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# Construction of A Smart City Roadmap, Application to A Medium Size City in France

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**Abstract — This paper presents the approach adopted for the construction of a smart city roadmap for a medium-size city with an application to the French city Saint-Quentin. It describes the methodology followed to identify the city's challenges and expectations as well as the role of the smart city solution in addressing the city challenges. A roadmap was established for the smart city implementation. It includes three steps: data collection for the diagnostic of the city challenges and the expectations from the smart city projec, data analysis to figure out the priorities and the roadmap for the smart city solution and finally the recommendations for the pilot projects for the smart city. This work shows the importance of the realization of a relevant diagnostic with the municipality departments and services to setup a collective and pertinent roadmap for the smart city solution.**

***Keywords : Smart city, participatory, roadmap, diagnostic, pilot project***

## I. INTRODUCTION

Nowadays, cities are more and more interested in the smart city concept. Questions arise about the steps to be taken to ensure a successful implementation of this complex project [1]. This paper presents the approach followed for the construction of a roadmap for the implementation a "Smart City" project in a medium-size city in France. This roadmap requires an extensive analysis of data related to the city management and operation [2 - 3] .

In general, the smart city concept refers to innovation in urban management to improve the quality of life of citizens. The smart City is not just the simple use of technology in a defined area, Smart City is “something more complex and human” [4].

According to [5]–[8], Smart Cities with a proper roadmap will serve people at large and will surely help in reducing man power for the long term. To face these threats, technology has been used as a vital tool leading therefore to the creation of smart cities.

The knowledge necessary to understand the process of building efficient smart cities in the real world has not yet been produced, nor the tools to support the actors involved in this activity [9]–[12]. In addition, most smart city initiatives are not integrated into the city's urban planning mechanisms [13]. This paper presents the work conducted with a medium-size city to establish a collective roadmap for the smart city as well as the identification of pilot projects as a first step for the construction of the smart city.

## II. METHODOLOGY AND MATERIALS

This work was conducted with the city of Saint-Quentin in France for the implementation for its transformation into a smart city. This transformation aims at improving the quality of life for citizens as well as the efficiency of the urban infrastructures and services. The first step of the smart city transformation focused on the construction of a clear and collective roadmap. This construction was based on an extensive discussion with the city departments, representative of the population as well as economic actors. This discussion resulted in a good understanding of the city’s challenges as well as the of the expectations of the city stakeholders. The 2nd step includes analysis of the impact of the smart city transformation in coping with the city challenges and meeting the stakeholders’ expectations. This analysis allowed to rank the steps and projects of the smart city transformation as well as the identification of pilot projects to explore in real condition the capacity of implementation of a smart city project as well as its impact on the city. The following sections will present in detail these steps.

## III. SMART CITY ROADMAP

### *A. Roadmap construction*

The preliminary phase intended to prepare the discussion with the city stakeholders. It started by the identification in coordination with the mayor office of the departments and other structures and representative to interview in order to understand the city challenges and the stakeholders’ expectations. Figure 1 shows the list of participants in the diagnostic phase. It includes 18 municipal departments and services as well as five municipal committees (3 neighborhood councils, seniors’ council and youth council).

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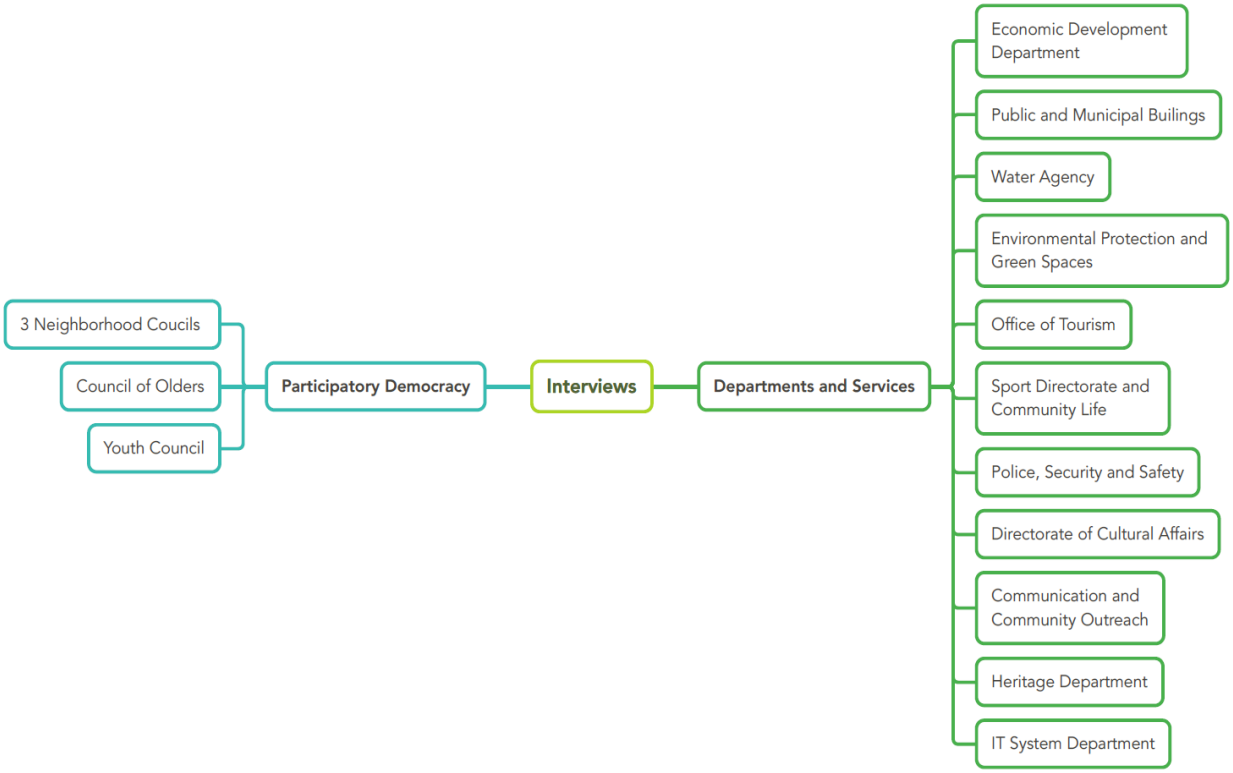


Figure 1: List of participants in the discussion phase

The diagnostic phase was conducted according to the methodology illustrated in Figure 2. This methodology included three phases: data collection, data analysis and recommendations.

*B. Data collection*

Data was collected from different sources including municipal documents, questionnaires, interviews and discussions. The exchange with the participants was based on a questionnaire including questions about their activity, relationships with other services and stakeholders, data availability and management, difficulties, solutions to overcome these difficulties and expectations from the smart city transformation. This phase resulted in the collection of data and information about the departments and municipal committees functioning, challenges and expectations.

*C. Data analysis*

Data analysis included the following steps: data cleaning, data consolidation from different sources, data classification according to the major issues on the smart city transformation and finally data description using statistical or graphic methods.

One of the big issues in this phase concerned data sharing and interaction among the municipal department and services. Table 1 summarizes the level of this interaction. "0" indicates the absence of interaction, while X refers to the existence of interaction. This table shows the existence of interaction among the majority of departments and services, except for the water service, which is an external service of the municipality as well as the heritage conservation department.

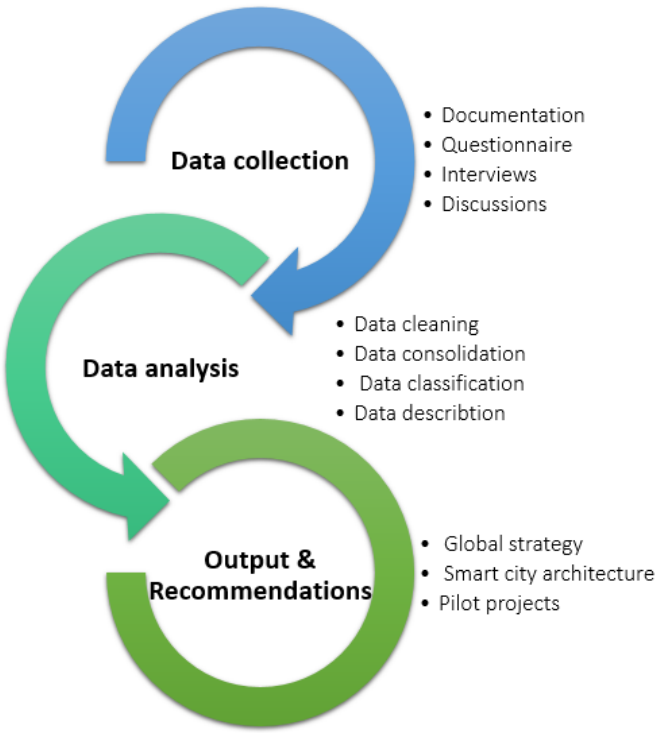


Figure 2: Diagnostic process and output

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Table 1: Interaction among municipal departments and services

| | Economic development | Municipal buildings | Water agency | Environment and green spaces | Tourism | Sport | Security and Safety | Culture | Communication | Heritage conservation | Social and Neighborhood Services | Information technology |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Economic development | | 0 | x | x | x | x | 0 | x | x | x | x | x |
| Municipal Buildings | 0 | | x | x | x | x | x | x | x | x | x | x |
| Water agency | x | x | | x | 0 | x | x | 0 | 0 | 0 | 0 | x |
| Environment and green spaces | x | x | x | | x | x | x | x | x | 0 | x | x |
| Tourism | x | x | 0 | x | | x | x | x | x | x | 0 | x |
| Sport | x | x | x | x | x | | x | 0 | x | 0 | x | x |
| Security and safety | 0 | x | x | x | x | x | | x | x | x | x | x |
| Culture | x | x | 0 | x | x | 0 | x | | x | x | x | x |
| Communication | x | x | 0 | x | x | x | x | x | | x | x | x |
| Heritage conservation | x | x | 0 | 0 | x | 0 | x | x | x | | 0 | x |
| Social and neighborhood Services | x | x | 0 | x | 0 | x | x | x | x | 0 | | x |
| Information technology | x | x | x | x | x | x | x | x | x | x | x | |

*D. Recommendations*

Discussion with the city stakeholders showed the necessity to implement the smart city solution by steps following a global strategy, which provides a comprehensive vision and roadmap for the smart city construction. This strategy is based on establishing the fields of the smart city project, with for each field the selection of pilot projects, which aim at the verification of the feasibility of the projects as well as the investigation of the barriers and impact of these projects. The discussion showed that the smart city solution should cover the following three fields: (i) community and services, (ii) infrastructures, and (iii) buildings. The following sections present these fields as well as the pilot projects.

*1) Smart Community and Services*

The discussion with the city stakeholders showed the existence of a strong tradition in the city for social actions and participatory democracy, which is a major feature of the smart city [14]. The neighborhood councilors highlighted the city challenges related to the security, the cleanliness of urban spaces and intergenerational solidarity. They expect from the smart city solution improving the public services (administrative services, transport, culture, sports activities, catering in canteens, waste collection and cleaning) through the creation of a digital identity of the citizen. Four pilot projects were identified in the field of the smart community and services (Table 2): platform for urban services dematerialization, modernization of the current "Allo Mairie" system, implementation of an intergenerational inter-aid program and reinforcement of participatory governance tools.

Table 2: Pilot Projects for the section Smart Community and Services

| Pilot Project |
|---|
| 1.1 Integrated platform for the dematerialization of all urban services |
| 1.2 Modernize the "Allo Mairie" system - Tool for interacting with citizens |
| 1.3 Intergenerational mutual aid program |
| 1.4 Citizen consultation and participation tools |

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*2) Smart Infrastructures*

Urban infrastructures cover large areas such as drinking water, sanitation, public lighting, urban roads, green spaces and public space. They have a vital role in providing urban services as well as in ensuring good life quality for citizens. In addition, a large amount of the city budget is devoted to the infrastructures operation, maintenance, renovation and extension. The discussion high highlighted the high concern of both the municipality services and citizens' committees for the digital modernization of these infrastructures to improve their efficiency, reduce the expenses and improve the operation security as well as services to the community. Five pilot projects were identified in the field of the smart infrastructures (Table 3): construction of integrated GIS system for the urban infrastructures, installation of Automated Meter Reading (AMR) for the drinking water network, monitoring of the storm water network for flood prevention, installation of a smart public lighting system, and installation of a smart irrigation system for the green spaces.

Table 3: Pilot Projects for the smart infrastructures

| Pilot Project |
|---|
| 2.1 Integrated GIS system for the urban infrastructures |
| 2.2 Automated Meter Reading (AMR) for the drinking water network |
| 2.3 Storm water network monitoring for flood prevention |
| 2.4 Smart public lighting system |
| 2.5 Smart irrigation for the green spaces. |

*3) Smart Municipal Buildings*

The municipal building has a major role in providing public services such as administrative, education, culture and sport services. They have also an important role in providing technical services to the city. Since the majority of these buildings are old, their operating expenses are significant for the city. Discussion with the city services and department showed a high expectation of the smart city project to improve both the energy efficiency of these buildings as well as their comfort and security. Four major pilot projects were identified (Table 4): Smart building monitoring including fluid consumption, comfort and safety, smart access control of sport buildings, smart monitoring of social housing including consumption, comfort and safety, and development of an Augmented and Virtual Reality system to promote the historical buildings.

Table 4: Pilot projects for the smart building

| Pilot Project |
|---|
| 3.1 Smart monitoring including fluid consumption, comfort and safety |
| 3.2 Smart access control of sport buildings |
| 3.3 Smart monitoring of social housing including consumption, comfort and safety |
| 3.4 Augmented and Virtual Reality system for historical buildings |

## *E. Pilot projects ranking*

The municipality was interested by the13 pilot projects presented in tables 2 to 4. However, for resources restrictions, the municipality asked to rank these projects according to indicators and stakeholders' opinions. Eleven indicators were selected for the project ranking. They cover the following issues (table 5): investment, social impact, economic impact, environmental impact, implementation delay, barriers,
interoperability, technological difficulties, return on investment, availability of human skills, and social acceptance.

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Table 5: Indicators used for the pilot projects ranking

| No. | Indicator |
|---|---|
| 1 | Investment (SI) |
| 2 | Social Benefits (SRS) |
| 3 | Economic Benefits (SRE) |
| 4 | Environmental Benefits (SRV) |
| 5 | Delivery times (SD) |
| 6 | Implementation Barriers (RIB) |
| 7 | The degree of interoperability (I) |
| 8 | Technological difficulty (TD) |
| 9 | Return on Investment (RI) |
| 10 | The Availability of Human Skills (HC) |
| 11 | Social Acceptance (SV) |

Table 6 shows the scores given by the stakeholders for the different indicators. The score includes three levels: 1 (low), 2 (medium), and 3 (high). It also indicates the global score of each project. It could be observed that the projects related to smart building monitoring, smart access control of sport buildings, citizen consultation and participation tools, smart public lighting and smart monitoring of social housing obtained the highest scores. They concern mainly the efficiency and comfort of buildings and infrastructures as well as citizens' participation. The projects related to the construction of an integrated platform for the dematerialization of urban services and the integrated GIS system for the urban infrastructures obtained the lowest scores. These projects are perceived as technical projects.

Table 6: Smart City projects ranking

| Project/score | SI | SRS | SRE | SRV | SD | RIB | I | HC | TD | RI | SV | Global Score |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.1 Integrated platform for the dematerialization of all urban services | 1 | 3 | 3 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 3 | **25** |
| 1.2 Modernize the "Allo Mairie" system - Tool for interacting with citizens | 2 | 3 | 2 | 3 | 2 | 1 | 3 | 1 | 3 | 3 | 3 | **26** |
| 1.3 Intergenerational mutual aid program | 3 | 3 | 1 | 1 | 3 | 2 | 3 | 2 | 3 | 3 | 3 | **27** |
| 1.4 Citizen consultation and participation tools | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 1 | 3 | 3 | 3 | **29** |
| 2.1 Integrated GIS system for the urban infrastructures | 2 | 1 | 3 | 3 | 2 | 2 | 1 | 1 | 2 | 2 | 2 | **21** |
| 2.2 Automated Meter Reading (AMR) for the drinking water network | 1 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 2 | 3 | 3 | **27** |
| 2.3 Storm water network monitoring for flood prevention | 1 | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 2 | 2 | 3 | **27** |
| 2.4 Smart public lighting system | 1 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | **29** |
| 2.5 Smart irrigation for the green spaces. | 2 | 2 | 3 | 3 | 2 | 3 | 2 | 2 | 2 | 3 | 3 | **27** |
| 3.1 Smart building monitoring including fluid consumption, comfort and safety | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | **32** |
| 3.2 Smart access control of sport buildings | 2 | 3 | 3 | 3 | 2 | 3 | 3 | 2 | 3 | 3 | 3 | **30** |
| 3.3 Smart monitoring of social housing including consumption, comfort and safety | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 2 | 3 | 3 | 2 | **29** |
| 3.4 Augmented and Virtual Reality system for historical buildings | 2 | 3 | 3 | 3 | 2 | 2 | 2 | 1 | 2 | 3 | 3 | **26** |

## IV. CONCLUSION

This paper presented the approach followed for the construction of a smart city roadmap for a medium-size city with an application to the French city Saint-Quentin. The construction of the roadmap aimed at the elaboration of a collective understanding of the city challenges and expectations from the smart city solution. To achieve this objective, the departments and citizens' committees were involved in the diagnostic phase as well as in the selection and ranking of the pilot projects. This work resulted in the construction of a collective roadmap, that defines the city challenges, the role of the smart city solution in addressing these challenges and the identification of the projects of the smart city solution as well as their ranking.

This work shows the importance of the involvement of the city departments and citizens' representative for any smart city initiative. According to our experience, this involvement is vital for establishing a pertinent roadmap for the smart city, which includes a collective diagnostic of the city challenges, expectations of the smart city project and priorities in the smart city implementation.

## REFERENCES

[1] R. Bolici and L. Mora, “La rigenerazione urbana nell’era digitale: come sviluppare strategie Smart City in città europee di grandi dimensioni,” *Techne*, vol. 10, no. November, pp. 110–119, 2015, doi: 10.13128/Techne-17507.

[2] M. Angelidou, A. Psaltoglou, N. Komninos, C. Kakderi, P. Tsarchopoulos, and A. Panori, “Enhancing sustainable urban development through smart city applications,” *J. Sci. Technol.*

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
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*Policy Manag.*, vol. 9, no. 2, pp. 146–169, 2018, doi: 10.1108/JSTPM-05-2017-0016.

[3] L. Mora, M. Deakin, A. Reid, and M. Angelidou, "How to Overcome the Dichotomous Nature of Smart City Research: Proposed Methodology and Results of a Pilot Study," *J. Urban Technol.*, vol. 26, no. 2, pp. 89–128, 2019, doi: 10.1080/10630732.2018.1525265.

[4] A. Camero and E. Alba, "Smart City and information technology: A review," *Cities*, vol. 93, no. May, pp. 84–94, 2019, doi: 10.1016/j.cities.2019.04.014.

[5] J. Hernantes, P. Maraña, R. Gimenez, J. M. Sarriegi, and L. Labaka, "Towards resilient cities: A maturity model for operationalizing resilience," *Cities*, vol. 84, no. December 2017, pp. 96–103, 2019, doi: 10.1016/j.cities.2018.07.010.

[6] H. P. Lu, C. S. Chen, and H. Yu, "Technology roadmap for building a smart city: An exploring study on methodology," *Futur. Gener. Comput. Syst.*, vol. 97, pp. 727–742, 2019, doi: 10.1016/j.future.2019.03.014.

[7] M. Mantyneva and H. Ruohomaa, "Creating a roadmap for smart city development based on regional strategy work," *SMARTGREENS 2018 - Proc. 7th Int. Conf. Smart Cities Green ICT Syst.*, vol. 2018-March, no. 2013, pp. 151–156, 2018, doi: 10.5220/0006665201510156.

[8] S. Joshi, S. Saxena, T. Godbole, and Shreya, "Developing Smart Cities: An Integrated Framework," *Procedia Comput. Sci.*, vol. 93, no. September, pp. 902–909, 2016, doi: 10.1016/j.procs.2016.07.258.

[9] A. Caragliu and C. F. Del Bo, "Smart innovative cities: The impact of Smart City policies on urban innovation," *Technol. Forecast. Soc. Change*, vol. 142, no. December 2017, pp. 373–383, 2019, doi: 10.1016/j.techfore.2018.07.022.

[10] I. Bouzguenda, C. Alalouch, and N. Fava, "Towards smart sustainable cities: A review of the role digital citizen participation could play in advancing social sustainability," *Sustain. Cities Soc.*, vol. 50, no. November 2018, p. 101627, 2019, doi: 10.1016/j.scs.2019.101627.

[11] N. Komninos, C. Kakderi, M. Angelidou, and L. Mora, "Exploring the relationship between smart cities and spatial planning: star cases and typologies," *Smart Cities Post-algorithmic Era*, vol. 3, no. January, pp. 217–234, 2019, doi: 10.4337/9781789907056.00019.

[12] L. Mora, M. Deakin, and A. Reid, "Strategic principles for smart city development: A multiple case study analysis of European best practices," *Technol. Forecast. Soc. Change*, vol. 142, no. July 2018, pp. 70–97, 2019, doi: 10.1016/j.techfore.2018.07.035.

[13] M. Angelidou, "The Role of Smart City Characteristics in the Plans of Fifteen Cities," *J. Urban Technol.*, vol. 24, no. 4, pp. 3–28, 2017, doi: 10.1080/10630732.2017.1348880.

[14] I. Shahrour, O. Abbas, A. Abdallah, Y. Abou Rjeily, A. Afaneh, A. Aljer, B. Ayari, E. Farrah, D. Sakr, F. Al Masri (2017). Lessons from a Large-Scale Demonstrator of the Smart and Sustainable City BT - Happy City - How to Plan and Create the Best Livable Area for the People (A. Brdulak & H. Brdulak (eds.); pp. 193–206). Springer International Publishing. https://doi.org/10.1007/978-3-319-49899-7_11.