Exploring the benefits of smart city strategies: Evidence from 213 Belgian municipalities

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Statement of the research problem

The smart city strategy is identified as a comprehensive commitment to innovate, inspire and push cities generating positive economic, organizational, cultural and social transitions.

The development of the smart city niche in Europe engenders entrepreneurial willingness, an increasing number of startups and several economic opportunities for giants and private companies

... But, what are the benefits for public authorities developing top-down initiatives?

The smart city concept is always in an emerging process with only long-term potential benefits

(hardly noticeable, observable and measurable at this stage for initiating and implementing new smart city projects)

…. The case of Belgium

Based on smart city indicators calculated by the Smart City Institute (Academic reference in Wallonia)

58,21% of Belgian municipalities have already initiated a smart city strategy

Average year of initiation : *2017*

2006-2008	2008-2010	2010-2012	2012-2014	2014-2016	2016-2018	2018-2020
2,56%	5,13%	00%	5,13%	17,95%	46,15%	23,08%

Belgian cities are developing initiatives responding to their local realities in line with the smart city ideology

Three years after the average year of initiating smart city projects, do municipalities observe any noticeable form of benefits ? If so, what are they?

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Literature review

The literature of smart cities highlights generally the necessity to reach intangible benefits such as sustainability or quality of life, and not necessarily financial benefits.

The profitable side of smart cities is progressively explored by analyzing forms of business models developed by public authorities. However, the effective benefits remain vague.

Examples:

Diaz-Diaz, R,, Munoz, L,, Perez-Gonzalez, D. (2017): Analysis of business models of public services operating in different domains of the smart city (waste management, tourism, mobility, etc.)

Walravens, N. 2015. Proposition of smart city business models (public value creation, partnership model, stakeholder management, good governance, etc.)

Abbate, T, et al. 2019. Linkages between business models, benefits generated, opportunities for cities, key resources and activities, key partners, etc.)

Ballon 2009. Exploration of the main benefits and value creation attended by developing different business models in the context of smart cities

Talari, S, et al,2017. Exploration of outcomes of cities and the implemented business models

(focus on smart grids)

Literature review

City	Outcomes
Amsterdam [61]	Traffic-reduction, energy conservation, and improvement of the security level
Barcelona [62–66]	Accomplishment of sensor technologies, utilizing the information evaluation of traffic flows to design new bus networks as well as the accomplishment of smart traffic
Stockholm [67]	Providing global fiber optic networks all over Stockholm
Santa Cruz [68]	Analyzing the information of criminal actions to predict the requirements of police and to find the maximum presence of police in the needed regions
Songdo, Korea [70]	Fully automated buildings, smart street lighting, smart meters and telepresence
PlanIT Valley, Portugal [5]	Deployment of 100,000,000 sensors
Fujisawa, Japan [5]	Decrease carbon footprint by 70%
Groening, The Netherlands [5]	Improvement of public transportation systems with real-time access to locationss and schedules
Norfolk, England [5]	Improvement of data delivery services, data collection and system analysis for the municipality
Santander, Spain [5]	Smart parking systems
Vienna, Austria [5]	Increasing energy efficiency and climate protection, reduction in carbon footprint

Source: Talari, S, et al. (2017)

Based on the nature of the smart city project, cities can reach different forms of benefits. As example, educative system projects generate intangible benefits, whereas, energy optimization projects generate a cost reduction for the city.

Data & Methodology

In order to support a sustainable and smart transition on the Belgian territory, Belgian municipalities benefit from different European, federal and regional subsidies to develop smart city initiatives

Population: 589 Belgian municipalities

Sample: 123 Belgian municipalities (21%)

Urban municipalities: 79% - Rural municipalities: 21%

Small municipalities: 84% - Big municipalities: 16%

Flemish Brabant 10% - Walloon Brabant 6% - West Flanders 12% - East Flanders 8% - Hainaut 12% - Liège 15% - Limburg 7% - Luxembourg 11% - Namur 6%

Data collection: October 2017 - April 2018

An online survey has been addressed to all mayors and general directors (only one response has been recorded and accepted for each municipality)

Different communication channels have been used to push them to participate to this research (commercial databases, network, private and public partners, etc.)

Research framework (variables explaining benefits)

Var 1: Level of implementing a smart city strategy/approach

Var 2: Aspects supporting a smart city strategy

Political support, flexible and participative leadership, shared vision, strategic cells and teams, flexible procedures, citizen involvement in municipal strategy

Var 3: Prior strategic smart city domain to implement

Economic attractiveness, educative system, energy optimization, ecology and sustainability, Balanced budget, emergency and risk management, governance and citizen involvement, health services and system, quality of buildings, leisure and cultures, security and crime, waste management, IT, digitalization and innovation, mobility and transportation, urban planning, wastewater management, sanitation management, LED and smart lighting (ISO 37120).

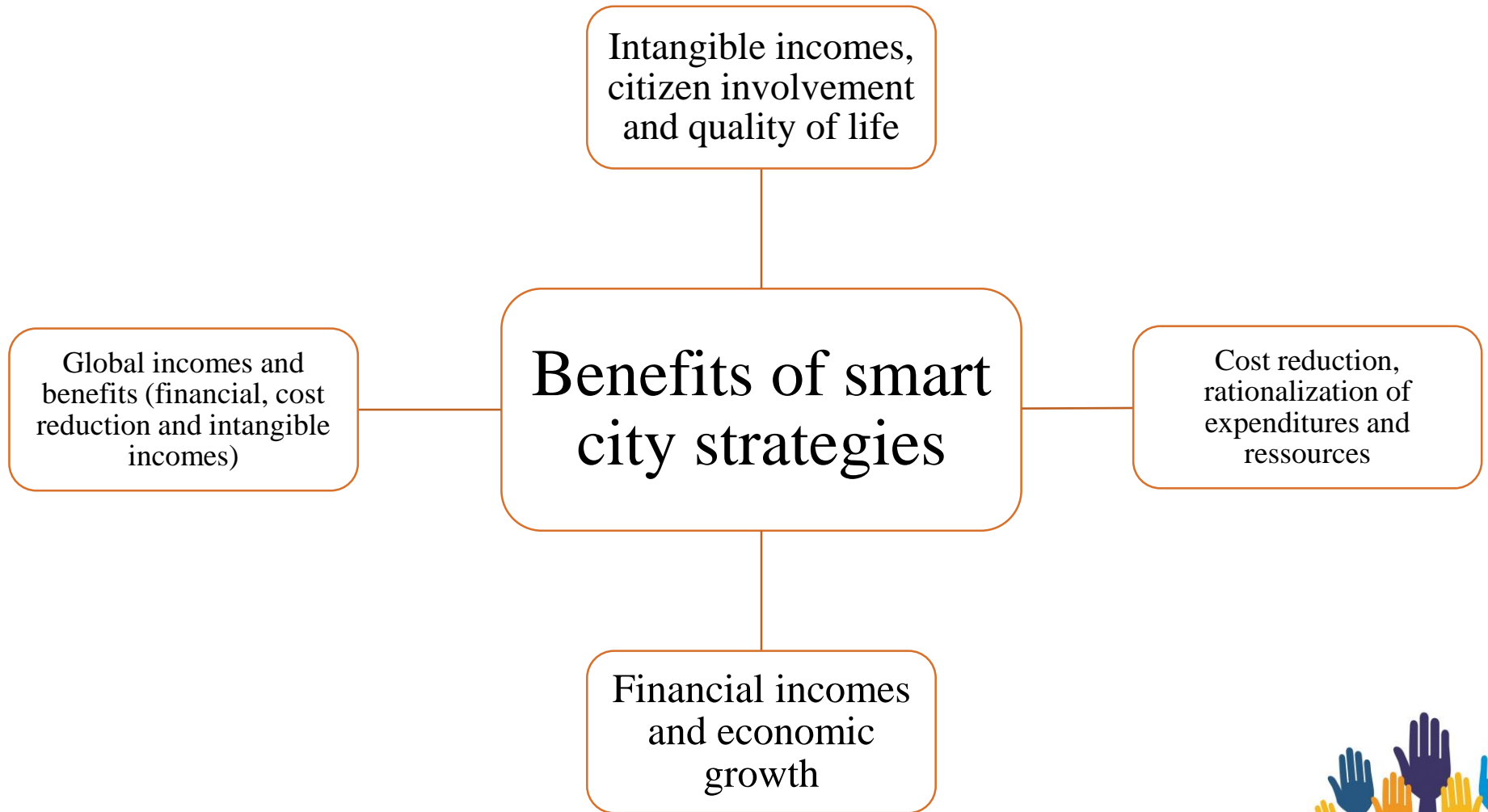Var 4: Obstacles limiting the implementation of smart city projects

Political priorities, city administration expertise, citizen involvement, technology implementation, actors' dynamics, transparency and transversal collaboration, city challenges, budgets to mobilise

Var 5: Demographic-Socio-economic characteristics

Nature, size, provinces, regions, surface of wood, gardens and parks, sport activities, price of building land, per capita area, highway, municipal, regional and provincial routes, cars/inht, density, average income….

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Research framework (different forms of benefits)

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                        │  Intangible incomes,    │
                        │  citizen involvement    │
                        │  and quality of life    │
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┌──────────────────────┐   ┌─────────────────────┐   ┌──────────────────────┐
│  Global incomes and  │   │                     │   │  Cost reduction,     │
│  benefits (financial,│───│  Benefits of smart  │───│  rationalization of  │
│  cost reduction and  │   │   city strategies   │   │  expenditures and    │
│  intangible incomes) │   │                     │   │  ressources          │
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                                     │
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                        │   Financial incomes     │
                        │   and economic          │
                        │   growth                │
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Empirical approach

- Qualitative data (based on observations and perceptions of the respondents) are used to understand the potential benefits generated by implementing smart city strategies/projects

- Data were aggregated into three categories (Weak, average and high/big) for ratios/ rating systems (example the level of implementing a smart city strategy (0 to 10/10)), and the data including a mention of yes or no were recorded as 0-1

- Different demographic, social and economic variables have been integrated in the model (databases developed by Belfius in Belgium) to strengthen the robustness of the model

- A multiple correspondence analysis is retained as the econometric model
  - Factorial method allowing to highlight clusters based on the main correlations between variables
  - A better representation of qualitative data
  - Allows to illustrate all different associations and correlations for each value of variables
  - The model is limited to 5 dimensions, the aim is mainly to illustrate variables associated to different forms of benefits
  - Only the best representation per variable is illustrated in dimensions
  - For a better readability, each dimension with its best representation is illustrated in a single slide
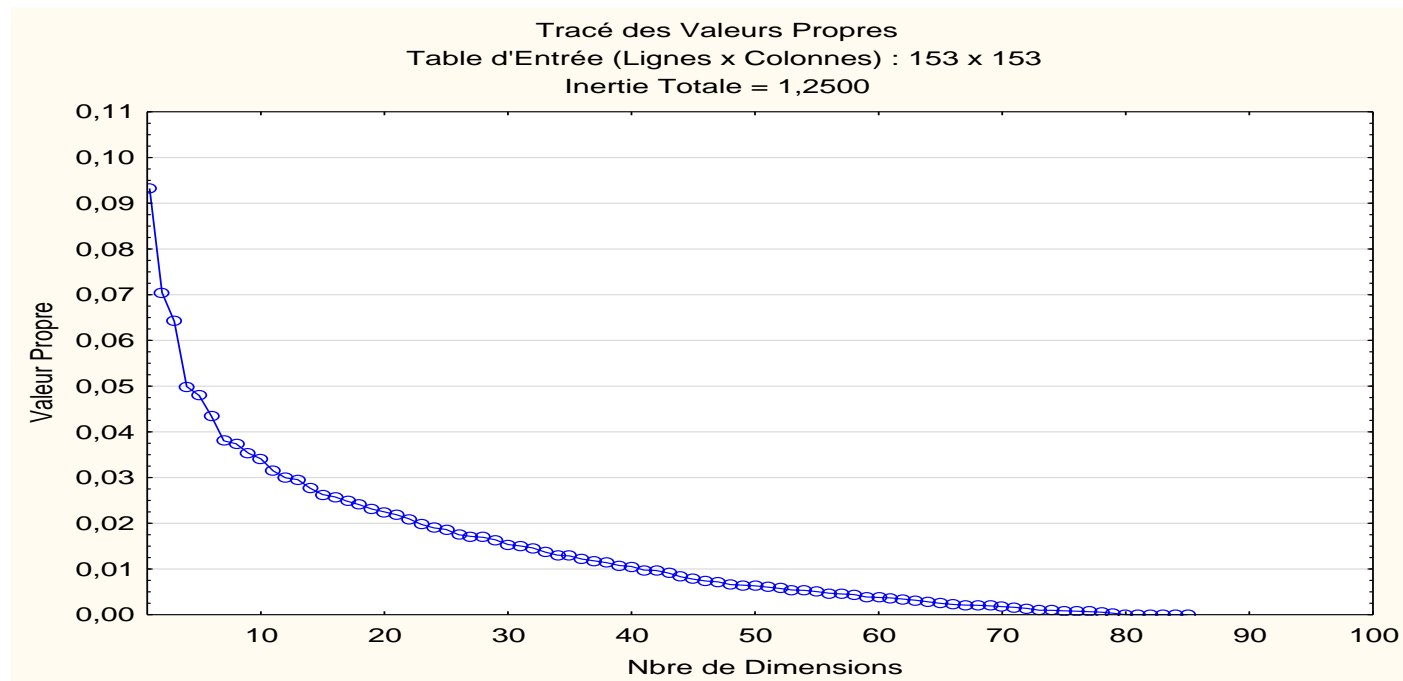
Statistical Analysis

Multiple correspondence analysis
Selection of 5 dimensions in order to propose clusters
The aim: identifying socio-organisational-economic characteristics impacting on the
generation or not o any form of benefits for the Belgian municipalities

Tracé des Valeurs Propres
Table d'Entrée (Lignes x Colonnes) : 153 x 153
Inertie Totale = 1,2500

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Results: Dimension 1

Variable	Dim 1
Big number of provincial and regional km / inht	0,99
Big number of municipal km / inht	0,98
Community dynamics as an obstacle	0,91
Observable intangible incomes, citizen involvement and quality of life	0,83
Observable cost reduction, rationalization of expenditures and resource consumption	0,82
Big population density	0,79
Political priority as an obstacle	0,70
Big surface area per inhabitant	0,66
Budget to mobilize as an obstacle	0,62
Priority to security and fight against crime	0,60
Identification of priorities and challenges as an obstacle	0,59
Technology implementation as an obstacle	0,57
Priority to citizen involvement and governance	0,49
Priority to urban planning	0,48
Municipal expertise as an obstacle	0,47
Average implementation of a smart city approach	0,46
Weak participative and flexible leadership	0,45
Priority to transportation and mobility	0,43
Average citizen involvement in the municipal strategy	0,34
Antwerpen	0,30
No financial incomes and economic growth	-0,11
Technology implementation as a facilitator	-0,15
Citizen involvement as a facilitator	-0,15
Identification of priorities and challenges as a facilitator	-0,19
No priority to security and fight against crime	-0,21
Weak citizen involvement in the municipal strategy	-0,22
No priority to economic attractiveness and growth	-0,23
No priority to urban planning	-0,25
Political priority as a facilitator	-0,26
Transparency and transversal collaborations as an obstacle	-0,29
Small municipalities	-0,29
Community dynamics as a facilitator	-0,29
Municipal expertise as a facilitator	-0,30
No priority to transportation and mobility	-0,33
No cost reduction, rationalization of expenditures and resource consumption	-0,37
High price of building land	-0,37
No priority to citizen involvement and governance	-0,39
No intangible incomes, citizen involvement and quality of life	-0,46
Weak implementation of a smart city approach	-0,47
Strong participative and flexible leadership	-0,51
Budget to mobilize as a facilitator	-0,61
Average cadastral area of gardens and parks	-0,73

Intangible incomes and cost reductions :

- Bigger and denser cities

- Identified in the province of Antwerpen

- Implement projects on security, citizen involvement, governance, urban planning, transport and mobility

- Average implementation of a smart city strategy and citizen involvement

- Different limits and obstacles to face (community dynamics, political priorities, budget to mobilize, identification of challenges and priorities, technology implementation, municipal expertise, weak flexible leadership…)

Results: Dimension 2

Variable	Dim 2
Flanders	0,90
Average number of km of highway/inht	0,72
Weak political support	0,69
West-Vlaanderen	0,65
Weak shared vision of city's main challenges	0,54
Priority to balanced budget	0,47
Priority to leisure and cultures	0,35
Weak development of strategic cells and teams	0,33
Priority to LED and smart lighting	0,32
Average population density	0,24
Urban municipalities	0,24
Observable global incomes and benefits	0,16
Brussels	-0,02
Strong political support	-0,19
No priority to leasures and cultures	-0,21
No priority to balanced budget	-0,24
No priority to LED and smart lighting	-0,47
Non observable global incomes and benefits	-0,48
High pensioner rate	-0,55
Walloon Brabant	-0,65
Big cadastral surface dedicated to sports	-0,74
Liège	-0,74
Wallonia	-0,85
High log of average income	-0,88
Rural municipalities	-0,90
Big number of vehicles per household	-0,94
Hainaut	-0,98

Global incomes and benefits:

- There is no significant global incomes and benefits noticed in Belgian municipalities

- Municipalities in the region of Flanders and in the province of West-Flanders implement projects on balanced budget, leisure, cultures, LED and smart lighting. They suffer from a weak shared vision and political support

- Belgian municipalities that do not observe any global incomes have a high pensioner rate and are mainly located in the region of Wallonia (Walloon Brabant and Liège)
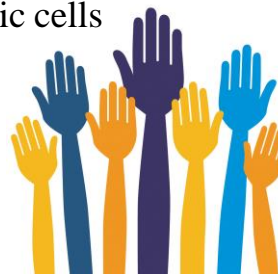
Results: Dimension 3

Variable	Dim 3
Luxembourg	0,98
Small number of vehicles per household	0,94
Advanced implementation of a smart city approach	0,93
Priority to health system and services	0,93
Priority to improving precarious housing	0,86
Small pensioner rate	0,75
Big cadastral area of gardens and parks	0,62
Priority to the educative system	0,59
Average flexible procedures and continuous learning	0,59
Priority to IT, digitalization and innovation	0,55
Priority to the energy efficiency	0,52
Average cadastral surface of wood	0,50
High net taxable income/ inht	0,45
Average development of strategic cells and teams	0,44
Priority to ecology and sustainaility	0,44
Observable financial incomes and economic growth	0,37
Priority to economic attractiveness and growth	0,32
Oost-Vlaanderen	0,20
Small cadastral surface dedicated to sports	-0,01
Small population density	-0,06
No priority to water and sanitation management	-0,10
Average political support	-0,15
No priority to health system and services	-0,15
No priority to the educative system	-0,16
No priority to improving precarious housing	-0,16
Weak flexible procedures and continuous learning	-0,17
No priority to risk and emergency management	-0,23
No priority to ecology and sustainaility	-0,28
Strong shared vision of city's main challenges	-0,33
No priority to IT, digitalization and innovation	-0,36
No priority to the energy efficiency	-0,41
Strong development of strategic cells and teams	-0,44
Vlaams-Brabant	-0,47
Average number of provincial and regional km / inht	-0,64
Big cadastral surface of wood	-0,68
Big number of km of highway/inht	-0,74

Financial incomes and economic growth:

- Located in Luxembourg and Oost-Flanders

- Implement projects on health, building land, education, IT, digitalization and innovation, energy efficiency, ecology and sustainability, economic attractiveness and growth

- Are advanced in the implementation of a smart city strategy

- Have small pensioner rate, an average cadastral surface of wood and a big cadastral area of gardens and parks

- Have a high net taxable income per inhabitant

- Inhabitants use alternative means of transport

- Have already established strategic cells

Results: Dimension 4

Variable	Dim 4
Priority to wastewater management	0,78
Priority to water and sanitation management	0,77
Average number of municipal km / inht	0,69
Priority to waste management	0,56
Average net taxable income/ inht	0,38
Average surface area per inhabitant	0,31
Medium log of average income	0,31
Average number of vehicles per household	0,23
Average participative and flexible leadership	0,18
Small cadastral area of gardens and parks	0,15
No priority to wastewater management	-0,13
No priority to waste management	-0,20
Small number of municipal km/ inht	-0,46
Big municipalities	-0,60
Citizen involvement as an obstacle	-0,63
Small surface area per inhabitant	-0,71
Small log of average income	-0,88

- Belgian municipalities implementing wastewater, water and waste management have established an average participative and flexible leadership

- Big municipalities have difficulties to motive citizens to actively participate in developing smart city projects

Results: Dimension 5

Variable	Dim 5
Limburg	0,84
Namur	0,82
Transparency and transversal collaborations as a facilitator	0,44
Average price of building land	0,40
Small cadastral surface of wood	0,25
Average shared vision of city's main challenges	0,25
Small number of provincial and regional km / inht	0,21
Average pensioner rate	0,13
Small number of km of highway/ inht	0,05
Small price of building land	-0,35
Priority to risk and emergency management	-0,51
Small net taxable income/ inht	-0,73

- Belgian municipalities located in the provinces of Limburg and Namur have already established transparency and transversal collaborations between city administration's departments. They also started to develop a shared vision of the main local challenges. Based on demographic, social and economic parameters, these municipalities have an average size.

- Small municipalities prioritize the development of risk and emergency management

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Discussion

The main benefits observed at the level of Belgian municipalities are:

#1 Improving the life of residents and citizens on aspects such sustainability, social cohesion, social climate, citizen inclusiveness….

#2 Reaching a reduction of different costs that public authorities need to optimize such energy efficiency….

And then, *#3 increasing a financial incomes and an economic growth* such a balanced budget and net revenues for municipalities

Municipalities with *an average implementation of a smart city strategy* have already *perceived intangible benefits and a cost reduction*.

Bigger and denser cities have to face *different organizational and social limits* in the development of smart city projects

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Discussion

Based on the main projects that municipalities develop, different forms of benefits can be observed:

Intangible benefits and a cost reduction: *security, governance, citizen involvement*, etc.
Financial incomes: *Health, building land, education*, etc.

Municipalities benefiting from an active ecosystem participation *(more inclusive behavior (mobility), development of strategic cells composed by public, private and civil actors, etc.)* can more easily foster financial incomes and an effective economic growth thanks to the implementation of smart city projects

New insights on the role of the business models implemented by public authorities on :

The benefits that they want to generate
The main smart city domains that they want to implement

Demographic, social and economic characteristics of municipalities have a significant impact on:

The complexity to develop smart city projects and strategies
The perception of a positive benefit

Thank you
questions?

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