in a recent article [6]. They are:

[a] the "Declaration on Island Regions" annexed to the Treaty of Amsterdam of 1997 [5], in which the structural disadvantages of island contexts are recognized and the application of specific measures are encouraged to further integrate them into the internal market with fair conditions; [b] "Guidelines for integrated actions on the island regions of the European Union" published in 2002 [5], in which the structural indications to undertake an evaluation of the policies to be implemented are highlighted and some characteristics of the structural problems, common to the island regions, are listed.

With these premises, the paper is organized as follows: Sect. 2 reviews the scientific literature on the definition of smart island. Section 3 combined these concepts in order to define a unique main topic on this field. In Sect. 4, the aggregation of all concepts founded, defined in the previous sections, is aggregated for identifying which are the terms that can connect the smart island field to urban policies and smart governance. Finally, the paper concludes by analyzing the obtained results.

2 The Attempt to Frame the Smart Island Definitions

In the light of the emerged information, Table 1 shows a schematic framework of the different definitions of smart island, existing in the scientific community.

The comparison of the different definitions (Table 1) led the authors to define a smart island as a place in which the peculiarities of insularity are valued through the good practices to preserve the sustainable development, with the aim of creating sustainable local economic development and high quality of life, mitigating the negative effects of insularity through the use of information and communications technology (ICT). In other words, a smart island develops the entire territory through the management of infrastructures, the natural resources and the culture heritage; the climate change mitigation and adaptation efforts; finally, the enhancement of tourism and coastal-marine resources that represent the main source of income.

In addition, this comparison allows to find not only the key words best suited to the concept of smart island, but also common issues and solutions. Table 2 shows the outcome of the research and a first schematization of the main components that characterize the most widely used terminology associated with the smart islands concept. They are: "Sustainability Island", "Insular Territories", "Smartness and Island", "Smart City and Insular", "Island Urban Planning", "ICT Island", "E-government Island". From the comparative analysis of the definitions (Table 2) three fundamental points emerge:

[a] although there are several projects under the smart island paradigm, a standardized definition - that describes its relationship with urban policies and governance - does not yet exist;

[b] the six dimensions typical of the smart city (economy, mobility, governance, environment, living and society) are respected and used. However, new questions are imagined in order to implement the six pillars with issues closely related to insularity (for example, coastal and marine resources, tourism);

Table 1. Definitions of smart island

Author	Definition
(2013) SMILEGOV Project Multi-level Governance [7]	"An insular area […] creates sustainable local economic development and high quality of life by excelling in multiple key areas of sustainability" [7]
(2015) Opinion of the European Economic and Social Committee [8] TEN/558 Smart Island [9]	"With the term « smart islands » , the EESC is specifically referring to an insular area that creates sustainable local economic development and a high quality of life by excelling in multiple key areas of sustainability" [8:3] [9:3]
(2015) EE-Spanish government project [10]	"The objective is to finance initiatives that integrate smart island strategies, contribute to the improvement of public services in the territory, and are aimed at mitigating the negative effects of insularity through the use of information and communications technology (ITC)". [11]
(2016) Smart islands projects and strategies [12]	"The definition of an island as smart relates to its ability to implement integrated solutions to the management of infrastructures and natural resources, namely energy, transport and mobility, waste and water, all while promoting the use of innovative and socially inclusive governance and financing scheme" [12:11]
(2016) Smart islands declaration [13] Smart island initiative [14]	"Define a smart island as an insular territory that embarks on a climate resilient pathway, combining climate change mitigation and adaptation efforts, in order to create sustainable local economic development and a high quality of life for the local population by implementing smart and integrated solutions" [13:2, 14]
(2017) Pantazis et al. [15]	"The term smart sustainable island […] has the same meaning with the term smart sustainable city, but in addition: (1) it refers to the entire region of an island and not to a specific city (2) the term "sustainable" means that the entire island follows all the good practices to preserve the sustainable development and the protection of the environment, natural and urban, including the culture heritage in a holistic and integrated manner" [15:47]
(2017) Dominguez et al. [16]	"An island is an ecologically isolated self-contained territory with a principal and network of smaller cities and villages. In many islands, in recent decades, tourism has formed the main source of income" [16:236]
(2018) Herrera Priano et al. [17]	"The main scientific contribution of The Model for the Smart Development of Island Territories is to define an initial model that considers the significance of the

(*continued*)

Table 1. (*continued*)

Author	Definition
	Smart effect for both governments and cities as part of a regional/territorial development scheme" [17:23]
(2018) Garau et al. [6]	A "smart island is […] a territory capable of responding to structural problems related to insularity, also through a network of relationships that have as main points the structural characteristics of the place" [6]

Table 2. Overview of terms used in smart island definitions

	Local Development	Quality of life	Instruction	Human capital	Culture heritage	Tourism	Public services	Governance	Protection landscape	Coastal marine resources	Sustainable Development	Climate	Mobility	Economy	Energy	Environment	Water	Waste	ICT	Smart city comparison
[10]	X	X		X				X					X	X	X	X				
[11] [12]	X	X	X	X				X			X		X	X	X	X		X	X	
[13] [14]						X	X		X										X	
[15]								X	X	X			X	X	X	X	X	X	X	
[16] [17]	X	X						X				X	X	X		X			X	
[18]			X		X	X				X	X		X	X						X
[19]		X													X				X	
[20]	X						X													X
[7]	X			X				X		X	X	X	X	X	X	X	X	X		

[c] most of the analyzed projects highlight a strong use of e-governance and its application through Information and Communication Technologies (ICTs), by promoting the Islands' competitive development [18–20].

The terms derived from the smart island definitions (Table 2) allowed to identify some key words that integrate the smart island concept, such as smart governance and urban policies. Therefore, authors decided to extend the search for a terminology that links these three terms, through a literature revision that has already used these keywords: Smart Island, Sustainability Island, Insular Territories, Smartness and Island, Smart City and Insular, Island Urban Planning, ICT Island, E-government Island. The purpose of this research was in fact to determine if a suitable terminology exists in

literature, capable of encompassing the three terms just mentioned (smart island, smart governance and urban policies).

2.1 Literature Review Methodology

In the review of the scientific literature a systematic approach is adopted [20]. The keywords, summarized and identified in Table 3, were searched in the main databases (Google Scholar, Scopus, Science Direct) through a time filter from 2007 (because it is the year in which the smart cities term started to be used in the current meaning [21]) to 2018. Table 3 shows the results of the research, where, after a preliminary analysis and after having eliminated the repeated items, 203 articles were obtained. Of these, 90 articles were open access.

Table 3. Result of the search from Google Scholar, Scopus and Science Direct databases

Termini	Articles for each database			Total number	Total number (excluding duplicates)
	Google Scholar	Scopus	Science Direct		
Smart Island	16	22	8	46	43
Sustainability Island	100	25	3	127	121
insularTerritories	2	2	0	4	3
Smartness and Island	0	0	0	0	0
Smart City and Insular	1	0	0	1	1
Island Urban Planning	10	4	1	15	15
ICT Island	6	1	1	8	8
E-government Island	11	2	0	13	12

Then, titles and keywords are evaluated in order to understand which documents faced the smart island paradigm in relation to the sought concepts (Sustainability Island, Insular Territories, Smartness and Island, Smart City and Insular, Island Urban Planning, ICT Island, E-government Island). In this way, 33 articles were selected.

A further selection was made after reading the abstracts, thus arriving at 16 documents, totally reviewed in full. This work allowed to put together information on the tools and performances adopted in the smart islands. Nine papers were selected. Table 4 summarizes these nine papers selected and for each one identifies the purpose, the methodology adopted, the tools used and how the urban performance was analyzed.

The literature study highlights that 4 articles [15, 16, 23, 27] present methods and tools able to connect insular contexts with smart governance and urban policies. This shows how the three terms (smart island, smart governance and urban policies) are linked through the objectives and methodologies expressed in Table 4 despite their

Table 4. A literature review of the concept of smart island

Papers	Aim	Methodology	Tools	How the Urban performance is analyzed
1. [22]	After identifying the main sustainability issues of EU islands, authors argue for a stronger awareness of islands issues in EU policy processes. In particular, they identified three issues: (a) many islands are excluded from the definition of EU Islands; (b) many islands do not fit into categories provided in the EU's impact assessment guidelines; (c) there is no statistical data for monitoring sustainable development in EU insular regions	**SENSOR protocol** it is based on surveys in the 4 SENSOR sensitive regions, that can be summarised as follows: coastal, post-industrial, mountainous and islands	Sustainability Impact Assessment Tools (SIAT) to support decision-making on policies related to land use (European FP6 funded project SENSOR3)	It identifies the location of EU islands based on a spatial dataset, and elaborates a set of European island sustainability issues that are identified through expert interviews
2. [23]	The objective is the urban sustainability, in order to improve the quality of life. From this investigation and strategies, authors analysed best practice	**Q METHODOLOGY** It is organised as follows: (1) semi-structured interviews (2) The data collected are then processed through the Principal Component Analysis (PCA), (3) their results are translated in factors as groups of opinion or social perspectives	(1) semi-structured interviews (2) PCA (see methodology section)	The authors chose different indicators of urban sustainability (they are: 1. the city's current development level; 2. public security; 3. environment; 4. culture and education; 5. economy; 6. funding; 7. governance; 8. migration; 9. public 10. participation and poverty)

(*continued*)

Table 4. (*continued*)

Papers	Aim	Methodology	Tools	How the Urban performance is analyzed
3. [24]	The main objectives are: (i) the analysis of the ICT developments in Samoa, (ii) how implementing these ICT developments (iii) which strategies are necessary for Samoa	**Qualitative methods** through interviews of key stakeholders in the ICT sector in Samoa	(1) semi-structured interviews	The interviews are compared (a) with the World Bank Infodev framework (2005) and also (b) with the Regional framework for action on ICT
4. [25]	The main objectives are: (i) developing an integral model which incorporates the factors and key processes of a socio-ecological system, (ii) defining the most relevant sustainability indicators in the case study of El Hierro	**Fuerteventura sustainability model (FSM)** The methodology is an integral dynamic model, combined with other methods (indicators, policy and scenario analysis)	The FSM was constructed following the system dynamics methodology and using the Vensim software	A set of sustainability indicators is integrated in the sustainability island model. FSM is constituded by nine macro variables
5. [26]	The aim of this study is to investigate patterns of landscape changes in small islands (such as Gili Matra Islands, Lombok, Indonesia)	**Patterns of land use/land cover (LU/LC)** Authors use different images in different years (from 2010 to 2014) in order to understand landscape change pattern	(1) Satellite images QuickBird in 2010 and GeoEye in 2014 (2) Geographic Position System (GPS) (3) ArcGIS 10.2.2	The authors layered different satellite images
6. [27]	The aim of this study is to estimate the effects of e-government (e-G) development on environmental sustainability in Small island developing states (SIDS)	**three empirical models** 1. model estimates the impact of (e-G) development on government effectiveness 2. model for estimate the impact of e-G on	Authors examined every model with the Wooldridge test for autocorrelation, with the Breusch-Pagan test and White's test for heteroscedasticity. They detected autocorrelation and	Performance is assessed throught e-government development index. Authors established the equation to estimate the effects of e-government on government effectiveness and a

(*continued*)

Table 4. (*continued*)

Papers	Aim	Methodology	Tools	How the Urban performance is analyzed
		environmental sustainability; 3. model for estimate the impact of e-G development on environmental sustainability	heteroscedasticity in any models, in order to apply feasible generalized least squares to correct the autocorrelation and heteroskedasticity	second equation estimates the effects of e-government on environmental sustainability
7. [16]	The aim is to create a theoretical and practical conceptualization of smart island, using the case study of El Hierro (Canary Islands, Spain)	**Theoretical and practical conceptualization** The methodology is	Authors used the case study as a research method. This study considers as smart prototype the Hierro Island. The used tool is (a) literature review and (b) the European Smart Cities indicators	Authors considered a set of indicators as a result of the analysis of the different strategies of development of cities and destinations. They define3 groups of 12 key indicators (Smart Gov; Smart Tech, Smart Experience)
8. [15]	The aim of this work is to: (a) have a new concept of "smart sustainable cities" and "smart sustainable islands" (b) have a methodological framework of concepts and actions	**Island smartification and sustainability (S2I2) index** The S2I2 index is used to measure the efficiency of the local authorities	(1) The major part of the ITU index system (ITU 2016) is adopted. (2) The typical used indices or indicators is Key Performance Index (KPI) for Smart Sustainable (green) Cities	Authors create an island smartification and a sustainability index called S2I2. They consider diferent parameters
9. [28]	The aim is considering the complex dynamics of insular territories/regions	**CORINE Land Cover (CLC)** The CLC maps homogeneous landscape patterns (areas smaller than 25 ha are considered and a set of generalization rules were defined)	(1) GIS tools (2) CLC, (3) literature review	Performance is assessed trought three-level hierarchical classification system and trought 44 classes at the third and most detailed level

connection is not explicit. Moreover, none of the articles presented the same tool and it is necessary to underline that 2 of the 9 articles use a series of Smart factors already applied to the now consolidated representation of smart cities through the six classics dimensions: economy, mobility, governance, environment, living, and society [21] to describe the smart islands. These are:

1. Theoretical and practical conceptualization model in [16]: The smart island is divided into indicators by European Smart City and then 12 criteria, inserted in three sets, are identified. These are: (a) Smart Gov (1. The government investments cover the visitors 'needs; 2. Local societies benefit from tourism suppliers; 3. Internet facilities 4. E-Government); (b) Smart Tech (1. Technology for data management; 2. Broadband networks infrastructure; 3. Tourism products and services platform; 4. Sharing Data); (c) (1. Tourism experience exchange; 2. Corporate Citizenship; 3. Improved Smart Management in innovation and participation; 4. ICT services for Smart experience). These criteria were tested through the case study of the Island of El Hierro (Canary Islands, Spain). This appears effective because the article, extending the Smart City paradigms, focuses on the typical characteristics of the island territories. This is important for building a set of easily operational criteria to define a smart island.
2. Island smartification and sustainability (S2I2) index model in [15]: the transition from the concept of smart sustainable cities to smart sustainable islands, led the authors to develop an index for the smartification and sustainability of the islands. Subsequently, a review of the literature on Smart Cities defined 5 main dimensions of smartification that contain different sub-dimensions. These are: (a) ICT and economics (Network Facilities, Information Facilities, Innovation & Opportunities, Economic sustainability, Island Productivity, Tourism); (b) Sustainability of resources (Energy, Water Natural Resources, Environmental monitoring & sustainability); (c) Infrastructure (Building, Transport, Sanitation, Municipal pipe networks, Recycling infrastructures); (d) Quality of life (Convenience & Comfort, Security & Safety, Health care, Education); (e) Company (Openness & public participation, Social sustainability & equity, Governance sustainability).

3 Results: Main Topics on Smart Island Definitions

This analysis shows that the aforementioned articles [15, 16] are the most theoretical ones. This underlines how the search for an optimal definition of smart island leads to a more all-encompassing fragmentation of the same term into indicators. However, in the literature the study of the terms used to analyze the urban policies and the smart governance of the islands is less investigated, even if in these articles the connection of these three terms is not explicit. In other words, what are the terms that can create a comparison between urban governance, urban policies of the smart island territories?

To this end, authors defined the main topics on smart islands, through an in-depth analysis of the 9 revised articles (Table 5).

All articles reviewed contained information on sustainable development and on the environment. The social analysis - that includes "local development", "quality of life",

Table 5. Smart island definitions and the main topics of the revised articles

	Local Development	Quality of life	Instruction	Human capital	Culture heritage	Tourism	Public services	Governance	Protection landscape	Coastal marine resources	Sustainable Development	Climate	Mobility	Economy	Energy	Environment	Water	Waste	ICT	Smart city comparison
[26]			X	X		X			X	X	X	X		X	X	X	X	X		
[27]	X	X	X	X			X	X			X	X		X	X	X				
[28]	X		X					X			X					X			X	
[29]	X			X		X			X		X	X			X	X	X	X		
[30]						X	X		X		X					X	X			
[31]					X		X	X			X	X		X	X	X	X	X	X	
[32]	X	X	X	X		X		X		X	X		X	X	X	X	X	X	X	X
[33]		X	X		X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
[34]	X	X							X		X					X	X			

"instruction", "human capital" - is included in 7 articles: all 4 topics are present in the articles [23] and [16] that show the growth and progress of the cities of Angra do Heroísmo (Terceira island, Azores) and of El Hierro (Canary Islands, Spain).

In summary, the most discussed issues are local development [16, 23–25, 28], quality of life [15, 16, 23, 28], education [15, 16, 22–24] and of human capital [16, 22, 23, 25]. Cultural heritage is also an important topic [15, 16, 22, 23, 25, 26], highlighting several island correlations related to case studies [16, 23, 25] and to the relationship between Insularity and European policies [22].

The environmental analysis (which includes the terms "protection landscape", "coastal marine resources", "climate", "mobility", "economy", "energy", "water", "waste") is, in a different way, included in all articles except in one [24]. It focuses on the use and application of digital technologies. The use of ICT is a predominant theme [15, 16, 24, 27] from the theoretical to the practical conceptualization in terms of e-government and use of digital technology [24, 27], and also in term of theoretical critical analysis on "smartification" [15] and of application to a case study [16]. While a comparison between smart island and smart city was not so a common topic [15, 16].

This analysis led authors to try to understand the possible connections between the keywords of the 9 revised articles and the most used terminologies within them, summarized in Table 2. Figure 1 shows the keywords of the 9 articles, summarized in Table 4 and represented in 8 groups.

The six groups represented with dashed lines show the terms emerged from the analysis of the definitions shown in Table 2. The two groups represented with a

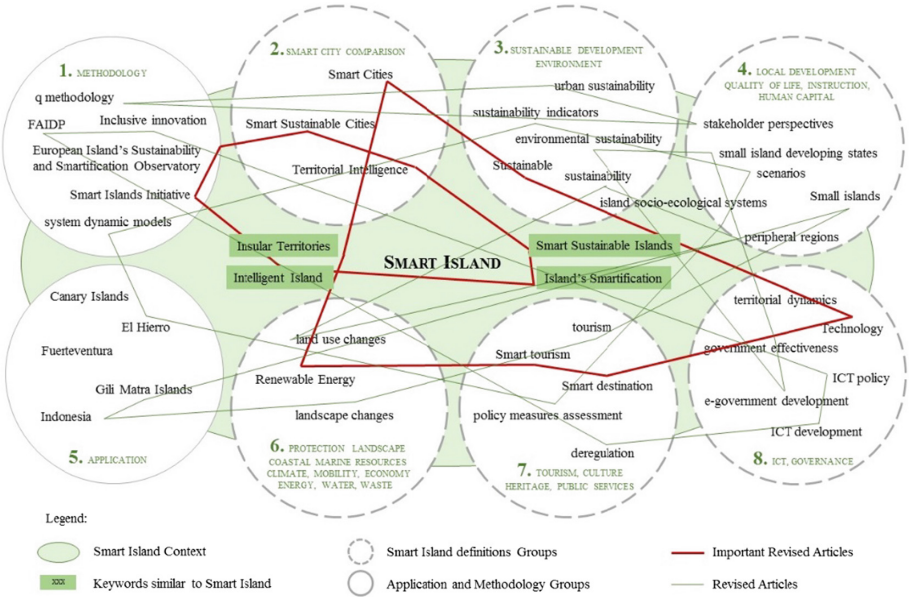

Fig. 1. Smart island definitions and keyword analysis (Color figure online)

continuous line represent the keywords that describe a methodology and the case studies analyzed in the articles. While the keywords that are more similar to smart island terminology are included in the green rectangle, the keywords are joined by green lines representing 8 revised articles, and only an article has no keywords [22]. It is interesting to note that only one article mentions in its key words "Smart Island" [16], and only one article approaches the concept [15], these articles are represented in Fig. 1 by red lines. Even if the other articles [16, 23–28] do not use the specific term "Smart Island" the keywords are all referable to the terms used in Smart Island (Table 2).

4 Discussions: Smart Island Definition Through Urban Performances Analysis

The analysis conducted revealed that there are no keywords, able to identify urban policies and a smart governance of a smart island. For this reason, authors found these keywords through the analysis of the urban performance indicators of the 9 revised articles outlined in Table 4. This is because the authors noted that most of the revised articles analyze the urban performance, through a set of sustainability indicators that, although they consider different parameters, identify insular territorial development strategies.

The objective of this analysis was to determine how the performance indicators of the different articles may highlight one or more terminologies capable of synthesizing and connecting the terms described in Sect. 2 (smart island, governance and urban

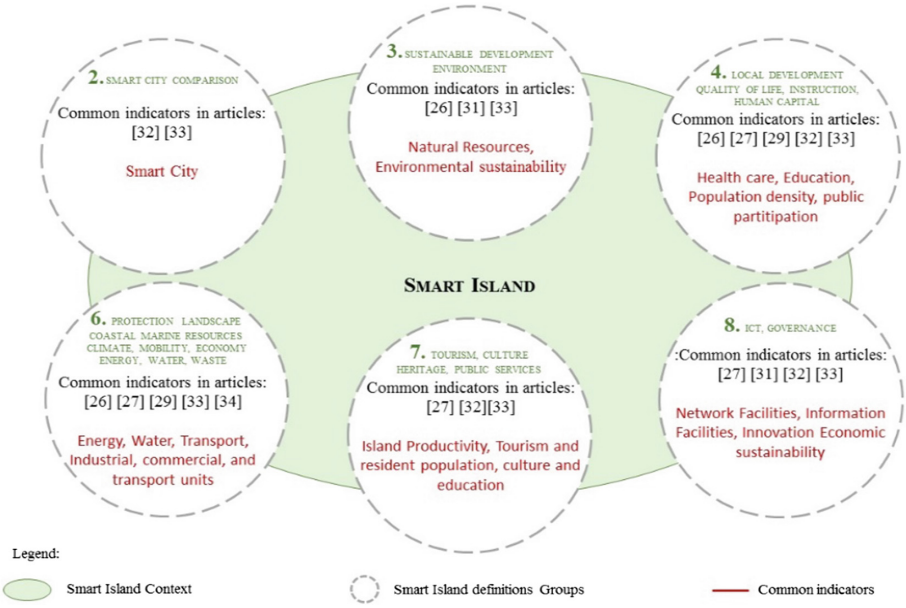

Fig. 2. Smart island definitions and urban performances analysis

policies). In order to achieve this, the authors analyzed which indicators used in the articles can be traced back to the terms derived from the Smart Island definitions (Table 2).

In this regard, Fig. 2 shows that 7 of 9 articles [15, 16, 22, 23, 25, 27, 28] use indicators to define the smart island. Social indicators including "local development", "quality of life", "instruction", "human capital" are used in 5 of 7 articles [15, 16, 22, 23, 25]. Environmental indicators include terms such as "protection landscape", "coastal marine resources", "climate", "mobility", "economy", "energy" and "water", "waste" and they are described in 6 of 7 articles [15, 22, 23, 25, 27, 28].

The other groups have fewer indicators. In summary, terms similar to "sustainable development" and "environment" are used as indicators in 3 articles [15, 22, 27]. "Tourism", "culture heritage", "public services" are used in [15, 16, 23] and terms similar to "ITC" and "governance" become indicators in [15, 16, 22, 27].

The analysis shows that indicators used in [15] are the only ones that include all the terms derived from the definitions. While, as underlined in Sect. 2, a comparison between smart island and smart city is made only in [15, 16]. Furthermore, it is important to underline that in all 9 articles no indicator has been found that cannot be included in one of these groups.

Figure 2 shows the indicators used in the analyzed articles. Figure 2 also shows three distinct sub-categories (territory, governance and environment) in relation to the terms study in relation of the typical features of the islands.

5 Conclusions

This paper presented a detailed review of the terminology, through the analysis of smart island definitions and the literature. The concept of smart island, extensively analyzed in this paper, is therefore represented by the definitions described in Table 1 and by the terms that characterize the urban performance of the projects described in the revised articles (Fig. 2).

In a nutshell, the study of smart island definitions - related to (1) the main topics of the revised articles (Table 5) and to (2) keyword analysis (Fig. 1) - constituted an important basis of analysis to identify which are the terms that create a comparison between the urban performances of the smart island territories. In fact, these last concepts shown that in the revised articles there is, although this is not explicitly, the connection between the urban policies and a smart governance of a smart island.

In this context, authors found that, considering the previous analyzes, it could be possible to have a synthetic indicator of smart island.

Smart Island = Smart city and Smart Territory paradigms (economy, mobility, governance, environment, living, society) + Peculiarities of Islands (insularity, island productivity, tourism, island culture, Coastal marine resources).

Therefore, on the basis of the analysis described, the authors propose 6 keywords that identify the urban policies and smart governance of the smart islands. These are:

(1) Smart island territory and smart insular territories.
(2) Smart island government and smart island local development.
(3) Island Sustainable Development and Island Environment.

The condition of insularity must be the basis of each term because it serves to identify the typical characteristics of the islands. The used terms represent a schematization of how a territory, through a smart paradigm, is able to respond to the common problems related to insularity.

In other words, these allow to identify issues related to the territory, governance and sustainability for an intelligent insular context.

Moreover, this paper established the basis for a future comparison of the maturity of the smart island and the identification of the synthetic indicator above-mentioned.

In fact, considering that all the revised articles make quantitative analysis, the performance measurement and the identification of a synthetic indicator are necessary preconditions to study the smart island.

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