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# The Socioeconomic Disparity in a City is Inversely Proportional to Its Intelligence and Sustainability

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**Abstract:** The higher the socioeconomic disparities within the urban area, the bigger the obstacles for building smart and sustainable cities. Such a scenario may be observed in places where there are poverty, hunger, poor education and infrastructure, diseases, lack of environmental care, gender inequalities, among others, which are found in increasing dominance. The outcome of such a scenario is typical of places which are constantly hindered to be transformed or developed. Smart cities are at odds with such a stagnant trend, since they adopt sustainability practices as one of its concepts. A new insight arises therefrom: work on city issues by focusing on its development and prosperity. The aim of this work is to describe possible solutions regarding urban mobility, which would be able to boost the smart and sustainable development of the city. This could be done by mapping different existing realities and by open management, along with the engagement of citizens. Information technologies are crucial, be them free or open source, which would provide efficient, structured and affordable solutions to public management. The expected results, besides social and economic development of the city, also include innovation roadmaps, progress, social inclusion, synergy, and a better alignment of different areas within the urban area.

**Key words:** smart city, sustainability, socioeconomic disparities

## 1. Introduction

The United Nation (UN) identifies poverty eradication in all its forms and dimensions as one of the biggest global challenges nowadays. This is crucial for the development of any nation, regardless of being from developed or underdeveloped countries. When this scenario is dealt with within the urban area, it is noticed that the higher the existing socioeconomic disparities, the bigger the obstacles for developing sustainable practices to the town, for working the strategic plan focused on city growth, using he existing urban infrastructure efficiently, and motivating the intellectual and social development of its inhabitants. Besides these issues, there are also other challenges associated to the dynamics of the city, such as population growth, traffic jams, increasing demand of water and energy, etc. Cities that were able to tackle these issues collectively are going through a transformation from traditional to smart ones. The pursuit for becoming a smart area is mainly associated to the need of reshaping the cities, which requires the development of a sustainability culture by promoting the intellectual growth of its inhabitants. Moreover, there is the massive use of information and communication technology interconnecting a myriad of existing systems within the urban area, which enhances their efficiency and efficacy.

A model for “smart cities” is proposed herein, whose features are associated to sustainability indicators, digitalization, and urban infrastructure, along with social aspects of their population, such as cultural and educational levels of its inhabitants aiming at

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improving socioeconomic development of the town. It is assumed that a city might only benefit from its technological or economic efficiency if it develops its social and cultural intellectuality. Among all the existing urban systems within the urban context, urban mobility was chosen herein in light of being directly related to the ability of promoting the smart development of the place, besides being the biggest challenge cities are facing when becoming smart. This work was structured in the following manner: Section 2 describes the model for the smart city according to the Brazilian context, in which the concept of sub-centrality is introduced, along with indicators for the proposed model. Section 3 describes the methodology by means of real case studies for urban mobility in the city of Campinas. Section 4 describes the results, whereas section 5 provides the analysis of the data confronted with three real urban mobility projects developed in Milan and Warsaw. These cities have faced similar challenges to the ones found in Campinas. Finally, Section 6 describes the conclusion of this work.

## 2. Model

The concept of smart city has been widely explored within the academic, public, private, and social domains. Nevertheless, it still requires further advances, since there are obstacles hindering the creation of projects which could enable its implementation in a pragmatic manner in most Brazilian cities. Differently from European cities, which have advanced levels of infrastructure, sustainability, and social development, Brazilian cities still face challenges regarding these topics. Besides the diversity of issues arising from this context, one of the biggest challenges within the Brazilian scenario is to succeed in translating the subjectivity associated to smart city to more practical indicators for public managers, somehow helping them in this transformation journey. The existing local urban infrastructure would be used, as well as sustainable practices and different levels of socioeconomic development. Recent research data has suggested the study of a city by unveiling its sub-centralities, since this would unfold its existing needs and peculiarities. Therefore, distinct limitations could be identified, which in turn could help investment planning for its development and motivate the improvement of its competitive advantages. The suggested model for smart city in this work was devised by the intersection of concepts based on sustainability, digitalization, and creativity, which are directly associated to the socioeconomic development of the town.

### *2.1 Sustainability*

The concept of sustainability explored within the Brazilian smart city framework is related to its self-sufficiency and enhancement in the use of available infrastructure in its territory, as well as the optimization of its resources and the reduction of wastage from the city [4]. These are the places pursuing the comprehension of its dynamics. They struggle to become rational, since they know that it is more relevant to regenerate and reuse the territory already explored than substituting it [4]. They explore concepts within the territory capable of working on its densification and multiple centralities (sub-central generation of jobs, housing, education, health, security, etc, inside the same city), which provide a better use of existing empty spaces in regions with available urban infrastructure. Therefore, there is no need to invest in additional infrastructure to meet the demand of the city. Densification and multiple centralities also provide, as long as the integration of the territory is planned, an efficient urban mobility system. This is feasible due to the connection of sub canters, by better exploring the public transportation and mobility options. Then they become part of the daily routine of the population after providing security, reliability, and applicability [3]. Some examples include bike lanes aimed at interconnecting the dynamics of the city (residential areas with industrial and commercial ones, which are not bike lanes isolated in neighbourhoods, squares or

parks) and the use of walks as an alternative means of transportation [4]. Such a change in behaviour naturally contributes to reduce the number of vehicles on the streets, thereby decreasing traffic jams, improving the accessibility and the use of alternative means of mobility. Significant improvements in air quality are observed when reducing the emission of pollutants and, consequently, lower levels of greenhouse gas emissions per capita [5]. Fig. 1 shows the multiple centralities and their relationship with urban mobility.

*2.2 Digitalization*

Within the Brazilian smart city framework, the digitalization is aimed at complementing the organization of the cities, since it promotes the interconnection among existing systems (commerce, transport, public management, infrastructure, health, work, education, the environment, etc) by massively using digital technologies (RFID labels, smartphones, apps, sensors, etc). This way services are efficiently provided, processes are improved, while agility and economy of scale within the territory are achieved [10]. In terms of urban mobility, it promotes to its inhabitants, by means of interconnectivity, a digital community space with the construction of networks where data and information are exchanged in real time. In this model the cities pursue the implementation of

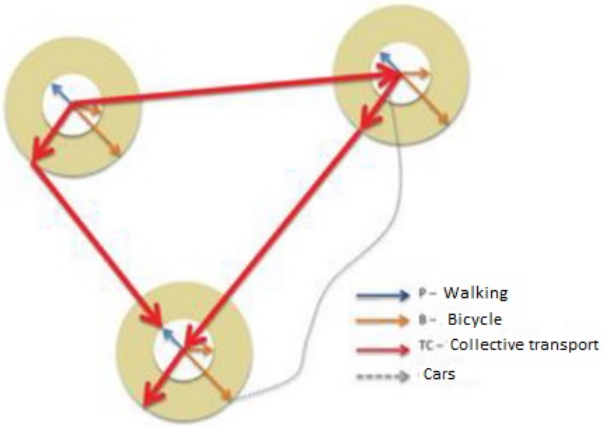


**Fig. 1 Scheme showing the relationship between multiple centralities within the same city in terms of urban mobility. Source: Adapted from KNEIB (2013, p. 30).**

service networks to meet specific requirements and talents from the territory under analysis. They are connected to other multiple centralities where knowledge functions are spread among their citizens, institutions, software companies and smart devices [2]. These are cities responsible for implementing information and communication technological resources focused on solving problems arising from the daily routine of the urban area. In this model the technology works for the population, i.e., population does not work for the technology.

*2.3 Creativity*

Each sub-centrality in the proposed model is intimately compromised with knowledge development, research, innovation, culture, arts, economy, and technology. These areas provide the raw material for stimulating the creation of ideas, building knowledge and intelligence cultures within the city [6]. Contributions promoted by creativity allow a smart city to consolidate its identity, develop its features and stimulate its potential towards differentiation. This is only possible when access to new and diverse knowledge is enabled, as well as the respect to diversity and differences, since they are the source for creativity and innovation. The generated ideas are connected to new technologies in a constant and increasing rate within the territory, which improves a number of dynamic aspects of the city, especially the quality of life of its inhabitants [8].

Another identified feature within this model for smart city, based on sub-centrality in which creativity is encouraged, corresponds to the construction of communities where there are engagement, cooperation, tolerance, and multiculturalism regarding common objectives and responsibilities in the city [7].

Geographically speaking, smart cities naturally show a structuring layout that makes them different from the traditional patterns. The so-called creative geography favours the appearance of creative canters which correspond to the concentration of activities to

stimulate working on the ideas [7] supported on each of the existing sub-centralities within the territory. Table 1 shows the main features associated to each of the studied areas included in the Brazilian smart city model: sustainability, digitalization, and creativity.

**Table 1 Features from the Brazilian smart city model. Source: Jordão (2016)**

| Concept for the territory | Characteristics |
|---|---|
| Sustainability | 1. Compact (it may be considered for a neighborhood and not the entire city), and multi-centralized; |
| | 2. Pursue its growth and self-improvement, not its expansion; |
| | 3. Rational, since they work to enhance the use of existing resources in the territory; |
| | 4. Work better on wastage issues; |
| | 5. A better management of solid residues; |
| | 6. Reduction of pollution indexes due to a higher efficiency in managing the urban mobility; |
| Digital | 1. Massive internet access; |
| | 2. Open data and transparency as a strategy to engage citizens; |
| | 3. Engangement of a citizen within all levels of a social class; |
| | 4. Growth of the digital industry; |
| | 5. Collaborative digital platforms enhancing the probability of innovation; |
| | 6. Citizens are guided to provide ideas through an inclusive innovation plan, independent learning, feedback; |
| | 7. Citizens receive information in real time, which allows them to have a stronger participation in decision making and, therefore, they become more conscious, engaged and collaborative; |
| Creativity | 1. Cities become intimately compromised in developing knowledge and wisdom from their inhabitants; |
| | 2. The knowledge and intelligence culture is encouraged in order to provide stronger competitive advantages for the territory; |
| | 3. Creativity is the DNA of smart cities; |
| | 4. They are able to unveil its identity, develop it and stimulate their growth towards differentiation and competitiveness; |
| | 5. Fostering creation provides access to new and diversified knowledge; |
| | 6. Ideas that are connected to new technologies in a constant and increasing rate within the territory, which boosts the quality of life of its citizens; |
| | 7. Communities are able to practice engagement, cooperation, tolerance, multiculturalism in terms of common objectives and responsibilities in the city. |

The Brazilian smart city model proposed herein deals with the basic aspects for the implementation of a smart culture within the municipalities, since it takes into account the sustainability, creativity, and digitalization. It is believed that the simultaneous development of these aspects could enable the social, economic, cultural and technological development of cities aiming at becoming smart [11].

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## 3. Real Case Study: Evaluation of Urban Mobility in the City of Campinas

Based on the smart city model proposed herein, the analysis of the city (Campinas, Brazil) was suggested for 6 sub-centralities: the North, South, East, Northwest, and Southwest perimeters, according to Fig. 2.

- Sub centralities from the North macro region: District of Barão Geraldo (BG), District of Nova Aparecida (NA), AR 04, AR 11.

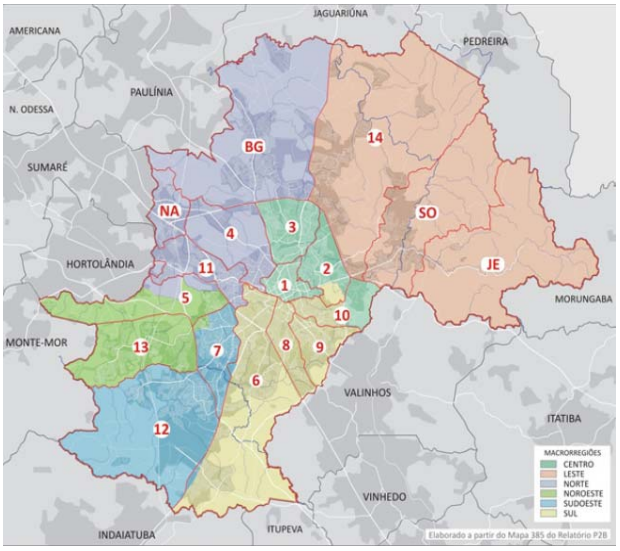


**Fig. 2 Macro regions from the city of Campinas, Brazil. Source: FUPAM/PMC/SEPLAN, 2014, p. 78.**

- Sub centrality from Downtown macro region — AR 01, AR 02, AR 03.
- Sub centrality from the East macro region — District of Sousa (SO), District of Joaquim Egídio (JE), AR 14.
- Sub centrality from the South macro region — AR 06, AR 08, AR 09, AR 10.
- Sub centrality from the Southwest macro region — AR 07, AR 12.
- Sub centrality from the Northwest macro region – AR 05, AR 13.

Data was collected and the main problems of the city were mapped from the experience of its inhabitants (bottom up approach) by analyzing the city's Master Plan from 2016, according to Table 2.

**Table 2 Main problems by macro region. Source: This Table was organized by the authors based on data from the P3B Community Diagnostic report.**

| | Problems by macro region | North | Downtown | East | South | Southwest | Northwest |
|---|---|---|---|---|---|---|---|
| 1 | Expensive housing | 453 | 318 | 26 | 119 | 43 | 15 |
| 2 | Lack of places devoted to cultural activities (theater, exhibitions, etc.) | 357 | 272 | 41 | 258 | 144 | 59 |
| 3 | Traffic is slow and there are traffic jams | 326 | 354 | 37 | 169 | 74 | 62 |
| 4 | Lack of good sidewalks | 319 | 322 | 35 | 208 | 98 | 28 |
| 5 | Poor public transport | 249 | 135 | 62 | 141 | 51 | 22 |
| 6 | Public squares and parks for leisure activities and the practice of sports are missing | 215 | 130 | 22 | 188 | 100 | 44 |
| 7 | Public squares and parks are abandoned | 189 | 160 | 6 | 127 | 53 | 23 |
| 8 | Health equipment, health centers, and hospitals are missing, etc. | 164 | 113 | 10 | 189 | 57 | 46 |
| 9 | Poor local commerce | 144 | 68 | 21 | 56 | 35 | 15 |
| 10 | The neighborhood is too noisy | 119 | 209 | 6 | 87 | 49 | 16 |
| 11 | Education equipment, nursery, and schools are missing | 91 | 42 | 21 | 82 | 39 | 18 |
| 12 | Complexes make urban mobility more difficult, hinder the access to public places and create extensive walls, which yield empty and insecure streets | 82 | 59 | 13 | 18 | 0 | 3 |
| 13 | There is too much commercial activity disturbing the houses | 27 | 57 | 6 | 15 | 8 | 4 |
| 14 | Historical buildings lack maintenance | 27 | 60 | 7 | 23 | 0 | 0 |
| 15 | The neighborhood has too much residents | 22 | 18 | 1 | 18 | 11 | 10 |
| 16 | The neighborhood has a few residents. It seems empty. | 21 | 17 | 3 | 5 | 5 | 1 |
| 17 | The wind disturbs considerably the upper apartments | 16 | 30 | 1 | 12 | 0 | 0 |
| 18 | There are many tall buildings close to each other, hindering insolation and ventilation | 6 | 72 | 0 | 6 | 0 | 0 |

Table 3 was based on data from the analysis of the Strategic Master Plan (2016) of the City Hall of Campinas, in terms of urban mobility and soil occupation.

The analysis of Tables 1 and 2 provided diagnostics for each of the 6 macro regions in the city regarding urban mobility.

**Table 3 Data for each Macro region from the city of Campinas regarding urban mobility. Source: This Table was organized by the authors based on the data from the Strategic Master Plan of the city.**

| Data from each Macro region | North | Downtown | East | South | Southwest | Northwest |
|---|---|---|---|---|---|---|
| Population | 190,775 | 185,855 | 44,674 | 300,350 | 237,378 | 114,019 |
| Jobs | 107,443 | 196,721 | 20,489 | 105,888 | 65,406 | 25,052 |
| Mobility index | 1.73 | 1.98 | 1.71 | 2.21 | 1.84 | 1.73 |
| Collective mobility index | 0.52 | 0.48 | 0.52 | 0.55 | 0.69 | 0.71 |
| Individual mobility index | 0.80 | 1.10 | 1.01 | 0.87 | 0.68 | 0.51 |
| Number of motorcycle trips | 8,717 | 13,584 | 1,283 | 15,427 | 11,280 | 5,467 |
| Identified empty areas | Yes | No | Yes, but urban infrastructure is missing | Yes | Yes | Yes |
| Maximum land-use coefficient | Low to medium | High | Low | Low to medium | Low to medium | Low |

## 3. Results

The analysis of Tables 1 and 2 provided diagnostics for each of the 6 macro regions in the city regarding urban mobility.

### *3.1 North Macro Region*

It is responsible for 17.78% of the population within the urban area. This region creates 20.62% of the urban jobs. It has an adequate urban mobility index, despite having individual mobility predominant over the collective forms of transportation. One of the problems of this region is the poor collective transport, which could justify the preference for relying on individual rather than the collective mobility modes. Potential opportunities for exploring in this region include the exploration of empty areas with available infrastructure and the low to medium land-use coefficient.

### *3.2 Downtown MacroRegion*

It is responsible for 17.32% of the urban population and for 37.76% of the jobs created in the city. This region has high mobility indexes, even though individual mobility is preferred over collective transport, albeit the latter is also explored significantly. The preference for the individual mobility negatively affects the dynamics of the city. It is necessary to encourage other transport modes, such as walking and collective modes (restriction of cars, only within the downtown area, with a minimum number of passengers depending on its capacity, restricted access of vehicles to some places in this region within some periods of time, etc). Despite having a high population density, there are some empty areas benefiting from available urban infrastructure. Therefore, it is a promising working opportunity to be explored.

### *3.3 East Macro Region*

It has a low population density (3.93%) and poor job creation (4.16%). It has a medium urban mobility index, with the individual mobility preferred over the collective modes. One of the identified problems is the poor availability of collective transport modes, which is due to the geographical characteristics of this region (countryside).

### *3.4 South Macro Region*

It is responsible for 27.99% of the population in the

municipality and creates 20.32% of the jobs in the city. This region has the highest urban mobility index, and the collective transport is preferred over the other alternatives. This is probably the reason why the population has not chosen traffic jams as one of the problems in this area. Potential opportunities to be explored are the use of the empty areas, motivating the creation of a local commerce, the creation of new jobs and the exploration of empty areas found in this region.

*3.5 Southwest Macro Region*

It is responsible for 22.12% of the urban population, but represents only 12.55% of the jobs. This is certainly the best opportunity to be explored in the region. It has a high index of daily trips, as well as high urban mobility index, which is equally shared between the individual and collective modes. Besides the potential generation of jobs, another encouraging factor to be explored in this region is the usage of identified empty areas and also of the territory.

*3.6 Northwest Macro Region*

It is responsible for 10.63% of the urban population, generating only 4.81% of the jobs. Similarly to what was observed for the Southwest macro region, it has a potential for stimulating job creation. The collective mobility is preferred over the individual, with trips at a medium level. Besides the opportunity for increasing job creation, this area could be explored regarding empty areas and increasing the soil usage coefficient.

## 4. Analysis of the Results

It is clear that the urban area in the city required remodeling. Besides the poor soil usage, urban agglomerations and traffic jams, there are many other issues identified by the urban population yet to be addressed. The analysis of the municipality by means of sub-centralities allows new insights to the city problems, even though it does not provide a solution to them.

One of the intriguing issues identified by using the sub-centrality approach was the number of inhabitants per sub-centrality. Campinas has about 1.1 million inhabitants, but poor data was achieved in this work in terms of mobility, as shown in Table 3. Poor mobility data motivates the implementation of projects targeting each macro region to solve the spotted issues and develop the region according to its potentials and limitations. The following topics will describe projects implemented in European cities. They share some similar issues diagnosed in some macro regions from Campinas.

*4.1 Development of a Model to Improve Infrastructure for Pedestrians in the City of Porto, Portugal*

The Project “Smart Pedestrian Network – SPN” was developed in 2015 by the city management with the aim of encouraging its inhabitants to adopt walking as a valid and viable transport mode, which would match city dynamics. Another aim of this project was to avoid urban dispersion within the territory and encourage the creation of areas where the interaction of citizens and the city would be highly explored. The multi-criteria analysis considered the existing connectivity between streets and the items influencing walking needs. Some issues such as the type of constructions available, street accessibility, inclination, width of sidewalks, population density, available public transport, weather conditions and urban forestry were some of the analyzed criteria. Data analysis allowed modeling the urban area favorably for walking and the best routes were identified. This model was implemented in 2015 and has helped in the formulation of public politics and in focusing investments devoted to make the project feasible in the city. This project served as a blueprint for other European cities due to the creativity and innovation in terms of sustainability.

*4.2 Open Source: Information about Multi-Modal Trips in Milan, Italy*

Milan has about 1.3 million inhabitants and ca. 5.3

million trips per day. The private motorized transport is the biggest source responsible for generating high levels of noise in the city, pollution and traffic jams. The city has one manager for the urban public transport, which is not enough for managing the high dynamics required in the territory. Therefore, the city required a manager of multi-modal trips, able to provide citizens information in real time about trip operations within the urban area. The project entitled SUPERHUB required the partnership of a countless number of data providers in the city. It was implemented in November 2014 (apps for smartphones and tablets) and then users could access information about all the available urban mobility modes based on its location, as far as they accepted the system to choose his/her own itinerary and transport mode. The information available in the app was the traffic condition in Milan, price and time according to the itinerary options, as well as issues associated to the impact from user's choice to the environment. The system recommends the most sustainable transport modes for the searched route. This project was expanded to many other cities in Europe in light of the promising results achieved in Milan.

### *4.3 Reduction of Traffic Jams by Implementing the "Park and Ride" System in Warsaw, Poland*

One of the problems faced by inhabitants in Warsaw is the waste of time and money due to traffic congestion and the increasing per capita number of cars in the city. One of the identified consequences by the city managers was the degradation of urban areas and the lack of parking lots able to match the huge number of cars on the streets. They also observed that the cars were parked in inappropriate places once there were not enough parking lots to meet the demand. The city managers then proposed to project entitled *Park and Ride*. The aim of this project was providing social changes in population dynamics. The city has an excellent transport system, which drove the Ride and Park project to invest in building parking lots in neighborhoods connected to public transport hubs (trains, buses, subway, streetcars, etc.). Another investment in the city was devoted to creating cycling lanes as alternative transport modes. Parking lots are free if the user acquires at least one travel pass per day. The investment was worth it, since the price of the travel pass is cheaper than that for parking the car for 8 hours in any of the parking lots in the downtown area, in congested roads.

## 5. Conclusion

The proposed model for smart cities in this work allowed the demonstration, by means of different existing realities within the same territory (analysis of sub-centralities), of the feasibility of project implementation in order to encourage the smart and sustainable development of the urban area as far as urban mobility is concerned. The expected results, even though they were driven by distinct needs typical of each macro region, will provide promising results for the technological and economic development of the urban area. Social, creative and innovating skills of its inhabitants will also be enhanced.

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