UN HABITAT
FOR A BETTER URBAN FUTURE

URBAN MORPHOLOGY & COMPLEX SYSTEMS INSTITUTE

ECONOMIC FOUNDATIONS FOR SUSTAINABLE URBANIZATION

A STUDY ON THREE-PRONGED APPROACH

PLANNED CITY EXTENSIONS, LEGAL FRAMEWORK, AND MUNICIPAL FINANCE

Economic Foundations for Sustainable Urbanization: A Study on Three-Pronged Approach: Planned City Extensions, Legal Framework, and Municipal Finance

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Economic Foundations for Sustainable Urbanization

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Extended Preface

On Sustainable Urbanization and the New Urban Agenda

The year 2016 saw the launch of a crucial debate in sustainable urbanization with Habitat III: the UN International Conference on Housing and Sustainable Urban Development, in Quito, defining the New Urban Agenda.

Jane Jacobs once said that "whenever and wherever societies have flourished and prospered rather than stagnated and decayed, creative and workable cities have been at the core of the phenomenon." In fact, the positive correlation between economic growth and the rate of urbanisation is well recognized nowadays. Indeed, the adoption of Agenda 2030 for Sustainable Development recognized for the first time in the history of development the transformative power of urbanization as a tool for economic development as reflected in Sustainable Development Goal 11.

However, the debate on urban value generation through urban planning and design continues to lack concrete recommendations and multidimensional policy solutions. The New Urban Agenda, signed at Habitat III, will be an extraordinary opportunity to strengthen and consolidate a unified vision of urbanization as the driver for sustainable development through urban planning and design.

At UN-Habitat, the UN agency at the forefront of sustainable urban development, our mission is to develop and provide urbanization policies and best practices that promote sustainable, equitable and inclusive urban development.

Our approach to achieving sustainable urban development is founded on a policy triangle comprised of good governance, urban planning and design, and a model of municipal finance that provides a foundation for sustainable urbanization. If urbanization that is well planned and designed has the capacity to generate wealth ex novo, what are the factors that increase urban value generation?

While there is no magic recipe to urbanization, let me share with you the three elements that, in our opinion, contribute to increasing urban value generation: governance, design and finance.

I. Municipal Finance

Urbanization is expensive. It requires centrally planned infrastructure such as elec-

trical grids, power stations, roads and highways, water-supply networks and sewage, telecommunications networks and railways and airports in addition to public and private services such as schools, hospitals, markets and so on.

In high-income countries, cities finance the majority of urban infrastructure. In these countries, urban revenue is generated primarily through taxes, public assets such as public land and other publicly-owned properties.

The more economically developed the city, the less it tends to depend on inter-governmental transfers. In cities such as New York, Stockholm, Seattle and Tokyo, locally-based revenues are more than USD 3,000 per capita each year. Such cities are better equipped at attracting multinational corporations that benefit from strong property rights and contribute to municipal and national revenue streams.

In many cities in the developing world, locally generated urban yearly revenue ranges from USD 100 to USD 500 per inhabitant. And in smaller cities in Africa and South Asia, it is not unusual for some municipalities to receive less than USD 50 per resident.

Facing deficits, local authorities usually turn to revenue sources that are beyond their capabilities. When experts from my office visit cities in developing countries, we are frequently requested to support bond issuing or accessing funds from international financial markets.

While municipal bonds and access to international financial markets are important financial tools, it has to be borne in mind that bonds require creditworthiness, a credit history that signals the likelihood of repayment by the local government. This may be expensive to acquire and, even if obtained, it is still a debt that must be repaid in the future.

Meanwhile, many countries asking these questions are missing an important first step: taking advantage of their own domestic wealth or what we call 'endogenous' sources of finance. The Habitat III conference of 2016 and its outcome, the New Urban Agenda, is an opportunity to refocus the global discussion on endogenous sources of finance.

Yet, while the Habitat III preparatory documents that will support the draft for the New Urban Agenda do mention this issue, they do not do so strongly enough. Habitat III needs to adopt as a priority the need for local governments to understand and leverage their own assets and wealth. After all, these are the resources that are within cities' immediate reach.

Three priority revenue sources for local governments are land assets, productive capacities, and financial expertise.

Land Assets: Municipalities need to improve property rights via land registration. In addition, local governments must have a system that enables them to periodically update information on asset and property ownership. Such a system requires a basic level of technical expertise, an electronic network and an accounting system. By reinforcing property rights through a central system that monitors and updates public and private land assets, municipal governments can establish a foundation for land-value sharing. In turn, this enables all interested parties such as residents and local governments to apply urban planning tools to renew and expand cities, improve neighbourhoods and increase property values.

Cities that apply these tools are able to generate more revenue from property taxes and 'betterment levies', and to direct those resources toward improving housing for residents and compensating proprietors with income. This creates a virtuous circle for city renewal and expansion. Indeed, land-value sharing has been very successful in cities in Japan, the Netherlands and other countries, where such systems have been in place for more than a century.

Productive Capacities: Improving and expanding the layout of cities enhances productive capacity and the mobility of people and goods, so urban areas can generate more income from the private sector. This dimension is usually considered part of the strategy around local economic development, and such policies will need to be updated in order to support productive economies that prioritize liveability and equity as well as higher urban revenues.

How the city is configured — its transportation system, public space and more — is directly connected to its capacity to improve productivity and expand wealth. Look at the example of mobility: cities with improper transportation infrastructure cannot connect people to jobs, and firms are unable to compete and generate sufficient income. Thus, municipalities lose revenue, hampering their ability to provide public goods. In contrast, cities that offer a good environment in which to live and an efficient urban layout in which to produce can attract people and firms, creating sustainable sources of income.

Financial Management Expertise: This varies broadly among municipalities depending on the level of revenue, region and country. In non-metropolitan municipalities, it may be important to improve basic financial capacity, ranging from accounting rules, capital investment plans, sustainability financial ratios and rules for expenditures and revenue.

Improving financial management top to bottom can have significant benefits. As demonstrated by UN-Habitat projects in Asia and Africa, understanding accounting principles, training on capital investment plans and helping to set up basic electronic government systems have immediate results. Later, support must be given to improve technical knowledge of more complex financial instruments such as bonds, credit ratings, loans, green financing and others.

An alternative source of funding is local and international commercial banks but these institutions are often too risk averse to provide local financing. Moreover, commercial banks usually have more profitable and less risky investment options. Private investors are another source of finance but typically are able to finance only small local projects.

Financing the Gap: One potential solution is a national municipal corporation. This can be an umbrella department housed in a national ministry that supports municipalities with technical cooperation and consulting expertise. In some cases, it could also offer loans or guarantees that encourage pooled investment schemes.

For example, development banks can offer credit directly to the municipal corporation, which could act as a guarantor for all municipalities. As cities get bigger and become more metropolitan, they can create their own municipal corporation that serves smaller municipalities.

Another financing mechanism is local infrastructure funds, where municipalities

create an external investment body to manage local infrastructure. Such funds can be adapted to local conditions and provide funding to develop a project pipeline or, eventually, to co-finance local infrastructure projects.

Such a fund would require proper oversight to guarantee transparency and expertise. But, by encouraging private sector consulting and investment, local governments can generate capacity around incremental financing. There are several such examples in cities in the United States, Canada and Western Europe but also in Africa and Asia. Those funds can also have a climate change component and attract bilateral donors.

Financial markets can also be strengthened through the use of bonds, though significant challenges remain in this area. In Latin America, Rio de Janeiro, Bogotá, Belize and others have issued bonds, although the maturity of these bonds were less than ten years, which is too short for the lifecycle of an infrastructure project, which typically runs for more than two or three decades.

In Africa, the situation is even more complicated. For the most part, African governments allow bonds to be issued only at the national level, with just a few exceptions of bonds being issued at the sub-national level - including in Dakar, where the process remains in limbo. The financing of bonds requires technical expertise, credit ratings and a proper legal framework. And still bonds are not a panacea: like any loan, they constitute a debt and must be repaid.

One form of classical bonds is what is known as a pay-for-success contract, also called a social-impact bond. These don't require a credit rating and can be implemented by a municipality through an external institution that manages the issuing of the bond and pays all parties if and when the social policy is achieved.

In order for a city to prosper, a minimum level of financial sustainability and autonomy is needed. Still, finance is a necessary but not a sufficient condition. According to what UN-Habitat calls the Three-Pronged Approach, finance is joined by design and governance as one of the three elements required for prosperity.

II. Urban Planning and Design

Urban Layout and Supply Chains: Urban planning and design that supports urban value-generation requires that we examine the transaction costs imposed by inefficiencies resulting from poor urban design at both the neighbourhood and city level. We begin by looking at how urban layout can support supply chain development and promote economic diversification and growth.

Supply chains are comprised of different firms in distinct locations each of which performs activities necessary to the production of a final good or provision of services. Cities with diverse and efficient supply chains often become self-sustaining entities that facilitate innovation and growth in other industries. For example, many successful international companies producing a variety of goods that require advanced technology, skilled labour, and collaborative urban environments are located in hubs where transit systems are efficient and human capital endowments are high. Not only are these firms able to hire the most qualified candidates, but they also reduce their production costs by locating in cities where transportation

infrastructure maximizes the mobility of people and goods.

However, efficient supply chains cannot operate in any city environment; they require an urban layout that minimizes the costs of transportation and enhances collaboration and knowledge sharing. Investing in adequate and appropriate transportation infrastructure and street design is essential to minimizing the transaction costs imposed by slow and inefficient transit systems that limit the mobility of individuals and the transport of goods.

Mixed Use: In addition to lowering transaction costs through better urban transportation infrastructure and design, urban planning should include diverse neighbourhoods with mixed use spaces.

Mixed use neighbourhoods are characterized by the presence of primary and secondary use buildings and/or spaces. While primary uses can be thought of as a neighbourhood's anchor, secondary uses serve people drawn in to the neighbourhood by the primary use. Primary and secondary uses include buildings and/or spaces that serve residential, commercial, public, or industrial purposes. When the primary use or uses of a neighbourhood are effectively combined with secondary uses, further entrepreneurial activity is supported setting the stage for continued urban growth.

Cities that feature many mixed use neighbourhoods attract people from different socio-economic backgrounds, regions and countries, thus fostering internal capacity for creating new industries, activities and livelihoods for their residents. Mixed use also has social benefits such as, in the case of residential use, mixing middle and high-income housing with low-income housing. This helps create neighbourhoods conducive to inclusive growth whereby low-income residents are incorporated into the economic fabric of a city, thus providing economic mobility and income gains.

Adequate Density: Urban design that promotes value generation considers density as one of the leading indicators. When cities have a high concentration of people (in the realm of 15,000 people per km^2) they are able to maximize the benefits associated with mixed land use while supporting urban supply chain development and minimizing the costs associated with low density urban infrastructure. Urban sprawl not only kills the economic and social vitality of neighbourhoods, but also produces ghost cities where urban residents' mobility is limited due to the distance from the urban centre. Urban sprawl often results in abandoned neighbourhoods due to the prohibitively high cost of transport and logistics.

By the same token, limiting land use specialization prevents neighbourhoods from succumbing to the economic stagnation associated with homogenous single-use neighbourhoods.

Density also provides a strong tool for local governments to plan and design better cities, facilitating regeneration, reordering streets and parks, extending roads, providing metro lines, highways and trains.

Urban Competitiveness: If value generation is supported by vibrant communities that foster economic activities and the production of goods for export, then a city can achieve high competitiveness. Urban competitiveness implies that it is

easier for people to move and meet, to exchange ideas, and implement them, increasing entrepreneurship and economic activities in the city. Lively neighbourhoods (mixed use and density) get the best out of their local residents and attract foreign talent, expanding innovation and knowledge.

For a city or country to be competitive, multiple factors are at play including trade rules, economic planning, industrial policies, education, health, geography and perhaps history. Urbanization and how the city is designed clearly have a major role in urban value generation.

We see that urban planning and design, through urban value generation, has the capacity to foster sustainable, inclusive and efficient urban environments. This is more than just an architectural approach; when city design is well conceived and strategic, the economic power of urbanization is unleashed even at a neighbourhood level. A city is ultimately a combination of vibrant neighbourhoods.

III. Legal Framework

Cities need rules, governance, and legislation to unlock the benefits of urbanization. Walking through cities in Latin America, Africa and Asia, you see common features in most of the developing world: slums are next to formal settlements, high rise buildings are surrounded by low income neighbourhoods and housing complexes are sometimes empty when people need decent housing. When you dig into the cities, typical problems are that local governments lack proper sustainable finance, they are permanently in deficit and not able to capture value from their neighbourhoods. Furthermore, city planning is usually absent or improper and rules and regulations are not working. All of these symptoms are indicators that cities are unable to integrate municipal finance, planning and legal framework, in order to achieve sustainable urbanization. Why then is the legal framework one of the essential components for cities to prosper?

Legal Framework and Urbanization: The legal framework determines how the game is played; though everybody can kick a ball, playing a soccer match requires rules, time and arbiters. Building shelter and houses is one thing but mixed-use housing and urban expansion requires coordinated actions and regulations known and agreed to by all parties. In all instances of urban development, a proper legal framework needs rules and regulations, governance and institutions and property rights.

Rules of the Game: Rules and regulations, a lack or an excess of them prevent or burden economic transactions. Ronald Coase, who believed that markets are imperfect and have frictions, indicated that once 'transaction costs' - the costs of dealing and exchanging things in a market economy are taken into account, contractual arrangements are not always efficient because they may cost more than the gain they produce. This is of course when arrangements are not too complex.

Lack of rules and regulations; on the other hand, make it hard or impossible to produce sustainable urbanization. In Africa almost 60 per cent of cities are composed of slums which tend to be close to the Central Business Districts (CBDs) where land is more expensive. Nairobi, where the largest slum in Africa, Kibera, is located, is an example of slums scattered all across the city with local governments unable

to renew or upgrade land because rules for conversion or expropriation are not in place, promoting instead, an informal control network that feeds corruption. Kibera, if converted to formal land, would produce almost USD 1billion in value and revenue gains for the county and central government.

According to the Doing Business Database by the World Bank, in low-income countries simple things such as registering properties or obtaining a construction permits take more than 100 days, whereas in most OECD countries that is done in less than ten days. There is a clear relationship between transaction time and growth.

Institutions for Urbanization: Institutions design and improve laws, providing a stable framework for incremental governance development and technical evolution. Without institutions, self-adjustment and social learning is stopped or regressive.

Institutions are key in the design of rules and regulations and in the necessary application and enforcement for cities to plan long-term. Interventions in infrastructure require good institutions since urban structure typically remains for 100 years, with buildings staying from 20 to 150 years and roads lasting for 200 years. Certain layouts and patterns have survived historical eras as is the case in several cities in Europe where the layouts in place come from the Roman or the Ottoman Empires. Thus, cities badly designed have the ability to adversely affect generations.

Strong institutions come together with good governance. In developing countries, urban infrastructure such as water management systems, roads and electricity are either oversupplied or scarce and this is a symptom of fragmentation of governance structures, due to government layers with unclear mandates at local, regional and national levels, and ministries and agencies with competing and overlapping responsibilities.

Legal Property: Property rights or legal property define how resources are owned and used. Legal property helps to reduce informality allowing local governments, residents and firms to plan cities and obtain resources from land and property. Lack of legal titles and ownerships explain 'dead capital' which the Peruvian economist, Hernando de Soto, estimates as USD 9.3 trillion of potential but unrealized wealth, because people who cannot use property as collateral remain poor, since they are unable to get loans and scale up their properties and capital.

Legal property provides people and institutions with protection; increases incentives for landowners to invest long term; and makes it possible to use assets as guarantees for financing capital formation or expansion. Land and property titles are usually conditions for citizens and firms to have creditworthiness and access to loans and use complex financial instruments. Insecure property rights increases transaction costs since exchanges need non-traditional guarantee mechanisms to support market exchanges, leading to informality and corruption. Consequently, in the absence of proper titling and proof of ownership, simple processes such as buying property and selling or renting a house can become extremely complex.

Legal Framework and Efficient Markets: As a legal framework is the basis for proper functioning markets, lack of it causes market failure. This occurs when transactions are prevented from taking place and reaching an efficient outcome. In urban planning, weak legal frameworks affect three major markets -land, housing and finance– which are all closely inter-connected.

For proper land markets, local governments must be able to implement planning policies to provide affordable access to commercial properties and housing while maintaining appropriate densities and mixed land uses. Public authorities must be able to act responsively to readjust land and provide access to suitable areas for economic purposes. This implies that several things are in place: recording tenure rights, avoiding illegal and improper use of land, having a mechanism for land valuation and raising income from land taxation. Currently, lack of property rights are the norm in developing countries due to the weak technical capacity of local governments to record and update land registration.

Providing housing for all citizens through proper housing markets must be a policy priority. Ideally, housing must be available for different income groups, and alternatives should exist comprising of a mortgage system and social housing for low-income populations, which must be a temporary solution until better housing conditions become available. Since housing is not a public good and requires a financially sustainable solution, there needs to be proper incentives for the private sector to engage in a mortgage market. However, at times, local governments, wanting to act on their own, end up building houses themselves and crowding out the private property development industry or, worse, end up multiplying subsidies that make social housing unsustainable. Other cities, on the other hand, leave slums to take care of housing problems.

Financial Markets must support conditions for housing mortgages and the financing of properties through land acquisition or expropriation by the government, which should compensate landowners with the land's market price to avoid negatively affecting private sector involvement. Several financial instruments must be in place to make housing available to different income groups of the population. For example, land value finance, allows local governments, residents and private sectors to obtain a return from urban renewal and expansion.

Numerous multiple distortions affect financial urban markets, such as subsidies which are provided for political ends rather than technical solutions. Inflation, which depends on the country's monetary policy, can also destabilize rent and mortgage markets and result in speculation and segregation.

Cities are not able to function properly in large parts because proper legal frameworks are not in place. With slums and informality becoming the rule rather than the exception, cities become dual economies where, in the formal sector, markets exist to some extent while in the informal sector there are no rules or regulations, institutions are absent and property rights do not exist. Having dual economies, one formal and connected to modernity and another backward and constrained, is the main cause of inequal-

ity and the origin of potential social crisis, with serious economic and political consequences. Fortunately, fixing and improving the legal framework is possible. Based on our work at UN-Habitat, we have developed a set of principles to support cities. First, it is important to understand that improving a legal framework should not aim to change cities overnight; as cities evolve, institutions must be strengthened in parallel with increased technical capacity. Second, improving the legal framework is incremental. The formal and informal rules and institutions in place must be identified and leveraged as a continuum. Third, cities belong to a country and therefore they cannot improve further if limitations come from their nations' constraints, rules, and technical expertise, which are all linked to the capacity of the central government.

IV. In Conclusion

When we zoom out of cities to regions and countries, a clear pattern emerges as efficient neighbourhoods are clustered and well connected to each other leading to more productive regions and countries. This provokes the philosophical question of which factors drive development? While dozens of theories and hundreds of approaches have traditionally emerged in addressing this, we cannot deny the fore role of urban layout, planning, and design in driving economic growth and development based on years of field work and technical analysis all over the world.

Working in neighbourhoods to improve urban design, planning, regulations, and finance is the essential starting point before scaling up to cities, regions and countries. As we continue to support the implementation of smart urban design policies, we are also enhancing our understanding of how urban value is generated and sustained in cities.

Dr. Joan Clos

Secretary General of Habitat III
Executive Director, UN-Habitat

Introduction

UN-Habitat's priority is to support city leaders to achieve sustainable urbanisation by providing urban planning methods and systems to address current urbanization challenges such as population growth, urban sprawl, poverty, inequality, pollution and congestion. International experience shows that cities and local governments can support productive activities through suitable investments in urban planning, infrastructures and institutions.

The main objective of this study is to provide local governments and planning departments with a rational approach to Planned City Extension (PCE)[1] by integrating the three fundamental principles behind sustainable urbanization proposed by UN-Habitat's Three-Pronged Approach: good planned city extension, efficient municipal finance and proper legal framework. Through a quantitative and qualitative assessment of how these principles affect urban productivity, it aims at illustrating the following points:

- Well-planned cities have higher urban productivity in the long run
- Financial and legal factors are key for a successful implementation of plans and for creating an urban ecosystem with steady and resilient value creation patterns

In order to measure the impact of a city's performance in financial, legal and urban planning matters on urban productivity, robust indicators are needed for both quantitative and qualitative analysis. This study sets the basis to select a set of metrics and indicators which are reliable and can be measured and monitored to put figures on the generic Three-Pronged Approach framework and to provide a model of how the performance on these indicators affects urban productivity in the long run.

It is meant as a practical tool as it provides the methodology for measuring the economic impacts of different decisions in spatial planning, urban financial management and legislation. It supports the promotion of a comprehensive integrated urban planning agenda among policy makers and urban managers; strengthens the understanding of present and future gaps in urban strategies and creates a scientific methodology for developing and managing urban space, creating a comprehensive legal and institutional framework, prioritizing investments and evaluating the impact of long-term spatial planning decisions and infrastructure investments.

This model is meant to encompass the dynamic process in urban environments. Urban planning is not a once and for all process; instead, it is a dynamic process of urban evolution. The initial general plan for a Planned City Extensions is the result

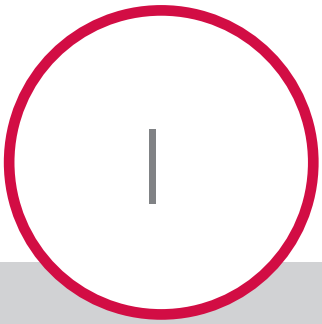
1 See UN-Habitat (2015) Planned City Extensions: Analysis of Historical Examples, and Urban Lectures: Principles of Urbanisation http://unhabitat.org/tag/three-legged-approach/ [Accessed 29dec2015]

of a planning process within a legal framework, under a certain budgetary restriction. This plan is meant to evolve over time to foster processes of urban intensification such as the densification of human activities, diversification of economic activities and consolidation of land markets. To support these dynamic processes of intensification, diversification and consolidation, local governments have to provide the following:

- An initial general plan, that gives room to further evolution
- A legal framework that allows the initial general plan to be implemented and that allows urban evolution processes to take place
- A financial framework to finance the implementation of the plan and feed and support the process of urban evolution

The major objective of this model is to highlight the benefits of a Three-Pronged Approach on urban productivity. Increases in urban productivity result from a complex web of processes, including economies of scale, economies of range and economies of agglomeration induced by cost savings, location advantages, specialization premiums, or the higher intensity of interactions between people and companies. The concept of urban productivity will be investigated into details in the second part of this report. The major assumption that this study aims at demonstrating, however, is that increases in urban productivity can be achieved through following the fundamental principles of the Three-Pronged Approach in Planned City Extensions.

This study is structured as follows. The first part by Serge Salat is a broad overview of the Three Pronged approach to sustainable urbanisation discussing key patterns: planning, transit, community design, and financial patterns. This part investigates the concept of urban productivity and the socio-economic mechanisms that make cities more productive: economies of scale, economies of scope and agglomeration economies; while also discussing the negative externalities that might arise. The second part, by Loeiz Bourdic and Marco Kamiya is structured as follows; It presents the elements of integrated urbanization, the Three-Pronged Approach and the three essential components it rests upon: urban planning, municipal finance and legal framework. The third section provides a methodology to measure urban productivity and assess the performance of the components of the Three-Pronged Approach, using a comprehensive set of indicators. The fourth section present empirical evidence and case studies that highlight the links between urban planning, legal framework and financial indicators to urban productivity. Urban planners, urban economists and practitioners can find broad case studies supporting integrated approaches to urbanization and can rely on these cases to defend policy interventions. The fifth section is an annex that provides a theoretical economic model linking Planned City Extension characteristics and urban productivity. Non-mathematical readers can safely skip this annex though it is important to highlight that this model can help to support future approaches to measure a city's productivity and can help to design impact evaluation schemes.



Part 1

A New Approach to Urban Value Creation

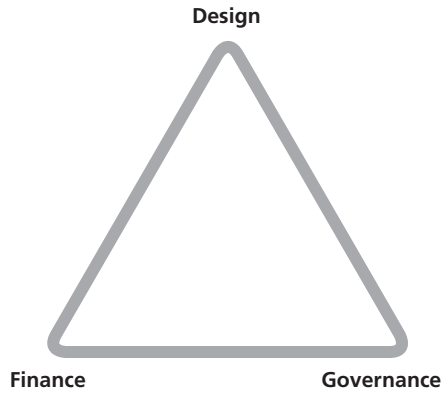
Serge Salat

In 2008, for the first time in human history, half of the world's population lived in urban areas, with two thirds in low-income and middle-income nations. This is estimated to rise to 60 per cent in 2030, and 70 per cent in 2050 to a total of 6.2 billion. Fast-growing cities face challenges of populations to shelter, huge infrastructure needs to finance, a changing climate to adapt to and the imperative to thrive in an evolving and competitive global economy. How it meets these challenges will determine a city's success and quality of life. Accelerated urbanization is confronted by the triple challenge of speed, scale and the scarcity of resources. This can be summarized in simple figures: in the coming 20 years, 1 million people per week will be urbanised with an average of USD 10,000 per household. To this constraint, other threats such as climate change can also be mentioned.

This book, developed jointly by UN-Habitat and The Urban Morphology and Complex Systems Institute, addresses the issues of urban governance, finance and planning for sustainable urban transformation from an economic perspective. It is rich in economic and institutional analysis based on sound scientific methodology. This introduction will not attempt to summarize its wealth of results. It will build upon UN-Habitat's Three-Pronged Approach from a strategic planning perspective for mayors, policy makers, infrastructure investors, decision makers, developers and more generally for practitioners who face the difficult task of making cities grow, while financing infrastructure and housing needs and creating economic wealth and social inclusiveness.

In 2008, for the first time in human history, half of the world's population lived in urban areas, with two-thirds in low-income and middle-income nations.

Dr. Joan Clos, UN-Habitat Executive Director, has, with great insight, clarified the triangle of urban development in a simple and elegant manner, which should be an inspiration for all policy makers. This triangle is as follows:



Once this is understood, the key planning problem becomes how to make this triangle work in a dynamic way, while creating positive feedback loops that self-reinforce and create value. Integrated planning with highly efficient patterns is the answer. The patterns explained in this book set in motion UN-Habitat's Three-Pronged Approach. They are the generative grammar of more competitive cities, with high quality neighbourhoods, lower infrastructure costs and lower CO_2 emissions. These cities have lower transportation and housing costs and are resilient to natural hazards. They also tend to be largely self-financed.

Due to the complexity[2] of cities, and their unpredictable emerging[3] properties, we need to plan and design our cities in an integrated way with a long-term development plan. Urban planning is often done in silos, optimized by different agencies. However, urban reality never works in this way and separate optimizations may lead to sub-optimal results. This is why integrated planning[4] is required, as it allows cities to come up with a common, shared vision for their development. Such action provides an overarching framework and integrates a multiplicity of actions and initiatives that will reinforce each other.

If there is a lack of integrated action in regards to urban planning, it will undermine a city's economy and quality of life. This will lead to housing that is too expensive and unaffordable for the urban poor, result in people whom are sheltered from storms but too far away from jobs, create large inequalities in access to education and health care across the urban space, produce neighbourhoods that need more playgrounds, water and power grids and result in congested streets with poor air quality, threatening the health of the most fragile.

Successful integrated planning can be based on the recognition that some urban patterns create value, while some dampen and destroy it. Thus, we need to understand which patterns initiate positive feedback loops and generate more value to improve human well-being. For this, we can build upon the newly developed science of cities as complex systems[5] and upon success stories of cities that have implemented successful patterns early in their development or at moments where they needed to reinvent themselves. As this introduction targets policy makers and practitioners, it will discuss more urban success stories than theoretical models, while also building a framework for an in depth understanding of the new urban pattern language.

We will show that integrated planning based on UN-Habitat's Three-Pronged Approach can be summarized in a few integrative cross-cutting patterns. In a series of four books[6], UN-Habitat has started to bring together planning strategies and bundle policies under the generic name of "Urban Patterns for a Green Economy". This series covers themes such as working with nature, leveraging density, optimizing infrastructure, and clustering for competitiveness. This introduction explains how this approach can become transformational when based on the most recent discoveries of complexity science applied to cities. The work done by the Urban Morphology and Complex Systems Institute, starting by the publication of Cities and Forms, On Sustainable Urbanism, in 2011, followed by a series of papers on mathematical regularities in efficient cities' spa-

2 Examples of complex systems are as diverse as the global economy: the human nervous system, ecosystems, the climate system and the Earth system. This implies in particular that urban variables are strongly interdependent and that changes can have unintended consequences. More generally, complex systems cannot be broken down analytically into separate variables. This makes it difficult to know exactly which inputs contribute to an observed output, and the extent of each factor's contributions.

3 An emergent behaviour or emergent property can appear when a number of simple entities (agents) operate in an environment, forming more complex behaviours as a collective.

4 See: Serge Salat, Integrated Sustainable Urban Planning. A Preliminary Approach. Draft Conference Paper Prepared for the Global Platform for Sustainable Cities (GPSC) Conference, Singapore, March 2016.

5 See: Serge Salat; with Françoise Labbé and Caroline Nowacki, Cities and Forms. On Sustainable Urbanism, Hermann, 2011. Michael Batty, The New Science of Cities, MIT Press, 2013. Nikos Salingaros, Principles of Urban Structure, Vajra Books, 2014.

6 http://unhabitat.org/series/urban-patterns-for-a-green-economy/

tial structures[7], has lifted the veil on the underlying structure of successful urban patterns.

This body of work allows a more in depth understanding of urban patterns that work. We have a deeper understanding of the concept of patterns today, 40 years after the publication of Christopher Alexander's seminal book. A pattern is a discernible regularity in the world. As such, the elements of a pattern are repeated in a predictable manner. Abstract patterns in science, mathematics, language, and urban space may be observable by analysis. Patterns have an underlying mathematical structure. Thus, mathematics can be seen as the search for these regularities. Similarly, in the sciences, theories explain and predict regularities in the world. Thus, a science of cities looks for explaining regularities, or patterns, in urban space. Understanding urban patterns that work helps us to plan cities in a more integrated way as patterns are integrative by definition.

Because cities are complex adaptive systems,[8] highly dependent on plans, financial frameworks and governance patterns, we have a lot to learn from the regulatory frameworks that work from network patterns that connect to economies that foster agglomeration and increase productivity. We have to study extensively the pattern designs of liveable and healthy communities and financial patterns that create positive feedback loops of value creation.

Regulatory planning patterns have the potential to foster an efficient city form or burden a city due to inefficient distribution of densities and poor connectivity. Network patterns, for instance, may agglomerate densities efficiently, by creating effective public transportation system. On the contrary, they may also end up dispersing urban settlements due to fragmented and diffused spatial expansion, causing urban sprawl. Community design patterns, on the other hand, may create liveable and healthy communities with positive and continuous flow of public places for residents. However, they may also create endlessly and repetitive accumulations of identical disconnected buildings separated by infrastructures. Finally, financial patterns create feedback loops of value creation that can capture or destroy value in cities.

We need a new pattern language because cities are complex systems and like any complex systems, they cannot be broken down into separate elements for analytical purposes. They exhibit emerging properties that cannot be predicted by simple regressions because the variables that describe them are interdependent. Urban space is also not flat but bumpy and even spiky: it exhibits concentration in a few square kilometres of very high values in a "spike" and a 'long tail" of low values on hundreds or thousands of square kilometres. This is true for many urban characteristics from demographic and job densities, to network connectivity, land lots and urban economics[9].

7 See among the most recent papers: Serge Salat, "The Break-Even Point. Impact of Urban Densities on Value Creation, Infrastructure Costs and Embodied Energy". SBE Turin Conference Papers, http://sbe16torino.org/papers/SBE16TO_ID068.pdf.

Serge Salat, "A Systemic Approach of Urban Resilience. Power Laws and Urban Growth Patterns", International Journal of Urban Sustainable Development, Special Issue Linking Urban Resilience and Resource Efficiency.

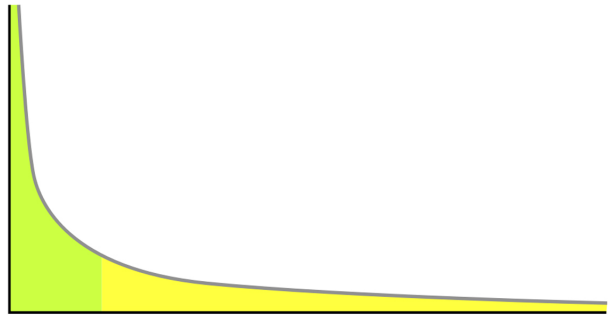
8 The notion of "complex adaptive systems" creates a unified method of studying disparate urban systems that elucidates the processes by which they operate and by which they increase or dampen value creation.

9 Serge Salat, "The Break-Even Point. Impact of Urban Densities on Value Creation, Infrastructure Costs and Embodied Energy". SBE Turin Conference Papers, http://sbe16torino.org/papers/SBE16TO_ID068.pdf.

We will limit ourselves to a list of striking examples. Inner London with 20 per cent of Greater London area produces 70 per cent of its GVA[10] and concentrates 56 per cent of all Greater London private sector jobs. This is due to strong agglomeration and localization economies. Office space in Manhattan (66 km²) corresponds to 60 per cent of the entire New York City office space, although NYC spans over 780 km². This office space is concentrated in only 6 km² of plot, which roughly correspond to 9 km² of urban land. These extreme concentration peaks are made liveable by high quality public space like in London's Canary Wharf or the project of Hudson Yard in Manhattan.

It is visible that the Square Mile of the City of London concentrates a disproportionate part of economic power in an extreme spike. The Square Mile of the City of London generated £45 billion in economic output in 2014, equivalent to 14 per cent of London's output and 3 per cent of UK's total GDP. The cascade of spikes within spikes, with inner London spiking extremely high within the city of London, points to a fundamental property of urban economy spatial patterns: that there is no characteristic scale; that urban economic space is scale-free.

This requires some explanation. Most urban values are not distributed around averages. They do not follow Gaussian distributions. A Gaussian distribution is a bell-shaped distribution clustered around an average, with ~68 per cent of the data within one standard deviation of the average, 95 per cent within two standard deviations, and 99 per cent within 3 standard deviations. As urban variables are not distributed according to Gaussian laws around averages, this questions the use of averages in urban studies. Actual urban distributions comprise "heavy tails", where those outcomes that are far away from the average are more likely than they would be in a Gaussian distribution. More generally, the shape of urban values distribution, their distribution pattern, is much more important than their average.



Inverse power laws are the hidden order of spiky economic landscapes, its pattern. People, jobs, and economic densities, office space density, accessibility to jobs, rents, subway network centralities, and so on, across the urban space follow skewed distributions that are modelled by inverse power laws known in economy for a long time under the name of Pareto distributions[11]. They comprise a few large and very large values (in green on the left) and a 'long tail' of small values on the right.

10 In 2009, Outer London produced 83 billion £ GVA and Inner London 186 billion £. Source: Regional and sub-regional GVA estimates for London, UK Office for National Statistics Briefing Note, 2009.

11 Serge Salat, "A Systemic Approach of Urban Resilience. Power Laws and Urban Growth Patterns", International Journal of Urban Sustainable Development, Special Issue Linking Urban Resilience and Resource Efficiency.

The new science of networks has shown that this scale free property is intrinsic to the various attributes of a network such as its size, number, and shape[12]. Thus, the intrinsic order of spaces and places depend on urban networks. As summarized by Michael Batty, "in essence, the distribution of elements that compose the city - the hubs or nodes that sustain them - present us with highly skewed distributions, reflecting the essential economic processes of competition that drive a city's functions and determine its form and structure[13]." These distributions usually describe large number of small objects and small number of large, following what are called scaling laws that are usually configured as power laws and which are also called Pareto distributions in an economy.

Power laws reflect processes of scale, which in some sense are self-similar. This signature of a system's function implies that the system's subsystems, components and elements, are ordered hierarchically. These scaling processes generate urban growth and underpin the city's evolutionary architecture, opening up our theory and model of urban economy to a world of complexity; from forms that associate a high level of order in their macro-structure to forms with a high level of diversity and randomness in their details.

The mathematical form of the regularities behind some examples raises the veil on the hidden fundamental nature of urban space. For example, cities distant in time and space, such as Medieval Paris or Lower Manhattan or Hong Kong, share certain mathematical form with the same mathematical parameters. What can be similar between feudal land tenure in Medieval Paris during the late 19th century, with intense real estate speculation by the emerging French bourgeoisie of the Second Empire, to Lower Manhattan's Wall Street, or Hong Kong? Surprisingly, what is similar is the way land is distributed in parcels of different sizes. The frequency of land lots of different sizes follows an inverse power law with the same exponent, - 0.5, even in extremely different cities.[14] This same exponent, -0.5, also characterizes the random fragmentation of the plans, as if, throughout different historical trajectories the socio-economic conditions and the urban land markets followed universal patterns rather than specific economic circumstances.

These patterns, of ordered complexity, that have shaped cities across centuries and in some cases millennia are what physicists call universality classes[15]. Universality classes are the signature of resource efficient and resilient patterns selected by urban evolution. They reflect a process of an emerging order from the chaos of a myriad of decisions, which become synchronized by a flexible but mathematically precise pattern of efficient systemic architecture.

It is not the purpose of this introduction to develop further on the fascinating in-sights of this new science of cities and of the new

12 Albert-Laszlo Barabasi, 2014, Linked:How Everything Is Connected to Everything Else and What It Means for Business, Science, and Everyday Life,Basic Books.

13 Michael Batty, 2013, The New Science of Cities, MIT Press.

14 Salat, Serge (2015). « Paris / New York 1215-1811-2015. Huit siècles de hiérarchie d'échelle dans les parcellaires urbains ». Données Urbaines 7, Economica, Marie-Flore Mattei et Denise Pumain (Ed). Salat, Serge. (2015). "Paris/New York 1215-1811-2015. Eight centuries of hierarchies of scale in urban land lots" Territorio Italia.

15 In statistical mechanics, a universality class is a collection of mathematical models, which share a single scale invariant limit. While cities, such as Paris, London, and New York, may differ dramatically at small scales, their behaviour will become increasingly similar as the limit scale is approached. In particular, asymptotic phenomena such as critical exponents will be the same for all cities in the class. In physics and in biology, they characterize complex systems and phase transitions.

science of networks. Interested readers can refer to Cities and Forms, On Sustainable Urbanism[16], and to a series of papers about cities as complex systems[17] as well as to the studies and books of Michael Batty.

We will now briefly describe in further detail the planning, designing, connecting, and financing patterns that work. These patterns have in common, that they embody in their configuration, the planning recommendations of UN-Habitat during the last years and during the preparation phase of Habitat III. Instead of being isolated metrics, they have a tremendous transformative power when combined into patterns and bundled into integrated policies. These patterns have contributed to the success stories of cities, such as New York at the beginning of 19th century, Tokyo, Seoul, Singapore and Hong Kong, which in one generation or two have moved from sometimes extreme poverty and urban chaos to wealth, prosperity and a complex and vibrant urban order with highly liveable communities. We will also describe patterns that dampen urban success or prevent it. To make cities both the engines of economic growth and places of well-being for their inhabitants, we must understand which patterns work and which do not in order to initiate urban spatial transformation through critical changes in design, finance and governance.

These patterns, in particular, the articulation of densities, are extremely efficient for decoupling economic growth and the efficient use of resources as demonstrated by UNEP's Report: *International Resource Panel on Resource Requirements of Future Urbanization*[18].

Like Christopher Alexander's described, when these new urban patterns are taken together, they begin to form a kind of language, each pattern forming a word or thought of a true language rather than being a prescriptive way to design or solve an urban problem. As the author of the original pattern language wrote: "Each solution is stated in such a way that it gives the essential field of relationships needed to solve the problem, but in a very general and abstract way—so that you can solve the problem for yourself, in your own way, by adapting it to your preferences, and the local conditions at the place where you are making it[19]."

1 Planning Patterns

Integrated urban planning patterns are key to create urban value. To transform connectivity and accessibility improvements into GDP increases, into enhancement in jobs accessibility and job opportunities for the urban poor, while decreasing environmental pressure, it is essential to develop compact city patterns, to articulate densities with highly variable floor area ratios (FARs) and fine granularity. It is also essential to develop neighbourhoods according to Transit-Oriented Development patterns while coordinating intensity of land use around public transportation stations.

16 Serge Salat; with Françoise Labbé and Caroline Nowacki, Cities and Forms. On Sustainable Urbanism, Hermann, 2011.

17 See in particular: Serge Salat, "The Break-Even Point. Im-pact of Urban Densities on Value Creation, Infrastructure Costs and Embodied Energy". SBE Turin Conference Papers, http://sbe16torino.org/papers/SBE16TO_ID068.pdf.

Serge Salat, "A Systemic Approach of Urban Resilience. Power Laws and Urban Growth Patterns", International Journal of Urban Sustainable Development, Special Issue Linking Urban Resilience and Resource Efficiency.

18 Co-lead authors: Maarten Hajer (IRP Member), Mark Swilling (IRP Member), Anu Ramaswami (IRP Member), Sangwon Suh (IRP Member), Serge Salat (IRP Member), Tim Baynes, Josephine Musango, Resource Requirements of Future Urbanization, UNEP IRP, 2017.

19 Alexander, Christopher (1977). A Pattern Language: Towns, Buildings, Construction. Oxford University Press, USA.

1.1 The Compact City Pattern

Compact city patterns and well planned urban extensions can support sustainable urban patterns that improve the functioning of cities across the world. Properly managed and appropriately applied compaction efforts can positively enhance the life of the city dwellers and support related strategies aimed at promoting a green economy and sustainable urban settlements. Compact city patterns aim to increase built area and residential population densities to an appropriate level, depending on contexts; to intensify urban activities, and to shape urban size, form and structure in search of environmental, economical and social sustainability[20]. Within both the developed and the developing world, the benefits of a compact city have been proven to be:

- Greater efficiency in the use of land with a positive impact on a city's spatial and ecological footprint, which implies reduction in reliance on cars, lower impacts of urban growth on rural and agricultural lands, and lower non-renewable resource consumption per household[21].
- Higher population and economic thresholds, which also means an increased accessibility to services and amenities with viable and effective public transport provision.
- Harnessing of agglomeration advantages.
- Reduction of time and cost spent travelling due to shortened distances to destinations.
- Increased social inclusiveness and reduction in social segregation through designing quality mixed-use areas.

1.2 The Articulated Density Pattern: FARs

Planning the growth of cities to achieve appropriate densities and providing alternative forms of mobility to private vehicles helps to slow urban expansion and can reduce citizens' demand for scarce resources by sharing them more efficiently.

This can be achieved only if high but reasonable demographic densities are articulated according to efficient patterns, with fine grain variations. This can be achieved through efficient public transportation systems and appropriate level of job densities. These combined with strong agglomeration effect and good jobs/housing ratio can promote the creation of liveable and vibrant communities.

International experience and the universal patterns that we have described in the introduction of this text suggest that intensity of land use should not be evenly distributed across urban space. Quite the opposite, it should present strong variations and peaks where accessibility to jobs is at maximum. More specifically, firms locate preferentially where they can increase their productivity through agglomeration and localization effects. Advanced service provider's locational decisions are particularly influenced by the number of firms of the same type they can access in a short period of time. Highly dense concentrations of economic activity foster local economic development through economies of

20 Jenks, M and Burgess, R. (2000). Compact Cities. Sustainable urban forms for developing countries. London: Spon Press.

21 UN-Habitat (2009). Planning Sustainable Cities, Global Report on Human Settlements. London: Earthscan. Jenks, M; Burton, E; Williams, K (eds.) (1996), The Compact City. A sustainable urban form? London: E&FN Spon.

urbanization and of localization[22], which attract skilled workers, as well as more productive entrepreneurs and firms[23].

In highly competitive cities, such as New York and London, the highly dense concentration of jobs peaks at 150,000 jobs/km² with one third of the jobs (1.5 million) agglomerated in 15 km². The urban form is both compact and polycentric with several fast growing sub-centres efficiently linked by public transportation: such as Midtown and Lower Manhattan to which other sub-CBDs should be added like Hudson Yards, Brooklyn Downtown and Long Island City.

Network analysis shows the benefits of developing sub-centres around transport stations. This is because inner subway network and suburban rail (termed between central stations[24]) concentrate passenger flows and thus, have a high growth potential. Beyond the high spikes of economic agglomeration, there still remain two thirds of jobs in mixed used plots, which necessitate the creation of a sufficient level of stations, although they are not part of the fast-growing core. This appears in the maps of London, Copenhagen, Stockholm, Hong Kong and Tokyo, where there is a concentration of jobs and social activity at close proximity of public transportation stations along the branches radiating from the core of the sub-way network.

While an average density of 15,000 people per square km² is efficient and can be considered a desirable target at the scale of about 10 million inhabitants in a 600 km² of urban land, what matters the most is the articulation of densities. To reap the opportunities created by investments in public transportation networks, it is important to coordinate intensity of land use and economic policies by:

(1) encouraging development in the major interchanges, in the most accessible stations of the network and in the stations that are major articulations of the network; (2) moderating development in the areas that are less accessible within the network and (3) discouraging development in areas that are more than 1 km from a subway station. One regulatory instrument to manage this articulation of densities is floor area ratio (FAR). Floor area ratio (also known as floor space ratio) is the ratio of a building's total floor area (gross floor area) to the size of the piece of land upon which it is built.

Zoning policies can be fine-tuned to enhance the accessibility of public transportation networks (subways, urban rail or Bus Rapid Transports) and improve the provision and coordination of infrastructure and land use development. First, it is encouraged that FAR is set at different levels, depending on uses and accessibility. Manhattan's East Midtown rezoning, for example, is based on adjacency to public transportation. It includes a FAR of 24 for highly accessible areas directly around Grand Central Terminal, 21.6 FAR along Park Avenue, and 18-14.4 FAR in other areas to the east and west[25]. Second, it is recommended that FARs have a margin

22 Rosenthal, S. & W. Strange, "Evidence on the nature and sources of agglomeration economies" in V. Henderson and J. Thisse (eds.) Handbook of Regional and Urban Economics, (2004).Vol. 4. Amsterdam: North-Holland, 2119–2171.

23 "Productive Cities: Sorting, Selection, and Agglomeration", Journal of Political Economy, (2014) 122 (3), pp. 507-553.

24 Salat Serge and Ollivier Gerald. 2016. "The 3V Framework: Maximizing Economic Opportunities in TOD Station Areas by Matching Place, Node, and Market Potential Values". World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

25 Proposed East Midtown text amendment, 2013, NYC

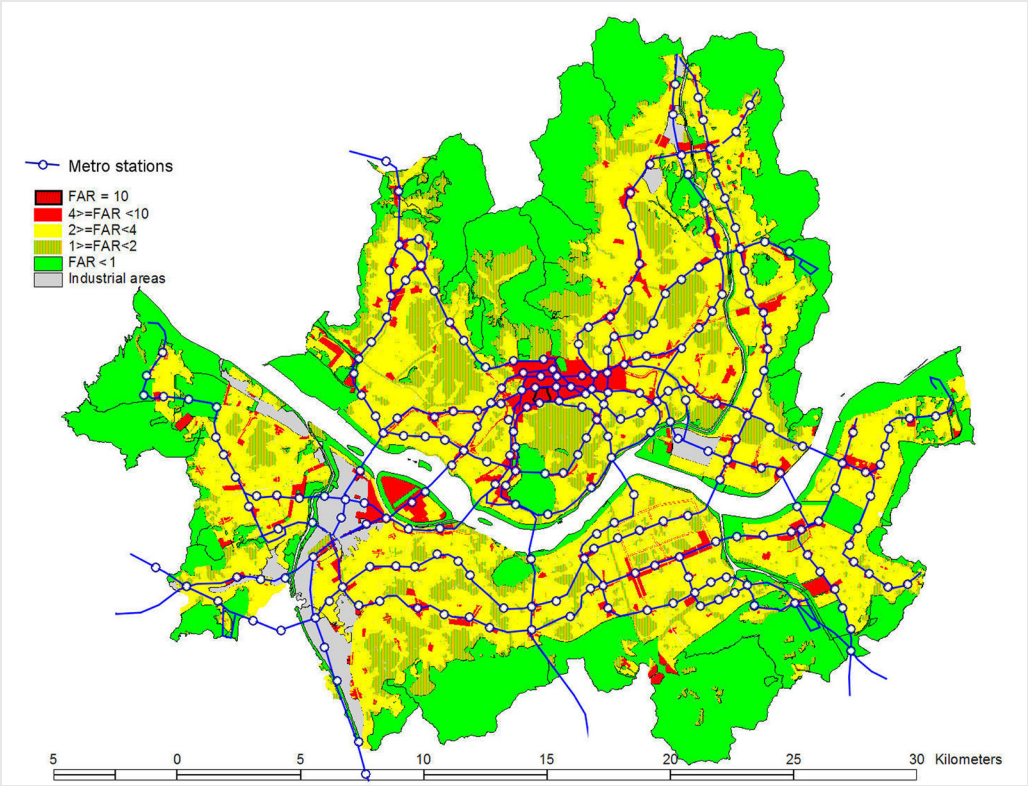
of flexibility both for transferring FAR between uses according to market changes and for allowing private sector to adjust intensity of development to market needs.

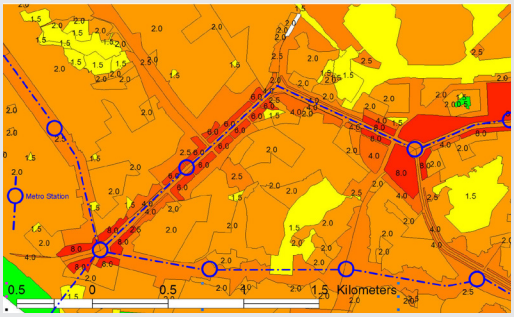
This has been applied in London's Kings Cross, with margins of flexibility of up to 20 per cent, which increases the marketability of real estate operations in developments that take years to be completed. This margin of flexibility can also be used to capture part of the value created by real estate developments to finance public transportation infrastructure, public space and affordable housing. For example, adapted zoning in Hudson Yards sets varied FAR for commercial (FAR 10 to 33), mixed-use (FAR 6.5 to 12) and predominantly residential (6 to 15) areas, in order to introduce flexibility and capture value[26]. Seoul has also successfully shaped its urban form by setting FARs to encourage high-density development around public transportation nodes as explained in the next sub-section.

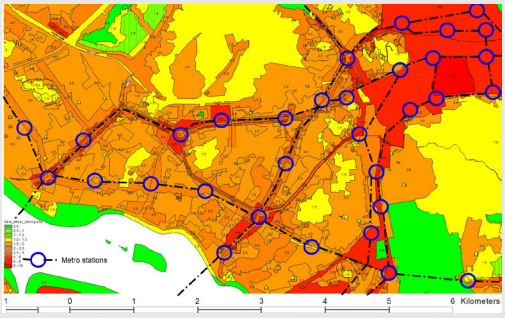
26 Developers who want to build over base FAR and up to maximum FAR (for example between base FAR 10 and maximum FAR 33 for commercial use in the densest blocks), can do so by paying bonus payments into the zoning-based District Improvement Fund. This creates an additional real estate opportunity and allows for demand-driven development. The District Improvement Fund can be used to finance subway lines extensions, public space and inclusionary housing, creating a positive feedback loop of development from the initial rezoning at higher density, and social mix within a Grade A mixed-use business district.

Seoul zoning regulations encourage high-density development around major public transportation nodes

Seoul zoning regulations set FARs as high as 10 for commercial uses, around the most connected and central public transportation stations, of between 2 and 4 for mixed residential and business areas and between 1 and 2 for predominantly residential areas; uses are defined with a fine granularity depending on proximity to and importance of public transportation stations. This creates a varied city juxtaposing quiet small residential neighbourhoods in close proximity to thriving business districts.







Seoul variations in FAR is linked to the location of metro stations and to the network of main streets.
Source of the 3 pictures: Alain Bertaud. © Alain Bertaud. Used with the permission of Alain Bertaud. Further permission required for reuse.

1.3 The Transit-Oriented Development Pattern

Transit-Oriented Development (TOD) is a planning and design strategy to ensure compact, mixed-use, suitably dense, pedestrian and two-wheeler friendly urban development, organized around public transportation stations. It embraces the idea that locating amenities, employment, retail shops and housing around public transportation hubs promotes public transportation usage and non-motorized travel. Well-planned TOD is inclusive in nature and integrates considerations of resilience to natural hazards.

Transit-oriented cities enhance mobility and provide higher access to jobs due to lower transportation and housing costs. For example, in Hong Kong, 83 per cent of jobs and 75 per cent of people are within 1 km of a mass transit station; in the USA, residents near Transit-Oriented Development stations spend 37 per cent of their income on transport plus housing against 51 per cent for others living elsewhere.

Transit-oriented cities are more competitive as they foster agglomeration effects to take hold in a city. Such cities have lower infrastructure costs and CO_2 emissions. They offer opportunity to reinvent urban space with public space and green areas while capturing economic value through high returns on investments. These cities are largely self-financed by capturing value created. For examples, Hong Kong Rail plus Property model allowed the Hong Kong government to derive about HKD 140 billion gain (1980-2005) while unlocking land for 600,000 public housing units. Hong Kong increased Gross Value Added (GVA) per capita by 50 per cent between 1993 and 2011 while CO_2 emissions for transportation per capita and road gasoline consumption per capita declined by about 10 per cent.

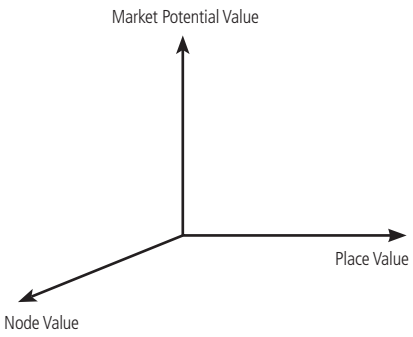
At the scale of functional urban regions and at a city scale, TOD aligns urban growth with transit accessibility thanks to integrated planning of public transportation and land use. At network scale, TOD develops public transportation corridors and station areas according to the importance of lines and centrality of stations within the network. At community scale, TOD develops mixed-use residential and commercial communities designed to maximize access to public transport, improve quality of life and avoid the need for private motorized transport. TOD incorporates features to encourage public transportation ridership and to improve walking and cycling opportunities. TODs generally are located within a radius of one-quarter to half a mile (400 to 800m) from a public transportation stop, as this is considered to be an appropriate scale for pedestrians, thus solving the last mile problem. TOD is a pattern of urban development that should be planned at three levels:

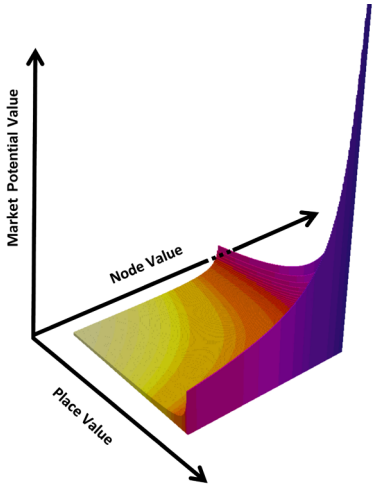
- At the metropolitan/city level, TOD coordinates economic, land use and transport plans in order to achieve the best outcomes in terms of urban efficiency.
- At the network level, TOD plans transit lines and human densities surrounding stations to achieve the highest levels of accessibility.
- At the local level, TODs emphasis density and a variety of land use and social mix around high-capacity public transportation nodes to harness and create vibrant, liveable, inclusive and sustainable communities.

There is no one single pattern to be duplicated as a blueprint for developing areas around public transportation stations. Intensity of development and planning strategies should be adapted to the economic potential of each station. This should be done in a dynamic

way, by leveraging changes of investment in connectivity to create financial value that can be captured. To create such a positive feedback loop of urban value creation based on the design/finance/governance triangle, it is important to understand what defines value in different urban locations and how to create and capture value. To do so, a recent methodology developed by the World Bank[27], The 3V Framework: Maximizing Economic Opportunities in TOD Station Areas has built a typological approach for clustering station neighbourhoods according to three values:

- 'Node value' describes the importance of a station derived from its passenger traffic volume, intermodality, and centrality within the network.
- 'Place value' describes the urban quality of a place and its attractiveness to residents in terms of amenities, schools and healthcare, of type of urban development, of local accessibility to daily needs by walking and biking, of quality of the urban fabric around the station, in particular its pedestrian accessibility, the small sizing of urban blocks and the fine mesh of connected streets that create vibrant neighbourhoods, and the mixed pattern of land use that creates diversity.
- 'Market potential value' describes the market potential of a station's area, based on the relationship between market demand and supply, which can be determined by various approaches, including: human density (that is resident plus job densities) with forecasted increases, which will attract real estate development; number of accessible jobs within 30 minutes by public transportation, which drive people and firms' locational choices; FARs, and land opportunities for development and market vibrancy. This approach should be looking forward rather than being static or looking backward.





Source: Salat Serge and Ollivier Gerald. 2017. "The 3V Framework: Maximizing Economic Opportunities in TOD

Left: 3V framework. Right: Synchronization of high peaks of node value (major connecting hubs) with high quality place making creates spikes of market potential value.

27 Salat Serge and Ollivier Gerald. 2017. "The 3V Frame-work: Maximizing Economic Opportunities in TOD Station Areas by Matching Place, Node, and Market Potential Values". World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO Station Areas by Matching Place, Node, and Market Potential Values". World Bank.

The 3V Framework provides an analytical method to classify public transportation stations according to their potential to foster economic concentration and land value increases. It aims at strategizing on ways to encourage the development of high-performing communities around public transportation stations and to build transit systems that maximize development potential. Additional policies should also address gentrification potential that ensure a social mix.

The 3V Framework presents two main interests for policy makers:

1. Building a typology of stations, which classifies the hundreds of stations of a mass transit network into sub-groups for applying different development strategies.
2. Determining the imbalances between connectivity, accessibility, place quality and market potential values in a station. These imbalances create a high potential for economic value creation, such as creating place value around an important connective node or bringing additional connectivity to a booming area (see Section 4 of this text)

Several levers are available to increase node, place and market potential value as summarized in the table below.

Node Value	Place Value	Market Potential Value
Increase number of hubs and number of lines/modes they connect to	Increase compactness (proximity to existing urban activity and short travel time to main destinations)	Increase residential density
Interlink neighbouring stations into clusters	Increase diversity of uses	Increase job density
Increase accessibility within the network for all	Increase concentration of commercial, cultural and education amenities	Increase human density
	Design neighbourhoods that promote walking and biking	Increase diversity of land parcels to create a vibrant land market
	Create a vibrant public realm	Increase social diversity
		Allow for vertical separation of development rights through differentiating in

2 Transportation Network Patterns

The layout of public transportation networks is a key force of agglomeration and density distribution across urban space. Cities are networks from which locations emerge. Transportation networks give shape and structure to cities. They can have a strong lock in effect as they reinforce density patterns with positive feedback loops.

Locations are the product of interactions. Cities, on the other hand, are networks of interactions and their density patterns are derived from their network patterns[28]. Thus, we can use the new science of networks[29] to study cities. Urban systems vary over time and from place to place, but some network patterns are so general that they transcend time and place[30]. These network patterns explain the number of people travelling between different origins and destinations within a city and the hierarchy of centralities in subway networks Such hierarchy is based on the ranking of subway stations according either to their number of direct connections to other stations (degree of centrality) or to the number of shortest paths through the network that go through them (between centrality).

Some networks, such as subway or airlines networks, present highly ordered patterns, structured around hubs (high degree centrality) while other networks are random and 'flat'. The striking structural differences between a random network and one presenting a high level of hierarchy in the pattern of its connections are best seen by comparing a road map with an airline routing map. On a road map, cities are the nodes and the highways connecting them are the links. This is a fairly uniform network: each major city has at least one link to the highway system and there are no cities served by hundreds of highways. Most nodes are fairly similar with roughly the same number of links. Such uniformity is an inherent property of random networks with a Gaussian degree distribution. The airline routing map differs drastically. The nodes of this network are airports connected by direct flights between them. This network has a few major hubs and the vast majority of airports are tiny nodes with at most a few links connecting them to one or several hubs. In a similar way, subway networks have a few major hubs connecting many lines to the city core.

Explaining how centralities in public transportation networks can be defined and measured with concepts such as degree centrality, closeness centrality and betweenness centrality, and how these measures can become a powerful tool for assessing the development potential of specific station areas and the structure of connective values across an urban transportation network 'node values' goes beyond the limited scope of this introduction. Interested readers may refer to Salat Serge and Ollivier Gerald (2017), The 3V Framework: Maximizing Economic Opportunities in TOD Station Areas by Matching Place, Node, and Market Potential Values.

28 Both are structured spatially by power laws (see introduction).

29 Albert-Laszlo Barabasi, 2014, Linked:How Everything Is Connected to Everything Else and What It Means for Business, Science, and Everyday Life, Basic Books.

30 An urban system is constituted of related parts or components. These components are connected by a network, or structure, that may be of more interest than the components. Actually, the equally simple laws that we have discovered in urban networks characterize most complex networks. They are behind the networks of actors in Hollywood, the linkages between mathematicians, the distribution of citations in physics journal, the interaction of molecules within the cell, the connections of neurons within the brain.

For simplicity's sake, we are going to divide the complex typology of urban networks into three pattern types and describe briefly their impact on people and economic densities patterns: random car-oriented patterns and sprawl; core and branches subway patterns and agglomeration economies; grid-like subway patterns and compact polycentric cities.

2.1 Random Car-Oriented Patterns and Sprawl

As random car-oriented road networks do not embed a hierarchy of nodes, they lead to uniform density distributions that result in American suburbia types of development. Quite the opposite is the street patterns of European cities, which embed a hierarchy of nodes (think of Paris Haussmann boulevards' star-like patterns) and a hierarchy of connectivity (measured, for example, by the number of streets that a given street connects). Although seemingly a uniform grid, New York streets' pattern presents a major asymmetry in connectivity: while the 11 avenues each connect with about 135 streets, each street connects with about 11 avenues. This means that avenues are 13 times more connective than streets. This break of symmetry in the streets' pattern has been enough to create strong forces of economic concentration in Midtown. While random networks disperse urban growth, hierarchically structured networks, such as historical streets and subways, concentrate urban growth.

2.2 Core and Branches Subway Patterns and Agglomeration Economies

The pattern of transit networks has important implications on the levels of transit accessibility of different urban areas. International experience suggests that efficient subway patterns in global cities tend to converge towards a similar layout characterized by a core and branches structure[31]. The core, with a radius of about 5 km is densely connected with a constant density of stations, highly interconnected by crisscrossing lines, and ensures high levels of accessibility for people and companies. The structure changes for branches, with a density of stations decreasing sharply,[32] when moving away from the city core. Thus, level of accessibility decreases sharply when crossing the core limit. The core and branches layout has a strong impact on the potential of local development. Once established, this core and branches structure determines the long-term trajectory of a city's density structure.

2.3 Grid-like Subway Patterns and Compact Polycentric Cities

More grid-like subway patterns may produce different densities and economic growth spatial distributions. The Seoul subway network pattern, which was designed at a later stage of development (the first line was inaugurated in 1974, 90 years after London's Circle line) for a city planned at a wider scale of 600 km² with 10 million inhabitants, has a layout less concentrated towards a core and more grid-like, encouraging the emergence of fast growing sub-centres such as Gangnam-gu.

31 Camille Roth, Soong Moon Kang, Michael Batty et Marc Barthelemy, A long-time limit for world subway networks, Journal of the Royal Society, J. R. Soc. Interface doi:10.1098/ rsif.2012.0259, 2012.

32 The sharp decrease in density of stations with distance to city centre follows an inverse power law of the form R. - 1.6. See: Serge Salat and Loeiz Bourdic, L Économie spatiale du Grand Paris. Connectivité et création de valeur, Urban Morphology and Complex Systems Institute and Caisse des Dépôts. 2015.

3 Community Design Patterns for Urban Vitality

Patterns should not be looked at in isolation as they are interlinked. Together, they form a new urban pattern language for fostering urban vitality. Since every pattern is part of the overall urban fabric, how they connect to each other and to the city is a central tenet of urban design. Streets, public transit, bike-ways and connected green space tie the city together, as underlined by Dr. Joan Clos, who said: "The proportion of urban areas dedicated to streets and public spaces is a crucial feature of the spatial plans of cities. Indeed cities that have adequate street and public spaces and greater connectivity are more liveable and productive[33]." Creating more direct connections with a fine mesh of streets shortens travel time, which effectively brings people closer to their destinations. With more available connections, community residents can easily travel to schools, retail centres and parks. The smaller the blocks, the greater number of intersections, the more storefronts, the more diversity, the more choice of routes and the more chances for serendipity. All this leads to more urban vitality. Actually, the vibrancy of mixed-use streets and neighbourhoods, cannot be achieved if the underlying urban fabric remains coarse, that is large and monotonous. The following patterns provide the framework for vibrant communities, which are the building blocks of liveable cities. They are described in more detail in the book Cities and Forms, On Sustainable Urbanism[34].

33 Joan Clos, "The value of public space in urban areas and street patterns in cities – a case of spatial fix", in UN-Habitat Working Paper, The relevance of street patterns and public space in urban areas, April 2013.

34 Serge Salat; with Françoise Labbé and Caroline Nowacki, Cities and Forms. On Sustainable Urbanism, Hermann, 2011.

3.1 Density Patterns

Density patterns are deemed appropriate based on the context. Transit-Oriented Development planning encourages intensification of human density (people plus jobs) with a good job/housing mix around the most connected transit stations outside the core, while preventing development in the less accessible areas between the branches. In addition to the core, polycentric centres, linked via public transportation with a sufficient mixed-use in terms of combination of jobs and housing, avoid creating a one-way flow of traffic at peak work hours. UN-Habitat[35] recommends that the job-resident ratio (the number of people employed divided by the number of residents) should be between 0.5 and 0.7 over every commuting district, which should have a spatial area that is no more than 15 km².

3.2 Street Patterns: The Leaf Pattern

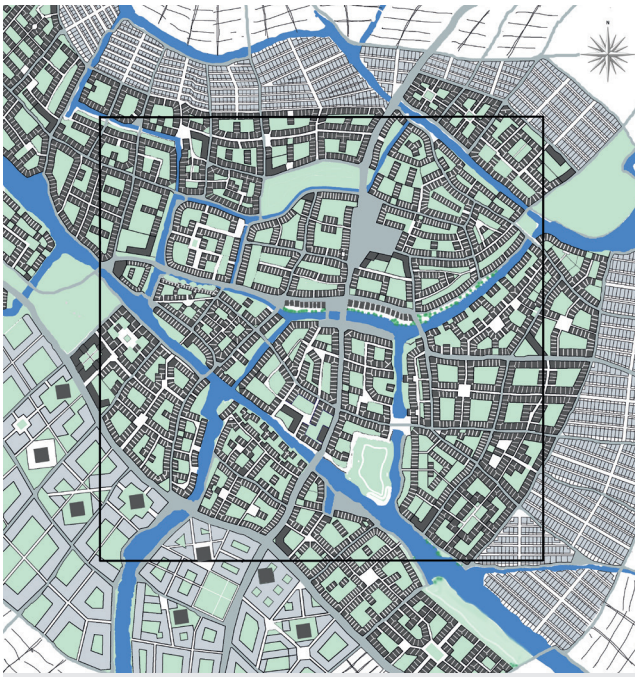
As stated by Dr. Joan Clos: "The relevance of street patterns and public space requires planning at the initial stage of urban growth. Otherwise, if urbanization happens spontaneously, the introduction of public space and street networks afterwards becomes very difficult and expensive, both politically and economically[36].

The street system provides the connectivity matrix for the city, which is fundamental not only for urban mobility but also for inclusiveness, economic vibrancy and people's interaction.

35 Issue and Policy Paper on Spatial Planning in preparation of Habitat III, 2015.

36 Ibid.

As underlined by Dr. Joan Clos, "the efficiency of mobility is a determinant for urban economic productivity. Secondly, the street pattern also provides the matrix for the layout of urban basic services, mainly energy, water supply and sanitation, drainage, transportation, parking slots and other services. The affordability of these urban services is related to the quality of street patterns. Thirdly, the street pattern, including plazas and public gardens, is the key element of personal interaction and communication between the citizens. In that sense, it defines the cultural and political quality of city life. Fourthly, the walkability of the spaces, the safety of the sidewalks and the form and location of shops along the street determines the quality and quantity of street life. When safety and security issues arise, public space is abandoned and gated communities emerge as a form of protection against the rest of the city. This results in the failure in the function of cultural life of the street[37]."



Left. Eco-neighbourhood based on a traditional urban texture in an area in Shanghai designed by the architect, Françoise Labbé. Size of square: 800 metres. The plan of the eco-district combines geometric and organic patterns. Its form is generated by dynamic forces. It grows organically with the patterns of a leaf. The plant comes from a single cell and develops organically according to a very precise geometry. It is one and multiple at the same time. Source: Serge Salat et al., Cities and Forms. On Sustainable urbanism.

Right: The veins in a leaf contain loops that arise to handle damage and the fluctuations in nutrient needs

37 Ibid.

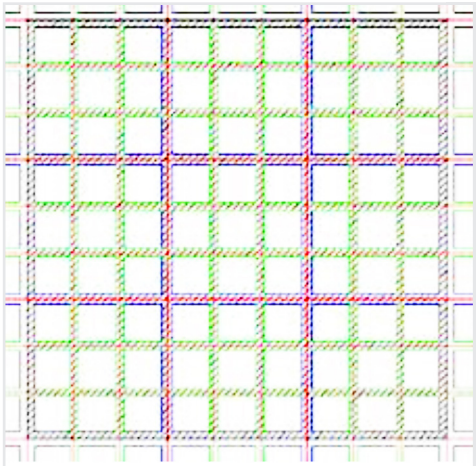
Urban connectivity leads to urban vitality. Street patterns must be easily navigable and lattice like, with blocks that are not too big and intersections that are not too far apart. In planned cities, streets are typically laid out on a grid plan, so that city blocks are square or rectangular. Using the perimeter block development principle, city blocks are developed so that buildings are located along the perimeter of the block, with entrances facing the street and semi-private courtyards in the rear of the buildings. This arrangement provides good social interaction among people.

The spacing of streets in grid plans varies widely among cities, or even within cities. Many cities around the Mediterranean, were originally founded as Roman military settlements, and often preserve their original grid layout around two main orthogonal axes. Notable examples are Turin, Florence and Bologna with their 70-metre side blocks. Japan has an even thinner mesh of streets with an average distance between intersections of 50 metres. The standard block in Manhattan is about 60m × 260m.

This traditional fine mesh street pattern diffuses automobile traffic onto several narrower roads at slower speeds. Traditional street meshes follow a pattern widely used by nature to optimize variable flow of diffusion and resist damage such as leaf patterns, making it one of the most resilient network structures.

On the contrary, hierarchical trees in nature, or in many systems such as the engineered roads in America, are entirely disconnected on a given scale: even if two twigs are spatially close, if they do not belong to the same branch, to go from one to the other implies moving down and then up all the hierarchy of branches. Urban highways, car-oriented infrastructures, centralized energy infrastructures are all trees: they separate urban elements and do not connect them at local scales. Leaves are quite the opposite.

Katifori and Magnasco[38] modelled the veins of a leaf, called xylem, as a network of pipes with varying flow and pressure. Given limited amounts of pipe, they asked how the pipe should be distributed to minimize drops in water pressure and to make the system as



Street network model design: Dense street patterns encourage efficient traffic, sustainable accessibility, social interaction, public safety and access to amenities. The figure shows a simple street network model. In an area of one km², nine vertical and nine horizontal streets are designed to form a street grid. The distance between two adjacent streets is 111m, and the total street length is 18km and the number of intersections per km² is 100. In this street network model, recommended by UN-Habitat, both street hierarchy and block size are considered. This simple model demonstrates the balance between street and other land uses. City management and urban planners could adjust the design pattern of the street network to the topography of the site or create rectangular patterns like in New York and most North American cities but a street density level similar to the one recommended in the model should be maintained.

38 Eleni Katifori, Gergely J. Szöllősi, and Marcelo O. Magnasco, Damage and Fluctuations Induce Loops in Optimal Transport Networks, Phys. Rev. Lett. 104, 048704 (2010), January 29, 2010.

resilient as possible to damage? Hierarchically nested loops patterns — meaning loops within loop within loops — are most resistant to damage. Loops make the network redundant. If you have damage, water can be rerouted to other channels. Loop networks can also better handle fluctuations in fluid flow as environmental conditions change. Francis Corson[39] of Rockefeller University in New York used computer models to examine why these loops exist. By studying fluctuations in demand, he discovered one purpose of the loops: they allow for a variable delivery system. Flows can be rerouted through the network in response to local pressures in the environment, such as different evaporation rates in different parts of a leaf. When time variations or fluctuations are allowed for, a class of optimal patterns different from trees is found: they share the hierarchical organization of trees yet they contain loops.

These results are relevant not only to biology but also to constructed urban networks that distribute goods over roads or electrical power over wires. Counteracting the vulnerability of contemporary cities requires a paradigm reversal and a shift from a mono-scale conception to a scale-free conception of cities. Only multi-connected scale-free structures, similar to natural leaves, can secure optimal efficiency and resilience of variable flow networks, while limiting the propagation of local perturbations.

3.3 The Fine Grain Urban Fabric Pattern

Urban fabric is the physical form of towns and cities. Urban fabric is not just the built form, however; it also reflects the delicate interweaving of social, economic and physical connections. Like textiles, traditional urban fabric come in many different types and weaves. These different ways of weaving the physical and social space of cities is what gives them their singularity and uniqueness. Traditional urban fabrics can be multiple and diverse in the same city, reflecting climate, time, evolution, culture and society., They are finely tuned to local conditions and their generative grammar has led to endless variations, with pure types and hybrids. Modernist super-blocks, on the other hand, have imposed a universal way of building cities identical to the ones found in South America, India and China.

For simplicity's sake, we are going to divide urban fabrics into two broad pattern types: coarse grain and fine grain or, put in another way, modernist superblocks and traditional small blocks[40].

Superblock urban fabric characterizes 20th Century modernist planning principles. It is actually an anti-fabric, as it unweaves the continuity of urban space, separates buildings and is designed as giant simplified structures with little or no details. It has been invented by Le Corbusier in the 1920s, and showcased in projects such as The City for Three Million Inhabitants, the Radiant City, or Plan Voisin, designed between 1922 and 1925, with the explicit aim of razing Paris to the ground, and replacing its fine grain urban fabric inherited from 1,000 years of urban history with modernist super-blocks of 400-metre sides and separated by giant highways 100 metres wide.

The Radiant City was to emerge from a

39 Francis Corson, Fluctuations and Redundancy in Optimal Transport Networks, Phys. Rev. Lett. 104, 048703 (2010), January 29, 2010

40 A city block, urban block or simply block is a central element of urban planning and urban design. A city block is the smallest area that is surrounded by streets. City blocks are the space for buildings within the street pattern of a city, and form the basic unit of a city's urban fabric.

tabula rasa: it was to be built on nothing less than the grounds of demolished vernacular European cities. The new city would contain identical high-density skyscrapers, spread across a vast green area and arranged in a Cartesian grid, allowing the city to function as a 'machine'. Within superblocks, buildings are usually not aligned along streets ("We must kill the street", wrote Le Corbusier in his book Urbanism). Building types are radically reduced to identical out of proportion cruciform towers (220-metres high with a 190-metre span in the original Le Corbusier prototype) with 1-kilometre or more long slabs spanning several superblocks. Though radical, strict and totalitarian in its order, with symmetry and standardization, Le Corbusier's proposed principles had an extensive influence on modern urban planning and led to the development of new housing types widely used in the reconstruction period in Europe in the 1960s and which are still very influential in the urbanization of fast-growing cities.

Most of 20th Century city planning has been based on superblocks, either in the highly-repetitive Le Corbusier model, leading to the endless alignments of identical high rise towers in Chinese city landscapes created during the past 20 years, or in diverse sprawl variations[41]. Shanghai's recent urban expansion, for example, combines sprawl with towers-in-a-park superblocks. Recent World Bank and Chreod Ltd. studies have shown a spectacular decrease in population and street densities in Shanghai. In ten years, from 2000 to 2010, Shanghai has built, with an urban pattern of superblocks, an additional land area equal to 125 per cent of the area of New York City and to two-thirds the area of Greater London. Average street intersection density in Shanghai is very low (13 intersections/km² in 2010), compared to UN-Habitat's recommendations of between 80 to 100 intersections/km², and has been considerably reduced during the past decade. Street intersection density presents high variations. It is high in the city core where it corresponds to international benchmarks (over 80) and it decreases sharply when moving to the suburbia to reach less than ten in most municipalities. This density has considerably decreased from 33 in 2000 to 13 in 2010 because urban expansion (almost doubling of built area from 1,147 km² in 2000 to 2,196 km² in 2010) has occurred in the form of superblocks with low connectivity.

Contrary to what is often thought, sprawl is not a consequence of the lack of planning. It is a highly planned form of urban expansion based upon scales for the automobile. Suburban subdivisions planning in the United States, for example, prescribes a strict command hierarchy classification of access roads based on highway engineering with no less than 300 metres between road crossings. Urban sprawl based on superblocks is also the direct outcome of road planning in China due to low FARs and strictly mono-functional zoning on dozens of square kilometres of land.

In a residential area of a suburb, the interior of the superblock is typically served by dead-ended or looped streets. The discontinuous streets serve the automobile for long distances, and the extra fuel required to go between destinations, is not of much concern. However, at the pedestrian scale, the discontinuity of the roads, on top of the distance that must be travelled, discourages walking. The discontinuity within the superblock also implies car dependency and more traffic onto the fewer continuous streets. This increased demand for through streets, leads ultimately to these streets

41 Superblocks are often found in suburbs or planned cities, or are the result of urban renewal of the mid-20th Century, where a street hierarchy has replaced the traditional grid.

having more travel lanes added for cars, thereby making it more difficult for any pedestrian to cross them. In this way, superblocks cut up the city into isolated units, expand automobile dominance and make it impossible for pedestrians and cyclists to get anywhere outside of the superblock.

We know today that superblocks create social alienation. They do not give opportunities for connecting people to people; due to their urban pattern that is inhospitable to interaction. Such places are not street oriented; instead, they turn inward and fortify themselves against the imagined dangers of the outside. Superblocks patterns are also highly energy intensive, as demonstrated in the Chinese context by the MIT and the Energy Foundation. Most new developments in China are built on superblocks, which are 400-800 metres long and that are two to four times less dense (in spite of their high rise towers-in-a-park form of development) and are two times more energy intensive per household than any other urban forms found in China as demonstrated by a MIT study in Jinan which compared operation, transportation, and embodied energy comsumption per household for four urban fabric types in 27 neighbourhoods across the city[42].

The opposite of superblocks is traditional small perimeter blocks, that have been re-discovered as the optimal pattern for sustainable cities, first by Jane Jacobs and then by the New Urbanism movement. Although extremely diverse, fine grain urban fabric follows a common pattern. It consists of several small blocks that are close together. Within each block, there are several buildings, most with narrow frontages, frequent store fronts and minimal setbacks from the street. This offers many opportunities for discovery and exploration. There are almost no vacant lots or surface parking. Also, as there are more intersections, traffic is slower and safer. Fine grained urban fabric evolves over time by responding and adapting to what will come afterwards. This evolutionary process creates places that are not frozen in the era when they were built, but are dynamic and reflective of a neighbourhood's changing needs. This creates an urban fabric that can seamlessly evolve over time from lightly developed residential areas to mixed-used retail to dense urban core, according to the dynamic interplay of three values describes in the 3V Framework. In this way, such patters are far more resilient than mega projects which, when they lose a single tenant, often fail.

3.4 Public Places Patterns: Designing the Space of Human Interaction

Public space gives vibrancy to urban life and it is intimately linked to the sizing, scaling and to the rhythm of the urban fabric. We cannot design good public places independently of fine grain urban fabric. Modernist layouts, with their repetitive architectural objects in an empty space and their urban space segregated into built form and unbuilt form, are actually the negation of urban fabric and of public space. The map of Roma drawn by Giambattista Nolli in 1748, for example, does not create a division between interior and exterior spaces or between solid masses and empty spaces, as we would do today, but rather between the continuous public space of streets, squares, large churches and interior palace courtyards, on one hand, and the compact mass of private buildings, on the other. The continuity of public space, encompassing outside

42 Designing Clean Energy Cities. New Approaches to Urban Design and Energy Performance. MIT, Tsinghua University, The Energy Foundation, 2010.

and inside, is fundamental in the traditional European city.

The primordial figure of public space stands out against the backdrop of continuous building facades, interior as well as exterior, creating a feeling of enclosure. Cathedral vaults become skies and the sky above squares becomes the ceiling over a big outdoor lounge. Urban public space is the stage of urban rituals. The modernist movement undid urban syntax and all urban rituals by destroying public space. In Le Corbusier's projects, positive public places were replaced by a formless empty space between buildings – a space divested of its positivity and which thereby becomes pure negativity. Form and ground were reversed. In traditional cities, public places were a meaningful form framed by building facades. In modernist planning, buildings become forms isolated in an empty ground.

Numerous perceptual qualities affect the individual reactions to a place, the walking experience, the sense of safety, the sense of comfort, the level of interest and, thus, the value of a location. To achieve overall walkability, urban designers should create urban qualities, such as spirit of place, enclosure, human scale, layering of space, complexity, coherence, legibility and linkage[43]. Urban design is subtler and complex than metrics as it shapes human perception of places and of sequences of spaces in a positive or negative manner. 'Negative' spaces are empty spaces left between buildings. They are spaces without shape, sense of direction and purpose. They will not sustain human interest even if benches and amenities are provided. Good urban design provides 'positive' space that is space with an identifiable shape and direction. Alexander, Ishikawa and Silverstein say that: "an outdoor space is positive when it has a distinct and definite shape, as definite as the shape of a room, and when its shape is as important as the shapes of the buildings that surround it[44]." This positive space traditionally comprised not only streets and sequences of squares and gardens but also the interior of large buildings, such as courtyards of palaces and interiors of churches. There was no separation between street and buildings but rather a continuum of public space, which was the stage of urban life.

In liveable cities, the largest public spaces are the size of a small block (they are an empty block carved out of the continuity of the urban fabric) and are endowed with urban design qualities.

3.5 Green Spaces Patterns

A hierarchical, interconnected system of natural spaces, ranging from a regional greenbelt to a pocket play park, should, from a landscape ecology perspective, provide the main structuring elements of urban settlements. This principle reflects the importance of identifying natural systems and strategic landscape patterns, which protect valuable ecosystem services and biodiversity hotspots, of designing the city around these, and of linking these systems when they are fragmented.

3.6 Diversity Patterns

Diversity patterns comprise a fine grain of mixed uses with varying housing typology options, economic opportunities, multi-func tional green spaces and social facilities. A

43 For a detailed explanation see Chapter 4 in: Salat Serge and Ollivier Gerald. 2016. The 3V Framework: Maximizing Economic Opportunities in TOD Station Areas by Matching Place, Node, and Market Potential Values. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

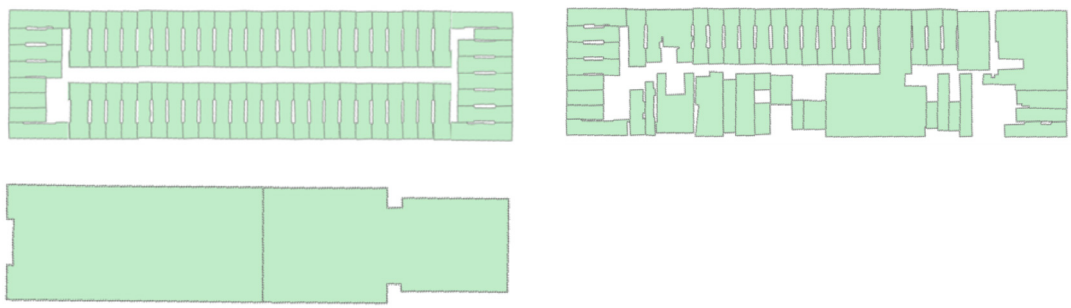
44 Alexander, C., S. Ishikawa, and M. Silverstein, A Pattern Language: Towns, Buildings, Constructions, Oxford University Press, New York, 1977.

better way of looking at mixed use is 'diversity'. This was advocated by Jane Jacobs[45] in her classic book, The Death and Life of Great American Cities. 'Mixed use' means more than mixing residential and commercial. It also means proximity to other uses such as schools/universities, parks, museums, courthouses, industries, train stations and so on. Not every building needs to have multiple uses or tenants, but each block and neighbourhood must. These kinds of destinations help to define a city's or a neighbourhood's identity. They do so through the variety of uses and public spaces that highlight local assets and unique talents and skills of the community -educational, cultural and commercial - that are all open and available to all visitors to enjoy for free.

Such neighbourhoods allow residents to visit, become involved and stay awhile. They are not defined by architecture but rather by the uses that are front and centre and by the buildings and design elements that support them. Diversity patterns imply creating neighbourhoods that build authentic places through multiple uses that are intimately related, interconnected and interdependent. True urban diversity comes from a meaningful relationship between uses, tenants and the organizations within a place.

3.7 Land Lots Patterns

City blocks may be subdivided into any number of smaller land lots, usually in private ownership, though in some cases, it may be other forms of tenure. These land lots are the basic unit of land markets. Diversity of land parcel sizes can meet future demand and create an adaptive city. However, Chinese current urban development is quite the opposite and is based on large superblocks (400-metre side), that are the current unit of land sales to developers. This contrasts strongly to the Manhattan land market, where the smallest unit of land sale is 80 times smaller than those used by the Chinese.



Manhattan plot consolidation principle. Top Left: Manhattan original plot subdivision in 1811. Average land lot size: 205 m². Right: Manhattan Intermediary lot consolidation. Average lot size: 255 m². Bottom Left: Manhattan Extreme lot consolidation. Average lot size: 6,100 m².

Source: Urban Morphology and Complex Systems Institute.

45 "It is fatal to specialize… the more diverse we are in what we can do the better." (Jane Jacobs).

Manhattan today displays a huge diversification of land lot sizes and lot intensity of development. On an area of 60 km² (the size of Manhattan), taking into account the much larger road surface in Chinese urban planning, there would initially be 300,000 units of land for sale in Manhattan compared to 250 in a Chinese New Town. The fine grain of lot and land market fosters an active land market with a great potential of future mixed use. Over time, land lots in Manhattan have consolidated but still 40 per cent remain with the initial sizing of two centuries ago, while very few occupy whole urban blocks.

3.8 Summary of key Benchmarks for Enhancing Value at Community Scale

Key benchmarks recommended by UN-Habitat for implementing the above patterns can be summarized as follows:

- Local accessibility based on small blocks and on dense and connected street patterns with, 80 to 100 street intersections/km².
- Adequate space for streets. Based on international benchmarks of efficient, inclusive, and sustainable cities, UN-Habitat recommends[46] that the street network occupies at least 30 per cent of the land with at least 18 km of street length per km².
- High-quality public space.
- Good-quality pedestrian connections such as sidewalks and street crossings.
- Effective traffic calming, traffic and parking management.
- Density levels over an 800-metre area within walking distance of a station depend on the magnitude of transit investment. UN-Habitat recommends densities of at least 15,000 per km² for sustainable neighbourhoods[47].
- Mixed land use that will attract occupants, create an attractive environment (services, amenities, public infrastructure and design qualities), and produce substantial public transportation ridership.
- At least 40 per cent of floor space should be allocated for economic use in a sustainable neighbourhood[48].
- Limited land-use specialization. This is to limit single function blocks or neighbourhoods; single function blocks should cover less than 10 per cent of any neighbourhood[49].
- Social mix. The availability of houses in different price ranges and tenures in a neighbourhood should accommodate different incomes; 20 to 50 per cent of the residential floor area should be for low cost housing and each tenure type should be not more than 50 per cent of the total[50].

46 A new strategy of sustainable neighbourhood planning: five principles, UN-Habitat, Discussion note 3, May 2014.

47 Ibid

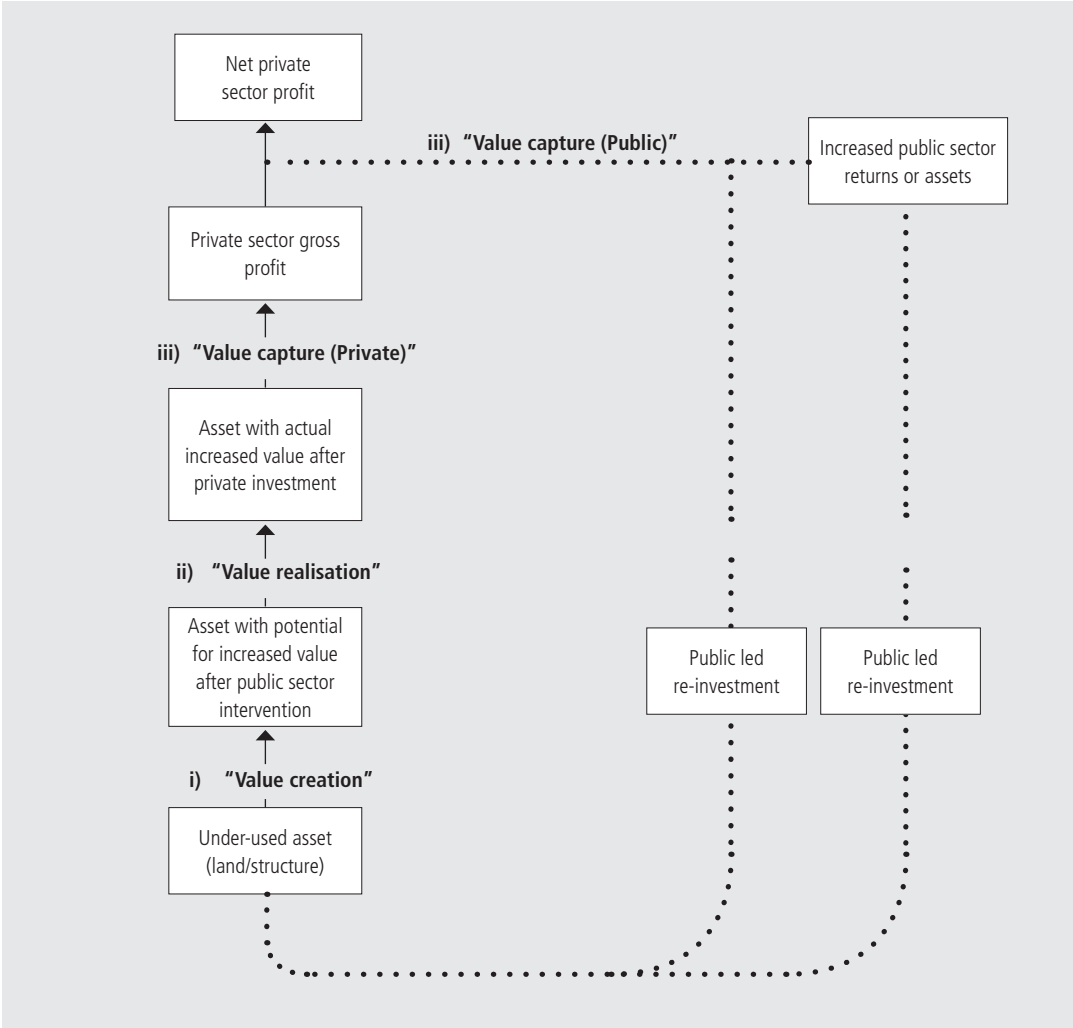
48 Ibid

49 Ibid

50 Ibid

4 Financial Patterns: The Positive Feedback Loop of Value Creation

Feedback mechanisms have been described as a threshold concept for understanding complex systems. A feedback loop is a mechanism by which a variable change results in either an amplification (positive feedback) or a dampening (negative feedback) of that change. The positive feedback loop of value capture is captured in the following chart:



An idealized Value Capture Finance feedback loop. Source ULI. © ULI. Used with the permission of ULI. Further permission required for reuse.

New transit infrastructure provision or planning decisions, such as rezoning at higher values or investing in the public realm, increases land value around transit stations, which can be captured for starting a positive feedback loop for financing infrastructures, enhancement of public realm and inclusionary housing. The unlocking of an increase in the potential value of under-used assets (land and/or structures) as a result of a public sector intervention (rezoning or provision of public transportation infrastructure) stimulates demand from the private sector.

Subsequent investment and development from the private sector ensures that potential asset value increase is realized. Value capture is the arrangements by the public sector for the acquisition of a proportion of private sector returns for local reinvestment[51]. Local value recycling is the reinvestment of acquired monetary or in kind contributions from the private sector within the same development site or scheme. This reinvestment can pay for the initial public intervention but tends to fund further interventions. According to Joe Huxley[52], Value Capture Finance, can therefore, be defined as the appropriation of value, generated by public sector intervention and private sector investment in relation to an underused asset (land and/or structure), for local reinvestment to produce public good and potential private benefit. Value Capture Finance increases the incentive for both public intervention and private investment by creating a win-win situation and shares the cost of urban development between the public and private sectors without the public sector necessarily undertaking a large amount of initial investment.

51 This can take the form of monetary or in kind contributions from the private to public actors.

52 Joe Huxley, Value Capture Finance. Making urban development pay its way, Urban Land Institute, 2009.

Initiating a positive feedback loop of Value Capture Finance starts by identifying imbalances in the different node, place and market potential value[53] in a given location and thus assets which are underutilized, either because an increase in connectivity linked to public investment in infrastructure calls for a redevelopment or because high place value calls for investment in connectivity to create a positive feedback loop for market growth. The 3V framework[54] allows the fine tuning of public investment to market response potential in order to initiate these positive value capture feedback loops addressing the challenges of financing the infrastructures of fast-growing cities.

4.1 Value Creation

Value creation strategies involve increases of the three values (node reflecting connectivity, place reflecting urban design quality and market potential reflecting market demand and supply in the location) characterizing a location, each one supporting the others. In London's King's Cross for example[55], enhanced infrastructure provision takes the form of future linkage of King's Cross and Euston Square into a single station, with HS1 and HS2, creating the biggest inter-change across several geographical scales in the UK (with High Speed Rail, National Rail, six subway lines, and 17 bus routes, connecting Europe, UK, and London). The planning engine for redeveloping the site has been to enhance urban quality and image. A lot of attention has been given to the provision

53 For a detailed explanation see Chapter 3 in Salat Serge and Ollivier Gerald. 2016. The 3V Framework: Maximizing Economic Opportunities in TOD Station Areas by Matching Place, Node, and Market Potential Values. World Bank, Washington, DC. License: Creative Commons Attribution CC BY 3.0 IGO

54 Ibid

55 For a detailed analysis see Chapter 6 of Salat Serge and Ollivier Gerald. 2016. The 3V Framework: Maximizing Economic Opportunities in TOD Station Areas by Matching Place, Node, and Market Potential Values, op. cit.

of high-quality public space with twenty connective new streets and ten high-quality squares and public gardens. Public investment in public parks will ensure that the location becomes one of the most liveable areas in London.

Similarly, for redeveloping the railyard sites in New York's Hudson Yards, public investment in public space has been the key strategy for value creation [56]. Three major New York parks (the third section of the High Line, Hudson River Park and Hudson Park & Boulevard) will converge in Hudson Yards. As a result, market potential has been enhanced due to the huge increases in people and job densities, creating very dense mixed-use communities. Regulatory planning interventions have also taken the form of rezoning[57] at higher values, with margins of flexibility to capture value between base and maximum, as well as for facilitating the adaptation to market changes. Rezoning at higher FARs levels creates high market potential values in well-connected and centrally located areas. Margins of flexibility between base FAR and maximum FAR also allow the capturing of parts of this value creation.

Similarly, for redeveloping the railyards site in New York's Hudson Yards, public investment in public space has been the key to the strategy for creating value

56 For a detailed analysis see Chapter 5 of Salat Serge and Ollivier Gerald. 2017.

57 Zoning is the planning instrument of the physical city. It aims to promote an orderly pattern of development and to separate incompatible land uses, such as industrial uses and homes, to ensure a pleasant environment. The Zoning Resolution is a legal instrument to regulate and establish limits on the use of land and building size, shape, height and setback. Rezoning FARs at higher values is a planning intervention that creates market potential value.

4.2 Value Realization

Potential increased asset values are realized by private sector investment. Asset values are tangibly increased and unlocked by private sector involvement and investment in a number of ways:

- Direct investment.
- Comprehensive master planning. In both Hudson Yards and King's Cross, for example, innovative master plans, with high quality public space and local connectivity, have been designed by developers with high level of public participation, in London, and a dialogue between public and private actors, in both cases.
- Area promotion through enhanced destination branding and marketing.

4.3 Value Capture

Increased asset values are captured for the public good and private profit. The inward rate of return is secured as profit by the private sector. This private value capture is primarily via the rent or sale of new or enhanced housing, retail or office units. The public sector then uses a range of mechanisms to capture enhanced asset values realized by private actors. We provide below a general list of value capture finance mechanisms, described as follows by Joe Huxley[58].

- Land transfers. Land held in private or public ownership is provided to the public promoter for public use.
- Local taxation. Local general targeted taxation and local real estate tax incre-

58 Joe Huxley, Value Capture Finance. Making urban development pay its way, Urban Land Institute, 2009.

ments where revenues are reinvested into the same area in which they were collected.

- Fees and levies. Planning approval fees, development levies and infrastructure tariffs.
- Debt servicing or loan guarantees. Securing loans against the increased or future increase value of the land.
- Local service agreements. Private actors agree to give priority to the local community for access to new facilities, public space or to manage basic public services.
- Private-led local infrastructure and amenity provision and enhancement. For example, provision of schools, community centres, affordable housing, transport links and utilities provision and upgrade, were part of the agreement between local government and private developer for both Hudson Yards and King's Cross.
- Operating revenue.

4.4 Local Value Recycling

The captured value (in monetary form or 'credit' to leverage in-kind contributions from the private sector) can be recycled or reinvested in the same development scheme for the public good in two main ways:

- Public sector led re-investment. Increased public revenues captured from the private sector through enhanced local taxation, fees and levies pay for further government interventions within the same development area. This reinforces asset values and positive social-economic impacts.
- Private sector led re-investment. The public actor offers private actors the opportunity to deliver community-orientated infrastructure directly. This further increases asset values and positive social-economic impacts.

Leaf Patterns: The Resilient Way of Urban Growth

Living cities are dense patterns of connectivity, where everything is linked to everything else. The new science of cities has discovered that these dense webs follow underlying efficient and resilient patterns captured by a few simple mathematical regularities. The patterns in the urban space economy that we have discovered have deep implications on resilience, resource productivity and infrastructure investment.

First, the spatial distribution and the intensity of connections in an efficient and resilient city, should obey a scale-free distribution. The more scale-free the city networks and the more connected within the same scale and through scales, the more they can absorb fluctuations and even build new structures upon the perturbations to which they are subjected, without letting them upset the stability of their structure. It is in assimilating the fluctuations that an urban system becomes more complex and more diverse. Hence, there is an ongoing dialogue between the city's capacities of resilience and the constraints to which it is subjected, between the fluctuations from the outside environment and its building structures to absorb these fluctuations.

Second, infrastructure investment, if it is to be resource efficient, should reinforce the emerging concentration properties of urban space rather than counteract them. Rather than levelling inequalities to reach a homogeneous and amorphous urban space, it is more resource efficient to enable peaks of concentration of economic density and productivity to grow, to encourage the formation of strong hubs in subway systems, to sharpen the hierarchy of accessibility, to shape and articulate densities with high concentrations around major hubs rather than a random distribution of urban growth across space.

Cities planned with these efficient patterns reduce traffic congestion, promote business, improve public services and boost revenues. These cities are more liveable, economically competitive and environmentally and socially sustainable. Finally, by creating and capturing higher land values around public transportation stations and corridors, these cities can recoup some of the costs of building, operating and maintaining mass transit systems, as well as supporting transit-oriented development in ways that make them more appealing places to live, work and do business.

II

Part 2

The Technical Framework of the Three-Pronged Approach

Loeiz Bourdic and Marco Kamiya

1 Urban Productivity

Urban productivity can be defined as the efficiency of resource use – the use of labour, capital, land, material, energy and information. Increases in productivity is the major source of economic growth at city and country level and these increases thereby potentially lead to raising living standards and prosperity.

Productivity is also closely related to competitiveness since cities, which are more productive in terms of goods and services production, are more competitive at a global scale. Competitiveness is ultimately a revealed productivity of a city. Cities are the result of multivariable and integrated factors working together and impacting on productivity and competitiveness[59].

The productivity advantage of cities and urban clusters with a high density of companies and workers have long since been perceived. Different theories have tried to explain why and under which conditions urban development is accompanied by rising productivity levels. Some key theoretical approaches which can be applied for discussing the relation of urban development and productivity, namely the theories of agglomeration economies, economies of scope and economies of scale, as well as, some further developments of these theories, are presented in this document.

The theory of agglomeration economies argues that concentrating production factors leads to higher productivity. The theories on economies of scale and scope argue that increasing the production amount of one good or the range of goods, respectively, can reduce the average cost per unit and thereby also raise the productivity level. These theories can be applied either on the level of a single firm or at a macro scale, which can be useful for the discussion of the productivity advantages of urban agglomerations.

These theories not only offer explanations for the often observed correlation between characteristics of urban agglomerations and their urban productivity level but also for the correlation between urbanization rates and the development of national productivity. They also provide indications on the conditions which the urbanization process has to fulfill so that the potentials of urban agglomerations can be fully exploited.

It will also be discussed why urbanization does not necessarily lead to higher productivity levels without addressing both positive and negative externalities, generated due to urban agglomerations. This offers the base for arguing that efficient, sustainable and equitable urban development is a requisite for a city to fulfill its potential as the engine of national economic growth. Efficient cities can drive gains in economic productivity and job creation, while spontaneously growing inefficient cities can be a drag on economic and productivity growth.

Thereby, this section offers the theoretical background to explain why a city's performance on the components of the Three-Pronged Approach is essential for successfully exploiting the productivity enhancing potential of cities. In the empirical section,

59 See the Global Competitiveness Report where competitiveness is computed based on 12 pillars that goes from education to infrastructure and classified in three main areas: Basic Requirements, Efficiency Enhancers, and Innovation and Sophistication Factors [http://www.weforum.org/]. On urban competitiveness (Ni, Kresl and Liu 2013) develop a sustainable competitiveness index including social and cultural variables in addition to environment, economic dynamics and global connections; an alternative index incorporating value chain and supply chain as a base for competitiveness (Kamiya & Roberts 2015).

different cities are examined on how they perform on the three components of the Three-Pronged Approach and on the effect this performance has on urban productivity.

1.1 Economies of Scale and Urban Productivity

The theory on economies of scale states that the greater the quantity of a good produced, the lower the average costs per product unit. The underlying reasoning is that the fixed costs occurring in the production process are shared over a larger number of goods if the volume of output increases. Economies of scale may also lead to a reduction of the variable costs per product unit due to operational efficiencies and synergies. Producing a high volume of one product type allows firms and workers to specialize in specific tasks and thereby achieve a high productivity level[60].

The theory on economies of scale differentiates between internal and external economies of scale. The concept of internal economies of scale focuses on explaining the cost reducing effects of specialization and increases in the production of single products through changes at the firm level.

The concept of external economies of scale, on the other hand, refers to the advantages of a high output volume on a macro-scale, meaning at the inter-firm level. It explains how changing factors outside of an individual firm can increase the productivity level of an entire industry, region or economy. This concept can be transferred onto the relation between city size and productivity level; however, for cities, this relationship is not mechanical since there are also dis-economies of scale due to governance and planning of large cities or metropolises that must be taken into account.

60 Lobo et. al. (2014) from the Santa Fe Institute demonstrates empirically that in a typical city in the US Total Factor Productivity in 11 per cent with each doubling in population.

1.2 Economies of Scope and Urban Productivity

The theory on economies of scope states that production costs can be reduced through producing a range of goods of a similar type together instead of producing each one on their own. By sharing centralized functions, such as finance or marketing, among the production processes for different goods, the fixed costs arising for the production of a single unit can be reduced. Furthermore, interrelationships in procurement, production and sale of different goods can be utilized to reduce the costs of business; such as opportunities to cross-sell one product alongside another, or using the outputs of one production process as the inputs of another. Transferred to the macro level (for the purpose of this study, to the city level), this theory explains the existence and growth of urban agglomerations with the opportunities they offer for businesses to utilize the interrelations between the production processes of their goods with those of other businesses. Cities enable businesses to share centralized functions in procurement, production and sale processes.

On the basis of this theory, it can be argued that cities exist as the proximity of firms in urban agglomerations, facilitating factor specialization and sharing of indivisible inputs. In the following parts of this document, two further developments on the theory of external economies are presented, both of which offer explanations on the productivity advantages of urban agglomerations. One approach argues that the advantages of scale relate primarily to higher levels of activity in a particular

industry, with the benefits accruing to that industry. The other one relates more generally to the overall scale of activity in a city which is argued to affect the productivity of all firms located there.

1.3 Urbanization and Localization Economies and Urban Productivity

The theory on urbanization economies seeks to explain the relation between city size and productivity level. It suggests that urban diversity and a large city size generate productivity advantages for any business locating in an urban agglomeration and argues that the urban environment creates positive externalities which benefit different industries. This theory is especially suitable for explaining the high and growing productivity levels in cities with no single dominant industry. Regardless of their industry, firms locating in a large city can benefit from the common physical resources such as roads, buildings and power supply, and from access to a large diverse labour pool.

The theory on localization economies, on the other hand, discusses how the size of an industry in a city affects the productivity level of a particular activity. The productivity advantages of cities are seen to relate primarily to higher levels of activity in a particular industry, with the benefits accruing to that industry (Jofre-Monseny, Marín-López, Viladecans-Marsal, 2012).

1.4 Agglomeration Economies and Urban Productivity

The theory on agglomeration economies unifies ideas from the theories presented above. It states that urban economies offer a diversified and large market for the purchase of inputs, on the one hand, and for selling the final goods, on the other. Moreover, they provide an environment for innovation, transport and energy network infrastructures plus the opportunity for cooperation with other local firms as suppliers and customers.

In the literature on economies of agglomeration, different factors are argued to cause productivity advantages in urban agglomerations. Higher concentration and scale of people, activities and resources in urban areas foster economic growth, innovation, and increase efficiencies (Kahn 2009; Glaeser and Kahn, 2010). The agglomeration economies made possible by the concentration of individuals and firms make cities ideal settings for innovation, job and wealth creation (Rosenthal and Strange, 2004; Carlino, Chatterjee, and Hunt, 2007; Knudsen et al. 2008; Puga, 2010).

Several factors can explain the productivity advantages of urban environments (Puga, 2010): (1) large markets allow for an efficient sharing of local infrastructure and facilities, and bring together a variety of intermediate input suppliers and a pool of workers with similar skills; (2) large markets allow for effective matching between employers and employees, buyers and suppliers and between business partners and (3) large markets can facilitate mutual learning and knowledge spillovers, by promoting the development and widespread adoption of new technologies and businesses practices.

Urban employment and services benefit from the economies of agglomeration due to cost savings and other advantages that accrue to firms when they locate near others in the same industry. When

businesses collocate near other economic activities, they can take advantage of shared markets, services, infrastructure, labour and information. Furthermore, due to the productivity advantages in cities, urban investment has a strong multiplier effects in stimulating other high-value activities. This benefit extends to rural areas, which needs access to urban markets to expand and diversify both agricultural and non-agricultural production.

Larger urban areas are the most productive since they allow greater specialization in labour, better matching of skills and jobs, and a wider array of consumption choices for workers and ancillary services for producers. It is also in large cities where the vast majority of substantial innovations emerge. As long as this greater productivity outweighs higher costs for land, labour, housing, and other necessities, a city can thrive (World Bank, 2003 and 2009).

An emerging approach associating urbanization to productivity comes by linking value chains and supply chains. As the urban setting is the place where goods are produced, and those goods are results of several inputs, goods and services, then the urban forms and the infrastructure that offers highways, roads, and information technology are as important as human capital in the production of final goods. Consequently, supply chains which determine the channels through which inputs are delivered to a production hub can have impact on efficiency, competitiveness and ultimately in productivity. In this study, this approach is not analysed, but it is an important research agenda in regards to urbanization and productivity[61].

1.5 Negative Externalities of Urban Agglomerations

Besides the productivity advantage cities offer, especially as compared to rural areas, there are also negative externalities being generated in urban agglomerations. Negative externalities, un-priced negative effects that actors impose upon other actors, arise due to high levels of proximity and density in urban areas.

Land in urban areas is scarce; this leads to higher land prices in urban compared to rural areas and leaves room for speculation. Where there is a lack of public and private transport networks, urbanization is accompanied by rising congestion, insecurity, noise, high pollution levels and adverse environmental effects. These, as well as limited interactive, recreational and cultural opportunities due to lack of public open space can reduce the liveability of a city. Unless some countering action is taken, spontaneous and uncontrolled urbanization can lead to spatial segregation in gated communities or neighbourhoods by income level and social status. This, again, can have self-accelerating effects, leading to high inequality of educational, social and economic opportunity, as well as limiting the interaction and community building beyond social, generational and cultural boundaries.

Negative externalities of urbanization on the urban economy are treated in the theory of diseconomies. Diseconomies of scale (the counterpart of economies of scale), are defined as the forces in growing urban areas which cause increasing costs for businesses and residents. The potential of negative externalities due to rapid urbanization grows with the increasing size of a city. Once the effects of diseconomies

61 Roads and productivity is a potential link (see Fernald, 1999). Another is proximity and access to jobs (see Bertaud 2002).

become too great, larger cities may lose their edge in creating jobs or improving the welfare of residents.

The effects of diseconomies can be overcome if businesses can shed those activities that are more mature and standardized to smaller cities to make room for more innovative and higher value industries and services and change the use of land (World Bank, 2003).

The discussion on the theory of economies of scale shows that a city has to generate more positive than negative externalities. This means that the factors causing productivity advantages have to be supported to create positive effects on the local economy, while the negative externalities of urban agglomerations have to be rooted out to the greatest extent possible.

2 The Three-Pronged Approach

2.1 Exploiting the Potential of Urbanization

Many of the factors leading to productivity advantages in urban agglomerations as discussed above are generated by the proximity and density of workers and businesses. Proximity, density, integration and accessibility, however, are not necessarily a given in every urban agglomeration and not automatically maintained during the urban extension process. There are rather planning and regulatory activities, as well as strategically sound public investments necessary to ensure sustainable urban development. The quality of a Planned City Extension, and other regional policies accompanying it, can be argued to determine the effect of urbanization on the economic development of a region by influencing various elements in the urbanization process. Besides having a strong impact on urban productivity, the quality of a Planned City Extension will also determine the level of inequalities within urban centres and among rural and urban areas.

UN-Habitat promotes three fundamental components that have to be considered by local authorities in the process of planning and implementing urban extension programmes in order to achieve sustainable urbanization. Sound performance in these three areas is essential to exploit the potential of a city to generate wealth, employment, coexistence and cultural interchange as discussed in the presented theories and to avoid the pitfalls of a spontaneous development.

In the following, the essential components for a successful Planned City Extension, namely urban design, financial management and rules and regulations, are presented in detail. They have to be seen as supplementary, as failing to consider one of these essential components can cause the urban authority to fail in its performance on the other two dimensions and can result in a Planned City Extension failure to create a sustainable urban fabric. For a Planned City Extension to succeed, UN-Habitat advises local authorities to balance actions on all three components and to avoid focusing on optimal performance in only one or two of the areas. It is advised to put similar effort towards good performance in all three since the action in one is complementary to the performance of the others. The three essential components of a successful Planned City Extension are to be seen as the foundation for further action. To tackle successfully central issues in

urban extension programmes such as urban youth issues and housing scarcity, it is essential to create an appropriate framework of good performance for each component of the Three-Pronged Approach.

Any action of a Planned City Extension programme has to be implementable in each of the three areas of the Three-Pronged Approach for the action to have positive consequences. Interventional actions to tackle any arising issue are difficult to undertake without the existence of an efficient legal framework. The provision of any public service, any public property or institution requires a minimum of financial funding to keep on functioning or to be maintained. Any physical development or addition to the existing urban fabric also requires investment. Urban design, finally, is central and has to be taken into account as the development of a city requires planning activities to ensure the development of a spatial layout that enables dense and diverse development and the maintenance or improvement of a city's accessibility, liveability and environmental quality.

In many contemporary Planned City Extension programmes, urban design is seen as the standalone component. This section, discussing the Three-Pronged Approach components, shows that, apart from the spatial planning matters, rules and regulations as well as financial planning inevitably have to be taken into consideration when formulating and implementing Planned City Extension programmes. Only then can the potential of a city to generate productivity advantages be exploited.

The concept of 'scale' is described later in this study but it is necessary to indicate that approaches have to be different for neighbourhoods, city-wide areas or metropolises, since the size of the area determines what kind of tools would be used to implement the Three-Pronged Approach in terms of planning, financial and legal frameworks.

2.2 Three Essential Components for Sustainable Planned City Extension

2.2.1 Urban Planning

UN-Habitat promotes five key principles for urban design[62], as concepts for urban planning rather than economics. These principles are empirical and pragmatic advice to 'good' urbanization and provided to policymakers when urban expansion plans are designed. Although these plans are not derived from an abstract model, each principle should be applied considering the geographic, social and political context of a region[63]. These five principles are:

- Adequate space for streets and an efficient street network. A street network that not only serves private and public transport vehicles but also specifically aims to attract pedestrians and cyclists. The street network should occupy at least 30 per cent of the land and at least 18 km of street length per km².
- High density. High concentration of people and their activities. At least 15,000 people per km², that is 150

62 UN-Habitat (2014) "A New Strategy of Sustainable Neighbourhood Planning: Five principles" Urban Planning Discussion Note 3. Nairobi, Kenya.

63 For example, public space of 50 per cent of the area is not to be intended for slums where upgrading must be incremental but would be so for established cities or cities which are being planned.

people/ha or 61 people/acre

- Mixed land-use. Combination of different residential, commercial, industrial, office or other land use in one neighbourhood. At least 40 per cent of floor space should be allocated for economic use in any neighbourhood.
- Social mix. The availability of houses in different price ranges and tenure types in any neighbourhood to accommodate residents from different backgrounds and with different income level. Twenty to 50 per cent of the residential floor area should be for low cost housing; each tenure type should be not more than 50 per cent of the total.
- Limited land-use specialization. Reduced amount of single function blocks or neighbourhoods. Single function blocks should cover less than 10 per cent of any neighbourhood.

The proportion of urban space dedicated to public use and the features of the street networks, commercial corridors and sidewalks, determine the walkability of a city. They thereby determine a city's quality and intensity of street life and the interaction among citizens. The amount of space dedicated to streets and transport infrastructure also shapes the city in terms of connectivity and accessibility, thereby affecting the level of congestion and air quality. A city's street network, moreover, functions as a layout for the provision of basic urban services. Its quality determines the affordability of various urban amenities and services. A sufficient, high quality public space, on the other hand, can significantly enhance a city's liveability, resulting in potential buyers to be willing to pay more for urban land. It also allows local authorities to plan for future development by facilitating easier reordering and reorganization of plotting areas and roads. Thus, to ensure the development of quality street patterns and public space, spontaneous growth has to be prevented through urban planning from the initial stage of urban expansion.

To prevent urban sprawl and promote sustainable urban extension, it is necessary to achieve high density of residents as well as economic activity. Compared with low density, high density has economic, social and environmental benefits. Efficient land use slows down urban sprawl because high-density neighbourhoods can accommodate more people per area. It is through high-density development that costs for public services, such as police and emergency response, school, transport, roads, water and sewage can be reduced. High-density development also leads to high walkability and accessibility, thereby reducing car dependency and parking demand, and facilitating the provision of an efficient public transport network. This increases energy efficiency and decreases pollution.

In the planning process, it is crucial to match efforts to increase urban density with the needs for public space. Therefore, the general plan on the urban layout has to integrate considerations on the present and future transportation and street infrastructure needs. Urban density must not overwhelm infrastructure due to risks of congestion. Reciprocally, under-using infrastructure because of low-density levels is not economically efficient. Public transport hubs should be located in an advantageous location for capturing the peaks of urban density, services and urban amenities. It is therefore important that densities are articulated across the metropolitan

area and strategically increased along key transit corridors.

Recent literature on urban planning proposes a general plan combined with rules and regulations rather than a detailed master plan that is conceptualized in the early stage of a development programme. A Planned City Extension based on a general plan with supplementing rules and regulations allows for evolution and adaption to changes in economic or environmental circumstances. The definition of the street network should be the key element of a general plan. This is because the street network, as the backbone of a city, determines the layout of a city.

The development of productive urban extensions relies on the capacity of stakeholders to integrate spatial planning and all essential urban infrastructure policies at different levels, from those conceptualized at a metropolitan scale to neighbourhood-scale development policies. Very often in rapidly-urbanizing countries, master plans focus on the large scale but lack the fine grain level of detail that is essential to urban productivity. For example, the diversity of land plot sizes is essential to support a vibrant and sustainable land market. As, plots are constitutive of land sale processes and land property structures, they are one of the basic bricks on which urban economic markets rest upon. However, due to the lack of human and technical resources, or due to different artistic and design concepts, most of the current urbanization process in developing countries and emerging economies is based on massive plots: the superblocks which result in an urban fabric lacking density and diversity.

According to the OECD (2015), the economic benefits of diversification of land use are multiple. They include:

- Lower transport costs
- Higher productivity due to shorter travel time for workers
- More efficient use of space and buildings
- Lower infrastructure and service costs
- Support for small business
- Higher property value
- Increase in local tax revenue
- Increase in economic activity and development

The notion of mixed use is not new, as advocated by Jane Jacobs, is not new, but its addition to urban planning is a relatively new development in contemporary urbanism theory. Since the end of the 19th century, with the introduction of modern urban planning concepts, the land-use zoning approach was applied frequently and single-function areas came into existence in cities all over the world. By promoting land use specialization, many single-function neighbourhoods have been created through zoning policies, which are seen to be the source of many contemporary urban challenges. Urban sprawl has increased, the quality and vitality of many urban centres have declined and car dependence and traffic congestion have increased as the urban population had to commute between different districts to be able to undertake all required activities.

To avoid these problems, new urbanism theories promote the core concept of mixed land use. Mixed land use requires some combination of residential, commercial, industrial, office, or other land use. However, for different economic and resi-

dential activities to be mixed in one neighbourhood, they have to be made compatible and be integrated in a well-balanced manner by careful design and management.

According to the Intergovernmental Panel on Climate Change (IPCC, 2014) concepts of fostering diversity and mixed use can be ambiguous. They must be conceptualized, implemented and evaluated at the right spatial scale as indicators at a city scale can hide whether large urban areas are dedicated to one single use. Usually, mixed-use incentives must be implemented at a neighbourhood scale (typically 500m x 500m areas) and at a block and building scale (IPCC, 2014). A neighbourhood should provide a 'smart' mix of housing buildings, office buildings, shops and urban amenities, as this has a positive impact on transportation patterns by decreasing the average distance travelled (McCormack, Scott Rutherford, and Wilkinson, 2001).

The only situation where zoning could be desirable at a city scale is when a specific activity is incompatible with the others; such as heavy industry which is generally incompatible with housing (Angotti and Hanhardt, 2001) and may be separated from other activities in the city. In this case, conventional zoning practices could be adjusted by combining compatible land uses into one block and neighbourhood; alternatively, mixed land-use zoning that respects market demand and cities' urban by-laws and regulations could be introduced.

Social mix provides the basis for healthy social networks, which are the driving force of a city life. Social mix and mixed land use are interdependent and promote each other. Mixed land use and appropriate policy guidance lead to social mixing. In a neighbourhood with mixed land-use, job opportunities are generated for residents from different backgrounds and with different income levels. People live and work in the same neighbourhood and form a diverse social network. Social mix is a socio-spatial concept, with the following objectives: through fostering social mix more social interaction and social cohesion across groups can be promoted; place-based stigma can be overcome and renewal/regeneration initiatives for the provision of additional services can be attracted to less wealthy neighbourhoods.

2.2.2 Financial Framework and Governance

The second essential pillar for a successful Planned City Extensions is a sound financial plan, meaning proper budgeting, revenue generation and expenditure management. Municipal finance authorities must be able to translate urban development policies into a sound financial plan and generate the revenues required for their implementation. Careful budgeting is essential to guarantee the maintenance and development of public institution programmes and infrastructure. Municipal finance activities should aim at preventing liquidity risks and reducing the dependency on transfers from the central government.

For the successful implementation of a Planned City Extensions programme, adequate financial frameworks and governance schemes must be in place, including:

1. The financial capacity of the municipality to finance and deliver infrastructures and plans
2. The financial know how of the munici-

pality to implement and monitor infrastructure delivery and plans

3. Effective institutions with clear roles and adequate human and financial capacity
5. Fiscal capacity of the municipality to raise revenues such as through land and property taxes
6. High degree of freedom of municipalities with regard to central governments

Throughout history, the role of the government has been highly discussed. How much responsibility they have to take is the big question; one which has not yet been solved and which probably will never be solved as it comes down to a matter of preferences. But in terms of local government responsibilities, the path has been narrowed, according to the Guide to Municipal Finance (2009). This guide states that the major role assigned to local governments is to provide goods and services within a particular geographic area to residents who are willing to pay for them. They should not carry out a stabilization policy because they do not have access to monetary instruments and they should not have redistribution as primary focus because it will result in a non-general equilibrium policy, with people moving from one place to another. Finance plays a huge role in this discussion. Responsibilities have a cost and, relative to the society, the government has to figure out a way to obtain the amount of money to fulfil those responsibilities. At the same time, the government has to determine a way of spending the resources they receive. There are six public finance principles that shape a framework on how to obtain money and how to spend it, namely:

1. Economic efficiency
2. Fairness (equity)
3. Accountability
4. Adequacy and stability
5. Autonomy
6. Ease and cost of administration

The six principles above set the path for designing an appropriate financial framework at a metropolitan level, but there are two questions still in the air: how to apply these principles? In addition, who should apply them? The answers to these questions are not straightforward. There are two theories that have to be taken in consideration in responding to these questions. The subsidiarity principle (Barnett, 1977) is a theory that states that the efficient provision of services requires that decision making should be carried out by the level of government that is closest to the individual citizen. The second theory has to do with the fiscal decentralization; it is a concept developed for transferring the financial responsibility from central governments to local governments forcing local governments to deliver and fund an increasing number of services.

The two theories mentioned above suggest dividing the financial framework in two parts, as usually reflected in budgetary planning: the revenues and the expenditures. Both portions of the financial framework should follow both principles mentioned before but in particular, the revenue has to follow the theory of fiscal decentralization while the expenditure has to follow the subsidiarity principle.

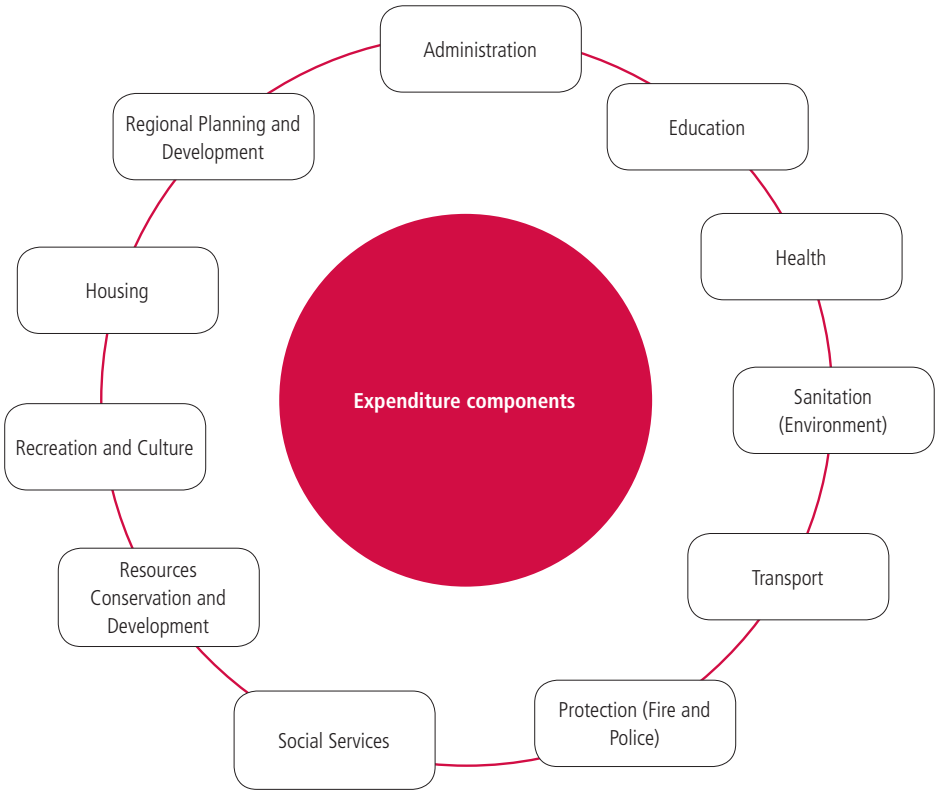
Expenditure

Each government, without taking geographical scale into account, should cover the minimum needs of its citizens. As it was mentioned before, the minimum a government should cover is a subject that has been in discussion throughout history. For reasons of simplicity, we are going to suppose that the more the government covers, the better it is for its citizens. This follows the non-satiation principle broadly used by economists. But the question in this sense is: what are the expenditures and investments for which a local government should be responsible? These are shown in Figure 1.

As it was mentioned before in the explanation of the subsidiarity principle, it is desirable that the expenditure components listed in the figure are done at the level of government that is closest to the individual citizen. Which level of government this will be varies between countries and context but it is usually at the metropolitan or local level. The 11 components of the expenditure portion of a financial framework are rarely covered on a 100 per cent basis by the local or metropolitan level, even by the state or at the national level. Those components are usually shared by the different governmental levels within a country.

FIGURE 1

Local expenditure components



Source: Authors

Revenue

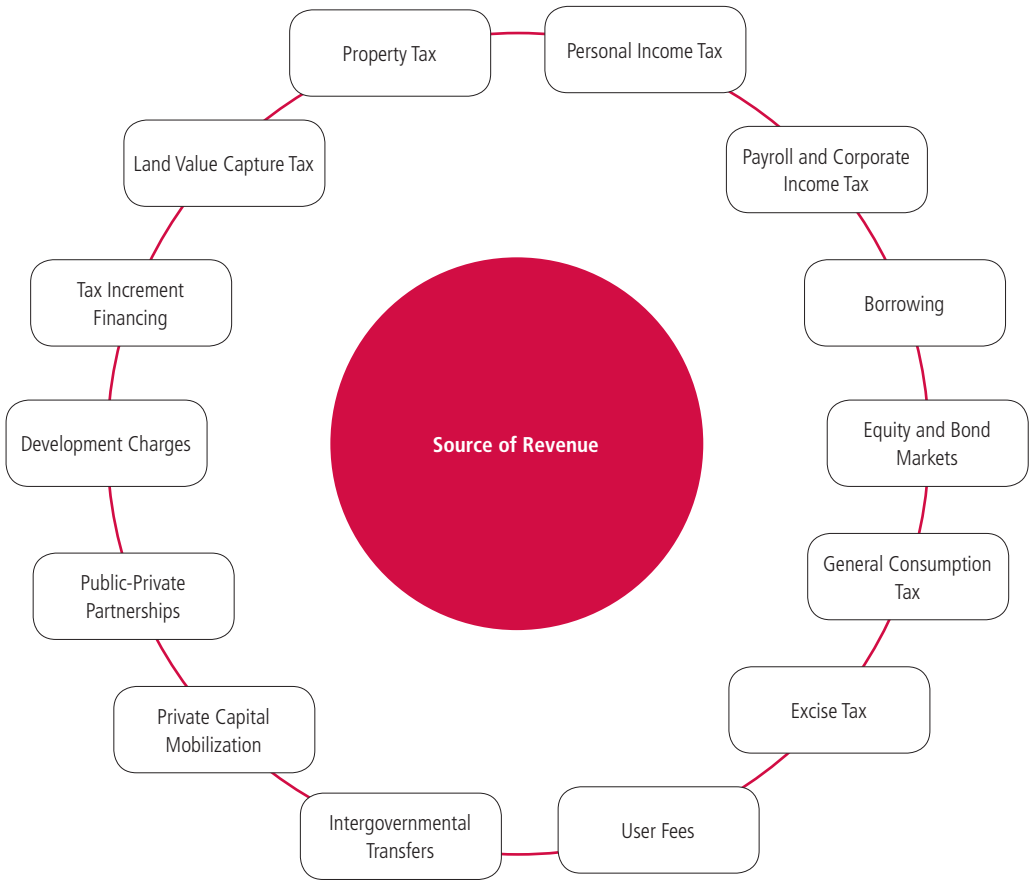
Now that the expenses have been covered, it is time to venture on to revenues in order to ensure funding and sustain those expenses. Similarly to expenses, there are different governmental tiers that could achieve the coverage of the necessary revenue collection in order to cover the expenditure components. Throughout history, revenue at the gov-ernmental level has been reinvented. While taxes have been the most predominant source of revenue; new forms of revenue for the different levels of government have also been developed.

As mentioned, taxes are a major revenue source. This is why tax sources such as property and labour need to be formally registered. The data on property value in particular must be updated regularly along with land value increases with the development of nearby infrastructures and services. Regularly updating data on land and property values is essential as it helps to capture increases in values, enhancing overall tax revenue collection.

As mentioned before, taxes used to be the main and possibly the only way of covering expenses at the local level. A financial plan for a Planned City Extension should now, however, incorporate innovative financing options such public-private partnerships (PPPs) and land readjustment schemes. Leveraging private finance and investment is increasingly important due to the constraints on public sector resources. Public policies have to promote private investment and address the causes and consequences of insufficient capital devoted to community economic development. According to Weiss (2006), "one of the most essential policy approaches is to strengthen the basic conditions that help foster private market activity, such as public investment in transportation and infrastructure improvements to enhance business activity, public funding of education and workforce development to increase employment opportunities, and public support for services, training, and technical assistance that builds the managerial capacity of small and medium-sized enterprises (SMEs) and community-based organizations (CBOs)." Direct public investment is a necessary condition for further leveraging private capital towards urban regeneration. Private investment must be recognized as a valuable tool to achieve these important public policy objectives.

FIGURE 2

Sources of revenue



Source: Authors

The different sources of revenues mentioned in Figure 2 can be generated by the different governmental levels. The different sources of revenue can be evaluated if they finance and to what extent they fund any of the expenditure components mentioned in Figure 1. Following the fiscal decentralization principle, it is desirable for the financial framework of a city that the smallest governmental level is in charge of the municipal revenue.

There has to be clarity regarding expenses and revenues. Even though the desirable level for both subjects is located at the local/ metropolitan level, the context and factors related with economies of scale should not be forgotten. As a result, the provision of services, such as transport, could be more efficient if they are delivered by the metropolitan government in collaboration with the national government.

2.2.3 The Legal Framework

Rules and regulations have the power to shape the form and character of the city by playing an essential role in the implementation of urban plans. Depending on the quality of rules and regulations supporting the general plan of a Planned City Extension and the quality of the local legal framework, the rules and regulation accompanying an urban plan can either support or hinder its implementation and evolution. A design following all the best practice of urban planning cannot be implemented if it does not comply with the local legal framework. Thus, first and foremost, special attention must be given to legal feasibility and implementability of all components of an urban plan. Possible rules and regulation that support the implementation of an urban plan are floor area ratio regulations, setback rules and mixed-use regulations, as well as regulations on plot sizes, maximum distance between intersections, street design and so on.

Different experts consider diverse elements before determining if a law is good or if it is not. But there are values that characterize a good law or a good legal framework. Those elements according to Mousmouti and Crispi (2015) are efficacy, effectiveness, efficiency and simplicity. Where the legislation concerns itself with urbanization, eight pillars also have to be achieved for a law to be effective. Those pillars are:

1. It has to be attached to the urban reality
2. It has to be developed based on evidence
3. Affected people should have a voice to express their position
4. Legislation has to be simple and easy to comply with
5. Legislation has to be easily accessible
6. It has to be coherent and consistent
7. Legislation must have a capacity to deliver results
9. Having legislative quality a guiding principle in the process of developing and implementing legislation

In addition to the eight pillars, there are 21 elements that compose an integral legal framework for the urbanization process. The 21 components are shown in Table 1.

TABLE 1

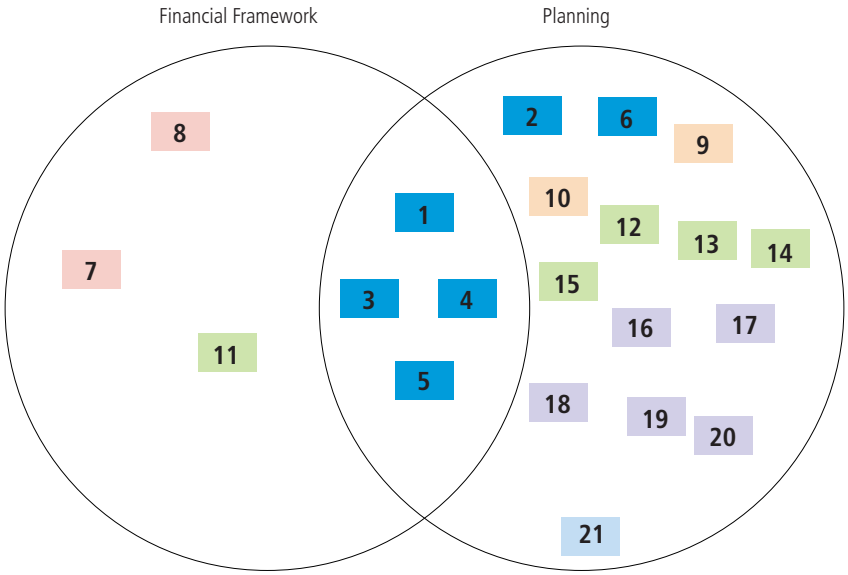
Components for a legal framework

Land Management	1	Support the establishment of a physical and fiscal cadastre, with an efficient, up-to-date and publicly available information system	**Land Based Financing**	7	Develop mechanisms to share increases in land value due to planning decision (urban to rural, building potential, valuable land use) and public investments (streets, public space, green areas, public transport infrastructure, basic infrastructure)	**Buildability-Development**	9	Allocate clear vertical development rights
	2	Develop a urban planning hierarchy that is adequate to the local needs, plans are designed and implemented. The planning instruments include a city street plan.						
	3	Provide an efficient tenure system with a legislation recognizing statutory and customary right (stability and security)						
	4	Regulate land use to foster land use diversity and mixed use		8	Develop a property tax legislation that allows a large collection rate. It has to be based on the value of the land and development. Progressive increase for undeveloped, vacant land or empty houses.		10	Define the buildable area (percentages, patterns, setbacks, etc.) based on desired densities and morphology
	5	Regulate land-readjustment activities for urban extension and densification						
	6	Support the provision of social housing						
Public Space	11	Provide a regulatory mechanism for private land acquisition	**Plots and Blocks**	16	Define a minimum plot size for residential use	**Building Codes**	21	Revise the building code
	12	Provide regulatory mechanism to allocate adequate space to streets (e.g. coverage ratio, number of intersections, width and length, street density)		17	Define a maximum block size			
	13	Provide regulatory mechanisms to allocate space to non-street public space (e.g. green areas, play grounds, sport facilities)		18	Provide efficient mechanisms to allow plot consolidation			
	14	Assign clear responsibilities of owners relating to the maintenance of streets and public space		19	Provide plot readjustments mechanisms to allow flexibility in uses			
	15	Formulate design guidelines for building facades		20	Provide efficient mechanisms to allow plot subdivision			

Source: Authors

FIGURE 3

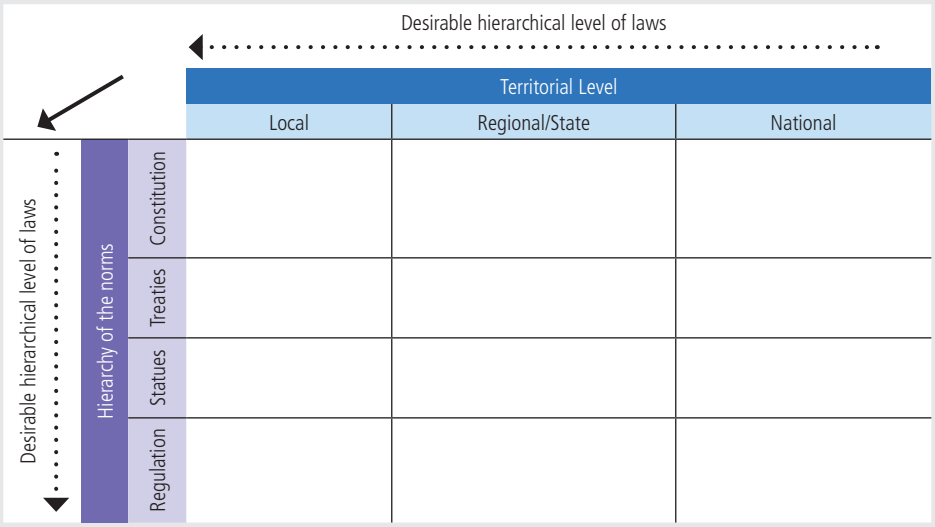
Venn diagramof the components for a legal framework divided in financial framework and planning



Taking into consideration the elements that provide an effective legal framework, the principle of subsidiary must be considered. Figure 4, shows this interplay among levels and hierarchies

FIGURE 4

Desirable territorial and hierarchical level of laws



Source: Authors

Even though it is desirable that the laws are established at the most immediate territorial level, where the norms could be easily modified according to the context, this cannot always happen. It is important to consider factors that could allocate certain authority to a level that do not fulfil the expectations established by the subsidiarity principle. Those factors could be economies of scale, lack of development of the local institutions in comparison to that of the national institutions and insufficient flexibility of the norms, among others. To give a practical example, the establishment of a physical and fiscal cadastre, with an efficient, up-to date and publicly available information system, should be desirable at a local level. However, the technological and physical infrastructure to fulfil this objective could be very expensive if each local government acquires it individually. Consequently, physical and fiscal cadastre is often established at a national level because it represents efficiencies in terms of specialization for the country.

An interesting exercise for the cities is to take each one of the 21 components mentioned on Table 1 and locate them in Figure 4. The outcome of the exercise will give a better understanding on how to improve the legal framework according to the subsidiarity principle, the effectiveness requirements, and determine if the non-desirable outcomes are caused by reasons such as economies of scale.

Even though it is desirable that the laws are established at the most immediate territorial level, where norms could be easily modified according to the context, this cannot always happen

3 Methodology: Applying the Three-Pronged Approach

3.1 Measuring Urban Productivity

Productivity is commonly defined as a measure of the efficiency of production in an economy and is usually expressed as a ratio of output to input used in the production process. In other words, productivity measures how efficiently human and physical production inputs are being used to produce a given level of output (OECD, 2001). While there is no disagreement on this general notion, a look at the productivity literature and its various applications reveals very quickly that there is no single measure of urban productivity. The choice between the metrics depends on the purpose of productivity measurement and, in many instances, on the availability of data.

Urban productivity can be measured either as productivity per capita (or job), or as productivity per km². Both metrics provide complementary information of the socio-economic structure of the Planned City Extension. The productivity per capita, which is the classically-used standard in economic literature, aims at capturing the economic output with regard to the human capital, and also reflects the impact of the economic situation on wages and living standards. The productivity per km², on the other hand, captures how a Planned City Extension is able to produce value with a scarce resource, namely land. This report builds on the existing literature and will use the respective indicators to measure the impact of the Three-Pronged Approach components on urban productivity.

The Model of Land Prices in Monocentric Cities

The standard model of land prices in monocentric cities is originally designated to make theoretical predictions on how far a city will extend. The theory is based on how much the urban population is willing to pay for a piece of land depending on the accessibility to the urban centre. The willingness to pay increases with accessibility to the centre, since people and companies prefer locations with better access to economic opportunities (Ottensmann, 1977; Alonso et al., 1964). As shown in Figure 5, this translates into a decreasing gradient of land value as the distance from the city centre increases.

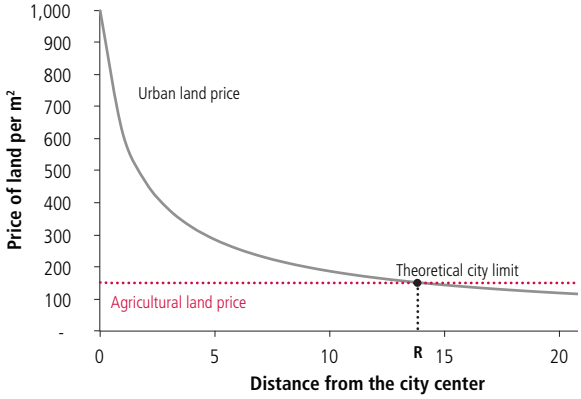
The price of agricultural land, on the other hand, is assumed to be constant in this model. The outer radius R of the potential built-up urban area is then defined as the intersection between the two curves. The theoretical city limit is thus the result of a trade-off between urban land price and agricultural land price.

This concept can be used for more than simply making theoretical predictions on the spatial limits of an urban extension; the decreasing gradient of land value with increasing distance to the city centre also offers an indicator on the quality of the urban development, as well as of the density at certain distance from the centre. It reflects the desirability and profitability of a city, on the one hand, and the quality of its infrastructure on the other.

The desirability and profitability of a city are reflected in the prices people and businesses are willing to pay, displaying the economic and commercial benefits of settling close to the urban centre. The difference between land value in the city centre

FIGURE 5

Urban land price and agricultural land price define the city size



Source: Urban Morphology Institute

and in the surrounding rural areas also gives an idea of the economic opportunities and the liveability and attractiveness of the city compared to the rural areas.

The more economic advantages a city promises for workers and businesses and the more liveable it is, the higher the willingness to pay for land in the urban area. This gives an indication of the opportunity costs of living in a city. By integrating the regional agricultural land price as well, this indicator becomes comparable among areas of different economic development levels.

The gradient of decreasing land value reflects how fast the accessibility decreases with growing distance from the urban centre. The better developed the public transport and street network in a city, the slower the accessibility of the urban centre degrades with increasing distance.

Besides analysing the decrease in land value with rising inaccessibility from the urban core, the productivity per km² can also be examined. Urban productivity per km² is defined as the Gross Value Added (GVA) per km² less the infrastructure costs per km². Beyond a certain distance from the city centre (where production is mostly concentrated), this indicator for urban productivity becomes negative. The indicator reflects how fast the urban productivity advantages decrease with distance from the centre. Again, the value of the gradient gives an indication of the quality of the urban infrastructure. For example, as certain activities require proximity, the agglomeration of activities provides higher productive areas and, in those areas, better and more sophisticated infrastructure is located.

All indicators discussed by now, namely the different indicators for urban productivity,

as well as the indicators for spatial distribution of land value and productivity, indicate how far the urban productivity advantages are exploited. Cities can be examined over time using these indicators in order to assess the effects of Planned City Extension programmes. These programmes and the local government`s performance in the process of implementation, can be assessed using the indicators which will be introduced in the following sections. The next section, in particular, shows how conceptualization and implementation of a Planned City Extension programme can be evaluated with regard to the three components of the Three-Pronged Approach.

3.2 Assessing the Performance on the Components of the Three-Pronged Approach

In the following section, different indicators to measure performance in the three areas of the Three-Pronged Approach are introduced. As this study seeks to give an overview on how local authorities can assess and evaluate their performance in conceptualizing and implementing Planned City Extensions, it has tried to give the broadest possible variety of potential indicators. The study concentrates on presenting indicators that characterize the performance of local authorities in the areas of urban design, financial management and legislature, as these areas build the foundation for successful Planned City Extensions. The study does not try to present indicators to assess a Planned City Extension with regard to all its features. Indeed, the set of indicators given can be seen as a tool for evaluating whether a Planned City Extension is built upon a proper foundation; it helps to identify issues that could hinder the successful implementation or could lead to unfavourable outcomes such as youth issues, housing scarcity and so on. The proposed indicators can also be supplemented by specific metrics which reflect the status quo and the developments on those issues.

Not all of the metrics suggested in this methodology section are used extensively in the empirical part. By presenting them and illustrating how they can be interpreted, however, local authorities are offered a variety of options to evaluate their own performance and its presumable consequences, given the limitations in data availability and the specificities of a city. The number of indicators which are proposed to assess a government's performance on the Three-Pronged Approach principles differs among the three areas. This does not imply that the evaluation of a Planned City Extension with regard to one area is more important than the other. The number of indicators of the Three-Pronged Approach components varies due to the differences in complexity and tangibility of the concepts they seek to measure. To assess the performance of local authorities in the conceptualization and implementation of a Planned City Extension, a balanced set of the indicators are presented below, reflecting the three areas in their full complexity.

Scales of Urban Assessment

When dealing with urban parameters, the scale of observation and of analysis is essential. Cities and urban environments are by nature highly heterogeneous areas, with intense concentrations and peaks of activities, and a long tail of areas with a medium to low intensity. Average figures have thus to be handled with care, as they can hide very heterogeneous patterns of urban development. This study differentiates three scales on which a city can be assessed:

- On the metropolitan scale, urban assessment addresses the spatial extension of the city. Analysis on this scale gives an indication of the spatial layout of a city by differentiating rural and urban land use and of human activities such as industries, offices and housing and the way they are organized and distributed in the territory.
- On the district scale, urban assessment addresses how streets and transportation networks are organized, as well as how urban amenities such as parks, hospitals or schools are distributed within the city.
- On the neighbourhood scale, urban assessment considers the form and the size of urban blocks and the way they are divided into plots.

For measuring urban design matters, the metrics and indexes proposed in this study aim at being implemented at a very local scale, such as at the neighbourhood and block level. Thereby the issue of city or district-wide average values obscuring trends and the existence of spatial mismatch can be circumvented.

A systematic approach for assessing a government's performance with regard to urban design should be based on data with all parameters being measured on the same scale; therefore, the urban area, for example, could be gridded to cells of 500m by 500m which can be considered as the neighbourhood scale. In the case studies provided in this report, the layout used is either based on a 500m x 500m gridding (Johannesburg), or 200m x 200m gridding in Paris and the Census Output Areas in London.

To assess a government's performance with regard to financial management and the efficiency of the legal framework, acquiring data on a neighbourhood scale is not always possible or useful. Rules and regulations normally do not differ among neighbourhoods; there might, however, be differences between city districts. Municipal finance activities are often done on a higher scale than neighbourhood level. The guiding principle, therefore, should be to acquire data for the lowest possible and sensible scale. The indicators provided seek to assess how well a Planned City Extension is funded. Therefore, they do not only capture characteristics of the conceptualization and implementation of a Planned City Extension, but also those components which constitute the framework for the extension. This explains why some concepts in the areas of financial management and legal framework are measured on scales which are higher than the neighbourhood level.

3.3. Assessing Urban Design

The five principles for the urban design suggested by UN-Habitat are accompanied by benchmarks indicating good performance:

- Adequate space for streets and an efficient street network: the street network should occupy at least 30 per cent of the land and at least 18 km of street length per km².
- High density: a city should have a density of at least 15,000 people per km², that is 150 people/ha or 61 people/acre.
- Mixed land-use: at least 40 per cent of floor space should be allocated for

economic use in any neighbourhood.

- Social mix: between 20 per cent to 50 per cent of the residential floor area should be for low-cost housing and each tenure type should be not more than 50 per cent of the total.
- Limited land-use specialization: single-function blocks should cover less than 10 per cent of any neighbourhood.

The urban planning indexes supporting this study aim at capturing these five principles to the full extent by defining a wider range of urban planning indexes and metrics than the above indicators with benchmarks. This study further proposes indicators, reflecting the performance on urban design against the backdrop of the five UN-Habitat principles which can be grouped into the following categories:

- Indicators on the intensity of population, jobs, economic activities and social infrastructure
- Indicators on the level of accessibility of economic and social opportunities by public transit
- Indicators for the assessment of walkability and street network connectivity
- Indicators on the diversity of land use and economic activities

In the following section, the indices for intensity, accessibility, walkability, connectivity and diversity are specified. The importance of the street network as a central planning tool is reflected in the choice of indicators as the majority of indicators are compiled from data on characteristics of the street network.

Intensity Indexes

The indicators on the intensity of urban fabrics aim at capturing the spatial concentration of the urban residents, of their activities and of their exchanges. We prefer the term 'intensity' instead of 'density', as the density of urbanites and businesses does not contribute per se to value creation. What makes urban environments productivity is not the density of people, but the frequency and intensity of interactions and exchanges among them. The concept of urban intensity captures the density of urbanites and businesses as well as the frequency and intensity of interactions and exchanges among them.

Residential Density

Residential density corresponds to the number of residents per km². High residential density results in well-populated streets, ensuring that urban places are lively, active, vibrant and safe places where people want to live. High density delivers a large customer base and labour pool for local businesses that makes local commerce thrive and offers productivity advantages for local businesses.

Job Density

Job density is the number of jobs per km². Job density feeds on economic productivity, as high concentration of economic activity in particular locations enables firms to reap economies of scale and scope and bring talented people together to share ideas and innovate. The number of jobs in a given area also has an impact on the attractiveness of the area for residents. This indicator gives an impression of the intensity of economic activity and the level of opportunity in a neighbourhood.

Business and Social Infrastructure Densities

Other indicators to assess urban intensity are the densities of businesses and social infrastructures (such as health and education facilities) within a neighbourhood. A high density of businesses, defined by the share of space in a neighbourhood occupied by businesses, fosters the local productivity. Businesses can benefit from the effects of economies of agglomeration, scale and scope. A high density of businesses, moreover, has a positive effect on the job density with the consequences described above. The density of social infrastructure, such as schools and healthcare institutions, can be measured as the share of total floor space in a neighbourhood dedicated to social infrastructure. A high density of social infrastructure makes the social institutions easily accessible for residents of a neighbourhood and thereby has a positive effect on the liveability of that neighbourhood by reducing transportation costs, as well as improving education standards and public health. This, again, increases the land value of the neighbourhood.

Floor Area Ratio (FAR)

The Floor Area Ratio (also Floor Space Ratio) is an indicator capturing the land use intensity. The FAR of a plot is calculated by dividing the total gross floor area of the buildings on the plot by the plot size. It can also be calculated on the neighbourhood scale as the ratio of the total area of floor in all buildings in a neighbourhood to the area of all plots in the neighbourhood. High FAR levels can support a high density of residents and businesses. The indicator is often mistaken for average building height, whereas there is no equivalence between high rise and high density. A neighbourhood with medium-rise urban fabrics can have a high building footprint ratio (built-up space divided by plot size) and can, therefore, have a higher FAR than a neighbourhood with high rise buildings and a low building footprint.

Accessibility Indexes

Accessibility is a function of the distance between travel destination, origin and travel time per unit of distance. High accessibility can be achieved through the provision of a multimodal transportation infrastructure.

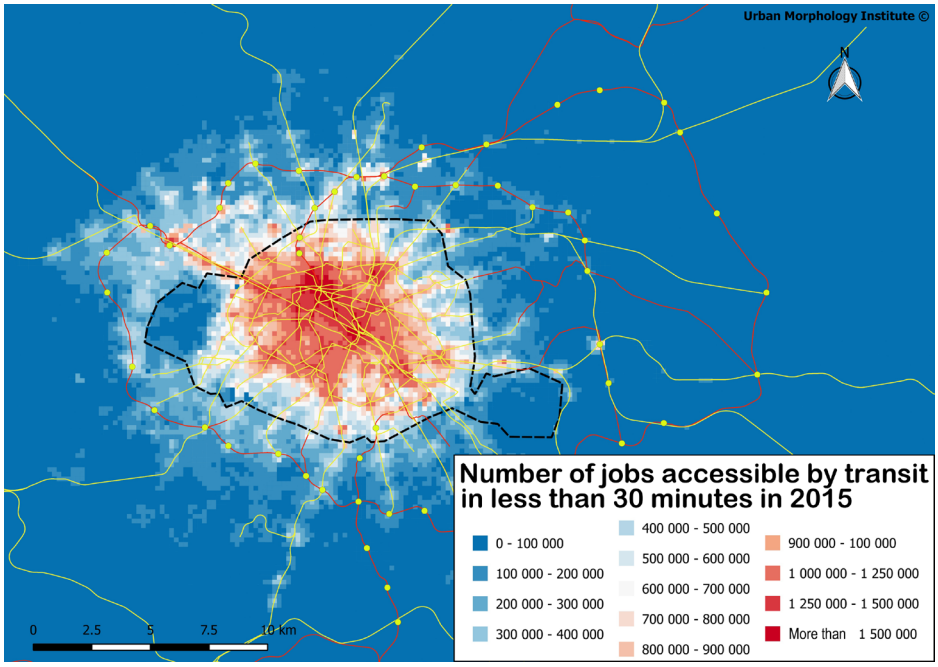
To exploit the urban productivity advantages, it is key to ensure accessibility to jobs, economic opportunities and social infrastructures in a Planned City Extension. In highly accessible neighbourhoods, lower daily commuting distances induce lower energy costs and emissions. For businesses, the higher the level of accessibility, the lower the transport costs for materials. Moreover, a highly and easily accessible pool of workers benefits companies and businesses. As a result, as will be shown later in this study, high accessibility has a positive impact on the economic productivity of urban centres. Accessibility can be measured through different indicators.

Accessibility to Transit Stations

The indicator ‘accessibility to transit stations’ aims at capturing the average distance of residencies and jobs, respectively, to transit facilities. Accessibility to a transit station strongly influences whether people use public transport for commuting and for other daily travels. Beyond a certain distance between a piece of land and the closest transit station, the influence of transit features on land value and land uses decreases. The area surrounding a transit station, in which the existence of the station has a significantly noticeable influence on land value and land use, can be called the transit catchment area.

FIGURE 6

Number of jobs accessible by transit in less than 30 minutes in Paris



Source: Urban Morphology Institute

Accessibility to Jobs Within 30 or 45 Minutes by Transit

Accessibility to jobs is among the most powerful drivers of urban productivity. The number of jobs accessible in less than 30 or 45 minutes from a given location can be used as an indicator to quantify the accessibility of jobs. The calculation of this index requires structured transit data[64]. The indicator reflects the attractiveness of a neighbourhood for residents and companies. For residents, it is beneficial to have access to a variety of jobs, as it reflects a high level of opportunity; for businesses a high score on this indicator also makes a neighbourhood attractive as it reflects a high density of economic activities in the neighbourhood. High job accessibility levels, therefore, are likely to result in a high market value of land for the respective neighbourhood.

64 e.g. generalized transit feed standards delivered by transit agencies.

Indexes on Street Network Connectivity and Walkability

Like other urban metrics, public space and street network connectivity metrics should be calculated at the local scale. The following metrics can be used to assess public realm and the connectivity of street networks:

- Public space area per km²
- Street length per km²
- Number of intersections per km²

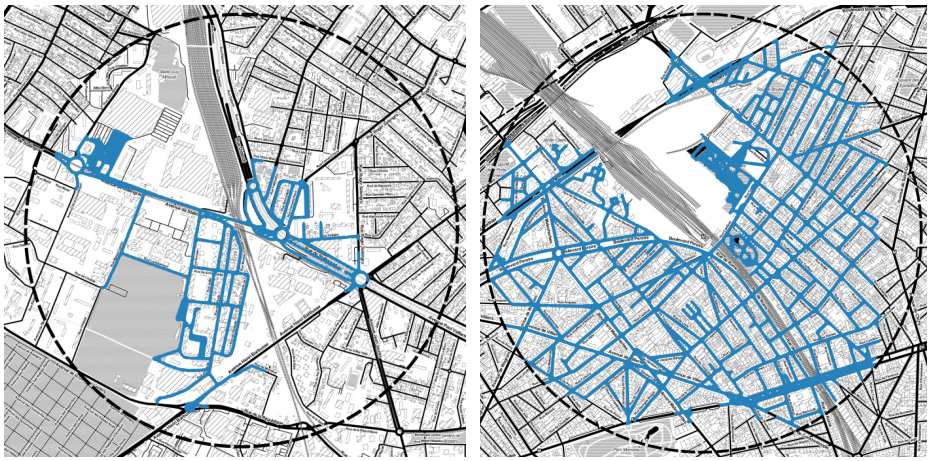
- Average distance between intersections
- Walkability index (see Box below)

UN-Habitat's recommendation for Planned City Extensions are that the street network should occupy at least 30 per cent of the land and that per km² at least 18 km of street should be built. These metrics can be supplemented by the indicators of intersection density and average distance between intersections. International best practice shows that an intersection density of about 100 intersections per square kilometre enhances accessibility.

Walkability Index

The Walkability Index has been developed by the Urban Morphology Institute to assess how walkable a street network is. It is calculated by dividing the actual area reachable in less than 12 minutes walking by the area that would be reachable in less than 12 minutes walking as a crow flies (a 1km radius circle).

The indicators on street network connectivity give an impression of the walkability of a Planned City Extension, meaning how pedestrian friendly it is. To assess the walkability of a Planned City Extension, the degree to which public realm and the street network are dense and connected has to be captured. Therefore, it is necessary to measure how direct travels are from one point to another within the city. This captures the number and diversity of paths which go from one point to another in the city, which makes the network more resilient.



Left: Non walkable area in the Parisian suburb, with a Walkability index of 0.2, due to cul-de-sacs and street network disconnection. Right: Highly walkable area in Paris, with a Walkability index of 0.9.

Source: Urban Morphology Institute

A poorly-connected street network with many culs-de-sac connected to few arterials provides less accessibility than a well-connected network, such as a grid (Litman, 2013).

Walk Score

Walk Score measures the walkability of any address. It analyses the walking routes of hundreds of addresses to nearby amenities. Points are awarded based on the distance to amenities in each category. Amenities within a five-minute walk are given maximum points. A decay function is used to give points to more distant amenities, with no points given for amenities reached after a walk of 30 minutes or more. Walk Score also measures pedestrian friendliness by analysing population density and road metrics such as block length and intersection density. Walk Scores ranges from 0 (car-dependent neighbourhood) to 100 (a walker's paradise).

Indexes on Urban Diversity and Mixed Use

Job-Housing Ratio

The level of job-housing mismatch can be assessed using the employment-housing ratio, which is the total number of employment divided by the number of total occupied housing units. . The employment to housing ratio indicates whether an area has enough housing for employees to live near employment centres and sufficient jobs in residential areas. An imbalance in jobs and housing creates longer commute times, more single driver commutes, loss of job opportunities for workers without vehicles, traffic congestion, and poor air quality. An employment to housing ratio in the range of 0.75 to 1.5 is considered beneficial for reducing vehicle kilometres travelled. Ratios higher than 1.5 indicate that there may be more workers commuting into the area because of a surplus of jobs. Employment to housing ratio is also a measure of land use diversity. The employment to housing ratio is likely to be more balanced in compact neighbourhoods that contain a mix of residences, employment opportunities, and services.

Land Use Diversity and Mixed Use

The two most common metrics to assess diversity are the Simpson index and the Shannon-Wiener entropy. Both capture the diversity within a set of elements. For an ecosystem, the score of the diversity indexe is maximal when the abundance of each species is the same. In an urban context, such as for measuring the diversity of land use, the diversity indexes are maximal when each type of land use is found in the same amount within a given area. The Simpson diversity index is considered a dominance index, as it gives more weight to dominant land uses. In economic science, the Simpson index is known as the Herfindahl-Hirschman index and measures the concentration or market power of a given industry. For an urban area, the Simpson diversity index is calculated using the proportion p of each type i of the N land uses found in the area such as residential, commercial, industrial and public infrastructure.

$$D = \sum_{i=1}^{N} {p_i}^2$$

Compared to the Simpson diversity index, the Shannon-Wiener entropy index is more of an index of the richness and diversitythan one of concentration. It is calculated with the following formula:

$$H = -\frac{1}{\log N}\sum_{i=1}^{N} p_i \log\left(p_i\right)$$

The increase in one specific land use does not significantly change the value of the entropy index. For an urban area, its score on the Simpson diversity index will be higher than on the Shannon entropy index with less consideration to the relative contribution to each land use type to the total number of activities that exist in a place (Kajtazi, 2010). For this reason, the Shannon entropy index has to be preferred to assess the land use diversity of urban areas.

3.3.1 Assessment of the Efficiency of the Legal Framework and Governance

To evaluate the legal framework and the governance system supporting a Planned City Extension, three major categories of assessment can be distinguished. The urban legal framework and the governance system, as well as rules and regulations which are introduced in the context of a Planned City Extension, can be analysed based on the criterion of efficiency. This, for example, requires an assessment of the level of bureaucracy and corruption. Apart from this, the regulations which define the layout of a Planned City Extension have to be evaluated on how flexible and reactive they are. As discussed before, regulations which are highly restrictive or do not allow for adaption to changing requirements and environments can prevent optimal urban development and the exploitation of the full potential of an urban agglomeration. The national legal system can be examined on the degree of legal decentralization, as a higher level of autonomy allows for the local government to introduce rules and regulations in accordance to the specificities of a city.

Compared to the metrics for the assessment of urban design, the characteristics by which the legal framework are evaluated are less tangible and may be more difficult to quantify. The design of the indicators for evaluating the legal performance of local authorities depends on the underlying concept of the attribute of the legal framework which is to be measured. Here, again, it is important to distinguish city-level from regional and national boundaries where different legal frameworks and rules and regulations are applied. On each of the dimensions on which the performance of the legislature can be evaluated, various studies can be found which differ in how they define the abstract concepts of the dimensions and on how they measure them.

In this study, a few common metrics are illustrated but there are various alternatives to measure different dimensions. Often, more information can be extracted from assessing a government's performance on these indicators over time, instead of only assessing the status quo. This way, the development with respect to a topic can be evaluated and consequences of policies can be made visible.

Legal and Governmental Efficiency

The best-known indicators on legal efficiency have been developed by the World Bank Group and the European Central Bank, namely The Indicator of Government Effectiveness and the Indicator of Public Sector Efficiency. Both indicators are composed of a set of sub-indicators measuring the legal/governmental performance on different dimensions (Van de Walle, 2005).

In this study four sub-indicators are suggested to measure legal and governmental efficiency. All indicators on legal and govern-

mental efficiency discussed in this section give an impression on whether the urban legal framework provides a stable investment and business friendly atmosphere and whether it creates a secure environment for residents.

Level of Bureaucracy

Following the methodology of the 2012 Global Cities Index and Emerging Cities Outlook, the level of bureaucracy and public administration processes are evaluated through the eyes of businesses (AT Kearney, 2012). Administrative activities of local public bodies are evaluated based on the bureaucratic hurdles for businesses and residents. It measures to what extent businesses and residents are hindered through resource-consuming bureaucratic procedures.

The indicator can be constructed from data on the average time and number of steps necessary to complete different administrative procedures, from survey results or from a combination of both. Potential components could be the average time required to get different licenses, to get permits approved or to get a new business started.

Level of Corruption

An often-cited index on corruption is the Corruption Perception Index by Transparency International, which is published annually and captures how analysts, business-people and experts perceive the level of political corruption in a country. The data published is only available on at a country level. Nevertheless, the methodology of consulting experts to assess the perception of corruption can also be applied at regional and urban levels and the sets of questions can be adopted in order to obtain a complex image of the perception of public sector corruption. (For a full source description on the construction of the Corruption Perception Index see Transparency International, 2014)

Many studies on the issue of corruption are based on directly asking the population in surveys how they perceive the level of political corruption, with the Americas Barometer survey as one example among many others (Americas Barometer, 2014). These surveys vary in size and complexity; some consist of one simple question on whether the interviewed person has paid a bribe to a public body in the past year (Global Corruption Barometer by Transparency International), other studies confront the sample with a set of questions on their perception of the corruption situation. The results of repetitively carried out one-question-surveys can form a particularly suitable and easily-accessible indicator for measuring the general development of the corruption situation and consequences of anti-corruption policies.

Extent of the Informal Sector

Like the other indicators on legal and governmental efficiency discussed before, there is no clearly identifiable data on the extent of the informal economy. Again, there is the need to consult experts on how they estimate the extent of the shadow economy or to carry out surveys among the urban population. The extent of the informal sector can be used as an indicator for the efficiency of the legal framework as it reflects the quality of labour regulation and the functioning of labour market institutions.

It can be measured as the share of urban population employed in the informal sector or the share of income from informal economic activity, measured by total Gross Value Added (for more information on alternative methods to measure informal employment see ILO, 2013).

Level of Instability and Insecurity

The measurements on the level of instability and insecurity, crime and clearance rates and their development over time are important indicators. They can be supplemented by surveys in the urban population and among business people to obtain the share of criminal incidents reported, the general perception of the security and political stability situation and the trust in the legal and judicial institutions.

Potential for Adaption/Flexibility of the Legal Framework

Level of Decentralization

The level of legal decentralization gives an indication on the potential of local authorities to adapt to a city's specificities. Among various indicators on the national level of decentralization, one which is often cited is the indicator of political decentralization by the World Bank Group. This indicator is comprised of information on the numbers of government tiers existing at different levels and whether the municipal and provincial governments are locally elected. (See: On the conceptualization of the Indicator: World Bank (2013c) and for data: World Bank (2013d)). While this indicator gives an impression on the potential of adaption, it does not provide information on whether this potential has been exploited and to what degree. Therefore, the indicator has to be supplemented by others to show how adaptive the urban legal framework is.

Time for Regulatory Changes

Another indicator to quantify the flexibility of the rules and regulations supporting a Planned City Extension could be the average time required to change rules and regulations. With this indicator, the rules and regulations can be examined as to how long changes have been considered on average before they were implemented. In addition, it would be useful to consider the share of discussed changes which have finally been implemented and, retrospectively, the share of rules and regulations which have been subject to change. All these indicators can give an impression on how adaptive the regulatory framework for the general plan of a Planned City Extension has been to changing circumstances.

3.3.2 Assessment of the Financial Management

Indicators on the performance of financial management can be better quantified since municipal budget is an easily accessible data source. Consequently, the financial performance of a Planned City Extension can be analysed more tangibly. To evaluate a local government's performance with regard to municipal finance, the size and composition of the budget can be assessed while public investments can be analysed on whether they are feasible and sustainable. This allows evaluation on the quality of the expenditure management. A local authority's performance concerning revenue generation, on the other hand, can also be assessed by examining the extent to which the potential of different sources were exploited.

Budgeting

Different indicators are presented based on information that is directly extractable from the municipal budget. Besides introducing indicators to analyse revenue and expenditure management, the indicators illustrated in this section give an indication of whether the municipal finance authority is able to plan, forecast and prioritize and whether it

is capable of translating policy decisions into financial plans.

Budget Projection Accuracy

To measure how accurately the local body planned its budget, there needs to be a comparison between the planned and the actual budget. Starting with a comparison of the predicted amount of expenditures and revenues with those that have actually occurred, the analysis can go further into detail to examine in which areas the predictions differ most significantly from the actual numbers. The data on budget projection accuracy gives an impression on the quality of budget planning and on future risks for illiquidity and excessive indebtedness. Moreover, it can give an indication whether a Planned City Extension can be completed as originally planned or how projects similar to ones that have already been fully implemented, can be scheduled for the future.

Liquidity and Debt Coverage Trends

A government's performance in liquidity and debt matters can be measured through assessing the status quo and trends of its score on various indicators. To quantify a municipality's liquidity, its short-term operating assets can be divided by its total short-term liabilities. This score gives an impression of the short-term financial performance of a municipality. A score below 1 signifies that a municipality has less cash and assets that can easily be converted to cash than the amount required to pay current obligations which can indicate a problem of cash flow.

To assess the long-term financial performance, the principal and interest paid on long-term debt can be divided by the total own source revenue. A high score on this indictor could limit a municipality's ability to borrow in the future. Moreover, paying debt expenses ties up revenues. Rather than evaluating a municipality's performance negatively in the case of high debt repayment, the interest paid on long-term debt could be looked at separately. (Adapted from: Government of Nova Scotia, 2015)

Feasibility and Sustainability of Public Investments

Expenditures for Maintenance and Development

With the ratio of operational expenditures and expenditures for development and with its trends over time, an indicator is given to assess how far a municipality has used and still uses its financial capacity to invest in further development. A high score can give the indication that some existing infrastructures or services are unsustainable. A high score may also indicate that the municipality is suffering from a general lack of funding resources.

To create a second indicator, the repair and maintenance expenses can be put in relation to the fixed assets. On this indicator, a low score is desirable. An increase in the score over time can be indicative of ageing infrastructure, of infrastructure being pushed to its operating capacity limits or of increasing investments in unsustainable, low-quality infrastructure.

The Structure of Infrastructure Costs

Proxies, such as infrastructure costs in the form of street, water and drainage network per km² or per resident can be assessed over time to get an estimate on how expenditures increase with population growth or urban sprawl and on whether the investment in infrastructure and public assets increased. By additionally measuring the development of the estimated

value of public assets and infrastructure per km² or residents respectively, information can be obtained on whether the quality of public assets has improved through the investments, meaning whether the investments have been sustainable. The costs or the estimated value of infrastructure and public assets can be compared between different neighbourhoods in a city. By assessing the spatial distribution of the costs and value, an impression is given on whether the investments have an equalizing character, whether they increase or whether they reduce inter-neighbourhood differences.

Exploitation of Revenue Potential

Reliance on Inter-governmental Transfers

The share of revenues from inter-governmental transfers depends heavily on the level of fiscal decentralization of a country. Nevertheless, inter-governmental transfers as a share of total revenues can be compared among cities in a country. A high share of transfers in a municipality can result from a high amount of capital transferred from the central government and/or from a small amount of other revenues generated by the municipal finance authority. However, it is important to note that it is advisable to not only compare the share of transfers but also the transfers per resident among cities in a country. Moreover, the position of a city among others with regard to reliance on transfers can be analysed over time to identify increasing or decreasing trends.

Share of Conventional and Innovative Financing Methods

In addition to assessing the share of inter-governmental transfers, the share of revenues generated through innovative financing methods such as land value capture can be measured. It is also interesting to measure the share of investments financed through PPPs. These indicators provide information on the extent to which the municipal finance authority exploits the potential of innovative financing methods. Again, this indicator can be analysed over time or compared among cities in a country as they are subject to the same legal constraints from the central government.

Share of Property Registered

This indicator, of course, cannot be exactly obtained but has to be estimated based on existing GIS data, surveys or interviews with experts. It gives an impression of the extent to which property taxation is exploited as a revenue source. Moreover, the amount of additionally registered properties per year can be assessed to measure how municipal finance authority improves in exploiting property taxation as a source of revenue.

Uncollected Taxes

Based on the estimation on the share of non-registered property, the amount of uncollected property taxes can be assessed. Moreover, the revenue lost, due to the non-taxability of the informal sector can also be estimated. The potential tax revenues the local government misses by not being able to collect these taxes, together with the losses from not exploiting other sources of tax revenues, form the indicator of uncollected taxes. These can be expressed as a percentage of the actually collected tax revenues to get an impression on the revenue generation potential the local government is not exploiting. Again, this indicator can be assessed over time to identify changes.

4 Empirical Evidence

This section analyses selected Planned City Extension programmes in different cities, which are representative of contemporary urban development practice as well as programmes with best practice characteristics using the Three-Pronged Approach framework.

4.1 On the Productivity Advantages of Urban Agglomerations

The correlation between national urbanization and productivity level has been examined in various empirical studies. The studies show that transitions from agrarian and rural societies to urbanized ones largely coincide with a country's level of industrialization and economic development (Tisdale, 1942; Jones, 2004). This correlation is reflected through increasing trends in the share of the Gross Value Added generated by industries and services and the proportion of the workforce employed in these sectors. This is often accompanied by an increase in the level of urbanization (Satterthwaite, 2007; World Bank, 2009).

Urban economies generate more than 90 per cent of global gross value added output (Gutman, 2007). In 2007, 600 cities contributed 60 per cent to the global GDP while only 23 megacities generated 14 per cent of the global GDP (McKinsey Global Institute, 2011).

According to Puga (2010) evidence for the existence and magnitude of agglomeration economies is given through the following empirical observations:

- Productive activities are much more clustered than would be expected if location was simply the result of a random outcome or if they merely reflected underlying differences across space leading to comparative advantage
- Spatial patterns in wages and land rents reflect productive advantages in dense urban environments
- There are systematic variations in productivity across urban space

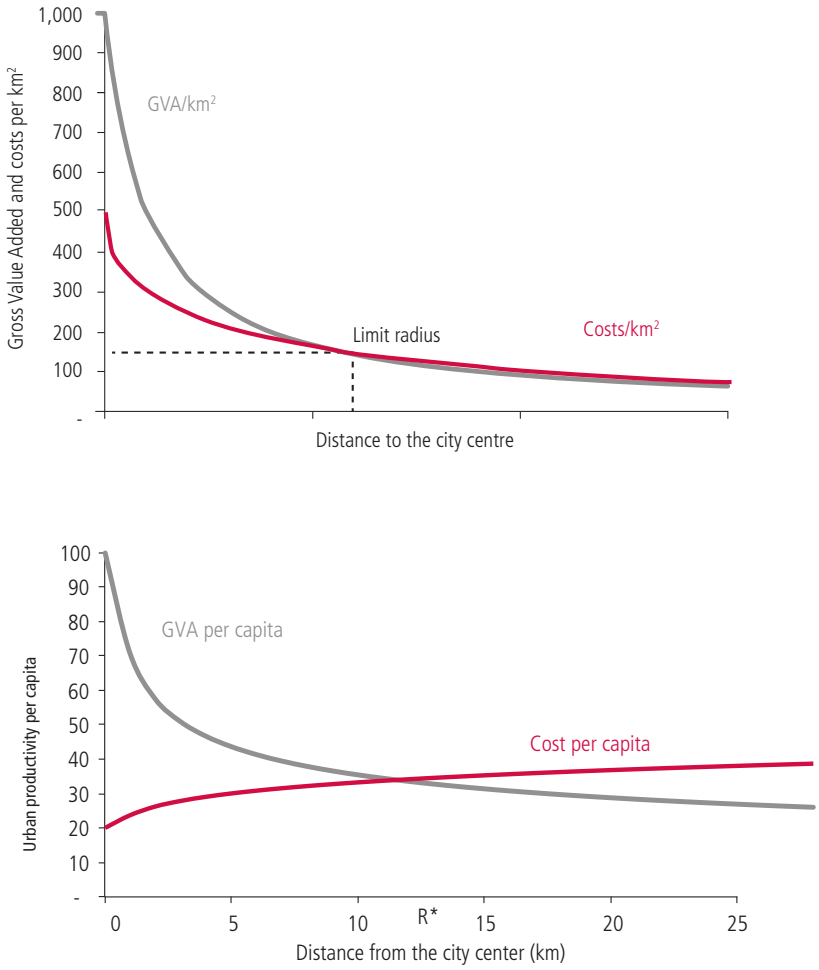
The Spatial Distribution of Productivity Advantages

In Hong Kong, banana and orange crops are the most profitable activity in rural land, with returns of approximately USD 240,000 per km² per year on average. In comparison, converting and selling 1km² of rural land to developers generates USD 80 million, an amount likely to provide an annual income of USD 4.8 million with a 6 per cent interest rate, which is a revenue 20 times higher than that of most productive agricultural uses. If reinvested in residential or industrial development, it can generate revenues up to 20 per cent per year. During the speculative phase of the 1990s in Hong Kong, some pieces of land generated an annual return of more than 50 per cent in the residential real estate market (Jenks and Burgess, 2000).

The results of an analysis of the spatial distribution of the productivity advantages within a sample of cities can be seen below. It has been analysed how the Gross Value Added/km² decreases with increasing distance from the urban core. The graphs also show the development of infrastructure costs with distance to the centre. The decrease in population densities when moving away from the urban core induces higher infrastructure costs per capita (Müller et al., 2013). As a result, urban land is less and less economically productive and more and more costly in terms of infrastructures when moving away from the urban core.

FIGURE 7

Gross Value Added/km² versus Infrastructure costs/km² (Top) and Gross Value Added and costs per capita (Bottom)



Source: Urban Morphology Institute

The (de)correlation of Urbanization and Economic Development

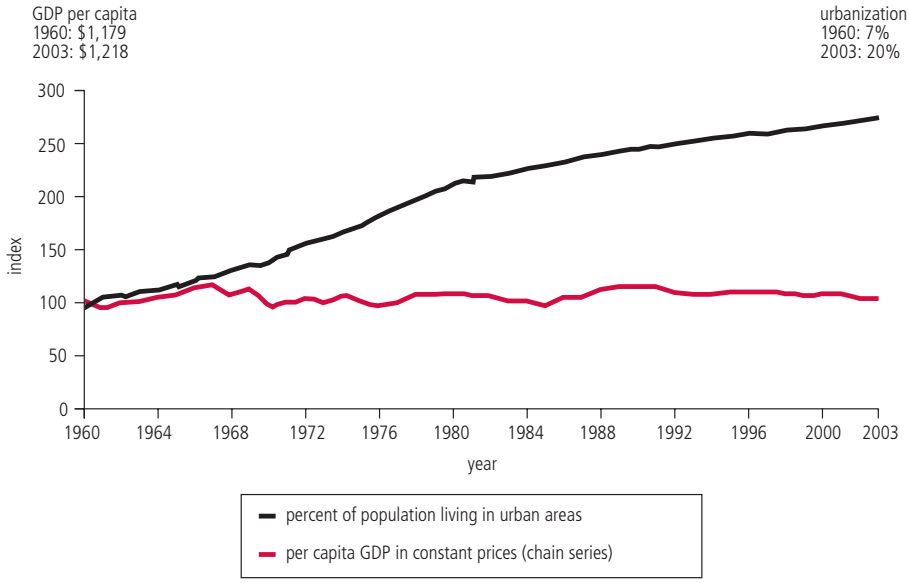
Globally, a positive correlation between the level of economic development and the level of urbanization is observed. Some countries, especially in Africa, however, have not experienced economic growth despite the increasing share of people living in urban agglomerations. Instead, the rapid urbanization rate is accompanied by stagnation of per capita income (Spence, Annez, and Buckley, 2008).

Kenya today has an urbanization level of 25 per cent (World Bank Data). As shown in Figure 8, it is visible that the urbanization trend in Kenya is not accompanied by economic growth. It has to be noted, however, that in many countries, urbanization

rates and GDP/capita moved together after a certain level of urbanization was reached. In the case of the USA, for example, the urbanization level which induced a rapid take off of the GDP/capita was 60 per cent; in China, however, the rapid take off took place from an urbanization rate of 30 per cent and Brazil experienced a pattern more similar to the United States with a strong growth in productivity starting in the 1960s while urbanization stood at about 50 per cent (Spence, Annez, and Buckley, 2008).

FIGURE 8

Urbanization and per capita GDP in Kenya



Source: Spence, Annez, and Buckley 2008

This shows that there is no one threshold for urbanization to bring along a rapid take off in economic growth. For most countries there can be periods of faster urbanization than identified economic growth, independent of the stage of economic development. This reveals that there is no causality between urbanization and economic development. This also support the theoretical considerations described above that the urbanization process has to fulfil certain conditions, so that the potential of urban agglomerations to create productivity advantages can be fully realized.

4.2 Urban Design

4.2.1 The Floor Area Ratio (FAR)

The Floor Area Ratio (FAR) in traditional European urban fabrics, composed of medium-rise buildings with internal court-

yards, is often higher than in many recent modern high-rise developments with low building footprints. The continuous medium-rise urban fabric with high building footprint (50 to 60 per cent of the ground) and compact continuous urban street blocks of many European cities results in a FAR of 3 to 5. Contemporary urban planning in many fast urbanizing countries, on the contrary, features tall buildings with a low footprint of 5 to 10 per cent, having the characteristic of a 'tower in a park'. Those urban fabrics must approximately have 6 to 12 times taller buildings (50 to 100 floors) to reach the same floor density as the urban fabric of seven story buildings with a FAR of 3 to 5. As a result, most high-rise developments, such as in Chinese new towns, present a gross built density between 1 and 2 despite an average building height of 40 to 50 floors.

CASE STUDY

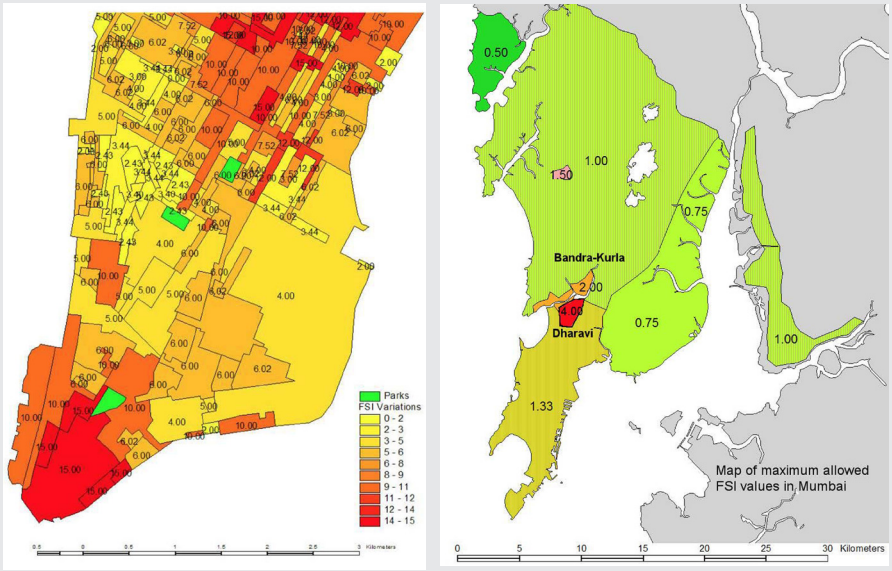
FAR and Street Width in Paris

In Paris, France, the Plan Local D'Urbanisme prescribes buildings heights according to the district and the street width. The height of the façade has to be between W+2m and W+3m with W representing the street width. The height of the building under eaves must be between W+6m and W+8m. A maximal height is also given according to the district: 25m in central districts and 31m in peripheral districts. Alignment to the street is compulsory. Through predicating the allowed building height to the width of the street the development of dark and unpleasant streets is avoided without setting a uniform restriction on building heights for a whole neighbourhood, which would have led to an unnecessarily low density.

CASE STUDY

FAR and Urban Infrastructure in Manhattan and Mumbai

Manhattan's density zones are typically small and vary with street width, infrastructure capacity and land use (commercial office districts have higher FAR than residential ones). In contrast, Mumbai's density zones are large, uniform across the city and generally low. Local urban planners justify such low densities as not to overwhelm infrastructure. Rather than increasing densities, new urban developments have been pushed out to new towns and suburban industrial estates. But this strategy ignores the opportunity to increase FAR to finance better and higher-capacity infrastructures (World Bank, 2013b).



Maps of FAR regulations in Manhattan (left) and Mumbai (right) Source: World Bank, 2013a

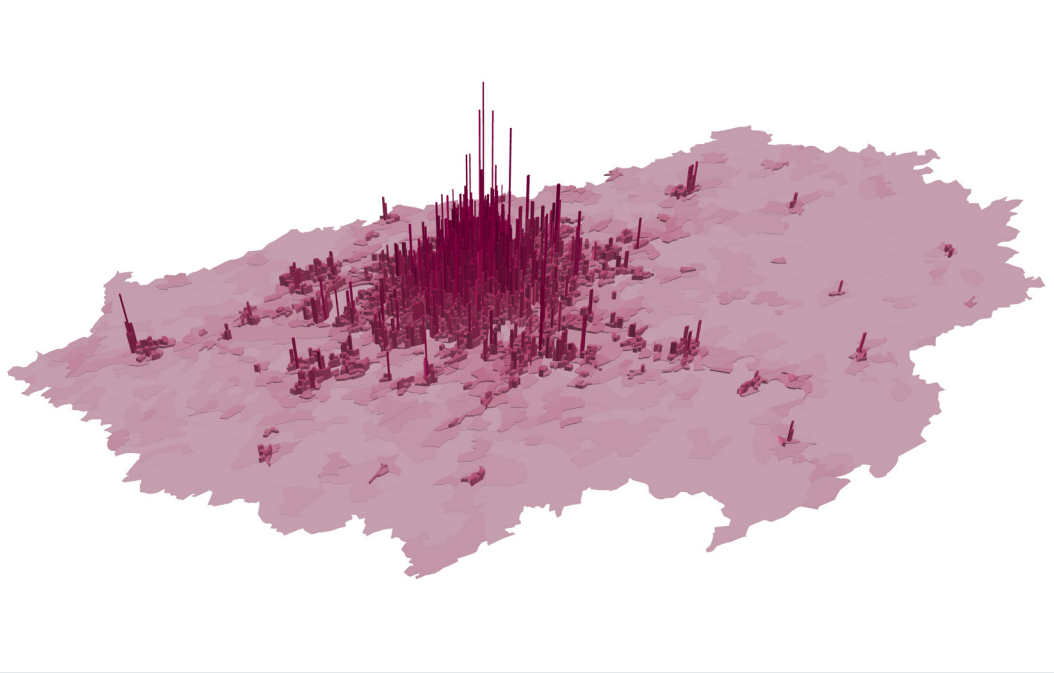
Source: Urban Morphology Institute

4.2.2 Residential Density

CASE STUDY

Comparing Density of Residents in Paris and Johannesburg

The following figures display the spatial variability of residential density within urban areas. With a 200m x 200m gridding, the residential density in the Grand Paris area varies from fewer than 5,000 to more than 50,000 inhabitants per km². On average, the density of the urban core (Paris intramurros) is above 24,000 inhab/km² within an 87km² area.

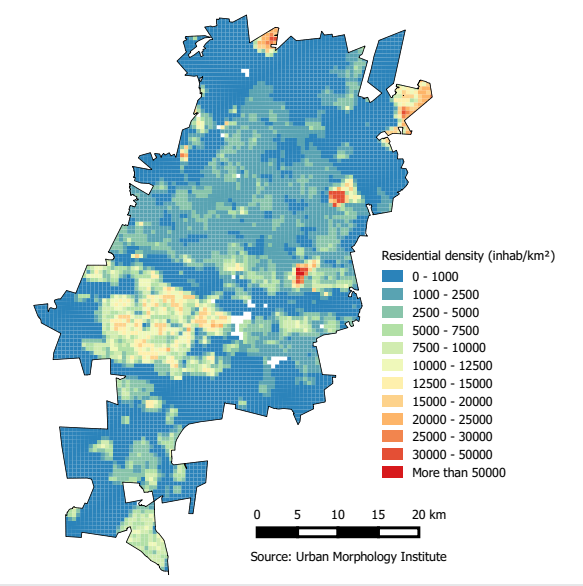


Source: Urban Morphology Institute

The second figure shows the distribution of densities in the City of Johannesburg, South Africa, using a 500m x 500m gridding. It shows a much different density pattern, with pockets of medium to high residential density in the inner cities of Soweto and Alexandra (higher than 5,000 inhab/km²), and low densities in the rest of the city. The second chart highlights the span of residential densities in 11 neighbourhoods in Johannesburg, ranging from very low densities in wealthy areas (below 2,000 inhab/km²), to very high residential densities in deprived areas (above 100,000 inhab/km²).

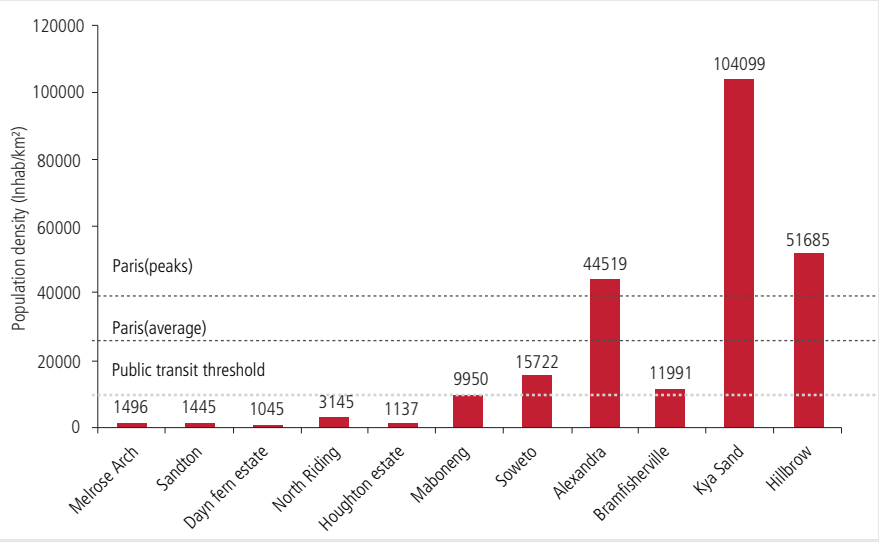
CASE STUDY...CONTINUED

Residential density in the City of Johannesburg, using a 500mx500m gridding



Source: Urban Morphology Institute

Residential densities in 11 districts in Johannesburg



Source: Urban Morphology Institute

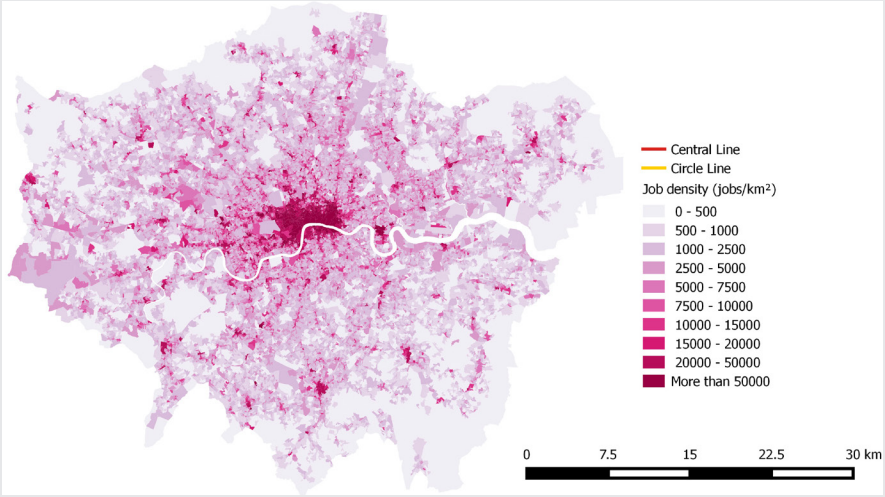
4.2.3 Job Density

CASE STUDY

Comparing Job Density in London, UK, and Johannesburg, South Africa

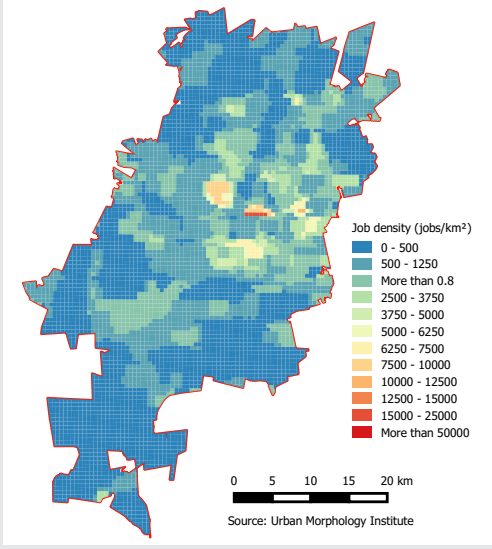
The first figure shows the distribution of job densities in the Greater London area and highlights the strong urban core. The second figure displays the spatial distribution of formal jobs in the City of Johannesburg and shows that these are scattered in wealthy Northern areas.

Distribution of workplace densities in London, using census output areas



Source: Urban Morphology Institute

Formal job density in the City of Johannesburg, using a 500mx500m grid.



Source: Urban Morphology Institute

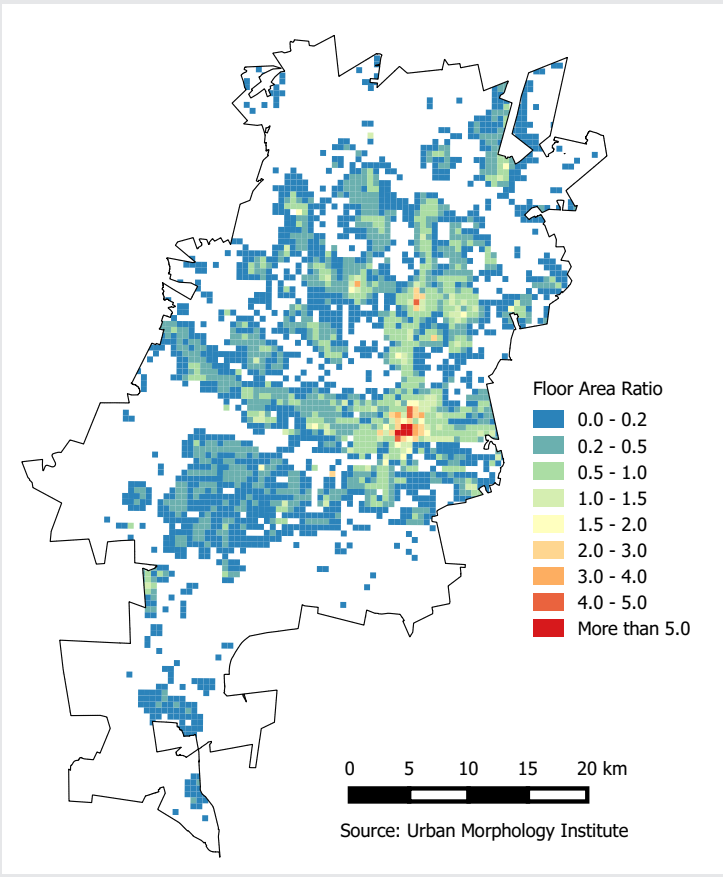
CASE STUDY

Density of Jobs, Residents and Floor in Johannesburg and New York

The following figure displays the FAR in Johannesburg with a dense urban core and high built area in the job-intensive urban centres. On the contrary, the residential areas display a very low density. .

The second map displays floor area ratios in New York city, and exhibit two business districts (Wall Street and Midtown) with high FAR (20 to 40). The medium density in most of Manhattan island is between 4 and 8 while the low density areas in the rest of the city have a FAR that is lower than 2.

Gross built density in the City of Johannesburg, using a 500mx500m gridding



CASE STUDY...CONTINUED

Floor Area Ratio in New York City at plot scale

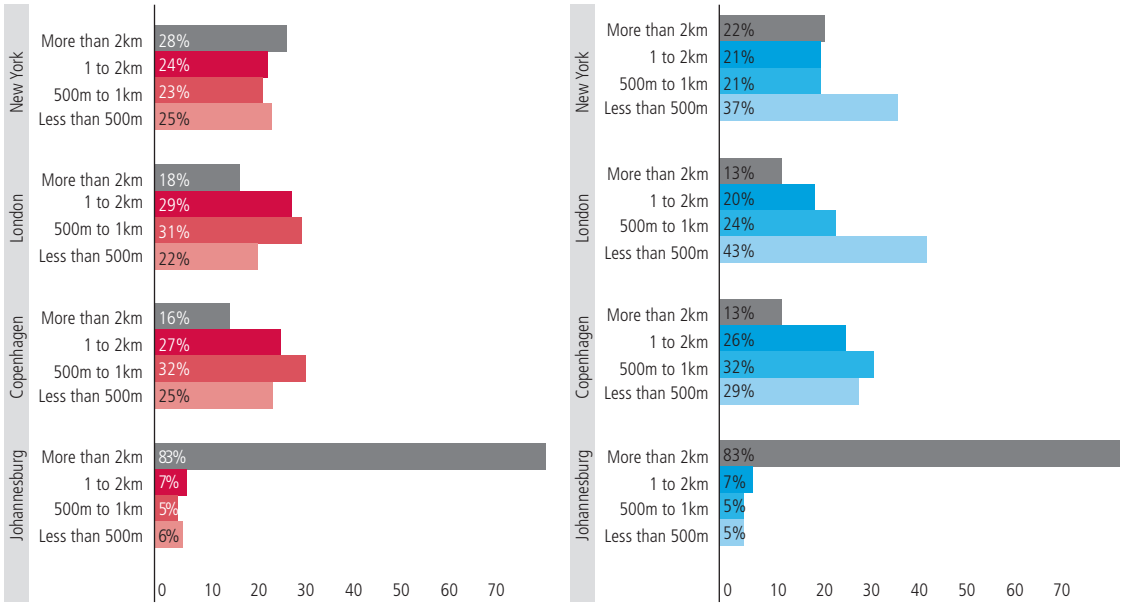
Source: Urban Morphology Institute

4.2.4 Transit Accessibility

The following chart compares the share of people living and working less than 500m, 1km and 2km from transit in four cities: London, New York, Copenhagen and Johannesburg. In London, New York and Copenhagen, one-quarter of people live less than 500m from transit and half live less than 1km. One-third to half of the jobs are located less than 500m from transit, two-thirds less than 1km. In Johannesburg, which is representative of many cities in fast-urbanizing countries, fewer than 5 per cent of the people and jobs are located less than 500m from a transit station, 10 per cent less than 1km, and 17 per cent less than 2km while 83 per cent of jobs and residents are located more than 2km from a transit station.

FIGURE 9

Respective share of residents (left) and jobs (right) and proximity to transit facilities in New York, Copenhagen, London and Johannesburg



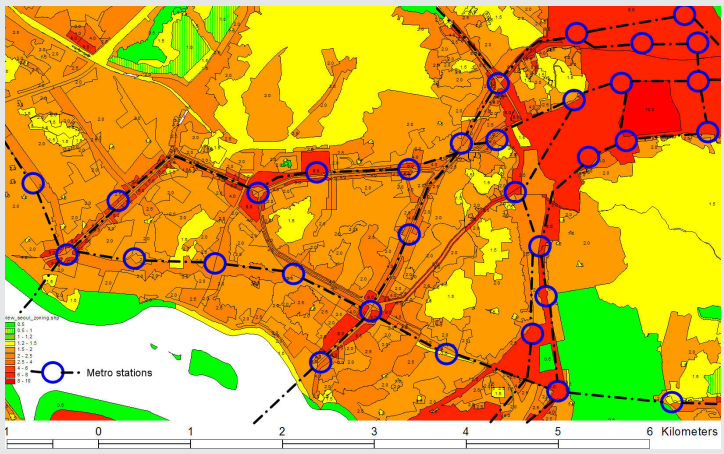
Source: Urban Morphology Institute

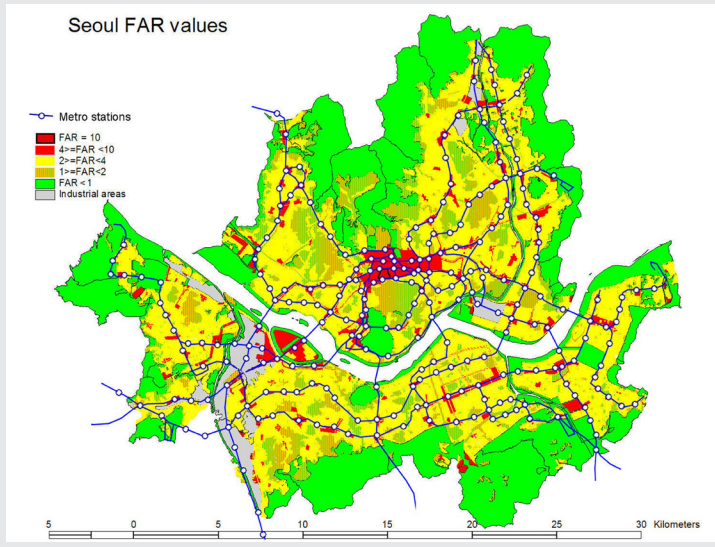
CASE STUDY

FAR in Seoul: Articulation of the Built-Up Density with Transit

Seoul's spatial structure is compact as expansion is restricted by hills and by the northern border. It is polycentric, with a large CBD but many important sub-centres. A grid-like metro system links the various sub-centres and the CBD. The FAR in Seoul is linked to the location of metro stations and to the network of main streets: 10 in part of the CBD, 8 in the rest of the CBD and sub-centres and 0.5 to 4 in residential areas. Seoul provides a best practice example for transit oriented development. Through regulations of the FAR, the limited space is used in the most efficient way as it fosters concentration of economic activity and residents close to transit stations. The resulting urban fabric enables a large share of residents and businesses to benefit from the existing public transport infrastructure.

FAR distribution in Seoul, South Korea





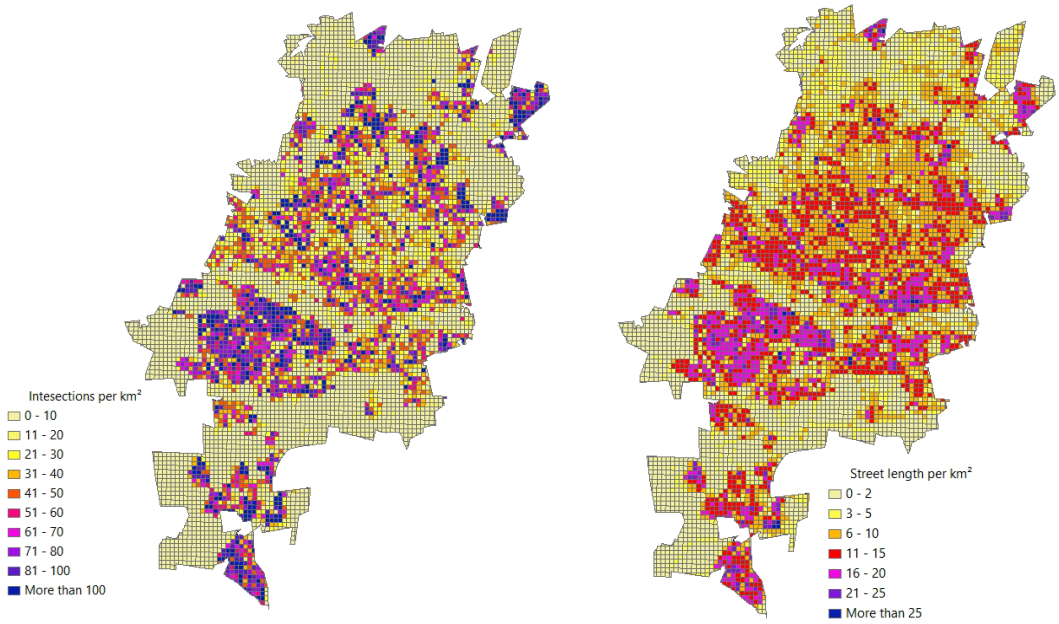
Source: Bertaud 2008

4.2.5 Street Network Connectivity

In fast-urbanizing countries, there is an identifiable trend towards street networks with a large distance between intersections, often above 400m, and a low density of intersections, often below 50 intersections per km². Such type of street networks increases walking distance and produces car dependent cities, which eventually have impact on urban productivity due to congestion and energy costs. The following figures present different street connectivity metrics in the City of Johannesburg, and show that the majority of the urban area is much below international best practice benchmarks.

FIGURE 10

Number of intersections per km²(left) and street network length per km²(right) in the City of Johannesburg, using a 500mx500m gridding



Source: Urban Morphology Institute

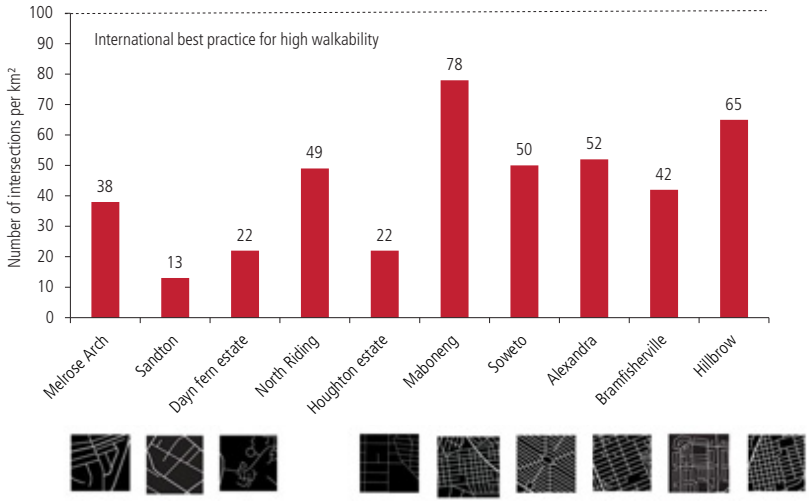
The case of Johannesburg is representative for contemporary urban development in rapidly-urbanizing countries but is far from being the worst case. Nevertheless, the consequences of the low level of walkability are easily perceptible. Johannesburg is a heavily car dependent city which, according to the WHO, has the highest level of air pollution in South Africa. This, in turn, has a negative impact on the liveability of the city.

On the contrary, Japanese cities are highly pedestrian, with 50m being the average distance between intersections (even in modern Tokyo). European 19th Century cities, as well as the historical core of American cities and some Asian cities like Hong Kong

also present average distances between intersections from 100m to 150m. This is the sizing of sustainable, vibrant and intense urban environments. Manhattan, for example, with urban blocks of 80m x 160m presents an average distance between intersections of 120m, identical to the hypercentre of historical Paris. Such type of small block sizes, about 100m with vibrant edges (facades with businesses on the perimeter of the block), promote more compact development and walkability.

FIGURE 11

Number of intersections per km² in 10 districts in Johannesburg, South Africa, which is much lower than international best practice



Source: Urban Morphology Institute

CASE STUDY

Street Network Sizing and Setback Rules in China

Over-sizing of the street grid in greenfield urban developments is common in fast urbanizing countries. In China, for instance, the regulatory sizing of the grid prescribes a main road every 500 metres and an even wider road (often an eight-lane highway) every kilometre for high-speed traffic, which cannot be crossed on foot. This wide grid leads to a disrupted urban fabric and an over-sizing of urban blocks, with middle and narrow street networks missing.

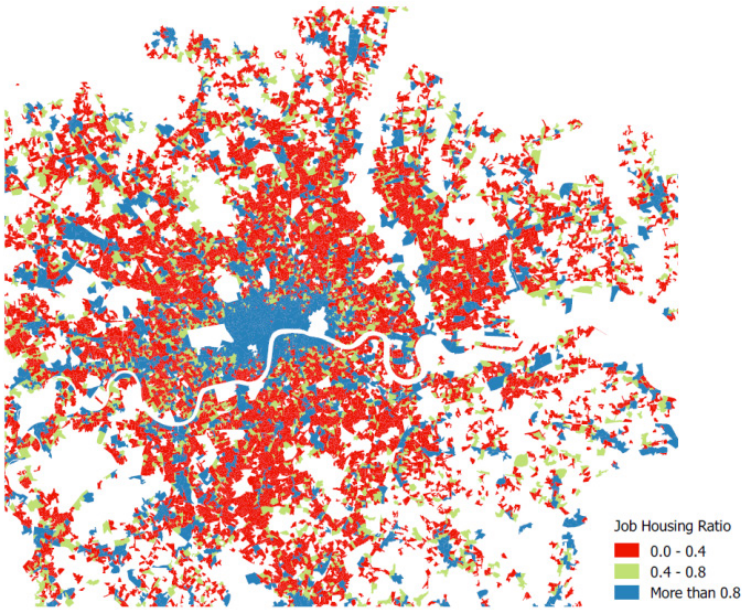
Setback regulations in China are variable. In extreme cases, the built front is set back 100m to 150m from an already oversized road width which results in distances of 300m to 450m between buildings on opposite sides of the road. Such an urban fabric is not designed on a human scale for pedestrians. Setbacks which are too large also prevent a reduction in the size of the urban block; if the urban block was smaller than 400m after deduction of the setbacks, there would be very little land left for the building foot-print. The consequences of such an oversized street grid and setback regulation are the prevention of walking and non-motorized transport modes which locks cities into a car-dependent path.

4.2.6 The Job-Housing Ratio

In best practice transit oriented cities, such as Tokyo, Seoul, New York City or Portland, the job housing ratio in the areas close to transit stations is higher than the average of a city, with a ratio higher than 0.8. This means that close to the transit station the concentration of jobs is higher than the concentration of housing units. This urban layout results in high accessibility of jobs with positive effects for both workers and businesses.

FIGURE 12

Job-housing ratio in greater London

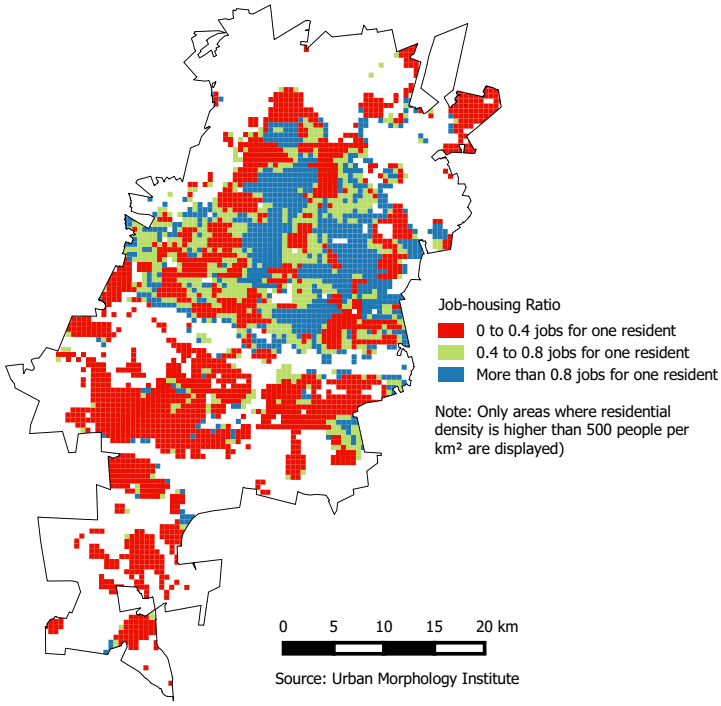


Source: Urban Morphology Institute

The spatial mismatch between residents and economic opportunities is a common pattern in rapidly urbanizing countries. In Shanghai, for instance, households are resettled in peri-urban locations where residential property is affordable but where the transit system, the local feeder bus services and the infrastructures for non-motorized travel are badly developed. Households, therefore, tend to become dependent on private vehicle and/or accept long commuting times. In South African cities, the spatial mismatch between the residents and job opportunities, which is inherited from the Apartheid period, has a very significant impact on the urban productivity.

FIGURE 13

Job-housing ratio in the City of Johannesburg



Source: Urban Morphology Institute

4.2.7 Land Use Diversity

In fast-urbanizing countries, there is a trend towards statutory urban planning resting upon rules inspired from zoning theories which prevents fine grain in mixed-use development.

CASE STUDY

The Italian Approach to Promote Mixed-Use Development

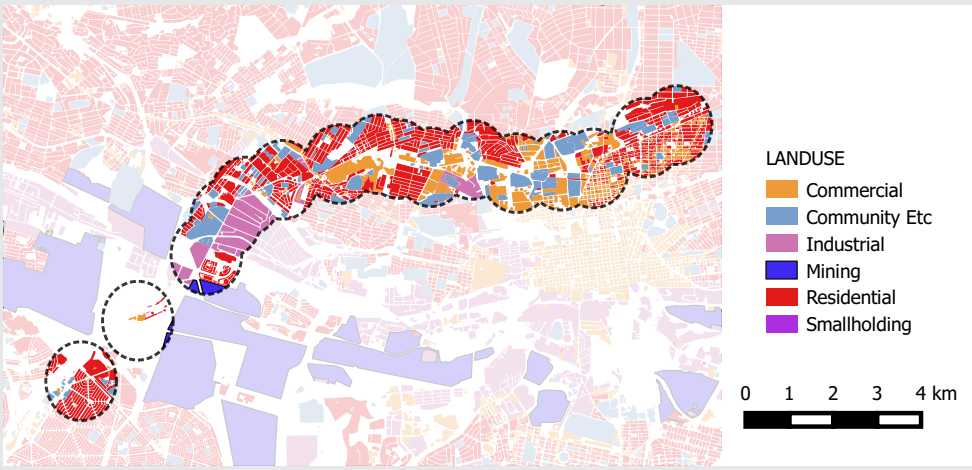
The Italian statutory urban planning obliges all first floors of buildings to be devoted to commercial activities, thus encouraging a mix of uses within the same building, distributing amenities, shops and restaurants everywhere in the city fabric, creating a streetscape of activities for pedestrians, ensuring there are no 300m long blank façades and preventing crime.

CASE STUDY

Land Use Diversity in Johannesburg

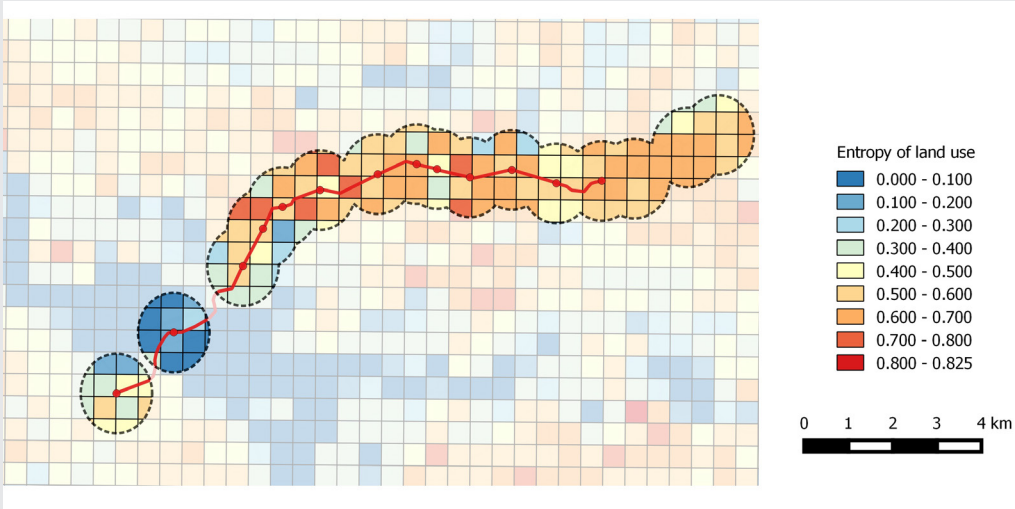
The following maps display a land use analysis of a transit corridor in Johannesburg. The local diversity of land use is calculated using an entropy formula, taking into account: commercial, community (health, education and public services), residential and industrial uses. The cells encompassing the four types of land uses display an index close to 1. The cells with one single use display very low entropy, close to zero.

Land uses along Empire Perth Corridor, Johannesburg.



Source: Urban Morphology Institute

Land use diversity index along Empire Perth Corridor, Johannesburg



Source: Urban Morphology Institute

4.3 Financial Management

CASE STUDY

Land Fragmentation in Japan

Japan has witnessed a process of fragmentation of very expansive land into small plots as shows below in the comparison of the same land area between the 19th Century and present-day Tokyo. This process has led to the creation of additional lanes to connect the inner parts of the former blocks, ewith an average side of 50m. Two antagonist schemes have taken place in Japanese cities, which have contributed to the creation of a very diversified land use:

(1) a consolidation process driven by PPP investment, merging small plots together to create larger plots and (2) a small private investment driven subdivision process, dividing large plots into smaller plots.

Unlike the American plot, the Japanese one is subdivided and became more complex over time, creating an urban fabric where the land use testifies to a complex socioeconomic structure.

Comparison of plot structure between the mid-19th Century Edo period (left) and the present (right)

Source: Salat, S., Cities and Forms, 2011

CASE STUDY

Land price as revenue source in China

Although this cannot be taken as an example of best practice, many municipalities in China follow an unconventional practice of revenue generation by selling urban land. This process is widely used by municipalities and local authorities for financing themselves. In Guangzhou in 2006, 55 per cent of municipal finances originated from land sale and this was 80 per cent in Shenzhen in the 1990s (Merk et al., 2012).

4.4 The Legal Framework

Land Use Flexibility

In China, the basic unit for selling land to developers is 400m x 400m or 160,000 m². In Manhattan, the basic unit for selling land established in the Commissioners' Plan in 1811 was 205m², which is 780 times smaller than the unit of Chinese urban development. The fine grain of plot land market fosters an active land market with great potential of future mix use. Through appropriate regulations and incentives, some plots of land can be consolidated over time for large investments, whereas others keep a small size and provide opportunities for housing and SMEs.

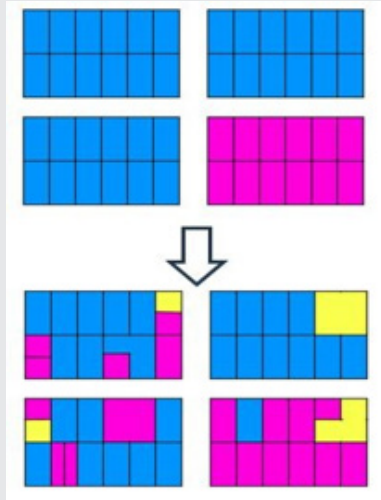
CASE STUDY

Land use flexibility in Manhattan

Compared to urban fabrics with large mono-functional urban blocks, such as slabs or towers, Manhattan is characterized by high flexibility of land use. The fine-grain character of plot subdivisions makes Manhattan's buildings highly adaptive and flexible. The use of floor areas can easily be changed from industry to commercial or from offices to housing, to adapt to changing economic circumstances. This high level of flexibility gives Manhattan a very high resilience in times of change. Fine grain allows an intensification process to happen: land sale is open to a whole variety of investors and developers, from individuals to large companies and institutions that can merge several plots together if needed. Superblock platting on the contrary is only open to large investors.

From a fine grain urban fabric with a limited diversity of uses (just residential in blue and commercial in pink and public facilities in yellow), appropriate legal and financial frameworks make it possible to generate a much more diversified urban fabric, with diversified plot sizes and diversified uses.

Example of a successful process of urban diversification, subdivision and consolidation



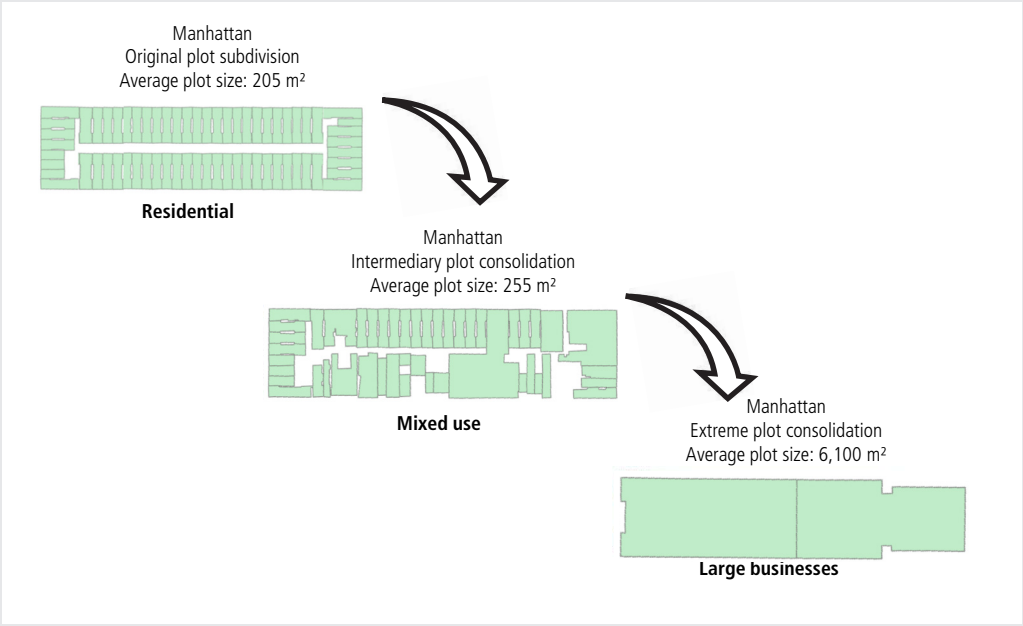
Source: Urban Morphology Institute

CASE STUDY

Comparing Plot Consolidation in New York City and Johannesburg

In 1811, the Commissioners' Map overlaid a seemingly uniform grid of rectangles over the rugged island of Manhattan. The grid was, above all, an easy format for the subdivision and development of land. The grid system stripped the land of topographical markers and repackaged it as a standardized lot. Blocks were then subdivided for land sale into identical plots of 205m² area, which, under the influence of market forces, started to consolidate and create a differentiated platting ordered by combinations of the same basic module very early in the process.

Process of plot consolidation in Manhattan.

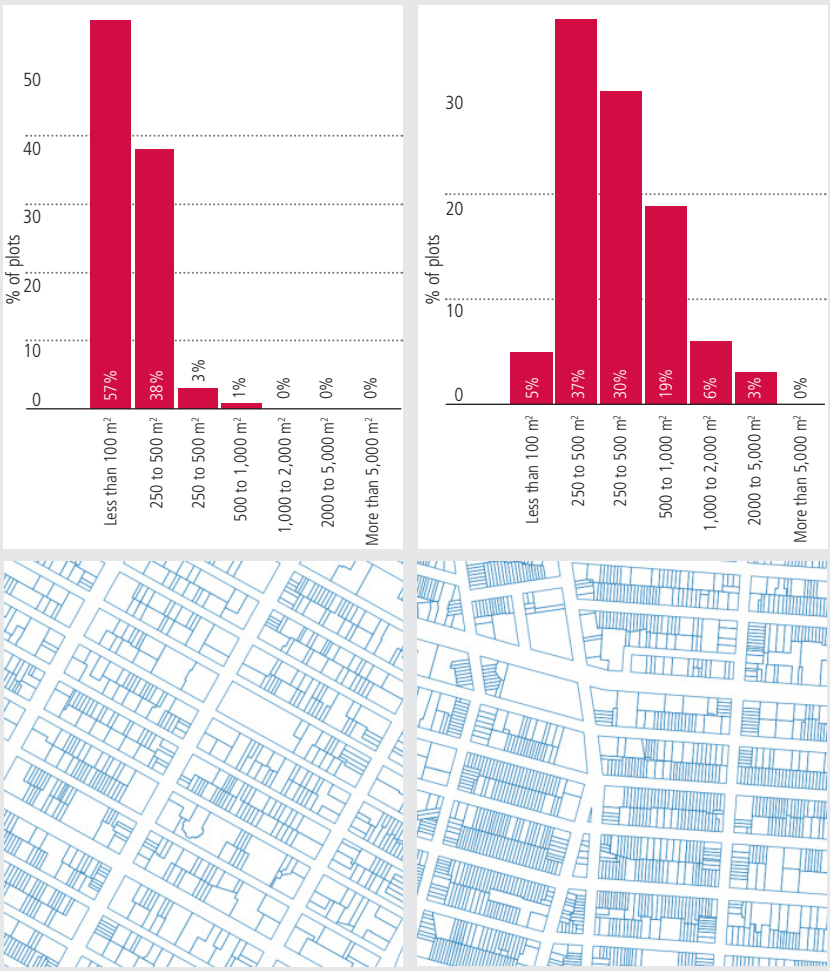


Source: Urban Morphology Institute. Salat, S., Cities and Forms, 2011

The figures below show that from an identical small-scale modular unit, plots in New York City have adapted to the socio-economic environment. Around Madison Square, only 40 per cent of the plots have kept the original platting of early 19th Century, while the other 60 per cent have consolidated at various sizes. In more residential Brooklyn, 80 per cent of the plot sizes date back to early 19th Century. In the very first decades after the Commissioners' Plan of 1811, Manhattan's vibrant emerging land market meant that the size and values of the plots had already begun to diversify, leading to a complex and flexible plot system.

CASE STUDY...CONTINUED

Diversity of plot sizes in New York: Madison square (left) & Brooklyn (right).

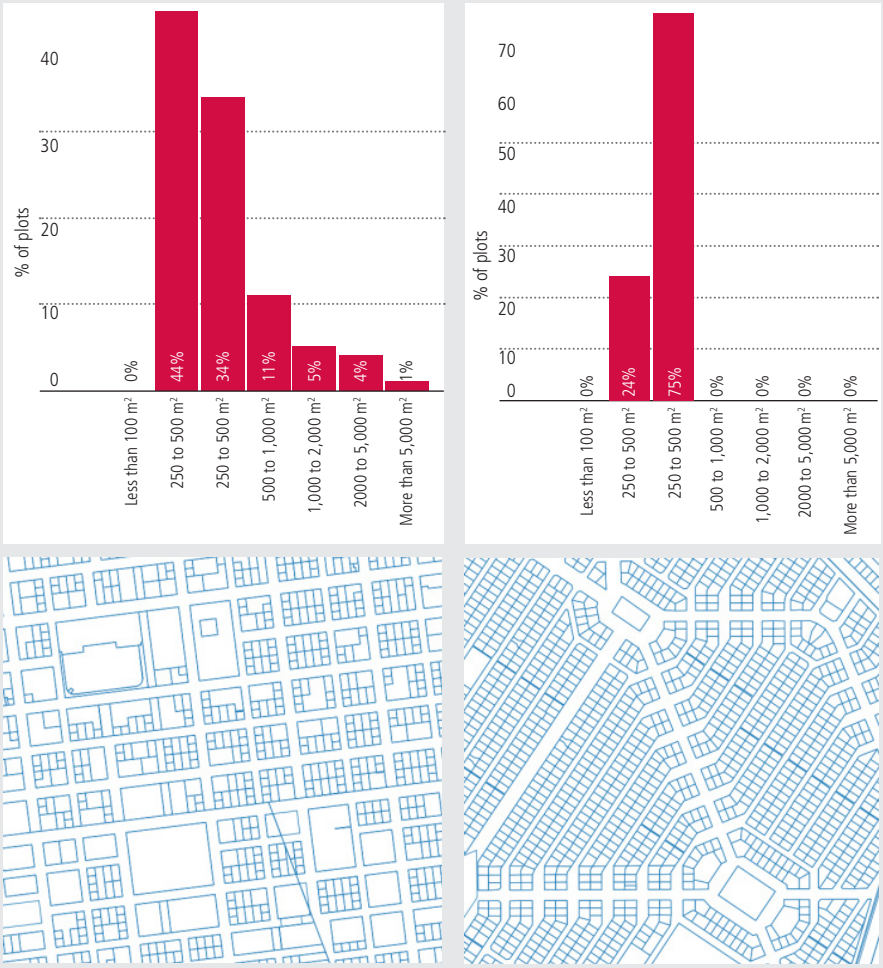


Source: Urban Morphology Institute

The South African platting system is also made up of small plots. In Soweto, the original plot, on average, is 200m². However, contrary to New York City, a series of financial, regulatory and fiscal barriers jeopardized consolidation and subdivision processes, and prevented the emergence of a sustainable and efficient land market. A feedback loop is then created where the absence of an efficient land market prevents the emergence of a diversified platting. This is shown in the following chart and map displaying characteristics of Soweto, in which platting has not evolved over a century. The distribution of plot sizes in Hillbrow (inner city of Johannesburg), on the contrary, exhibits a diversification of the plot sizes. This plot subdivision, which has experienced very little changes since the 1990s, testifies to the great vitality of land and property markets before the 1990s in the inner city of Johannesburg.

CASE STUDY...CONTINUED

Diversity of plot sizes in Johannesburg: Hillbrow (left) & Soweto (right).



Source: Urban Morphology Institute

A different example for diverse land use development can be found in Vietnamese cities. In Vietnam, social housing has been formed and transformed spontaneously and most of the time illegally. Therefore, these cities can, of course, not be named as best practice cases for efficient legal frameworks. Nevertheless, the development of these cities shows that restrictive zoning and land use regulations can prevent positive natural development. It shows that, in the best case, a functioning legal framework should allow for adaptive and flexible land use.

The modernist typology of parallel slabs with empty space in between has been transformed into the much more complex typology of shop compartments and commercial lanes where the street space is densely occupied by commercial or private activities. People have re-urbanized the space between slabs and have partially privatized it. This is where the principle of streets as places for people and the issue of social inclusiveness and diversification of the economy intersect.

4.5 The Impact of Urban Planning Characteristics on the Productivity Level

4.5.1 Density and Urban Productivity

Various empirical studies on the impact of urban characteristics on productivity - reveal that, among the urban planning indexes examined, density has the greatest impact on the urban productivity of a Planned City Extension at city wide level (this is difficult to estimate at a neighbourhood level). The level of residential, job and business densities have an impact on Gross Value Added/ km², CapEx/km² and OpEx/km² [65].

According to Ciconne and Hall (1996), over half of the variance of output per worker across states within the United States can be explained by differences in the density of economic activity. Cross-sectional analyses in the United States indicate that a doubling of population density leads to a 6 per cent increase in income per capita, which corresponds to an elasticity of 0.084[66]. The elasticity of income per km² with regard to density is thus equal to 1.084. Models derived from aggregate production functions and value-added data for states in the USA and European regions suggest that productivity increases by 4.5 to 5 per cent when employment density is doubled (Ciccone and Hall, 1996; Ciccone, 2002). This results in an elasticity of economic productivity with regards to job density of 1.063 to 1.07.

Recent studies, however, state that these analyses overstate the role of density because they do not account for the potential biases introduced by sorting, whereby people and firms with more valuable skills may locate themselves in denser places. Controlling for such potential biases, Combes et al. (2010) finds in a study in France that there is an accompanying increase in productivity from 2 per cent to 3.5 per cent when job density doubles.

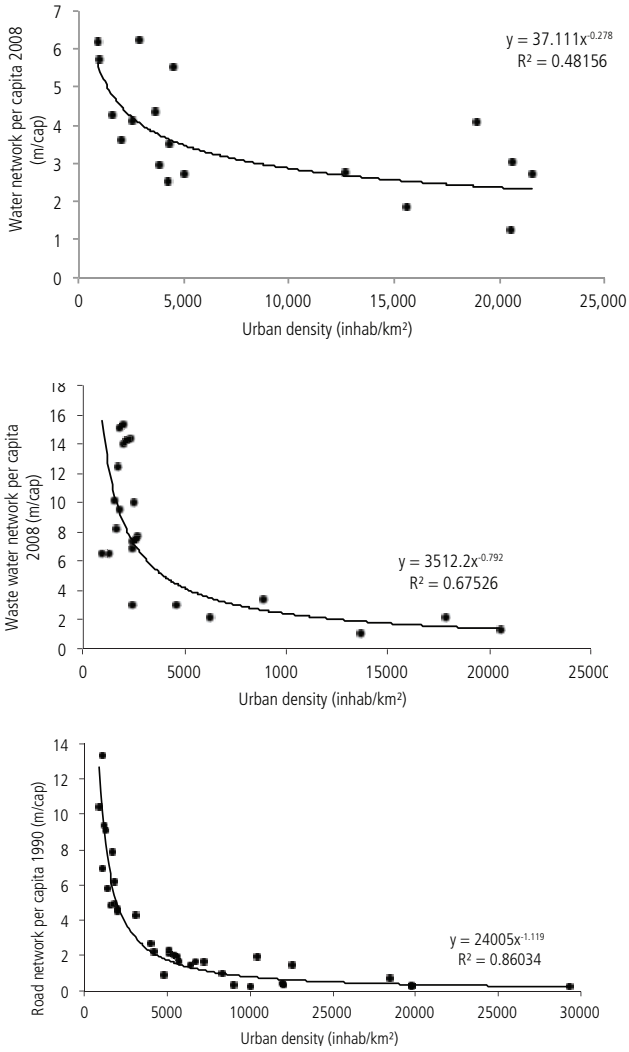
These studies imply that low residential densities result in additional costs to the community as it involves over-sizing of infrastructure networks. For example, the cost of automobile dependence related to urban sprawl in the United States is estimated at USD 184 billion per year, without taking into account the costs of congestion and loss of tax revenue due to the space used for traffic and parking (Osman, Nawawi, and Abdullah, 2008). When comparing a dense city such as Paris or Manhattan with an intramuro of 20,000 inhab/km² to a city with density of5,000 inhab/km², per capita infrastructure costs increase sharply (World Bank, 2014): they are multiplied by a factor of 4 for the road network, by 3 for the waste water network, and increase by 40 per cent for the water network. Resting upon a representative set of cities, the following charts provide a benchmark of the elasticity of water, waste water and street networks lengths per capita with regard to residential density:

65 CapEx is Capital Expenditures, OpEx is Operational Expenditures

66 If the increase in productivity is 6% when density doubles, the elasticity of productivity with regard to density is

FIGURE 14

Infrastructure costs per capita and residential density



Source: Urban Morphology Institute and Muller et al. (2013)

Network costs are assumed to be proportional to network length, which leads to the following equations:

$$\text{Waste water network costs/cap} = C_{ww} D_{res}^{-0.278}$$

$$\text{Water network costs/cap} = C_{w} D_{res}^{-0.792}$$

$$\text{Street network costs/cap} = C_{s} D_{res}^{-1.119}$$

Network costs per capita can be replaced by network costs per km² using residential density:

$$\text{Waste water network costs/km}^2 = C_{ww} D_{res}^{0.722}$$

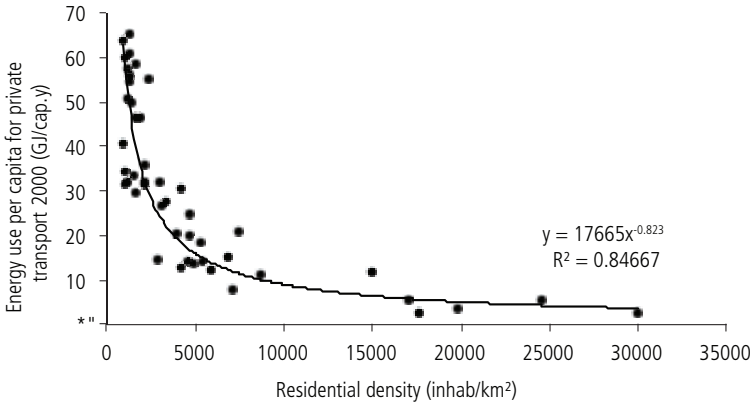
$$\text{Water network costs/km}^2 = C_{w} D_{res}^{0.21}$$

$$\text{Street network costs/km}^2 = C_{s} D_{res}^{-0.119}$$

From these equations we derive the respective elasticity for the waste water, water and street network costs per km² with regard to residential density: 0.722, 0.21 and -0.119.

FIGURE 15

Energy use per capita for private transport and residential density in a sample of 43 cities



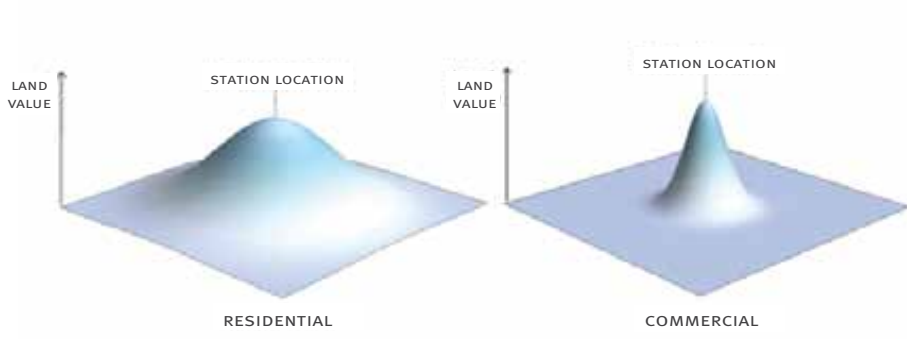
Source: Bourdic 2011

4.5.2 Accessibility and Urban Productivity

The level of accessibility impacts the gross value added per km², the operational expenditures per km² and the capital expenditures per km². The impact of accessibility to transit stations on residential land values can generally be seen across a relatively wide geographic area with a radius of up to 2km to 4km from transit station (Steer Davies Gleave, 2011). On the other hand, the impact on commercial and business property value is more limited in space, with a radius of 500m to 1km (Steer Davies Gleave, 2011). This difference in land value patterns around transit stations is shown in the following figures.

FIGURE 16

Residential and commercial land value patterns around transit stations

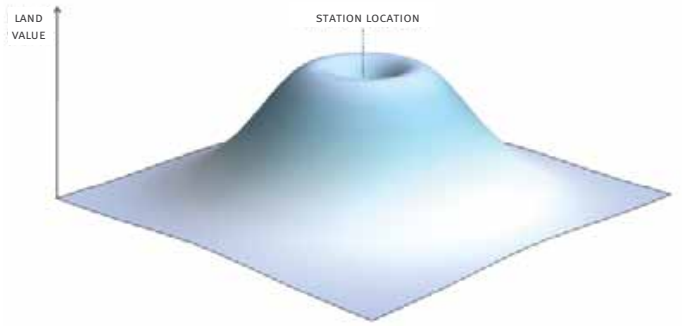


Source: Steer Davies Gleace, 2011

A poor quality station and built environment can depress land values: although the evidence generally supports a positive relationship between the presence of stations on land values. In certain circumstances, however, the noise from trains and station users, pollution and the general unsightliness of railway buildings can have a negative impact in the immediate vicinity of the station (Steer Davies Gleave, 2011). Unattractive stations in the public realm with a lack of quality investment tend to reduce land value in direct proximity to transit and, in certain cases, cause crime to increase in the surrounding area. This leads to a 'volcano' shaped pattern of land values around stations, as shown in the following figure (Steer Davies Gleave, 2011).

FIGURE 17

Volcano-shaped land value pattern around unattractive transit stations



Source: Steer Davies Gleace, 2011

In a detailed review of literature on transit accessibility, Wardrip (2001) shows that there is a general consensus that accessibility to transit outweighs transit nuisance and induces a premium on property prices and rental value. However, there is no clear agreement on the magnitude of the impact of transit accessibility on land value as it also depends on a number of exogenous factors.

For instance, the magnitude of this impact is likely to be greater in cities where transit provides a clear benefit in terms of accessibility to economic opportunities. This is, for example, the case in highly-congested cities or cities with reliable and frequent transit systems (Agarwal, 2011). The following table presents several case studies quantifying the impact of transit accessibility on land value.

TABLE 2

Impact of transit accessibility on land value in four US cities

Goetz et al. (2010)	Hiawatha Line in Minneapolis	USD 5,229 premium for single-family homes within half-mile radius catchment areas (4 per cent premium on average). USD 15,755 for multifamily properties (10 per cent on average)
McMillen and McDonald (2004)	Midway transit line in Chicago	10 per cent premium on single family homes on the long term
Knaap, Ding, and Hopkins (2001)	Portland light rail line	31 per cent premium within half mile radius catchment areas, 10 per cent within one mile radius catchment areas
Immergluck (2009)	Atlanta Beltline	15 per cent to 30 per cent increase in single family homes prices within a quarter mile of transit, compared to similar homes more than two miles from transit.
(Des Rosiers, and Marius 2012)	Commuter Rail Transit in Montreal	1 per cent to 1.5 per cent for houses located less than 1.5 km from the station.

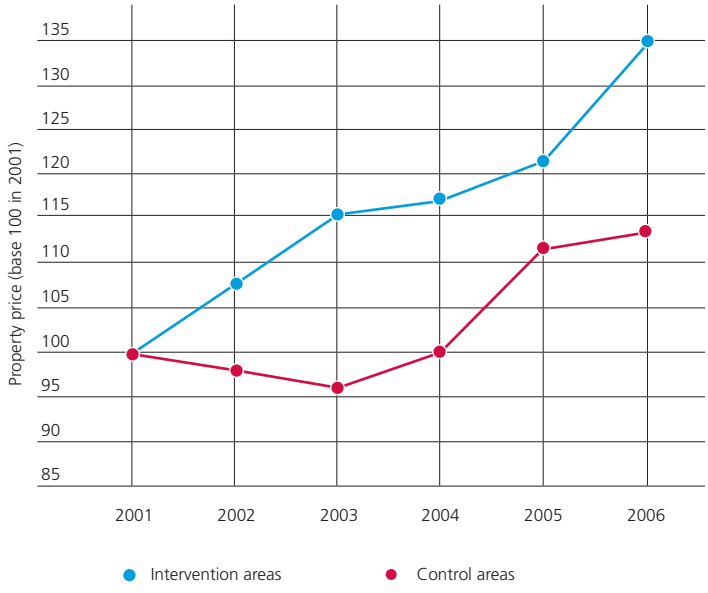
Source: Authors

CASE STUDY

The Impact of the Bus Rapid Transit, TransMilenio on Property value in Bogotá[67]

The TransMilenio is a Bus Rapid Transit scheme that was part of a broader, integrated strategy to address mobility challenges, reclaim public spaces for pedestrians and increase access to green space. The TransMilenio has been implemented in two phases, with a first phase planned in 1998, built in 1999–2000 and launched in December 2000 along two corridors. Rodriguez and Mojica (2008) analysed the impact of this first phase on property value, and show that properties served by TransMilenio benefited from the extension: property prices increased more than the prices of control properties in other locations (15 per cent to 20 per cent). The following figure shows the evolution of property prices in Bus Rapid Transit-serviced areas and in control areas, using a regression analysis to "isolate the price variation identified from the effects of inflationary pressures, differences in the supply of housing, or the impact of the Trans-Milenio extension on housing prices." (Rodriguez and Mojica, 2008)

Property price in Bus Rapid Transit-serviced areas and control areas



Source: From Rodriguez and Mojica 2008

67 Adapted from Rodriguez and Mojica 2008

The results of Rodriguez and Mojica confirm the earlier works of Rodriguez and Targa (2004), where the authors examined whether property prices were related to proximity to the Bus Rapid Transit for 494 multi-family residential properties in a 1.5 km area of influence surrounding the two TransMilenio corridors. Rodriguez and Targa (2004), show a premium of 6.8 to 9.3 per cent for every five minutes of walking time closer to a Bus Rapid Transit station. They also found that, for the properties located close to the bus way but not close to TransMilenio stations: the negative externalities of the transit infrastructure (noise and pollution) outweighed the accessibility benefits.

Beyond the benefits, in terms of land and property value, several studies show that transit accessibility contributes to agglomeration economies. According to Chatmand and Noland (2013), agglomeration economies induced by transit accessibility manifest themselves by significant impact on wages and gross metropolitan product per capita: "Doubling transit service levels (using measures such as total seat capacity) is associated with large increases in central city employment density and consequent wage increases ranging from 1.1 to 1.8 per cent, or between USD 7 million and USD 12 billion yearly, per metropolitan area, depending on the size of the workforce and the starting average wage." Graham (2007), further investigates the links between agglomeration economies and the provision of transport infrastructures and finds a positive correlation, with elasticities of 0.119 for the economy as whole, 0.186 for the service sector and 0.077 for manufacturing.

4.5.3 Transit Accessibility on Vehicle Kilometres Travelled

Last but not least, accessibility to transit has impact on car ownership, annual mileage, energy consumption and household budget, for the same level of services and access to economic opportunities, as shown in a detailed review of literature by Litman (2013). In the United States, households living within half-mile radius of the transit catchment areas own, on average, 0.9 cars per household, compared to 1.6, in US metro regions. Additionally, those living within half-mile radius of the transit catchment area commute, on average, only 54 per cent by car, compared to 83 per cent in US metro regions (America, Reconnecting and Centre for Transit-Oriented Cities, 2004). Similarly, Goldstein (2007) and Bailey (2007) found that households living within walking distance of rail transit stations drive, on average, 30 per cent to 45 per cent less, saving up to USD 1,920 of fuel cost per year. Similarly, McCann (2000) found that households in car dependent urban areas spend 50 per cent more for transportation than households benefiting from good access to transportation. The figures are more than USD 8,500 compared to less than USD 5,500 per annum, per household.

4.5.4 Walkability Indexes and Urban Productivity

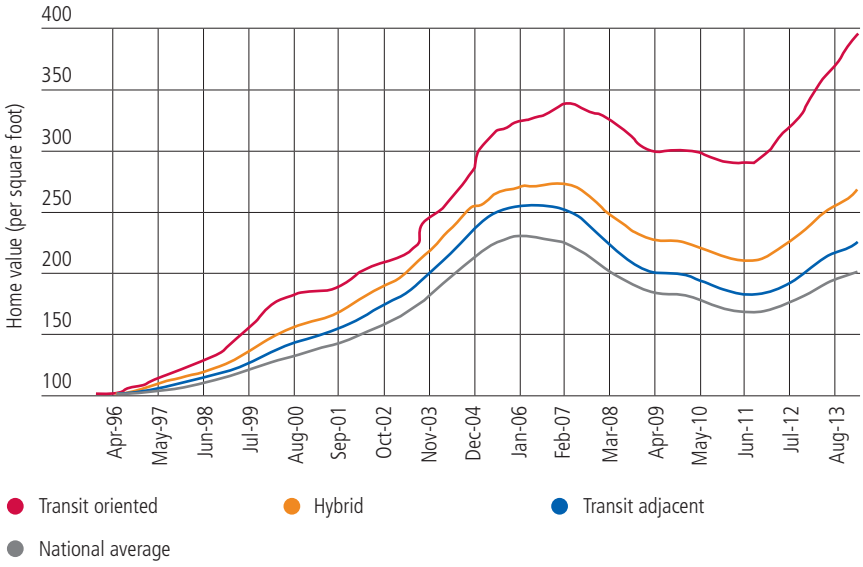
The quality of public realm and the walking accessibility to a wide range of urban amenities also has a great impact on the land value. In the US, the Transit Oriented Development (TOD) index data released by Zillow makes it possible to analyze the evolution of home values between 1996 and 2013 around 4,400 stations across the US, taking into account density, walkability and

proximity to urban amenities. Within the 4,400 stations across the US, three types of stations have been defined: Transit Oriented Development, Hybrid and Transit Adjacent Development. Transit Oriented Development stations are characterized by a household density above 2,000 households/ km² within the transit catchment area and a Walk Score above 70. Hybrid stations meet at least one of these criteria, and Transit Adjacent Development stations do not meet either of these criteria.

The following charts show the combined impact of density, walkability of the public realm and proximity to urban amenities on the growth of property values. For two similar homes priced 100 in 1996, the home located in a Transit Oriented Development district is worth 400 in 2013, while a home located in a Transit Adjacent Development district is worth 225. This impact on rental value is also very significant. For two similar homes rented 100 in 2012, the increase in the rental value of the one located in a Transit Oriented Development district is of 18 per cent, while a home located in a Transit Adjacent Development district is about 11 per cent.

FIGURE 18

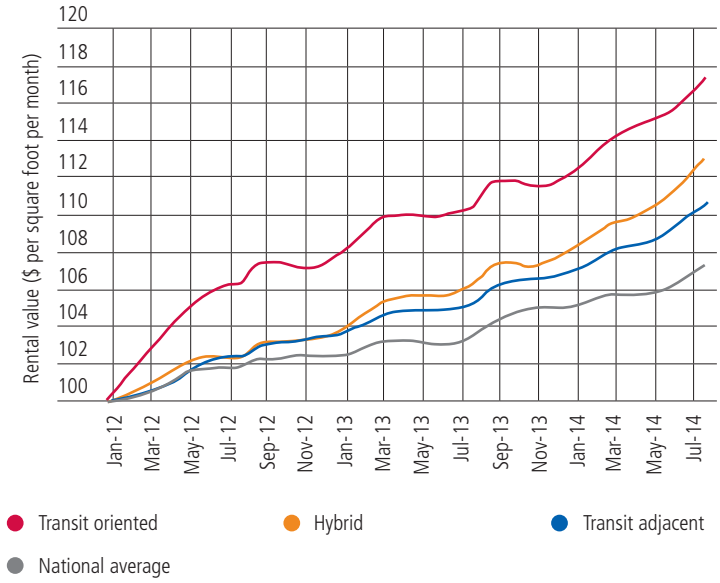
Average home value in the United States in transit oriented, hybrid and transit adjacent areas, and national average, since 1996. Base 100 in April 1996.



Source: Urban Morphology Institute. Data: Zillow TOD index

FIGURE 19

Average rental value in the United States in transit oriented, hybrid and transit adjacent areas, and national average, since 1996. Base 100 in April 1996.

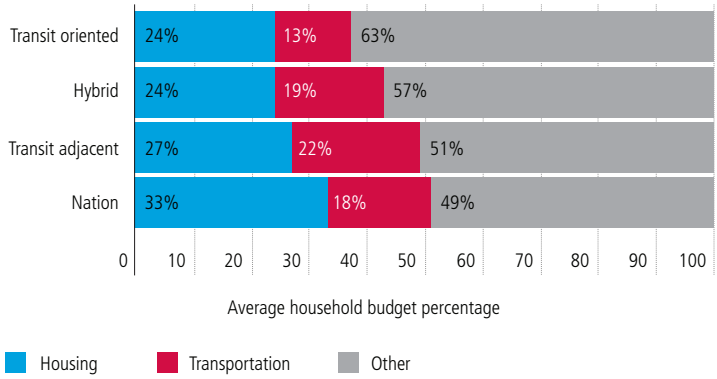


Source: Urban Morphology Institute. Data: Zillow TOD index

Proximity to urban amenities also has a wide impact on household budgets, as shown in the following chart. In Transit Oriented Districts, the budgets dedicated to housing and to transportation are, respectively, 24 per cent and 13 per cent of the total household budget, which amounts to a total cost of 37 per cent. In comparison, the households in transit adjacent districts spend respectively 27 per cent and 19 per cent of their budget for housing and transportation, which amounts to 48 per cent of their total budget.

FIGURE 20

Housing and transportation budget with regard to transit accessibility in US cities

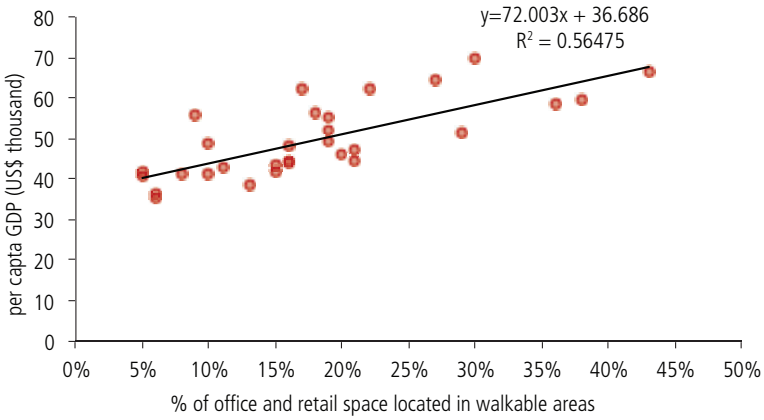


Source: Urban Morphology Institute. Data: Zillow TOD index

Resting upon an extensive dataset for the US top 30 metros, Leinberger and Lynch (2014) provide a consolidated database that makes it possible to assess the impact of walkability on urban productivity. Using office and retail data, as well as Walk Score, census data and economic data, Leinberger and Lynch (2014) define walkable areas (WalkUP) in the 30 metros. The following charts display urban productivity per capita and per km², with regard to the percentage of office and retail space located in walkable areas. These figures show the correlation between walkability and productivity, although the correlation with GDP per km² is weaker.

FIGURE 21

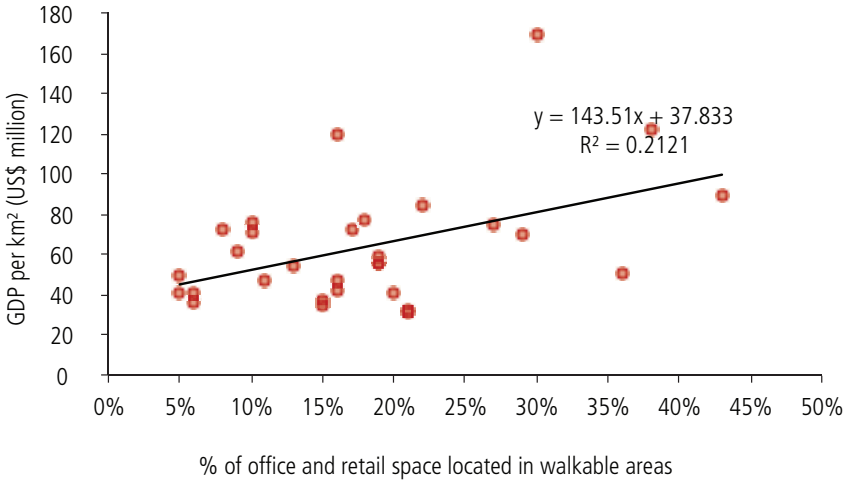
Urban productivity per capita (GDP/capita) and walkability in the top 30 US metros



Source: Urban Morphology Institute. Data from (Leinberger and Lynch, 2014)

FIGURE 22

Urban productivity per km² (GDP/km²) and walkability in the top 30 US metros.

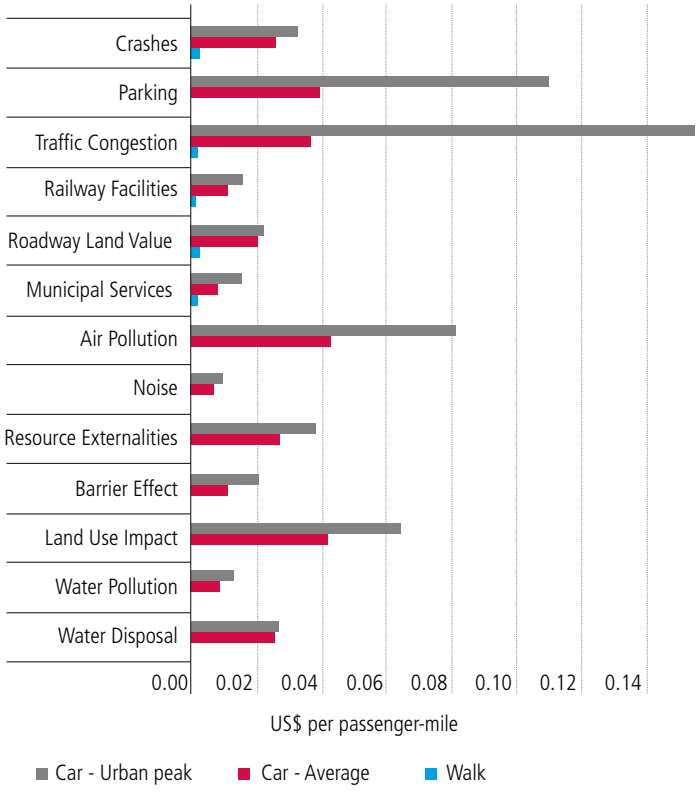


Source: Urban Morphology Institute. Data: Zillow TOD index

Compared to car-dependent urban environments, walkable Planned City Extensions induce lower costs to the community. The following chart, adapted from Litman (2009), reveal the additional costs for car dependent community compared to a community where walking is possible, in terms of health, safety, traffic congestion, and pollution.

FIGURE 23

Externalities of automobile compared to walking



Source: Urban Morphology Institute, adapted from (Litman 2009).

Street design variables also have a significant impact on vehicle kilometres travelled. This translates into energy costs for households and can also be considered as an important aspect of urban productivity per capita.

According to Ewing et al. (2011), street design variables taken individually have a limited impact on travel. However, the combined effect of all street design variables on travel can be quite large. The last IPCC report on urban forms and climate (IPCC, 2014) acknowledges that although "the literature is limited to developed or mature cities, there is robust evidence that these conditions and relationships would hold true in developing country or rapidly growing cities."

Building on the literature, the impact of street design variable on vehicle kilometres travelled are as follows:

- Grid networks: a meta-analysis conducted by Ewing and Cervero (2010), identifies three studies finding a correlation between the percentage of four-way intersections (grid-like intersections) and vehicle kilometres travelled, with a weighted average elasticity of -0.12. The proportion of

culs-de-sac within a street network also increases travel demand on arterial roads by 75 per cent and on collector roads by 80 per cent, compared to a 43 per cent lower vehicle kilometres travelled with a gridded street design (James Taylor Chair, 2001; Marshall and Garrick, 2010).

- Intersection density: Ewing and Cervero (2010), identify in six studies a correlation between intersection density and vehicle kilometres travelled, with a weighted average elasticity of -0.12. In other terms, doubling the density of intersections leads to a decrease in VKT (vehicle kilometre travelled) by 12 per cent. In Atlanta, the MARTRAQ Project found that that "doubling current regional average intersection density, from 8.3 to 16.6 intersections per square kilometre, would reduce average per capita weekday vehicle travel by about 1.6 per cent, from 32.6 to 32.1 daily miles, all else held constant" (Litman, 2013). In another meta-analysis, Handy et. al.(2010), found that the density of intersection impacts on vehicle kilometres travelled with an elasticity ranging from -0.06 to -0.59. Marshall and Garrick, on the other hand, show that holding other factors constant, increasing intersection density from 31.3 to 125 intersections per square kilometre is associated with a 41 per cent decrease in daily vehicle kilometre travelled, from 44.7 to 26.5 (Marshall and Garrick, 2010).
- Sidewalk coverage: For North American cities, the elasticity of walking with respect to sidewalk coverage or length stands is within the range of 0.09 to 0.27 (Salon et al., 2012).
- Block size: Emrath et al. (2009), show that the block size has impact on walkability and commuting patterns. Households living in smaller blocks walk and use transit 10 per cent more for commuting than the average.

4.5.5 Land Use Diversity and Urban Productivity

Several studies have shown the impact of land use diversity on land and property value. Households are willing to pay more to live in neighbourhoods with other uses than residential, such as business services or leisure.

On the contrary, wholesale or manufacturing for instance, seem to have a negative impact on land and property value. Studies in the Netherlands (Koster and Rouwendal, 2012) show that households are willing to pay up to 6 per cent more for a house in a mixed neighbourhood than for an otherwise comparable house in a mono-functional area.

But they also show that there is substantial heterogeneity in willingness to pay for mixed land use, depending on the housing typology. For example, households living in apartments are willing to pay 25 per cent more for mixed use than households living in detached housing (Koster and Rouwendal, 2012). Song and Knaap (2004), confirm the contradictory impacts of mixed use on single family property value. Single family property value tends to increase with the amount of commercial land in the vicinity, while it tends to decrease with the amount of multi-family residential uses. In terms of office property value, Cao and Cory (1982) suggest that mixed use contributes to property value increases, while Sohn and Moudon

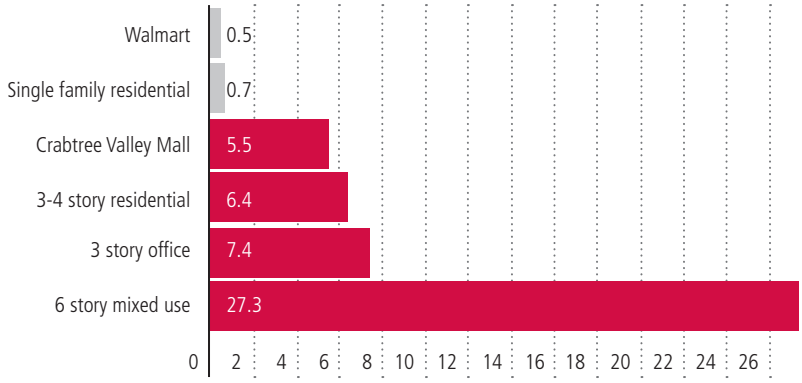
(2008) show a decrease in office property values associated with an increase in the proportion of retail uses.

Mixed use and diversity also significantly impact municipal revenue, through the level of property tax yielded. The two following charts compare the amount of property taxes raised by the municipality of Raleigh, North Carolina, in the United States in 2011, for different uses, from low density mono-functional land to medium density mixed use land.

In the following chart, the tax revenues per km² in absolute value range from USD 0.5 million per km² for low density mono-functional uses to more than USD 27 million per km² for medium density mixed use neighbourhoods. This chart also compares different floor areas per square metre on property taxes, to remove the bias induced by the built density. In terms of property tax per m², 6 story mixed use yields 2.3 to 4.4 times more revenue than mono functional areas.

FIGURE 24

Municipal tax revenue per km² and mixed use in Raleigh per km²



Municipal property tax yield in 2011 in Raleigh, NC (US$million per Km²)

Source: Adapted from (Fulton 2013)

Beyond property value, Fillion et al. (2000) suggest that mixed use centres in suburban areas increase the potential and the dynamism of urban cores, making their case on the Greater Toronto Area. Building on extensive data in the United Kingdom (8414 onwards), Graham and Glaister (2003), show that higher mixed use contributes to enhanced public health, by diminishing pedestrian casualties and fatalities.

Land use and the job-housing balance also contribute to decreasing travel distances and reduce the associated energy needs for transportation. The impact of mixed use on energy consumptions for transportation can be even more important than that of urban density. A meta-analysis conducted by Ewing and Cervero (2010), identifies ten studies finding a correlation between land use mix (entropy index) and VKT, with a weighted average elasticity of -0.09 and 4, and finding a correlation between the job housing ratio and vehicle kilometres travelled, with a weighted average elasticity of -0.02. Ewing et al. (2010) also suggest that residents living in neighbourhoods with high job housing ratios tend to have vehicle kilometres travelled up to 15 per cent lower than the average (Reid Ewing, DeAnna, and Li, 1996). In another analysis, Frank and Pivo (1994) show that destination trips with job housing ratios between 0.8 and 1.2 exhibited 29 per cent shorter trips than those ending in census tracts with a less balance job-housing ratio.

5. Annex: Modelling PCE Characteristics on Urban Productivity

5.1 The Model

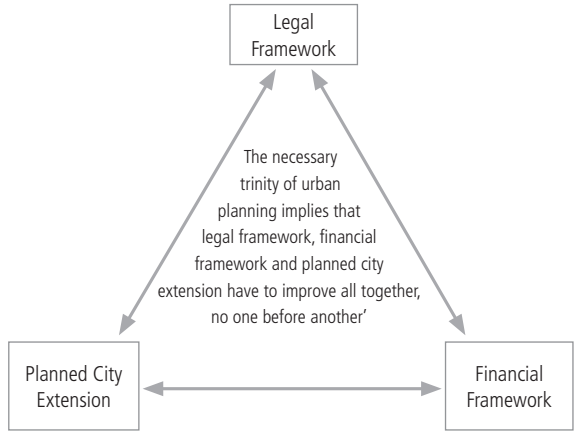
Some preliminary remarks must be made to define the scope and the area of validity of this model. Although rooted in the academic field and building on a wide review of literature, this model is not meant to be academic. It is also not meant as a complete econometric model providing direct and univocal correlation between planned city extension, legal framework, financial framework and urban productivity. Since cities and urban environments are complex physical and socioeconomic systems, the correlations between urban planning indexes and urban productivity are never straightforward, as many factors which intervene have an impact on productivity while also having correlations among each other, thereby inducing biases such as collinearity. According to Wagner (1999), "the notion of causality can only be meaningfully defined for systems with linear interactions among their variables". As cities are complex systems, the socio-economic and spatial variables examined in this study are characterized through interaction among each other, through feedback loops and non-linearities.

Most of the urban planning indexes are correlated. As an example, cities with high residential and job density often display, at the same time, higher walkability and transit accessibility. This is why trying to isolate the individual impact of a given parameter is often in vain, and why the correlations between urban planning indexes and urban productivity presented in this report must always be understood as partial correlation. This model is thus meant as a tool to inform about policy making and urban development. It aims at providing quantitative evidence and basis on the relevance of urban planning, legal and financial frameworks on urban productivity.

The benchmarks provided in this report do not aim at being prescriptive but should foster the policy-making and communication process. Instead of exact target values, prescriptive ranges should be preferred.

FIGURE 25

The necessary trinity of urbanization



Source: Authors

As this study aims at a better understanding on the benefits of the Three-Pronged Approach on urban productivity, the model presented in Figure 25 provides a framework to under stand the importance of the three prongs that result on a necessary trinity for urban planning; this concept was inspired by the impossible trinity concept derived from monetary economics.

The necessary trinity for urban planning is a concept that attempts to show the importance of obtaining parallel results in the three prongs during the urban planning process.

In practical terms, it means that the urbanization process is not going to be successful if there is a planned city extension and a financial framework, but lacks the necessary legal framework. If one of the three prongs is missing or if one is relegated in comparison to the other, even though it is difficult to establish a homogeneous measure, urbanization development will not achieve the desirable results. The process has to occur in simultaneous stages for every one of the components.

As was mentioned before, it is the purpose of this study to provide a framework to classify and measure the impact of dif ferent characteristics of the Three-Pronged Approach on urban productivity. The urban productivity is measured as the gross value added per km² in the area that has been subject to the Three-Pronged Approach programme less the capital and operational expenditures per km² and less the total over cost per km² occurring in this area. The strength of this approach is that urban productivity is decomposed into four components, on which the impact of each urban planning characteristic can be assessed.

$$\frac{Urban\ productivity}{Km^2} = \frac{GVA}{Km^2} - \frac{CapEx}{Km^2} - \frac{OpEx}{Km^2} - \frac{TotOve}{Km^2}$$

The decomposition of urban productivity comes as follows, with the Gross Value-Added, Capital Expenditures, Operational Expenditures and Total Over cost occurring according to augmented Cobb-Douglas functions.

5.2 Modelling Urban Framework

In economic literature, the Leontief production function describes perfectly the necessary trinity explained on the section before. The Leontief production function was derived from the utility function of perfect complements; which are goods where utility is restricted by the goods that are consumed in the smaller proportion. In this case, the Urban Framework will be modelled by the Leontief function and the mathematical formal ization will be as follows:

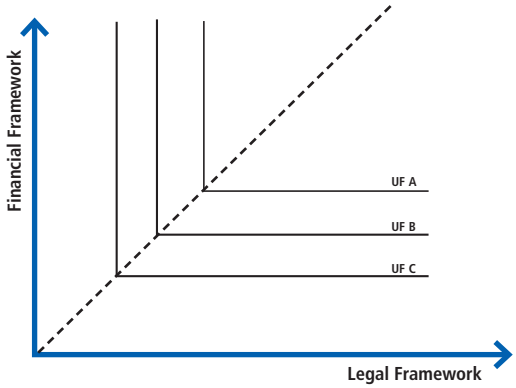
$$\begin{aligned} &Urban\ Framework \\ &= f(Planned\ City\ Extension, Financial\ Framework, Legal\ Framework) \\ &= \text{Min}\ (Planned\ City\ Extension, Financial\ Framework, Legal\ Framework) \end{aligned}$$

The Liebig's law of the minimum is another theory that is adaptable to the Three Pronged Approach. The difference between the Leontief production function (complementary goods) and the Liebig's law, is that Liebig's law states that growth is controlled not by the total amount of resources available but rather by the scarcest resource (limiting factor). The two perspectives are useful for modelling the outcome in terms of Urban Framework, with both theories (Liebig's law and Leontief production function) described by a minimum function.

The graphical example with just two prongs will look as follows, in Figure 26.

FIGURE 26

Leontief function for two prongs, legal and financial framework.

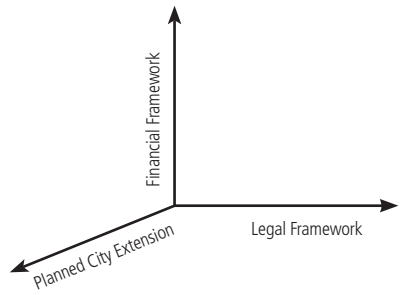


Source: Authors

As the model is designed for three prongs, the Urban Framework has to be visualised in three dimensions. The Leontief function can be applied in this case as well, as shown in Figure 27.

FIGURE 27

Leontief functions for three prongs, planned city extension, legal and financial framework.



Source: Authors

Adapting the economical concept of preferences, we could assign two desirable properties to the legal framework, the financial framework and the planned city extension. The properties assigned to the three prongs are complete[68] and transitive[69]. In addition to that, we are going to suppose that if an element A contained in any of the three prongs is at least as preferred to an element B contained in any of the three prongs chosen before, then element A is at least as expensive as element B. The assumptions mentioned before are formally seen as follows:

$$Legal\ Framework\ A \succcurlyeq Legal\ Framework\ B \succcurlyeq Legal\ Framework\ C$$
$$Financial\ Framework\ A \succcurlyeq Financial\ Framework\ B \succcurlyeq Financial\ Framework\ C$$
$$City\ Plan\ A \succcurlyeq City\ Plan\ B \succcurlyeq City\ Plan\ C$$

As an example of the difference in costs we will consider the case of the legal framework:

$$Cost(Legal\ Framework\ A) - Cost(Legal\ Framework\ B) \geq 0$$

In this particular case, the outcome of the model is based on the Urban Framework, as it is modelled by a Leontief function. The outcome will be determined by the function's minimum.

Example 1

The government of the city AAA decided to improve its Urban Framework. For that they hired an architectural firm to improve the Planned City Extension, turning it from a Planned City Extension C to a Planned City Extension A. As the government of this city considers that finance is a determining issue for applying the improvement in the Planned City Extension, the government decides to upgrade the Financial Framework from C to B. The government of city AAA considers the Legal Framework it already has is enough, so it leaves it as a Legal Framework C.

After the investments, the consulting company's hands out its outcomes. The Urban Framework will be described by the following equation:

$$Urban\ Framework = \text{Min}\ (Planned\ City\ Extension\ A, Financial\ Framework\ B, Legal\ Framework\ C)$$

The result of that equation will be an. $UIC\ C$

68 Completeness axiom: For every pair, either or both. An agent has complete preferences if he can compare any two objects.

69 Transitivity axiom: For every triple, if and then. An agent has transitive preferences if his preferences are internally consistent.

The additional costs are:

$$Cost(Planned\ City\ Extension\ A) - Cost(Planned\ City\ Extension\ C) = X$$
$$Cost(Financial\ Framework\ B) - Cost(Financial\ Framework\ C) = Y$$
$$Total\ Overcost = X + Y$$

5.3 Modelling Urban Productivity

The Y_{ij}, an urban capacity usage parameter, is the key in this model to link the Three-Pronged Approach to urban productivity, as it integrates the impact of all urban characteristics on urban productivity. The sub-index j stands for the urban region. Building on the literature of analysing urban productivity (Sveikauskas, 1975; Carlino, Chatter-jee, and Hunt, 2007; Abel, Dey, and Gabe, 2012), we assume that the effects of urban planning characteristics operate through the Hicks-neutral[70] urban capacity usage parameter shown as follows:

$$Y_{ij} = \gamma_0 \prod_{i=1}^{N} C_{ij}^{\gamma_u} = \gamma_0\, C_{ij}^{\gamma_1}\, C_{2,ij}^{\gamma_2}\, C_{ij}^{\gamma_3} \ldots C_{ij}^{\gamma_N}$$

with denoting the value of the technology parameter which is not related to urban planning matters, being the urban indicator to characterize a 3PA programme i, in the urban region j, and being the elasticity of GVA with respect to urban index
Even though C is considered as one of the variables that compose the measurement of urban productivity, another way of understanding C is interpreting it as one of the many forms of capital: with K being traditional capital, H human capital, S social capital, I institutional capital, and N natural capital. It is important to note that with the indicators of elasticity, only the positive effects can be expressed as having an effect on the GVA. The negative effects of a 3PA programme are taken into account in the CapEx and OpEx and Additional Costs

Job density for instance, which can be argued to have a positive correlation with GVA, and to be an indicator of institutional capital, appears in an equation as follows:

$$A_{ij} = \gamma_0\, job\ density^{\gamma_{ij}^{1}}\, C_2^{\gamma_{2,ij}}\, C_3^{\gamma_{3,ij}} \ldots$$

Land use diversity, on the other hand, which is also a component of institutional capital, can be assumed to correlate positively with GVA and, appears in as equation as follows:

$$A_j = \gamma_0\, job\ density_{ij}^{\gamma_1}\ \text{land use diversity}^{\gamma_{ij}^{2}}\, C_{3,ij}^{\gamma_3} \ldots$$

Abel et al. (2012) propose a model of urban productivity for an urban region j according to a human-capital augmented Cobb-Douglas production function. This model is made up ofe inputs that link the gross value added (GVA) to the technology parameter A, and contains different forms of capitals. The function is given as:

$$GVA_{ij} = Y_{ij} * \text{Urban Framework}^{\alpha}$$

70 Following the Solow model, Hicks-neutral is a technical change in the production function of a business or industry which change does not affect the balance of labour and capital in production function. Hicks-neutral urban capacity means that the citye ciechnical change keeps the share of labour and capital as given.

Where Yij is a Hicks-neutral technology parameter, UF is the minimum function a of a planned city extension, financial framework and legal framework. α parameter represent the elasticity of GVA with respect to UF.

For the sake of clarity, we will also assume that all the parameters will be brought to the scale of 1km², which allows to switch from extensity variables such as the amount of jobs to intensity variables such as the density of jobs.

5.4 Modelling capital and operational expenditures

As in the section above, a Cobb-Douglas function is used to model the impact of Three-Pronged Approach on Capital (CapEx) and Operational Expenditure (OpEx) per km², as follows:

$$\mathrm{CapEx_{ij}} = \varepsilon_0 \prod_{u=1}^{N} \mathrm{C}_{ij}^{\varepsilon_C} = \gamma_0 \, \mathrm{C}_{ij}^{\varepsilon_1} \, \mathrm{C}_{ij}^{\varepsilon_2} \, \mathrm{C}_{ij}^{\varepsilon_3} \, \ldots \mathrm{C}_{ij}^{\varepsilon_N}$$

$$\mathrm{OpEx_{ij}} = \mathrm{o}_0 \prod_{u=1}^{N} \mathrm{C}_{ij}^{\mathrm{o}_C} = \gamma_0 \, \mathrm{C}_{ij}^{\mathrm{o}_1} \, \mathrm{C}_{2,ij}^{\mathrm{o}_2} \, \mathrm{C}_{ij}^{\mathrm{o}_3} \, \ldots \mathrm{C}_{ij}^{\mathrm{o}_N}$$

with ε_0 and o_0 denoting the factors with an impact on CapEx and OpEx, respectively. C_{ij} denotes the characteristics of the 3PA programme i in the metropolitan region j with regard to the urban indicator C; ε_C and o_C represent the elasticity of CapEx and OpEx with respect to the urban indicator C. C_{ij} As an example, the costs for the initial development of pavement costs are taken into account as parts of CapEx, the maintenance costs for pavement are added to the OpEx. Negative externalities such as congestion or energy consumption are assigned monetary values and taken into account as parts of OpEx.

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