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REGULATION AND LOCAL INITIATIVE FOR THE DEVELOPMENT OF SMART CITIES - SUSTAINABLE PENTA-HELIX APPROACH

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Abstract- The development of smart cities requires a global reflection that takes into account all the concerns of the smart city. With urban sprawl and other urban planning phenomena, it is crucial to identify appropriate and frugal assessment methodologies. This paper originally comes to assess the maturity of local regulation with respect to the smart city concept; this assessment revealed that local regulation has significant limitations, something that can block the emergence of smart city sub-concepts. The perceived limits at the level of local regulations, pushed us to identify and evaluate the initiatives of the smart city initiated in a well-determined territory (Casablanca Smart city), for this purpose, a matrix is developed to assess the maturity and compliance with sustainability, this double assessment comes to show the possible complementarity between the regulators and the local initiative.

Keywords: Frugal Smart City, Sustainable-Penta-Helix Approach, Evaluation Matrix, Governance.

1. INTRODUCTION

More than 193 states in 2015 signed commitments relating to the 17 Sustainable Development Goals (SDGs) that are assigned on the 2030 Agenda, [1] in 2016, another pact on climate commitment, was presented during the COP 22 "COP of Action", to establish a new multilateral and cooperative model for the climate [1]. Both international commitments highlighted the importance of resilient and frugal sustainable urbanization through international and national goals [1].

In 2050, the phenomenon of urban spread will leave two out of three people in cities or other urban centers [2]. The city contributes to the order of 80% in the global BIP, this contribution is often limited by urban phenomena, and these issues have given rise to reflections on the transformation of the current city to a more efficient and smarter city [2, 18]. Urban sprawl, lets us discover the limits of current governance facing several dimensions of the city (Health, Governance, Transport, etc.), the reason why we see the transformations of cities towards smart cities as being an innovative approach of urbanization [2].

Morocco will grow to 44 million citizens in two decades against 30 million in 2014, Moroccan cities are facing significant demographic growth, in 2050 Moroccan cities will accommodate more than 73% of the population.

The transformation of cities presents itself as a major challenge, especially for emerging countries, which are suffering from the impact of urban phenomena. Adding to that the difficulty of investing in a difficult economic situation characterized by negative growth due to COVID 19. African cities are in the dilemma of accepting the impact of urban phenomena or investing in transformation and migration to a new form of city. This transformation requires significant reflection in relation to the effectiveness of the investments that will be undertaken; sustainability imposes other challenges on us in decision-making. Smart cities and especially frugal smart cities are coming today to rethink our way of seeing the city [3]. The city of Casablanca suffers from several problems in the employment of the frugal smart city project; this is mainly due to the current mode of governance [4]. The frugal smart city puts society at the core of these concerns while respecting the principles of sustainable development, any transformation project requires a diagnosis before prioritizing and describing the actions to be taken.

This paper focus on the analysis of local or provincial and territorial regulations in relation to the concept of the smart city as well as the complementarity with local initiatives (Case of Casablanca-Morocco) within the framework of the Sustainable-Penta-Helix approach (Citizen, Government, University, Industry, Society, Sustainability).

2. SMART CITY AND REGULATION

As of today, there is no compromise on the definition of the smart city, nor on the concept of the frugal city, which makes the implementation differ from the city-to-city [5, 6]. The city is presented as a complex and unique mechanism [5], the reason why the deployment of a smart city project requires standard implementation mechanisms; several approaches can be used to ensure this standardization for example (Standards, regulations and many other mechanisms) [7].

The frugality and intelligence of a city can be seen in its ability to actively interact with its stakeholders, as well as to efficiently manage the resources in place, whilst taking into account the current and future needs of society [5, 6].

Any project implementation requires a diagnosis that serves to enhance the existing situation, while reflecting possible failures, the regulations present common ground between all the cities[5, 6]. This point in common can serve as a basis for diagnosis, at the level of this paper we will focus our analysis on the maturity of local regulations in relation to the concept of the smart city, as well as the maturity of local initiatives initiated within the framework of the project of the smart city [2, 8, 9].

The R. Giffinger model comes to define the smart city as an interaction between several sub-concepts [10, 11].

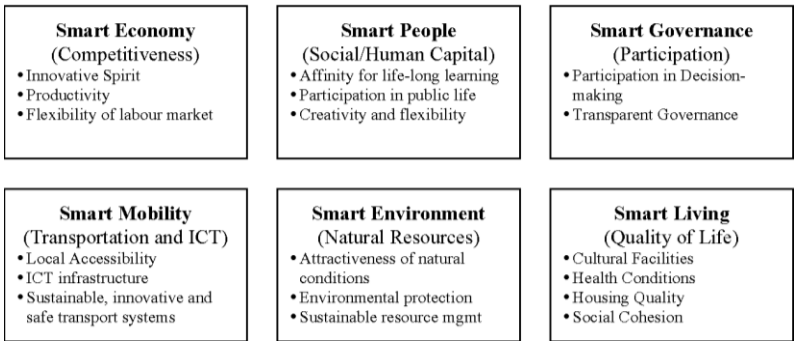

Figure 1. Concept of smart city [10]

3. EVALUATION MATRIX PROPOSAL

Matrix assessment is an engineering technique used to provide an overview of a given situation [7]. The assessment matrix comes to assess the maturity of local regulations. The matrix offers four rating scales, which are as follows:

- No formal approach
- Reactive approach
- System and formal approach
- Formal approach with continuous improvement mechanisms;

This assessment is used to determine the level of regulatory maturity in relation to the smart city concept [2, 12]. Secondly, a calculation will be made in relation to each sub-concept, namely that the sub-concepts are detailed using the ISO 37120: 2014 standard.

Table 1. Matrix to evaluate the maturity to the concept of smart cities [2]

Assessment	Level of Maturity			
	1	2	3	4
Area	No formal approach	Reactive approach	System and formal approach	continuous improvement
	Some elements of the regulatory system are in place	Evolving national regulatory system that partially manages essential functions	Stable, efficient and integrated regulatory system	Continuous performance and continuous improvement high level regulatory system

Table 2. Template of the matrix [2]

Area	Sub Area	City services (ISO 37120: 2014)	Evaluation			
			No formal approach	Reactive approach	System and formal approach	Continuous improvement
$Areas_1$	$Sub\text{-}Area_1$	$Indicators_1$				
.	.	.				
.	.	.				
.	.	.				
$Area_N$	$Sub\text{-}Area_N$	$Indicators_n$				

In order to have representative results, we put forward a calculation of average against each concept in order to know at what level concepts of smart city are assimilated. The calculation method will be as follows [13, 14]:

Namely, the average of each axis is the result of the evaluation of the sub-concept of the axis studied [1].

$$\bar{x} = \frac{\sum_{i=1}^{n} X_i = X_1 + X_2 + X_3 \ldots X_n}{\sum_{i=1}^{n} a = na} \quad (1)$$

$$\sum_{i=1}^{n} X_i = X_1 + X_2 + X_3 \ldots X_n \quad (2)$$

$$\sum_{i=1}^{n} a = na \quad (3)$$

where,

(1): The average calculated by smart city concept

(2): Sum of values sub-concept smart cities variants

(3): Total sub-concept smart cities variants

Table 3. Criteria for evaluating the maturity of local initiatives [15, 16]

Dimension	Maturity level	Description of maturity level
Smart Economy	Elementary	Presence of related facilitation procedures (infrastructure, facilities, economic support system)
	Standardized	Objectives set to ensure economic growth
	Rationalized	Presence of innovation mechanisms
	Dynamic	An integrated and sustainable economy
Smart People	Elementary	Accessibility to infrastructure and basic training programs
	Standardized	Presence of a framework for the continuous improvement of human capital and for the sharing of knowledge
	Rationalized	An ecosystem for the development of human capital through advanced mechanisms that serve to develop skills and monitor this development
	Dynamic	An ecosystem for the development of human capital through advanced mechanisms that serve to predict future needs of society and integrate them into the monitoring and learning loop
Smart Governance	Elementary	Presence of basic public services.
	Standardized	Decision-making mechanism that integrates the direct actors of the city
	Rationalized	Framework for the implementation of Public Private Partnership projects
	Dynamic	Presence of open platforms to ensure a fully participatory governance approach while ensuring continuous and accessible communication by all stakeholders (Digitalization)
Smart Mobility	Elementary	The whole city is served by means of multimodal transport
	Standardized	A complete public transport service, in the presence of communication mechanisms with users
	Rationalized	Full service with full connectivity of the transport network.
	Dynamic	Full service and interactive flow management using system connectivity, with consideration for sustainability in the solutions offered.
Smart Environment	Elementary	Presence of mechanisms to ensure a clean climate and environment.
	Standardized	Presence of mechanisms to ensure environmental protection (soil, air, water)
	Rationalized	Presence of continuous monitoring mechanisms for environmental issues through sensors.
	Dynamic	Presence of mechanisms to ensure environmental sustainability through technology and prediction of sensitive environments
Smart Living	Elementary	Presence of equipment that ensures a coherent social environment
	Standardized	Presence of a multitude of facilities that ensure a coherent social environment
	Rationalized	Presence of a multitude of equipment as well as equipment evaluation mechanisms in place
	Dynamic	Presence of a multitude of connected equipment as well as mechanisms for evaluating the equipment in place and for predicting the needs of the community

A second matrix will take into account the evaluation of smart city initiatives in Casablanca, Morocco Case the matrix will be as Table 3. A second assessment will focus on the sustainable development component of the initiatives put in place through a matrix that will take into account Table 4 elements [9, 10].

Table 4. The components of sustainable development [17]

What	How	Why
People	Considering people in the process	Understanding the needs of citizens, through their integration in the design of solutions. This integration also serves to limit the resistance to change on the part of the citizen
Planet	Considering natural resources	Initiatives must take into account the resource aspect, as well as promote the use of local resources
Profit	Considering sustainability and autonomy of the initiative	The initiatives must have an autonomous financial package, which does not depend only on subsidies and aid to ensure autonomy and sustainability
Profitability	Considering possible benefit for citizens.	Initiatives must be designed to serve the citizen with large-scale impact

3.1. Data Preparation

The evaluation process is mainly based on the collection of qualitative data relating to the city in relation to the following themes [17] [2, 15]:

- Local regulations: the regulatory texts studied and collected are mainly the regulatory texts dating from 1914 to 2020, namely that all the regulatory texts are present at the level of the website of the general secretariat of the government [19].
- Government initiatives at the level of the city of Casablanca: The inventory of government initiatives at the level of the city of Casablanca is made through the website of the city of Casablanca, which collects and highlights the initiatives put in place [20].
- NGO initiatives: With regard to NGO initiatives, data collection is carried out through the report drawn up by the city of Casablanca, concerning the initiatives carried out at the level of the city of Casablanca [20].

The data collected (regulatory text, government initiatives, NGO initiatives) at the level of the city of Casablanca are processed in relation to each component of the smart city, after an assessment is made for all the components, all of which refer to the table 4 to determine the level of maturity [16].

4. EVALUATION OF LOCAL REGULATION AND INITIATIVE

The assessment will focus on Moroccan regulations; this assessment is done with one of the sustainable development auditors and an expert in Moroccan regulations.

According to the evaluation (Table 6), all the sub-area of the frugal smart city are taken into account at the level of local regulations, albeit at different levels.

Table 5. Evaluation of the average score of the concept of smart cities on the bases of the local regulations [2-4, 16, 19]

Concept of smart cities	Indicators for city services and quality of life (ISO 37120:2014)	Variants of Smart cities	Level of Maturity				
			1	2	3	4	Regulatory Evaluations Average
Smart Environment	Energy	Protection and pollution control			O		2.6
	Environment						
	Waste management (Water and solid waste)						
	Sanitation						
	City planning	Judicious land use planning			O		
		Attractiveness of natural conditions		O			
Smart Living	Education	Cultural and Educational facilities			O		1.6
	Health	Quality Health conditions		O			
	Safety						
	Recreation	Accessibility to good quality housing	O				
	Fire and Emergency response						
	Shelter						
	Telecommunication and innovation			O			
Smart Governance	Governance	Involvement of the public in decision-making	O				1.66
		Government transparency		O			
	Urban planning	Public and social service		O			
Smart Economy	Economy	Entrepreneurship		O			1.34
		Culture of e-business & e-commerce	O				
		Promotion of local products	O				
Smart Mobility	Transportation	Public transport management		O			1.67
		Integrated transport (Access to ICT)	O				
		Accessibility		O			
Smart People	Learning	life-long Learning	O				1.50
		Ethnic diversity		O			
		Citizen awareness		O			
		Community participation & Creativity	O				

The regulator dynamics are mainly reflected at the level of the Smart Environment sub-concept with an average exceeding 2.6, a second group is identified with an average of between 1.5 and 2.0, it is (Living, Governance and Mobility) which reflects an incomplete consideration of the issues of these three sub-components.

The two remaining sub-components (Smart Living, Smart Economy) are presented with averages below 1.5, which reflects that the regulator is not prepared to support initiatives emanating from these two components.

Regulation is an important means for the rapid and factual implementation of the smart city concept, except that the current result gives us an idea of the maturity of the regulation. This maturity which can present a brake on the deployment of the sub-areas of the smart city, with the exception of environmental regulations which take into account the issues that emanate from the smart environment. In order to see at what level the local initiative can complement the role of regulation, we have identified and evaluated the initiatives of smart city Casablanca according to the matrix initially introduced.

Table 6. Score of the concept of smart cities on the bases of the local initiatives [1, 3, 4, 16]

Dimension	Maturity level	Description of maturity level	Description of the initiative	Type of partnership	Evaluation of the sustainable development component			
					People	Profit	Planet	Profitability
Smart Economy	Rationalized	Presence of innovation mechanisms	Presence of interactive platforms giving access to the various administrative procedures and a framework for innovation [4]	Public		x	x	x
Smart People	Standardized	Presence of a framework for the continuous improvement of human capital and for the sharing of knowledge	E-Douar project is presented as a territory ensuring the continuity of services to citizens of rural areas [14]	Public-Private	x		x	
Smart Governance	Rationalized	Framework for the implementation of Public Private Partnership projects	Presence of a platform for taking into account citizens' requests [4]	Public		x	x	x
Smart Mobility	Standardized	A complete public transport service, in the presence of communication mechanisms with users	Presence of a multimodal project in PPP mode [14]	Public-Private		x		x
Smart Environment	Rationalized	Presence of continuous monitoring mechanisms for environmental issues through sensors	Presence of a multitude of projects used for integrated waste management as well as the consideration of citizens' complaints via a specialized platform [4]	Public-Private		x		x
Smart Living			No initiative					

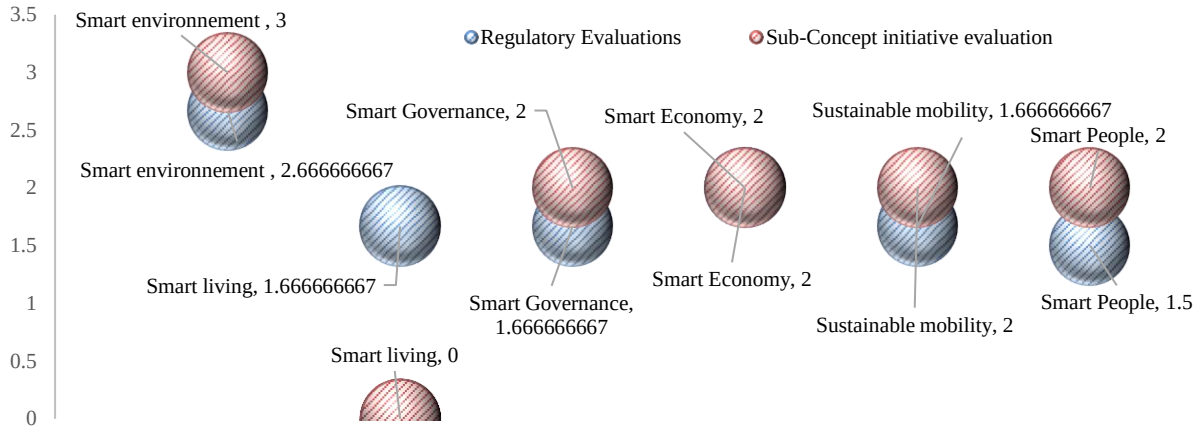

Figure 2. The maturity of the smart city sub-components regulations and local initiatives

Table 7 shows an important dynamic is registered at the level of the territory studied, namely that a multitude of initiatives relating to the change of the territory to a smart territory are undertaken, several initiatives register a significant scale of maturity.

At first analysis, two subcomponents (Smart environment, Smart economy) of the smart city appear with significant maturity, the two initiatives are initiated in Public-Private mode with a large scale of deployment, and respect for sustainability components is taken into account.

The model in place aims to improve the governance of the smart city while integrating the various interested parties as well as by taking into account the pillars of sustainable development at the decision-making level. The decision-making process at the level of the proposed model aims to establish mechanisms for taking into account the opinions of the various interested parties in the project, this taking into account can take several forms.

The proposed model is being studied for a possibility of deployment at the level of the city of Casablanca through the establishment of livings-labs which aim to take into account the needs of the interested parts of the city as well as the establishment of a continuous listening process.

A second part of the sub-concepts (Smart governance, Smart mobility, Smart people) records a standardized level as well as a deployment and impact that varies between small and large scale, with partial consideration of the components of sustainable development, local initiatives also allow the considerable improvement of the studied sub concepts. The smart living remains the only sub-concept without initiative recorded at the level of the territory studied. The complementarity between regulations and initiatives allows rapid deployment of the smart city concept, as well as allow citizens to familiarize themselves with the smart city concept.

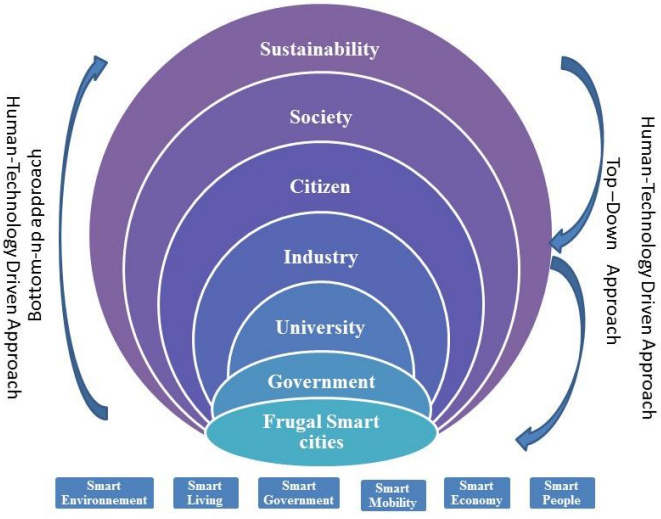

Figure 3. Sustainable-Frugal-Centric smart cities model proposed by the authors

The initiatives taken at the level of these two sub-concepts further improve deployment, a synergy is perceived between the regulations and the initiatives taken at the level of the territory. This complementarity between the initiatives initiated locally by the various stakeholders, reflects the importance of local initiative in the deployment of the smart cities concept, this complementarity lies at the core of the Frugal-concept. The Frugal-concept comes to confirm the Hexa-Helix approach model (Citizen, Government, University, Industry, Society and Sustainability. This model comes to put the frugal smart cities concept at the center of reflection of the problems.

Another important point that is added to our model is the use of the human-technology approach, this concept which gives importance to the transformation of the city through people and technology. This transformation of the city also involves the popularization of technology as well as an increase in the skills of citizens through the establishment of proximity points that promote technology these proximity points have as objective training, the proposal of services for citizens, listening to the needs of citizens [20].

Innovation is also invited to our new concept, namely that the business model requires that each operation passes through a foundation of frugal innovation through a participatory approach that takes into account the needs of citizens as well as the foundations of sustainability, technology plays the role of amplifying initiatives, sharing, etc.

5. CONCLUSION

This paper comes to feed a series of research around the frugal smart cities problematic as well as to propose evaluation methods, which serve to evaluate the maturity of a territory in relation to the smart cities problematic. Of course, the realization of a smart cities project does not depend only on regulations and local initiatives, but this step of understanding is essential to have a clear idea of the strengths and weaknesses of the territory. The territorial technical diagnosis presents an important opportunity to trace the future of the territory, all based on factual approaches and above all frugal approaches.

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NOMENCLATURE

1. Acronyms

GDP: Gross Domestic Product
ICT: Information and communication technology
SDGs: Sustainable Development Goals
PPP: Public Private Partnership

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BIOGRAPHIES

Adnane Founoun was born in Khouribga, Morocco on March 03, 1991. He is a member of IEEE, member of Casablanca IEEE core smart city project, and sustainable development auditor. He provides technical assistance for several projects related to the labeling and assembly of fundraising files (UNDP, AFD, etc.). Currently, he is a member of several R&D projects in the fields of smart cities (CNRST, AFD, ASTON, etc.).

Aawatif Hayar was born in Morocco on August 22, 1967. She received the degree of "Electrical Engineering Aggregation" with honors as the First Moroccan, from Normal Higher School of Cachan, France 1992. She received the "Diploma of Advanced Studies" in Signal Processing Image and Communications and the degree of Engineering in Telecommunications Systems and Networks from ENSEEIHT of Toulouse, France in 1997. She received the Ph.D. degree with honors in Signal Processing and Telecommunications from Institute of National Polytechnique in Toulouse, France in 2001. She was research and teaching associate at EURECOM's Mobile Communication Department in Sophia Antipolis, France in 2001-2010. She has an HDR (Habilitation to Direct Research) on Cognitive Wide and Wireless Systems from South Toulon Var University, France on 2010 and an HDR on Green Telecommunication from University of Hassan II Casablanca (UH2C), Morocco in 2013. She has joined the engineering in 2011 school ENSEM-UH2C in 2011. She was a Guest Editor of Elsevier Phycom Journal Special issue on Cognitive Radio Algorithms and System Design in 2009 and General Cochair of Crowncom 2010 (France), IW2GN2011, IEEE DLT Chair forEMEA region since 2014, General co-chair of ICT 2013 Conference, Awards Chair for ICUWB2014 conference and Technical Program Committee cochair for Next-Gwin Workshop in 2014. She is a Professor and currently is leading and involving in a couple of R&D projects on social smart home, smart grids and frugal smart cities.

Abdelkrim Haqiq was born in Morocco. He has a High Study Degree (Diploma of Postgraduate Studies) and a Ph.D. both in the field of modeling and performance evaluation of computer communication networks, from Faculty of Sciences, Mohammed V University, Rabat, Morocco. Since September 1995 he has been working as a Professor at the department of Applied Mathematics and Computer at Faculty of Sciences and Techniques, Settat, Morocco. He is the Director of Computer, Networks, Mobility and Modeling Laboratory: IR2M. He is an IEEE senior member and an IEEE Communications Society member. He is also a member of Machin Intelligence Research Labs (MIR Labs), Washington, USA, and since 2020 he is a member of the International Association of Engineers (IAENG). He was a co-director of a NATO Multi-Year project entitled "Cyber Security Analysis and Assurance using Cloud Based Security Measurement system", having the code: SPS-984425. His interests are in the areas of modeling and performance evaluation of communication networks, mobile communications networks, cloud computing and security, emergent technologies, Markov Chains and queueing theory, Markov decision processes theory, and game theory. He is the author and co-author of more than 170 papers (international conferences/workshops).He is an associate editor of the International Journal of Computer International Systems and Industrial Management Applications (IJCISM), an editorial board member of the International Journal of Intelligent Engineering Informatics (IJIEI) and of International Journal of Blockchains and Cryptocurrencies (IJBC), an international advisory board member of the International Journal of Smart Security Technologies (IJSST) and of the International Journal of Applied Research on Smart Surveillance Technologies and Society (IJARSSTS).