Expanding Locations for Growing Middle Classes of Emerging Markets

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Abstract

With a motorization rate constantly growing, the BRIC countries are often seen as new eldorados in term of consumer market. Moreover, in the case of India the population is projected to sharply increase with a massive development of the middle classes. In contrast it is important to keep in mind that the megacities will not host the biggest demographic growth due to the saturation of the metropolitan areas. This saturation combined with reverse migration to provincial towns in an overall situation of fast economic growth will lead the core automotive market to be mostly located in small and mid-sized cities. These areas are accommodating a bigger and bigger share of the growing middle class. Thus, the standard of living increases as well as the economic growth will not be distributed in a homogeneous way within a territory where the segregation is already worsened by a hermetic caste system. It is therefore essential for a car manufacturer to locate as accurately as possible the present consumer market as well as forecast the coming potential of the other living areas. The case of India with a massive population and a chaotic urban structure may generate new innovative ecosystems based on:

- Top down construction processes such as integrated townships, Special Economic Zones, IT corridors…shaping archipelagoes and generating a kind of islanding mobility
- Bottom up free carbon emission appearing as a potential dissemination path for electric vehicles, mainly through e-rickshaws or e-bikes.

The aim of this study is to link the standard of living with both the urbanization processes and the ability to shift towards a socio-demographic modernity for the local peoples. In order to reach this aim, a multi-scale and spatial database has been built especially for this project. To deal with the long and complex story of India a conceptualization has been performed in order to select 59 criteria from this database as inputs to be used in a Bayesian five-step procedure. In this paper, the results of the Bayesian network model will be presented showing that the Indian Territory can be segmented in eleven kinds of spaces. Some of these profiles like "well-being eco-system", or "innovation vector ahead of its time" may help a company to get a better understanding of the ongoing processes occurring in India. The internal and external characteristics of these spaces as well as their potential consumer markets will be highlighted and put into perspective by comparing these profiles with the preliminary results of a fieldwork step. These elements combined with environmental concerns and willingness of energy autonomy highlight the potential of micro-grids. They are consistent with new electric mobility and the use of local resources building new ecosystems for innovation.

Keywords: India, rising middle classes, Bayesian analysis, spatial segmentation, innovative ecosystems.

1. Introduction

Most of the American and Western automotive companies are trying to establish themselves in India and more generally in BRICs[1] and CIVET[2] countries. For these companies that are operating at an international scale, the 2007 financial crisis has accelerated the need to settle abroad. The timing matches perfectly because the position of the BRIC's countries in the world economy GDP share is expected to increase from 13.1% on the 2005-2009 period to 21.6% by 2015[3] against 22% to 16.6% for the Euro Area. The future potential of BRICs and CIVET countries may seem unstoppable with sale trends steadily rising especially in the automotive sector. It is expected that India will become the most populous country by 2025[4] becoming a primary target in term of emerging markets. But the Indian case study is more intricate and cannot be considered as a uniform space with a homogeneous consumer market. Moreover, the implementation of a foreign company in this country is a complex issue. Indeed, beyond the technical and human challenge, the company also has to deal with an unknown local culture. It is also too frequently forgotten that India is a new country that has been unified for the first time after the independency in 1947. This geographical area consists of a wild range of different ethnic populations, languages, landscapes and so on. The mass poverty and the luxury integrated townships seem to coexist in a country wherein there is more than one reality. The increase of the standard of living related to economical growth will not be distributed homogeneously throughout a territory already full of disparities. From an economic point of view India has experienced several major waves of reforms in the 80-90's and 90-00's decades which have brought positive results to the GDP growth (around 3% in the late 80's, 6% in the early 90's, 8-9% in the early 00's). However, the India's economic growth slowed down to 4.7% for the 2013 October-December period in the wake of fifth consecutive sub 5% quarters. Regardless of this trend, we have to keep in mind that a growing GDP does not lead necessarily to a balanced distribution of the standard of livings, especially in India where the population growth is disproportionate and the job creation insufficient in the secondary and tertiary sectors (Boillot, 2006). Furthermore, with the green revolution still occurring in rural areas, the employment level in the primary sector keeps decreasing from 1 to 2 % by year (Boillot, 2006). Simultaneously, on the same 2013 October-December period the agricultural GDP slowed down to 3.6 %. From this perspective, it becomes apparent that the future opportunities in term on consumer market will be mostly located in urban areas. Moreover, the development of rural areas and the massive wave of out-migration towards urban areas are co-existing realities in a context of saturated and overcrowded megacities (UN-Habitat, 2001). As a result, the households belonging to the middle classes are expected to fourfold in non megacities spaces by 2030 *(McKinsey, 2010).* But the increase of standard of living cannot be distributed homogeneously

[1] Brazil, Russia, India, China and South Africa
[2] Colombia, Indonesia, Vietnam, Egypt and Turkey
[3] International Monetary Fund, WEO database; OECD database; and IMF staff estimates.
[4] United States Census Bureau - International Data Base

throughout a territory of more than 1.2 billion inhabitants already full of socio-economic disparities. On an operational point of view, it becomes a prerequisite for a company willing to implement itself in India to obtain a a cross-disciplinary view of the ongoing complex processes related to middle classes. This paper is part of a larger research agenda[5] that attempts to study the socio-economic changes and the standard of living evolution related to the urbanization phenomenon. There are a lot of references concerning models related to urbanization for the old industrialized countries (Henderson, 1988; Black and Henderson, 1999; Fujita *et al.*, 1995; etc.) but the references are limited for emerging countries and especially for India (Schaffar, 2010). Moreover, consumer in BRIC's and CIVET countries can be the source of radical changes in term of consumer patterns (**Section 2.2**, p. 6). Consequently, it implies to perform a new conceptualization which includes the special features of India such as the hermetic caste system. For this paper, emphasis is given to a geographical segmentation in order to target the population with appropriate car models, development strategy in sustainable locations and innovative geographical areas ahead of their time. In this study, each of the 640 districts of the Indian Union is considered as an ecosystem enjoying multi-criteria potentials. One of the assumptions being that it is possible to determine the openness degree to modernity of the Indian districts using a probabilistic model. On another hand, the national scale results combined with the GIS[6] database related to this project can be used to locate at a local scale the best location for point of sales implementation.

2. Emerging Markets, Enthusiasm and Disillusionment: the Indian Dilemma

2.1 BRIC, CIVET and Emerging Markets as Primary Targets for Private Companies

Megacities as the economy and/or the political capital of a country are the arrival port for new global trends or the export hub of locally redefined fashion within increasingly reduced cycles of time. Nevertheless megacities are over-loaded, congested and have to permanently self-regulate, implementing rules and law enforcements. Today, the long dominance by global cities may be ending. Instead of clustering increasingly in "world cities", economic power is now de-clustering away from the primary urban centers to smaller cities or to sprawling suburban peripheries (Kotkin, 2005). Indeed, in terms of high-end service jobs as well as headquarters, the hierarchy seems increasingly unsteady. Great cities will remain important as centers of commerce and culture, but corporations have started relocating their headquarters in suburban peripheries or even small towns. Even when the headquarters remain within or near the traditional cores, much of the activity is now carried out elsewhere. The cost pressure on companies operating on a global scale began to force these companies

[5] - Author's CIFRE thesis on tiers 2 and 3 cities in India related to mobility.
- e-Geopolis research program about worldwide urbanization.
[6] Geographical Information System

to place operations, including headquarters, in low-cost, less densely populated, more family-friendly local places where technical or managerial talents are now concentrated. The rise of dematerialized networks and discount air carriers allow now for even the most global players to operate from increasingly distant locations. Small and medium sized cities offer locally a lower magnitude of expansion for the automobile system but overall bigger volumes. The range of motorization is wider than in megacities often divided between the SUV large car for status and the small car easier to park and drive within congested areas. In second rank cities there are large opportunities for car-based mobility with multi-shape and multipurpose vehicles even if there are regional features to take into account (mountain regions, agriculture province, etc.): family/corporate, individual/collective, goods/peoples, product/service, status/taxi, etc. The household's sizes may vary within regional blocks of emerging countries and then impact the type of needed car. Moreover these small and mid-sized cities do not suffer yet from congestion with a public transportation offer not as high as in larger metropolis. Metropolis spread, disseminate, radiate out new trends in the countryside due to expanding interactions and reverse migrations. In São Paulo for example, a lot of migrants of Nordeste come back to their region and bring habits from the megacity (Lesteven, 2012). The mid-sized cities are both competing with each other and with the metropolis; and build efficient best practice networks. As the actual advertising of HSBC Bank says (**Figure 1**) *"in the future there will be no markets left waiting to emerge*", "*in the future, new trade routes will reshape the world economy*". In other words, new stakes and opportunities are about to emerge in the countryside of well-known metropolitan regions.

Figure 1: *HSBC advertising actually displayed in all the major airport hubs, these Russian dolls symbolize the market opportunities within existing markets that are waiting to emerge. Coincidence or not, the bigger Russian doll is the Indian one.*

In the fast growing economies, the social classes just below the middle classes represent a major future market: they are younger and will consume during a longer period of time than their elder due to life expectancy increase. But this begs the following question: is car growth sustainable, desirable or even possible? The diversity of India is great and the question of modal share quite

different from one place to another. Therefore, average rough figures about motorization rate have no real meanings. The closer and the sharper will be the knowledge and the understanding of the Indian needs; the more reachable will be that market.

2.2 Weak Signals in Emerging Markets

Zero emission mobility has become a great challenge expanding very slowly but very promisingly. Diverse paths of dissemination may deliver unprecedented opportunities. Personal electric car ownership rate is very low due to a strange business model mixing cars for sale, batteries for rental and a weak or a lack of consistent recharging networks. Counter-examples such as Auto'Lib in Paris, BlueLy in Lyon, BlueCub in Bordeaux show that alternative ways may develop. Moreover, these kinds of models are now eager to venture further towards the USA and some Asian cities[7]. The richness and diversity of the solution to move from e-urban furniture to home-style electro-apparatus show that a multitude of business models may emerge from both:

- Top-down solutions close to smart cities
- Bottom-up solutions pushed by communities of eco-districts and start-ups.

So these local zero emission mobility solutions are based on a new paradigm of vehicles-energies & infrastructures-services. At the same time, young people aged 15-24 years represent 18% of the world's population with 85% of them living in developing countries (United Nations, 2004). They are more numerous than the whole superior segments of the population, and they expect social climbing towards middle and upper middle classes. They are characterized by floating and diverse ranges of incomes and a behaviour showing a wish for education, advancement and emancipation. This younger generation entering the workforce is equipped with a mindset and skills that are more aligned with the evolving models (Veltz, 2000). Sometimes the emerging countries do not follow the occidental patterns. Indeed, these young peoples combined with the dynamism of emerging markets create favourable conditions for leapfrogging, especially in term of mobility. For example, in India, the mobile phone (80% penetration) has carried out a leapfrogging by surpassing the landline implementation (20% penetration). Emerging countries have been definitely decided not to be a primary target for electric car by western car manufacturers. But the legitimacy of this early conclusion should be questioned. As the **4.2 Section** about fieldwork will show, both top-down and

[7] Renault/Bolloré partnership about E.V

bottom-up local innovations in term of electric vehicles may appear in specific areas. And as well know, electric mobility solutions are a support to urban design and a basis for reshaping parts of cities that should not be neglected. Leapfrogging and new practices may dissemination electric mobility solutions. The Indian Bajaj Company assembling electric auto-rickshaws in Kano (Nigeria) is a relevant example.

2.3 Potential Consumer Markets and Urban Spaces in India

People living in cities have outnumbered people living in rural areas since 2008 (UN, 2008) in a context of several overcrowded megacities, especially in emerging countries (UN-Habitat, 2001). Sometimes, the strong urban density generates traffic congestion that influences the population to switch from one transport mode to another (Newman & Kenworthy, 2000). Officially, the Indian government announced during the publication of the last 2011 decadal census that the urbanization rate is now at 31.2 % with a 2001-2011 total population growth of 31.8% against 12.3% in rural areas. By contrast the fertility rate remains higher in rural areas implying that the development of rural areas and the massive wave of out-migration towards urban areas are co-existing realities. It is recognized that the urban Indian population could exceed 473 million by the next decadal census in 2021 (Government of India projection) and 590 million in 2030 (McKinsey, 2010). For the same period, the pursuit of economic growth should lead to a strong increase of the urban middle classes which are expected to fourfold. Moreover, urban areas already contribute to 62% of the Indian GDP (Bhagat, 2011). These results are based upon the official classification of what is "urban" decided by the Government of India. As well known, each country owns an official national statistical agency which has the authority to perform census surveys with its owns criteria. Consequently, the data are not fully comparable between countries, a major problem for urban studies (Moriconi-Ebrard, 1993). Furthermore, it happens that in some cases the urbanization definition within a specific country also needs improvements. According to the Indian census, a settlement is categorized as "urban" if it meets the following three criteria: a minimum of 5000 inhabitants, a minimum share of 75% of male employed outside the agriculture and a population density of at least 400 persons per square kilometer. The aforementioned projections are based upon these criteria and thus may be potentially underestimated. Indeed, there are weaknesses with such criteria. For example, specialized agriculture can generate urban patterns and cluster of villages may generate continuous built-up areas as demonstrated in the Bihar case study (Perez, 2013). Moreover, rural settlements recently reached by the spillover of an urban area may remain as a village for the census office despite the fact that they have become a physical extension of a larger entity. Furthermore, Sivaramakrishnan (*et al.,* 2007) points out that even if those criteria are met, the State Government may decide if a location will be granted the "urban" status through the *73th and 74th Constitution Amendments, part. IX.A.* From that

perspective, it becomes obvious that some future opportunities in term of consumer markets may appear in other settlements than the ones considered as urban by the Indian government. We must not be mistaken through this urban-rural official distinction. People contributing to the spatial diffusion of these trends are those who have adopted an urban lifestyle regardless of their living locations. These peoples are mobile and connected in an urban system highly structured including a large number of small and medium-sized human settlements that are far much older than the British colonization (Ramachandran, 1989). The diversity of these settlements combined with the wave of out-migration towards dynamic areas will lead to unexpected economic changes, a situation that must be anticipated.

3. Urban Areas, Spatial Indicators and Modeling

3.1 Localization of the Potential Market by Studying the Real Urban Areas

As mentioned in the previous section, comparing cities using raw data from official censuses without special caution can lead to comparing random urban fragments. To counterbalance this fact, this research relies on the e-Geopolis database and methodology (Moriconi-Ebrard, 1994) and its Indian counterpart (INDIApolis). The aim of the e-Geopolis program is to identify, localize and digitize the built-up areas of the world from morphological and demographic criteria. The definition of an e-Geopolis urban area is "harmonized" and allows a comparison of the urban sprawl of several countries whatever the criteria of the national censuses are, with only the two following conditions:

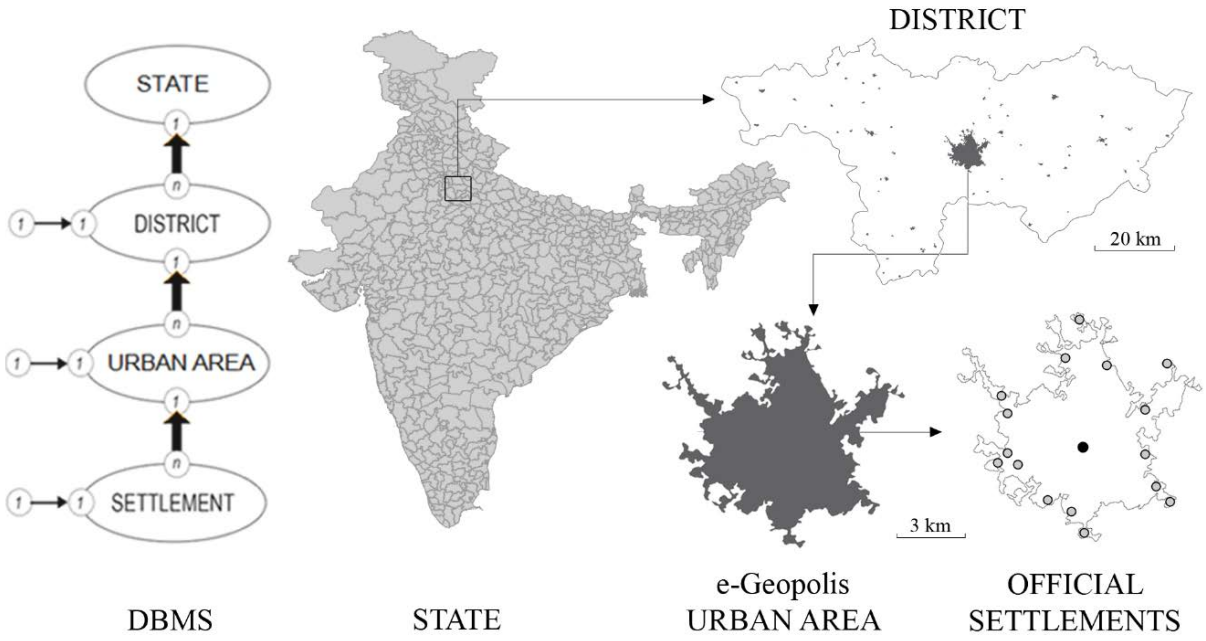
- A continuous urban area must have at least 10,000 inhabitants
- The distance between two constructed areas shall not exceed 200 meters.

For this research program the physical perimeter of the worldwide built-up areas were digitized as polygons in a GIS[8] software. The polygons delineating the perimeter of the morphological urban areas were seized from maps, aerial photographs, satellite images and seizures from Google Earth. Subsequently, demographic data about official settlements (urban and rural) were collected from worldwide national censuses and vital records or yearbooks before being linked and aggregated to their relative digitized built-up areas (**Figure 1**). The worldwide e-Geopolis program is organized in world regions with corresponding projects: INDIApolis for India, SINOpolis for China, MENApolis for the edges of the Mediterranean Sea, AFRICApolis for Africa, etc. The criterion about demography has been decreased to 5.000 inhabitants in INDIApolis in order to forecast the cities of tomorrow. INDIApolis has been used in this research about standard of living in order to comply with the Indian characteristic of such a great nebula of settlements (648.802 towns and villages in 2011). In this

[8] Geographic Information System

database, a built-up area can be composed of official towns or villages of at least 2.000 inhabitants as long as the overall built-up area hosts at least 5.000 inhabitants.

Figure 2: *Database management system architecture and geographical scale overlay. (Source: Author's work)*



The INDIApolis database used is made of 18.366 built-up areas digitized as polygons in a GIS software. 29.209 official settlements including villages (as grey dots at the bottom right of **Figure 2**) and towns (as black dots) are included within these 18.366 built-up areas. The centroids of the official settlements have been geo-located using latitude and longitude WGS 84 coordinate system. Official Indian censuses have been compiled at the settlement scale since 1961 to 2011 with a gap of ten years between each census. The population figures of the settlements located inside the perimeter of a digitized polygon are aggregated to obtain a more accurate record of the population living in urban areas.

Although the e-Geopolis program allows studying and comparing the urbanization pattern occurring across the world, e-Geopolis is not enough to study the inner dynamics operating in urban spaces. Indeed, the processes occurring in urban spaces and the relationships between the mains drivers affecting the growth of the middle classes are complex. In order to fill this gap, multidisciplinary data about the main drivers influencing our topic (demography, sociology, employment, economy, etc.) have been collected during one year. To build an analysis of this magnitude the primary step was a data mining approach involving a large amount of data processing. Data coming from official censuses and private sources have been gathered focusing on two dates: 2001 and 2011. The database developed for this research project possesses several millions of entries

spatially linked to a GIS layer. To analyze such a quantity of information, a database management system[9] has been used in order to store and extract the data in an efficient way. Data are related to four different geo-located scales (settlement, e-Geopolis built-up area, district and state). An urban area is composed of several settlements, a district is made of several urban areas and a state is composed of several districts. The DBMS use the same architecture (left part of the **Figure 2**) and allows aggregating the data from a lower level to an upper level automatically. The data are all related to a spatial object and can be geographically mapped and used in a decision support tool (**Section 4.3** p. 23).

3.2 Example of Urbanization and Standard of Living Indicators

Once again, the data collected in the previous section are not accurate enough to study a topic as specific as the rise of the middle classes. In order to go further in the analysis, some composite indicators related to urbanization and standards of living have been created. Several indicators have been created but we will not go through each of them in this paper. Therefore, we will focus in this section on one example for standard of living and one example for urbanization.

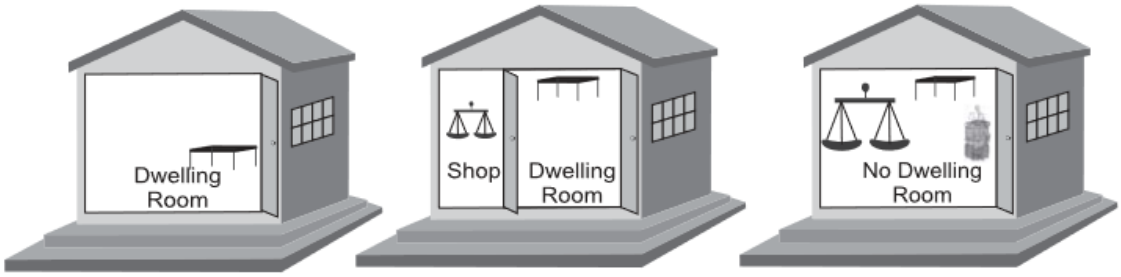
3.2.1 A Composite Indicator about Residential Welfare

The aim of this indicator is to quantify the residential standard of living based upon the weighted average of the house sizes (number of rooms) in relation to the household sizes. The first step was to define a required minimum number of rooms (in order to be not considered as an household living in an overcrowded house) by household size based on western standard of living criteria. The increase of surface per inhabitant in middle-class and upper middle-class dwelling units is a global trend which can be observed in Brazil, India, China, etc. According to the French official national statistical agency (INSEE, 2010) the criteria used to calculate the poor and inadequate housing conditions is a minimum number of dwelling units by household category. For example a couple without children needs at least two dwelling units for not being considered as overcrowded and a couple with one child needs three dwelling units. In the Indian census the number of dwelling units is covered but not analyzed. In the Census of India, *"a dwelling room do not include kitchen, bathroom, latrine, store room, passageway and verandah which are not normally usable for living. (...) In another situation when there is only one room in a Census house used as a shop or office the*

[9] A database Management System (DBMS) enables the user to store, add, delete, access, extract or modify the information from one or more databases.

unit will not be recorded as a dwelling room." Moreover a room used as a shop is not considered as a dwelling unit (**Figure 3**).

Figure 3: *Number of Dwelling units in the Census of India. (Source: Instruction manual for houselisting and housing census, Census of India, 2011.)*

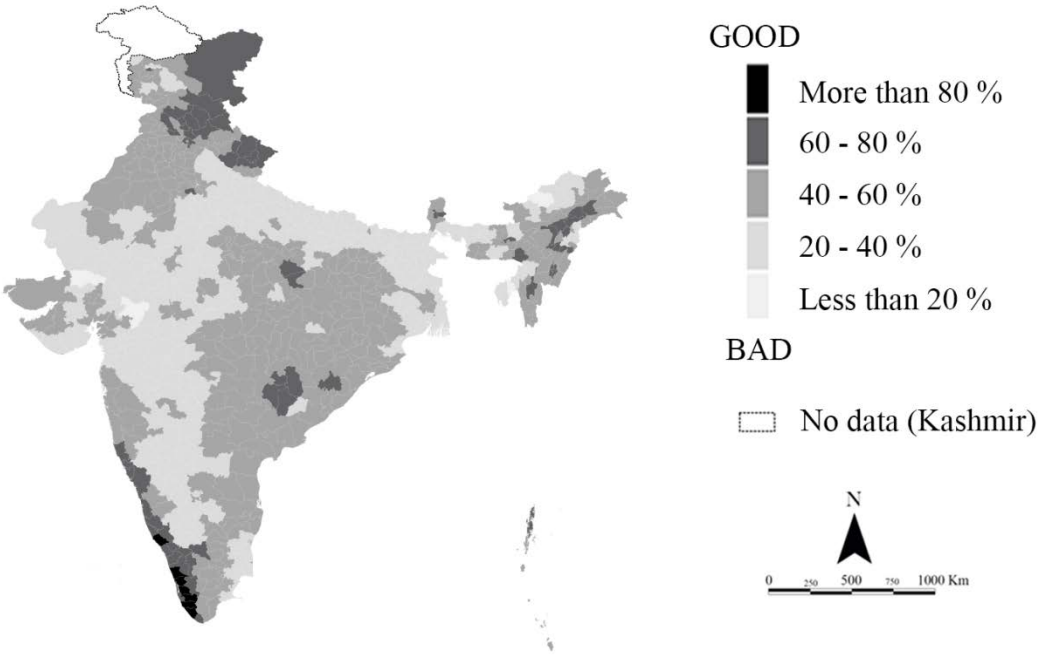


It is common knowledge that in India a non dwelling unit is often used as a room during nighttime. To counterbalance this fact, in our residential welfare indicator, a couple needs at least one dwelling room which is similar to two dwelling units for the French statistical agency. Below are the selected residential welfare thresholds by category of household's size with the related formula:

$$\mathrm{RF_x} = \frac{(C1x)+(C2x)+(C3x)+(C4x)+(C5x)}{HHx}$$

RF*x*: Residential welfare ratio for the district ***x***. **C1*x***: Number of households belonging to ***x*** composed of 1 to 2 people possessing at least 1 dwelling room. **C2*x***: Number of households belonging to ***x*** composed of 3 to 4 people possessing at least 2 dwelling rooms. **C3*x***: Number of households belonging to ***x*** composed of 5 people possessing at least 3 dwelling rooms. **C4*x***: Number of households belonging to ***x*** composed of 6 to 8 people possessing at least 4 dwelling rooms. **C5*x***: Number of households belonging to ***x*** composed more than 9 people possessing at least 5 dwelling rooms. **HH*x*** : Total number of household for the district ***x***

Figure 4: *2011 residential welfare calculated at the district scale (Source: Author's work on 2011 Census of India)*



Complex data like this residential welfare indicator are easier to grasp through visualization. The above **Figure 3** shows the spatial result of this indicator at the district scale and will be discussed in **Section 4.1** p. 17.

3.2.2 Extended Urban Areas Concept

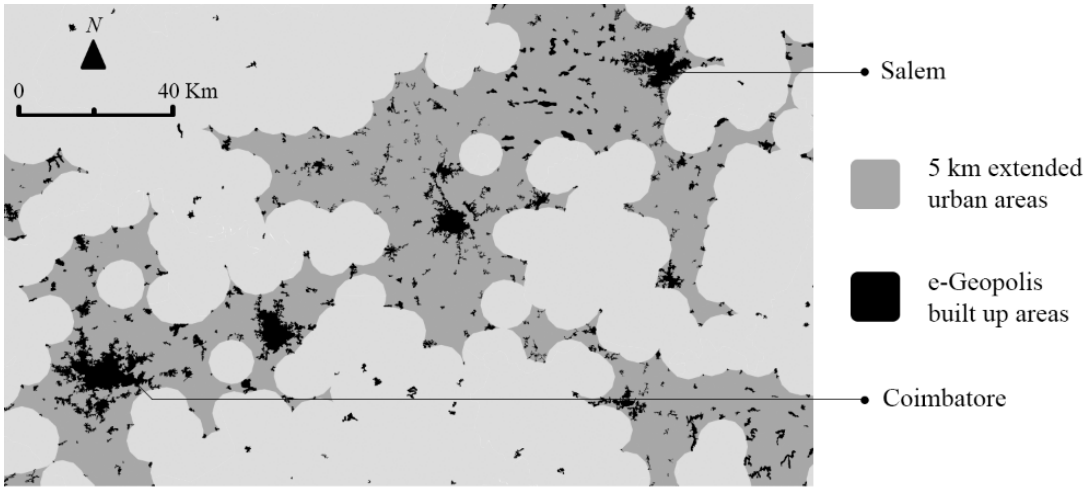
The areas outside the physical boundaries of the e-Geopolis built-up areas are not homogeneous in term of dynamism. Indeed, a close proximity to a built-up area could be an important factor of dynamism if benefiting from positive externalities related to this particular environment. As a comparison, the deep rural areas not directly under the influence of large urban spaces have been decreasing since 1950 in France (Ascher, 1995). A new concept has been thought in order to take into account the rural spaces that can fit into a form of urban macrostructure. A method has been developed in order to visualize and quantify what has been called "extended urbanization" or "meta-agglomeration". The aim of this method is to extract the urban macrostructures which find a consistency into a broader regional context. These macrostructures can take the shape of large spots or huge corridors (residential, IT corridors, etc.). They contain most of the Indian urbanization and almost all the major cities. To extract these specific frameworks, the first step was an expansion of five kilometres from the physical boundaries of the e-Geopolis built-up areas. The second step was to merge together the new surfaces. The last step was a reduction of the new obtained polygons by the same initial distance (5 km).

To conclude, a double filter has been applied in order to remove automatically:

- The extended urban areas with a low urban compactness i.e. those with a too-big artificially generated surface
- The small extended urban areas with a smaller surface than the lower threshold generated by the expansion step

The result of this expansion / reduction process is called a morphological closing (Voiron, 1995) linking the nearby urban areas of less than 10 km. There are no travel time statistics in India but the French median distance for home to work commuting is 10.2 km for rural areas (INSEE, 2007) and thus approaches the distance applied within this method.

Figure 5: *Extended urban areas extraction using GIS (Source: Author's work on e-Geopolis built up areas)*



As shown in **figure 5**, the distance used in this method connects without any gap the major urban corridors. An example is the corridor from Coimbatore to Salem, going through Erode and Tiruppur connected in a single set (dark grey in **figure 5**) covering a distance of 140 kilometers.

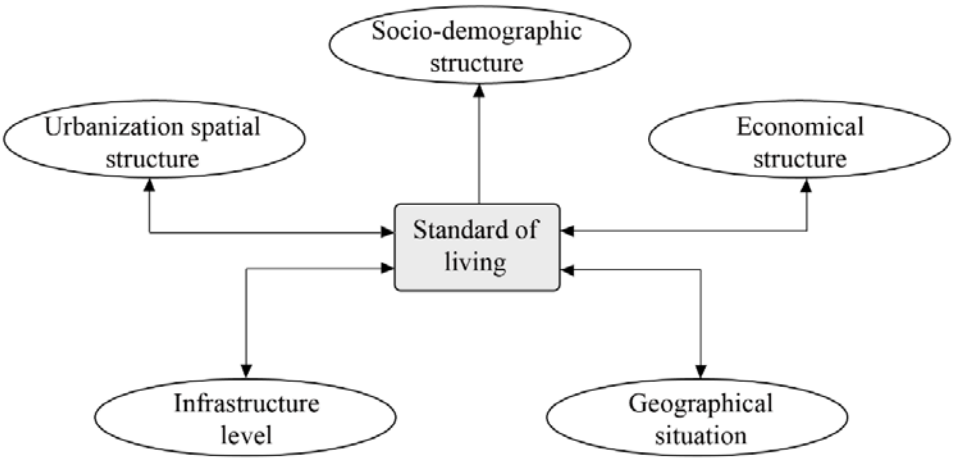
3.3 Middle Classes Rising: Conceptualization and Probabilistic Modeling

3.3.1 A Conceptual Model focusing on Standard of Living

The data aggregation is quite justified in many contexts, but it can become futile or useless in others (Sen, 1989). The diversity of India must not lead to blind data collection. The database developed for this research project possesses several million of entries stocked in a database management system and spatially linked to a Geographic Information System. Following this data mining step, an optimal selection of significant variables has been performed. The rise of the urban

middle classes is dependent upon a wide range of multidisciplinary criteria that interact between one another. In order to go further in the analysis, this issue has to be considered as a complex system within the meaning of the modern systemic approach: "*a system is a set of elements with dynamic interactions arranged depending on a purpose*" (De Rosnay, 1975).

Figure 6: *Reference scheme for Indian household's standard of living. (Source: Author's work)*



The purpose of this project is to study the rise of the Indian middle classes. Subsequently, the household standard of living is positioned at the center of the conceptual model (**Figure 6**). This reference scheme seeks to link the middle classes development with complex elements that go beyond urban geography. Much attention has been devoted for these six categories with a selection of the more relevant indicators for each of them. This conceptual model is suitable for any scale but the probabilistic approach of the following section has been performed at the district scale.

3.3.2 A Probabilistic Approach using Bayesian Networks

A total of 59 variables[10] have been selected within a 10 years' timeframe when possible (2001 and 2011).

Data are coming principally from:

- The 2001 and 2011 census of India (Population, motorization rate, mobile phone equipment etc.)
- Geo-located and open source databases (e-Geopolis, number of railways station using OpenStreetMap, number of ranked universities, etc.)

[10] Full list of selected variables available in **Appendix** page 26

- Indicator created especially for this project (number of car manufacturer outlets, airport location with annual flows, etc.)
- Composite indicators designed for this project (highway proximity, residential welfare, extended urban areas, etc.)

59 indicators have been selected in order to be used as the basis material for probabilistic modeling such (Bayesian networks). By using these indicators as inputs, the probabilistic methods lead to a multivariate classification. The Bayesian networks method has been carried out through a five-step procedure by extracting non observable latent factors. This procedure had had its first applications in urban geography a few years ago (Fusco and Scarella, 2012; Fusco, 2013). In a first step, the process is unsupervised meaning that there are no influences on the model structure provided by the operator. The result is a Bayesian network in which the 59 indicators are connected through 60 probabilistic links. During a second step, the indicators strongly bounded together by the probabilistic links are grouped together into clusters by a hierarchical classification algorithm. From example, one cluster is composed of the 2011 car motorization rate, the 2001-2011 car motorization rate evolution, the 2011 number of tertiary workers, the 2011 number of female tertiary workers and the 2001-2011 male ratio evolution. Indeed, from each cluster emerges a latent factor, not directly observable, corresponding to a general concept. For example, the general concept of the previous cluster may be "socio-demographic modernity related to mobility". The last step is to conceive a new factor that summarizes the information contained in the previous latent factors. The segmentation of the values of this factor provides the Indian profiles.

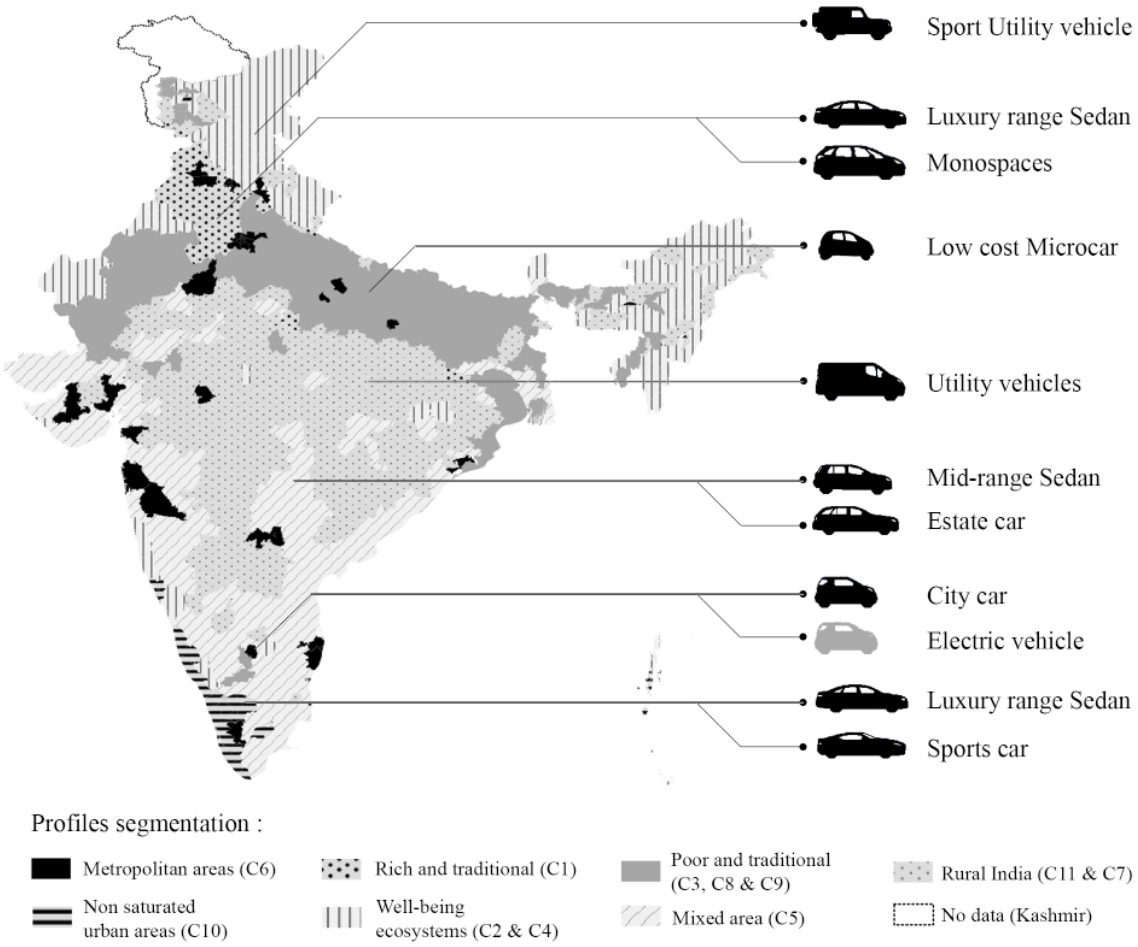
4. Modeling Results and Fieldwork Case Studies

4.1 A Geographical Lifestyle Segmentation using Bayesian Networks

The probabilistic approach performed in this study leads to an unprecedented segmentation of India induced from the bottom of the pyramid: the consumer market located mainly in built-up areas. This section focuses on the different lifestyles found in each profile in order to target areas with consistent car models. From a methodological point of view, the indicators and the latent factors that contribute the most to a specific geographical profile have been examined in detail in order to identify and analyze in details the consumer trends. Then, it becomes possible to understand the lifestyle behaviors of each profile by comparing the results between one another and with the average for the whole of India. Afterwards, for each identified geographical area, it is possible to find empirically the convenient car models that are the most suitable for each lifestyle. **Figure 7** below shows the product range offered by a standard car manufacturer linked to the segmentation. Each segmented profiles have been described in a previous paper for the following dimensions: socio-demographic shift

towards modernity, household equipment rate, urbanization rate and shape, urban transition, etc. (Perez and Fusco, 2014).

Figure 7: *Targeting geographical areas with appropriate car models (Source: Author's work)*



Some profiles with similarities in term of consumer lifestyle have been merged to reduce the complexity (**Figure 7**). The results of the above figure may help a car manufacturer to put forward a specific car model according to the consumer market geo-location as well as focus the advertising efforts in a geographical way. The segmentation leads to eleven different profiles, from cluster one to cluster eleven (C1 to C11).

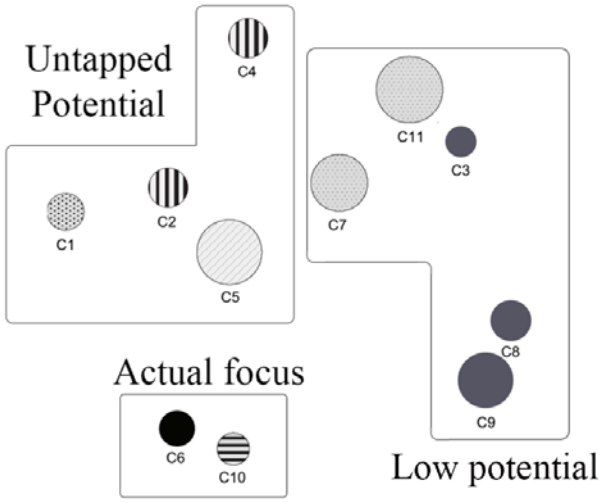


Figure 8: *Perspectives of the car market in India with indication of cluster proximities in the variable space. The circle's size is related to the number of district within each profile (Source: Author's work)*

In term of opportunities, the current situation of the Indian car market can be geographically divided into three categories: current and main focus of car dealer's, more or less untapped potentials and low potentials.

Present focus of the dealer's network (C6 & C10) :

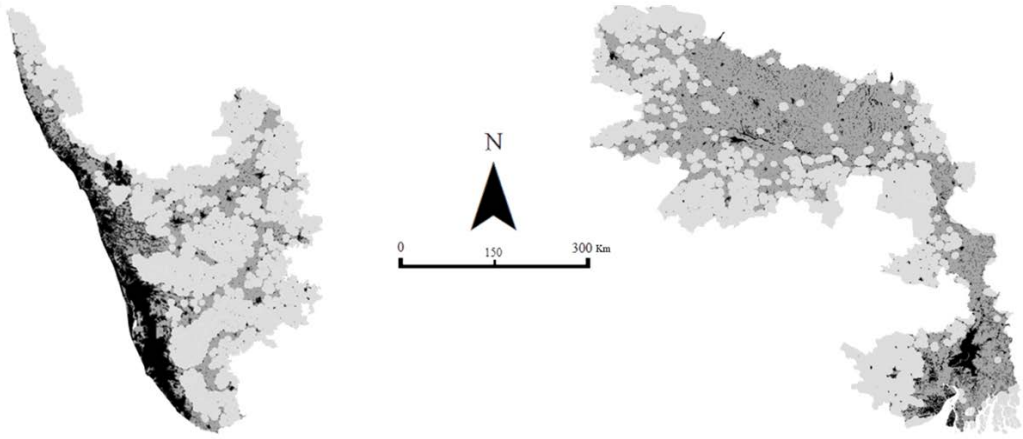
The C6 "metropolitan areas" and the C10 "non saturated urban areas" profiles are the major top-down focus of the foreign companies with a strong presence of point of sales. These profiles are characterized by the same characteristic i.e. a strong presence of the urban phenomenon (20% of these districts surfaces are covered by urban areas (e-Geopolis), 40% by extended urban areas). These two profiles share a unique phenomenon: a strong purchasing power combined with a significant rate of female workers within the tertiary sector thus revealing an ongoing socio-demographic shift toward modernity. The difference between these two profiles is the population density, excessively high within C6. Consequently the residential welfare is better within a non-saturated profile like C10 (**Figure 4** page 12). As seen in **Figure 7**, a mass motorization model shall not be promoted within a profile already highly saturated and overcrowded like C6. A product more adapted to this kind of environment, like a light city car seems more adapted. The next section (**4.2**) will focus on the metropolitan profile, and as we shall discuss, this profile could still be considered as a source of opportunities for a car manufacturer, especially in term of electric mobility.

Low potential areas (C9, C8, C3, C11 & C7):

These five profiles can be grouped into two categories. The first one is resolutely rural and made up by C11 and C7. This part of India is dominated by a strong primary sector that account for 70% of the employment rate. The average motorization rate for these districts is low (2 cars and 14

motorized two-wheelers for 100 households) with a slow 2001-2011 evolution. Urbanization processes are low with a share of urban areas and extended urban areas below 1% of the total surface area. Let there be no misunderstanding, this part of India is certainly rural but is absolutely not characterized by mass poverty or precariousness. People leaving in these areas have a countryside lifestyle that seems to suit them. The second group, called "poor and traditional" is composed by C3, C8 and C9 and has the same low purchasing power. Moreover, the motorization rate is slightly the same than the rural profiles. On the other hand, this geographical area accommodates the major part of the excessive demographic growth of India. The urbanization phenomenon is very important though largely underestimated by the Government especially in the eastern part of this geographical area (right part of **Figure 9**).

Figure 9: *The two biggest urban macrostructures of India. Left: Kerala and western part of Tamil Nadu. Right: Bihar state to Kolkata. Black: urban areas (e-Geopolis), dark grey: extended urban areas, light grey: district constituting the macrostructures.*



For instance, these two urban macrostructures seem to have opposed features despite a comparable size (121 043 km² and 154 023 km²). As discussed previously, the littoral part of the Kerala-Tamil Nadu macrostructure is made of households with a strong purchasing power living in a non-saturated urban environment. On the other hand, the Bihar-Kolkata macrostructure is characterized by a lot of old small and medium-sized settlements overtaken by the actual urban sprawl due to an important demographic growth (3 509 e-Geopolis settlements inside this macrostructure against 1420 in the Kerala-TM one). Consequently, the fast urbanization processes are producing negative externalities on the standard of living and thus generating mass poverty among a traditional lifestyle. However, large population allied with low purchasing powers suggests that these kinds of areas could reveal a potential for low-cost micro-cars (e.g. TATA NANO).

Untapped potential areas (C1, C2, C5 & C4) :

The C1 profile "rich and traditional" is mainly located within the Punjab state. The standard of living is high and this geographical area remains relatively forgotten by car manufacturer's points of sales (despite a very strong presence of points of sales in less than 10% of the observations). The urbanization level is higher than in the "rural India" profiles but lower than in the "poor and traditional" ones. However, the socio-demographic shift towards modernity is not yet started with a small and not evolving share of small sized household (1 to 3 peoples). We are faced with a traditional and rural area which had seen major changes including quick purchasing power increase due to the green revolution. The large family sizes that are not evolving allied with the increase of the purchasing power suggests that these kinds of spaces may be adapted to monospaces and luxury range sedan (**Figure 7**). The C5 "mixed areas" profile is more contrasted. First of all, it is located over a wide and heterogeneous area wherein the standard of living as well as the residential welfare are moderate. The share of extended urban areas is high thus including a lot of urban corridors. Moreover, the average distance from rank one metropolitan cities and highway is small. According to these facts, we are in presence of dynamics areas subject to change and under strong urban and metropolitan influences. The share of 2001-2011 home ownership is slightly decreasing in order to allow the relocation of an increasing share of 2001-2011 small household's size (1 to 3 peoples). It reveals future opportunities in a geographical area wherein half of the observations have a weak presence of point of sales. The C2 and C4 "well-being ecosystems" profiles will be discussed in another section (**4.3**).

4.2 Innovative Vectors ahead of Their Time: Unsuspected Opportunities for Electric Vehicle

The C6 "metropolitan areas" profile is well known by the car manufacturer companies with a point of sales network already operational. However, emerging countries have been definitely decided not to be a primary target for electric mobility. However, both bottom-up and top-down situations show that there is a strong potential for electric mobility. The case studies of Bangalore and Delhi show weak signals for e-mobility dissemination. These kinds of weak signals can only be found in a profile with high levels of innovative capacities due to a socio-demographic modernity ahead of its time.

4.2.1 Fieldwork Results: Bottom-up Solutions in Delhi

In Delhi there are almost 3000 electrics rickshaws in circulation that are bottom-up mobility solutions. SAERA, one of the Indian e-rickshaw manufacturer company expects to produce in the long

term 400 vehicles a day for the Indian market and afterwards the African one. They are manufactured locally and their numbers are rapidly increasing. The autonomy of a 4 seats vehicle is about 70 km. The price is 60 000 INR (about 1000 €) without battery + 15 000 INR for an Indian made Lead Battery. By contrast, a conventional auto-rickshaw costs approximately 150 000 INR.

Picture set 1: *Left: A 4 seats e-rickshaw in New Delhi. Right: A free charging point near a temple in New Delhi. (Source: Author's pictures, 2014)*

Delhi government banned the sale of certain categories of battery-powering rickshaws or e-rickshaws, as these vehicles were growing rapidly, last December. The idea was to allow the ones powered by a battery of less than 250W and keep the ones with a more powerful motor out of the circulation until they could be regulated. According to senior transport officials, the ban was put in place in order to control the proliferation of e-rickshaws. Vehicles with a power of less than 250W and speed less than 25 kmph are regarded as non-motorised vehicles under the *Delhi Motor Vehicle Act*. However, it was noticed that vehicles with more power, almost as big as conventional auto-rickshaws, were nonetheless in circulation despites the regulation act. A majority of these vehicles are running and operating with four batteries of 12V for a power of 650-850W. These vehicles usually carry more passengers than their four seats by accommodating people in seats beside the driver, ferrying each passengers individually (for 10 to 40 INR) instead of charging the global trip as conventional auto-rickshaws. These vehicles do not possess plate-numbers simply because they are still not registered by any civil or government body. Drivers do not need a licence and there is no background verification. Incredibly, the transport authority is blind to the sale of these e-rickshaws which clearly flout the 250W rule implemented by the government. A visit to different dealers in the city clearly shows that high-powered e-rickshaws are being sold in Delhi despite the ban. Although informal, the service of e-rickshaws is accused of generating congestion near the metro stations. On the other hand, this service is a key solution for the last mile, highly complementary to the use of public transport. The most surprising feature of this service is that there are no charging points in the city. Most of the e-rickshaw

drivers use free energy provided by temples so that you may see a few of these vehicles recharging with an amazing stretch of cable connections weaving them together on the pavement in a "do it yourself" way.

4.2.2 Fieldwork Results: Top-down Archipelagos in Bangalore

Innovation may disseminate in an incremental way within dedicated relevant areas like residential corridors. Indeed, megacities offer these kinds of opportunities within pocket areas distant from city centers. Some of these pocket areas take the shape of gated communities targeting the new already ongoing way of building cities: eco-building with integrated zero emission using renewal energy. Many initiatives or ambition are developing worldwide such as the ZED eco-districts built by BCIL (Biodiversity Conservation India) in Bangalore and other parts of India. In most cases, families living in these eco-districts are activists and concerned by the environment. The studied ZED eco-district contains 120 households that are off-grid in term of electricity and water (through solar panels and rain recycling devices, **Picture set 2**). There are no statistics in India about incomes. But most of the people living in this area are people owning all the following assets: TV, car, internet connection, mobile phone, and much more. The average monthly income of the households leaving in ZED is about 5000€ (4 to 5 INR lakhs a month). Some households living in ZED own a REVA electric car, a car made by the Indian car manufacturer Mahindra. The amazing thing in this story is that electric mobility settled by itself in these areas which finally provided the perfect context for such an implementation.

Picture set 2: *Left: Electric car as a second vehicle charging at home within the ZED eco-district. Right: Solar panel allowing peoples to live off-grid (Source: Author's pictures, 2014)*

These projects pushing forward the Electric vehicle may be a good ferment for new eco-systems development and be a lever for the use of local zero-emission mobility solutions. According to C.Hariharan, founder and CEO of BCIL *"such technologies have to be combined with an enterprise that could push away conservative values without compromising the everyday life and lifestyles"*. Indeed, the infrastructure is not ready for a full switchover towards electric mobility and consequently it was noticeable that the e-car was mostly used as a second car after a conventional one. But some strong weak signals like the parking of Infosys in Bangalore that has been equipped in charging points show that the situation may evolve quickly (**Picture set 3**).

Picture set 3: *Left: A Reva charging through solar panels near a Mahindra point of sale. Right: A whole row of Reva charging within the Infosys campus (Source: Author's pictures, 2014)*

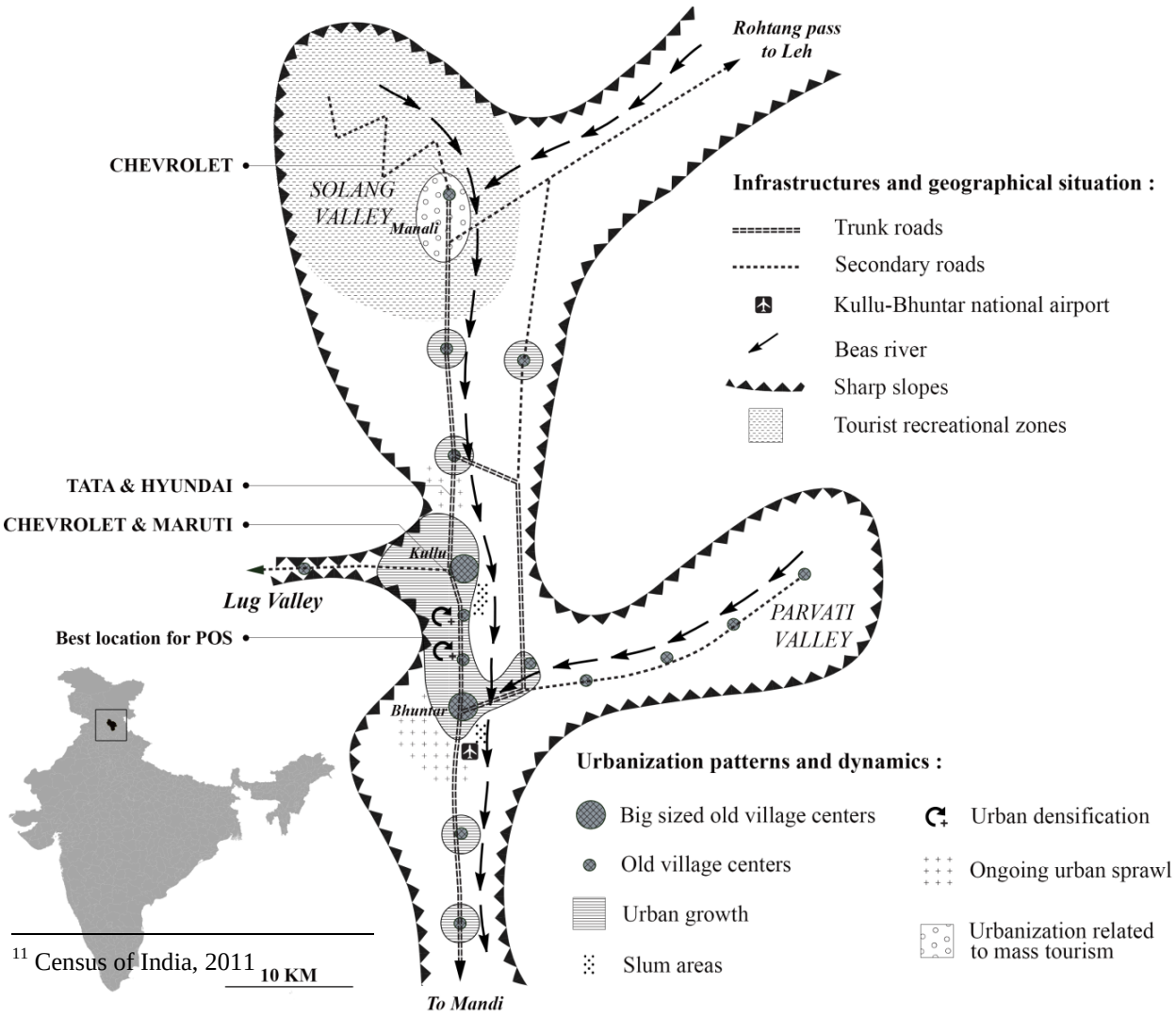
Opinion leaders living in these areas are testing new sustainable solutions by themselves and may deliver a model to be replicated by lower social classes glancing towards the upper classes. Even if these initiatives remain a weak signal, the demand for disseminating now practices is high. Moreover, another important point is the expensive price of petrol in India, about 0.95 €/ liter as if it was 6 to 7€/ liter in Europe according to the corresponding purchasing power. Moving through electric mobility is considered as a cheap solution in India. It is therefore necessary to anticipate the fact that a leapfrogging of the middle classes through electric vehicle is conceivable; especially by taking into account the fast capacity of India to assimilate new models. From a spatial point of view, these kinds of new models can only be disseminated with the metropolitan areas as starting points.

4.3 Well-being Ecosystems: A Practical Application for Network's Strategy

The C2 & C4 "well-being ecosystems" profiles are mostly located in elevated places like in Himachal Pradesh and in the eastern part of India (beyond Bangladesh: Meghalaya, Mizoram, etc.). The standard of living as well as the residential welfare are very high (**Figure 3** page 12). Moreover,

the urbanization processes are very weak with a primary sector decreasing. These results clearly show that we are in presence of touristic places and/or non-urban ecosystems. Consequently, these kinds of places possess a high level of well-being and are marginally occupied by car manufacturer's points of sales. For the Bayesian segmentation, the 12 districts composing the Himachal Pradesh state are considered as "well-being ecosystems". To validate the modeling results about this profile, the "Kullu" district located at the geo-center of the Himachal Pradesh state has been selected within the aim of market potential evaluation. Officially this district is the ninth most populous district of Himachal Pradesh with a population of 437.474 inhabitants including 9.43% of people living in urban settlements[11]. By comparison, 24.41% of the population is considered as living in built-up areas for e-Geopolis. Three e-Geopolis urban areas seem to have a significant surface area: Bhuntar, Kullu and Manali. On the one hand, the aim is to obtain a better understanding of the ongoing urbanization processes happening in this region using these three cities as fieldwork starting point. On the other hand, if the consumer potential is strong enough, the best location for the implementation of a point of sale will be located (**Figure 10**).

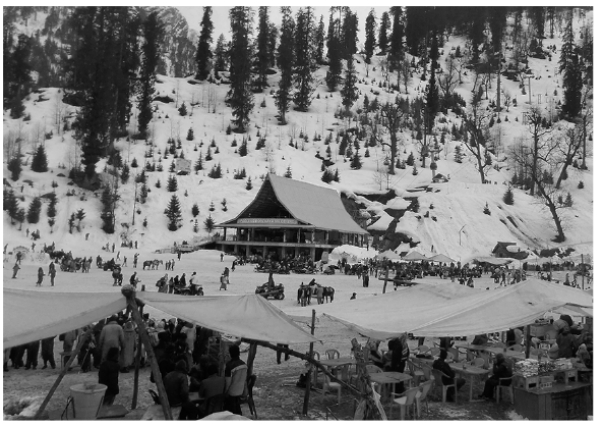
Figure 10: *Kullu district conceptualization resulting both from GIS database analysis and fieldwork results (Source: Author's work)*

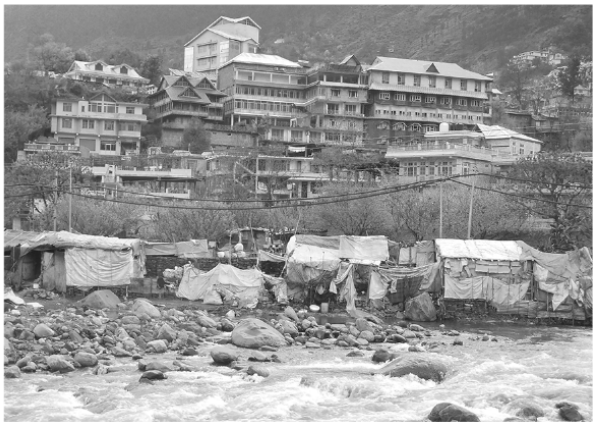


[11] Census of India, 2011

Located in the Himalayan part of India, the geography of the Kullu district is constrained by a major valley crossing the area from north to south. Consequently, the main urban areas are concentrated within the bottom of the valley. At some point during the fieldwork step, it became obvious that both the government and the e-Geopolis program underestimated the urbanization phenomenon. As regards of the e-Geopolis criteria, the problem lies in the specific geography of this place. Indeed, in some areas, the bottom of the valley is too tight thus preventing any construction except the road. Sometimes, these tight crossing exceed the 200 meters criteria of e-Geopolis thus generating urban pockets that are not accounted within the databases. Therefore, it became also obvious that the urban population of this district exceed at least 150.000 inhabitants. For example, there is a single built-up area including a lot of villages between the two main cities: Bhuntar and Kullu (**Figure 10**). The average standard of living seems high with single-family houses as a predominant model. There are only a few slums to be found near the river where the risk of flooding is high (**Picture set 4**). People living in these slums are not local and come from Rajasthan or Bihar or are Tibetan refugees. Most of them are working in the construction sector. The northern part of the district is totally dedicated to mass tourism. *Solang valley* has become a privileged geographical area for tourists coming from all over India and especially from Punjab. This has led to uncontrolled and growing urbanization mainly constituted of first class hotels and resorts.

Picture set 4: *Left: A ski resort in Solang valley. Right: standard of living vertical stratification in Kullu city (Source: Author's pictures, 2014)*





The car manufacturers seem to have only recently realized that these districts possess an important potential. The indicator about points of sales used within this research was conceived at the beginning of 2013. At this time, there were only two of them: Maruti and Chevrolet located within the narrow streets of the center of Kullu (**Picture set 5**). Due to the lack of surface within the showrooms, these two points of sales are working in permanent "tight flow" based on consumer orders. To counterbalance the lack of spaces, Chevrolet opened a second point of sale in Manali that acts like a warehouse for Kullu and as a showroom for the tourists. During the fieldwork on April 2014, a new Hyundai point of sale was found within the northern part of Kullu (actual urban sprawl) as well as a

Tata one under construction (**Picture set 5**). These two points of sale are modern showrooms with a large surface area showing the trust in the consumer potential of this district.

Picture set 5: *Left: Suzuki and Chevrolet old point of sales located in the narrow streets of Kullu since more than 3 years. Right: A new and modern Tata point of sales under construction (Source: Author's pictures, 2014)*

To conclude, it is important to emphasize the fact that both Kullu and Bhuntar possess a common dynamic since the urbanization has merged. Today these two cities act like twin cities with an ongoing densification process for each old center. Consequently, the best location for a point of sale is between these two cities, right in the middle of the urban corridor (**Figure 10**). Indeed, the narrow streets of Kullu prevent a point of sale from operating in a normal way. On another hand, the flows of people leaving Kullu towards the northern road are mainly tourists going to spend holidays in *Solang valley*. All of them are not in the mood of purchasing a car…

5. Conclusion and Implications

The world car fleet should grow by 30% to 80% in the coming decades due to emerging economies. According to A.Kundu[12], the middle class of India will be the one who will spend the most in the world by 2030. The potential of India seems indeed unlimited if we consider that today only 18% of the population can afford buying a new car (30% in Brazil, 50% in Russia). However, as discussed in this paper, the increase of the standard of living is not distributed homogeneously throughout a territory already full of socio-economic disparities. Sometimes, according to the studied profile, positive externalities on the level of development and on the ability to innovate can be found (C6, C10 etc.). On the other hand, the urbanization phenomenon may also generate a reverse effect by increasing the traditional inequalities (C8, C9, etc). The approach adopted in this paper allows obtaining a more accurate overview of the whole Indian Territory without generalizing, but rather by

[12] Jawaharlal Nehru University Professor, 2013 meeting

identifying the most important characteristics within each of the eleven different geographical areas. Beyond finding potential areas for a car manufacturer, this approach can also help for transport oriented development (TOD). Today, transport oriented development is a major challenge due to the worldwide growing urbanization, as is the creation of local eco-systems including innovations based on short distance trips, circular economy and frugality.

One the one hand, during the growth of the automotive sector in western countries until the 90s, every new driving license generated seven new parking spots within the metropolitan regions (for leisure, purchase, work, visit to relative, etc.) (Dupuy, 1999). Today, resources such as energy, raw materials, infrastructure, space, time, are not unlimited or endless especially in India. If this situation should lead to a kind of quota policy, prior knowledge on the complex phenomenon influencing saturation or non-saturation could be helpful. From this perspective, it is interesting to "play" with different scales in order to understand and anticipate how cities will accommodate the economical and demographical growth of fast emerging countries. On another hand, there are almost no electric two-wheelers in India while 120 to 140 million of e-bikes and e-scooters are already in use and have saturated the domestic market of China (Source: Transport Planning and Research Institute, Beijing). On a worldwide scale, millions of electric vehicles are already in circulation in a few hundred cities. At the same time, car manufacturers are questioning whether emerging countries shall be considered as a target for electric vehicles. Yet, as discussed in this paper, the Indian case study and especially the Indian metropolitan profiles are already displaying an important potential for electric mobility.

6. Appendix

Listing of the 59 indicators:

Standard of living:
- Share of households owning a car in 2011 Source: census of India 2011 , HH series.
- 2001-2011 Evolution of the share of households with a car. Source: census of India 2001 and 2011 HH series.
- Share of households owning a bicycle in 2011 Source: census of India 2011 , HH series. .
- 2001-2011 Evolution of the share of households with a bicycle. Source: census of India 2001 and 2011 HH series.
- Proportion of households with two wheelers in 2011 Source: census of India 2011 , HH series. .
- 2001-2011 Evolution of the share of households with a motorized two-wheelers . Source: census of India 2001 and 2011 HH series.
- Proportion of households with a phone (landline or mobile) in 2011 Source: census of India 2011 , HH series.
- 2001-2011 Evolution of the share of households with a phone (landline or mobile) . Source: census of India 2001 and 2011 HH series.
- Proportion of households with a bank account in 2011 Source: census of India 2011 , HH series. .
- 2001-2011 Evolution of the share of households with a bank account. Source: census of India 2001 and 2011 HH series.
- Proportion of households with not any of the following equipments in 2011 : television , computer,

telephone , two -wheeled motor car . Source: census of India 2011 , HH series.
- 2001-2011 evolution of the share of households having not any of the following equipments : television , computer, telephone , two -wheeled motor car . Source: census of India 2001 and 2011 HH series.
- Proportion of households owning their house in 2011 Source: census of India 2011 , HH series. .
- 2001-2011 evolution of the proportion of households owning their house. Source: census of India 2001 and 2011 HH series.
- Proportion of scheduled caste households owning their house in 2011 Source: census of India 2011 , HH series.
- 2001-2011 evolution of the proportion of scheduled caste households owning their of house. Source: census of India 2001 and 2011 HH series.
- Residential welfare 2011 Source: Author's design from the census of India 2011
- 2001-2011 evolution of the residential welfare. Source: Author's design from the census of India 2001 and 2011.
- Residential welfare for scheduled castes. Source: Author's design from the census of India 2011 .
- 2001-2011 residential welfare evolution for scheduled castes Source: Author's design from the census of India 2001 and 2011.

Spatial structure of urbanization:
- Share of urbanization e-Geopolis in 2011 Source: e-Geopolis 2011.
- Number of e-Geopolis built up areas in 2011 Source:. Geopolis e-2011
- extended urban areas grasp in 2011 Source: Author's Design using e-Geopolis 2011.
- share of extended urban areas in 2011 Source: Author's Design using e-Geopolis 2011
- Compactness of urbanization in the extended urban areas in 2011 Source: Author's Design using e-Geopolis 2011
- Density by District 2011 Source: Census of India 2011.
- Evolution 2001-2011 density per district. Source: Census of India 2001 and 2011

Geographical situation:
- Presence of coastline. Source: Author's Design
- Distance from centroid to a first rank megacities. Source: Author's Design
- Surface 2011 by district. Source: Author's Design
- Distance from district centroid to highway. Source: Author's Design

Infrastructure:
- Number of railway stations 2011 Source: OpenStreetMap 2013.
- Number of national or international airport in 2013 Source: Author's Design.
- Number of universities ranked in the top 500. Source : Spanish research project "Webometrics Ranking of World Universities" in 2013 CSIC: Consejo Superior de Investigaciones Científicas.

Demographic structure:
- Total Population 2011 Source: census of India 2011 .
- 2001-2011 evolution of the population. Source: census of India 2001 and 2011
- Scheduled castes population 2011 Source: census of India 2011 .
- 2001-2011 evolution of the scheduled castes. Source: census of India 2001 and 2011
- Share of small households in 2011 (households with 1 to 3 Individuals) . Source: composite indicator created by the author using the 2011 census of India
- 2001-2011 evolution of small households (households with 1 to 3 Individuals) . Source: composite indicator created by the author using the 2011 and 2001 census of India
- Share of large households in 2011 (households with more than 6 individuals). Source: composite indicator created by the author using the 2011 census of India
- 2001-2011 evolution of the share of large households (households with more than 6 individuals). Source: composite indicator created by the author using the 2011 and 2001 census of India
- Number of children under 6 years old in 2011 Source: census of India 2011 .
- 2001-2011 evolution of the number of children under 6 years Source: census of India 2001 and 2011

- Sex ratio in 2011 . Source: census of India 2011
- 2001-2011 sex ratio evolution. Source: census of India 2001 and 2011
- Literacy rate 2011 Source: census of India 2011 .
- 2001-2011 literacy rate evolution . Source: census of India 2001 and 2011
- Share of female in the tertiary sector in 2011 Source: . Composite indicator created by the author using the 2011 census of India
- 2001-2011 evolution of the share of female in the tertiary sector. Source: composite indicator created by the author using the 2001 and 2011 census of India.

Economical structure:
- Number of car manufacturers point of sales in 2013. Source: Author's Design using websites from the following manufacturers: Renault, Hyundai, Maruti, Tata, Honda, Ford, General Motors, Fiat, Skoda, Toyota, Nissan. Mahindra, Mitsubishi and Volkswagen.
- Share of tertiary sector workers in 2011 Source: Composite indicator created by the author using the 2011census of India.
- 2001-2011evolution of the share of tertiary sector workers. Source: Composite indicator created by the author using the 2011 and 2001 census of India.
- Number of hectares of special economic zones (SEZ) granted by the Indian government in 2007. Source: List of Formal Approvals Granted under the SEZ Act, 2005 Ministry of Commerce & Industry.

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