Urban Vitality Through a Mix of Land-uses and Functions:

An Addition to Citymaker

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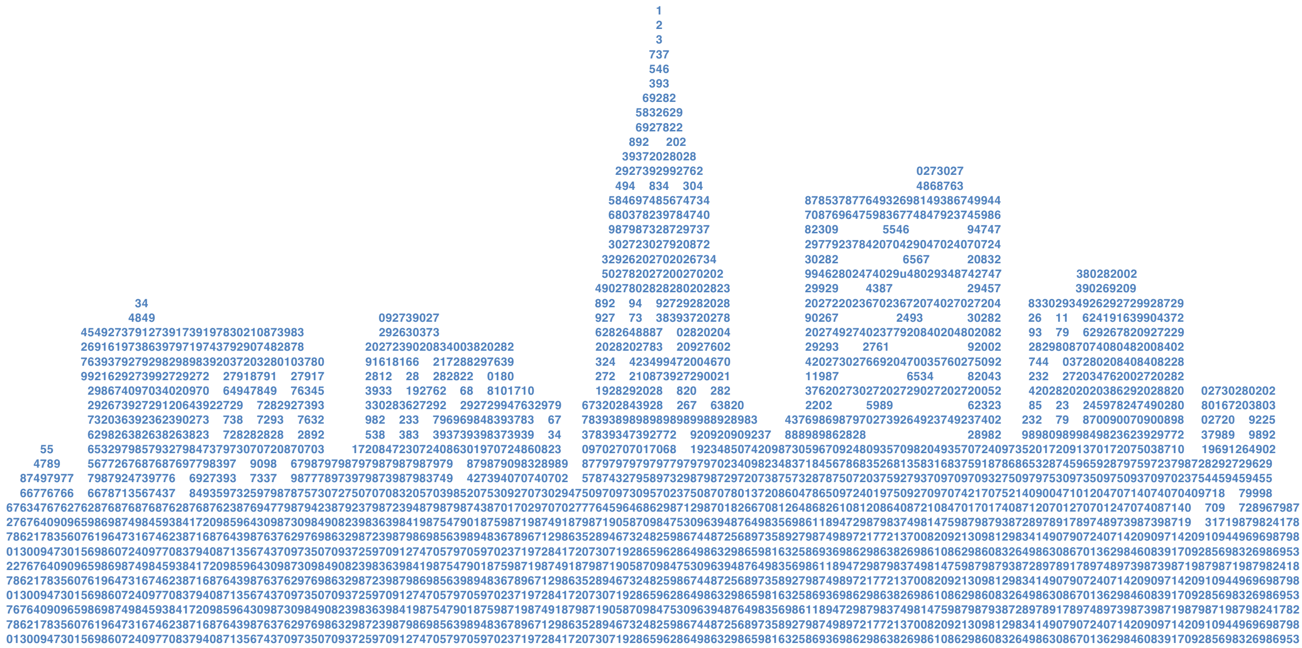

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Abstract — Current urban planning processes are becoming more and more complex because of the many aspects that need to be taken into account. Apart from the fact that due to economical fluctuations projects are financially scrutinized, the process of planning urban (re)developments also changed. In 2007 an urban planning tool called Citymaker has been devised that is able to guide the stakeholders of urban development through these changing market conditions. With this tool several planning scenarios can be quickly devised in order to find the most adequate one. However, these scenarios were compared on a relatively confined array of financial, demographic and environmental aspects. In order to compare the different scenarios in a broader sense this research set out to detect additional variables for the existing Citymaker tool in order to adequately represent the built environment. This lead to a comparison of scenarios through the concept of urban vitality, which embodies social, economical and spatial aspects of the built environment. Translated to an excel-based model this research developed an addition to the existing Citymaker tool that may also be used as an individual instrument for comparing different planning scenarios that come forth out of other planning processes.

Keywords— Area development, Mixed land-use, Mixed functions, Urban planning, Urban vitality.

1. INTRODUCTION

1.1 Motivation

The concept of mixed land-use and functions has been around for ages even before spatial planning existed. However it has not always been the leading paradigm in urban development and planning. Since this thesis relies heavily on the terms land use and function a clear definition of the terms is needed. The definition for land use is derived from Best (1981) who states that; '*Land-use deals essentially with the spatial aspects of all man's activities on the land and the way in which the land surface is adapted, or could be adapted, to serve human needs.*' In other words land-use is defined as the manner in which the land is customized e.g. built up, paved or cultivated arable lands. Functions in turn are defined as; services provided by the spatial environment e.g. housing or recreation.

Land-use planning is originally defined as an integrated manner of organizing the location, intensity, form and harmonization of land development in order to facilitate the activities in that environment (Chapin, 1965; Cullingworth, 1972). Within spatial planning most of the activities in a city are related to urban functions. In 2004 Albrecht defined a number of space-using functions within the urban environment such as housing, industry, recreation, transport, education, nature, agriculture, cultural activities. Since land-use planning is an integrated form of planning the combination of functions and the accordance with relevant policy are significant issues (Albrecht, 2004).

In current urban environments an adequate combination of different land-uses and functions becomes more and more important. Especially with inner-city redevelopments this is a significant issue. Due to a limited amount of space and usually high expectations of a developer for the project area the strain on the available space is high. Critical issues like environmental sustainability and social cohesion are sometimes overthrown by other demands that are prioritized by the developer such as financial gain (Campbell, 1996). When a developer gets the opportunity to compare several combinations of functions and land-use with each other in order to find the most adequate one the vitality of the city could increase (Sternberg, 2000). Urban Vitality in the context of this research needs some clarification. Related to the work of Jacobs (1961) and Montgomery (1998) Urban vitality is mostly related to the public life on the streets, squares and parks an the manner in which the users are able to identify themselves with the places in their neighbourhoods. Hereby all activities as defined by Gehl (2010) are of relevance so functional activities such as commuting, social activities such as children's play and optional activities such as taking a walk. The manner in which these activities are supported by the built environment determine in a great deal the urban vitality. A city or area is vital if there is a rich choice of interesting places for people to experience throughout the year. As proposed by Zhou (2012) quantified values that may be of relevance concerning urban vitality are for example the number of people, businesses and various activities in the built environment.

With the currently developed Citymaker tool comparing the scenarios in relation to urban vitality could be possible. However by adding other aspects of the built environment to the Citymaker tool the scope of the comparison will increase. In order to determine which aspects within the urban environment are of importance a case study was performed concerning the municipal vision documents for the coming decades of three of the larger Dutch cities; Amsterdam, Rotterdam and Utrecht. Additionally the vision document of the Randstad Metropolitan area of which the three cities are a part was also addressed. Within this case study the focus laid on green and blue aspects of the built environment since these aspects are linked to ecology. According to de Jong, et al. (2008) related aspects are of influence on the mysterious 'genius loci' which is seen by many spatial planners and designer as an important concept within the experience of the built environment and therefore a part of design processes.

The Municipality of Amsterdam (2011) has defined seven focus points; two of these are related to the public space and green and blue aspects. They state that the quality of the green and water related space should be improved and use should be intensified. Concerning Rotterdam the vision document defines six focus points; one of them is water and specifically in relation to rising sea levels. The Municipality of Rotterdam (2011) also states that adequate arrangements of water related issues should make the public space more attractive. The vision document of Utrecht defines seven important issues for the coming decades. Water is again one of them. However, different from Rotterdam the focus in Utrecht lies on drainage and retention. Furthermore, as a part of the interventions for a livelier city the green spaces should be improved (Municipality of Utrecht, 2004). The fact that the issues of green and blue aspects are a significant part of the structural concept of these cities justifies an addition of the Citymaker tool with these aspects. This choice is further validated by the structural concept of the Randstad metropolitan area that defines three focus points; the first is water and green, the second is connect and crosslinking, also related to green and blue networks and the third is urbanization and the impact on rural landscapes. With these points the former Ministry of Housing, Spatial Planning and Environment (2008) gives a clear signal of the importance of the green and blue cluster in the development of the metropolitan area for the coming decades.

1.2 The Citymaker

In 2007 Berend Hoffmann and Marc Engels of Keizerrijk Architects noticed that the process in urban and regional development was changing. The traditional way of working proved to be insufficient if the spatial program requested by the client only consisted of floor areas, parking requirements and operating models. Additionally, the demand for greenfield developments on the outskirts of the city declined and more and more projects consisted of urban redevelopment. This complicated the tasks of urban planners and designers. Apart from the fact that the demand by clients was changing slowly, the process also changed and sustainability issues became more and more important. Because of more integrated approaches concerning the various stakeholders in a project, issues such as cooperation and communication became an important aspect of the process (Hoffmann & Engels, 2013).

The traditional urban development process began with a preliminary set of requirements specified by the client. This lead to several different plans, trying to incorporate these requirements. Hoffman and Engels saw the many drawings and adjustments as a time-consuming and costly process. Two years later this frustration led to the first draft of the Citymaker tool. The main principle of the model is that the associated stakeholders calculate the potential of the area by balancing the required land-uses and functions before drawing the first plans. In the traditional process stakeholders attain several advisors with knowledge of their respective discipline to report on most appropriate program requirements. The Citymaker tool replaces all these advisors with a interactive tool allowing multiple aspects such as energy, waste, exploitation etc. to be combined. By doing so an appropriate balance of the different aspects in the urban environment can be determined that facilitates sustainable development. (Hoffmann & Engels, 2013).

The Citymaker tool is based on key variables related to real estate, land development estimates, demographics, the environment, parking and public space, all combined in a model based on a spreadsheet environment. According to Engels (2013) the initial variables were intuitively chosen and determined by the developers of the Citymaker tool based on their experience in the urban planning and design sector. In a later stage the relevant variables were selected with influences of reference projects in which certain parameters appeared more important than others. The last stage and the stage upon which this research builds, is the use of scientific theories and concepts to further justify relevant variables. The demand for expertise in the various disciplines and the specialized nature of the key indicators led to a collaboration with Stipo (urban development consultant), Stadkwadraad (land exploitation consultant), Sumcity (area economics consultant), Techniplan (area sustainability consultants) and Procap (project management consultants). Together with Keizerrijk Architects these five companies constitute the Citymaker Group.

According to one of the developers of the Citymaker, the goal of the Citymaker tool is twofold. Concerning project organization the tool is a way to facilitate communication between stakeholders by determining the impact of certain spatial decisions on other aspects of the area (Hoffmann, 2013a). This transfer of knowledge has proven to be an important factor for mutual understanding and can potentially eliminate conflict (Al-Kodmany, 2002). The changing paradigms in many sectors and also within the planning discipline are based in a shift from top-down towards bottom-up approaches (Rotmans, 2012). Because of these changing paradigms and the several crisis that have taken place the past few years the developers of the Citymaker tool decided to create a tool that does not assist in making a plan for a certain area but determines the possibilities for that area. The second goal of the Citymaker tool is formulated as finding a balance between the mix of functions and land-use in order to determine the most adequate terms of reference for an area by assessing the spatial and technical possibilities of that area within the set of preconditions (Hoffmann, 2013a).

Another feature of the Citymaker tool is the fact that stakeholders are able to produce multiple possible scenarios in a short period. The Citymaker also gives the stakeholders insight in the relations between the functions and land-uses, which in turn should result in mutual understanding between the involved stakeholders and it should facilitate communication (Cheng, Kruger & Daniels, 2003). However, the Citymaker tool does not yet incorporate a proper benchmark for comparing these scenarios.

1.3 Objective and Research Question

In order to compare different scenarios within the Citymaker additional variables are desirable since comparisons can then be made on multiple aspects and in an integrated manner. The expansion of the Citymaker tool can be a first step towards an integrated approach towards inner-city development. This integrated approach should make it possible that the totality of a plan can be measured and benchmarked. The objective of this research is therefore; to expand the existing Citymaker tool with additional variables needed to determine the value or potential of an area. In order to accomplish this objective the research question of this thesis has been formulated as follows:

Could the Citymaker tool be able to gauge different scenarios with the addition of green and blue aspects in relation to urban vitality?

This thesis attempts to determine the significance of several aspects of the research question before focusing on expanding the existing Citymaker tool.

1.4 Methodology

First the evolvement of urban planning through time is explained in order to determine the main factors of the paradigm shifts through history. This thesis proposes that the change in urban planning paradigm is related to the form of development, which in turn determines the use of land. The latest paradigm shift of urban planning is embodied by several societal aspects but also affected by other factors such as sustainability and vitality that should be determined before looking into the advantages the Citymaker tool could have concerning this paradigm shift.

Secondly the properties of the Citymaker tool were researched in order to determine in what way this could be useful in the division of urban space. In order to do so the Citymaker tool was analysed concerning the methods e.g. the calculation processes within the tool and the usage properties of the tool itself. Afterwards the scientific relevance of the methods and processes in the Citymaker tool was determined. With the outcomes of the analysis of the Citymaker tool the connection to relevant scientific (urban planning) theories and concepts was made in order to determine where possible knowledge gaps concerning functions, land-uses and their division are. In order to acknowledge the relevance of the variables found within the theory these gaps will be cross-referenced with three case studies concerning the structural visions of three mayor Dutch cities and a separate structural vision of the Randstad metropolitan area.

Thirdly, the determined additional variables for the existing Citymaker tool were quantified in order to make them functional for incorporation in the existing Citymaker tool. This consisted out of determining measurable values, researching the relation between the other variables in the Citymaker tool and designing the digital model in which the additional variables are represented. Furthermore the meaning and effect of the outcomes of the calculations were defined. The final step in the research will be a reflection on the methods, proceedings and outcomes of the entire research, which will be addressed in the discussion.

2. Urban Planning Paradigms

2.1 Urbanization

According to Mastop (1998) the first signs of spatial planning in Western Europe occur in the 1920s and 1930s. The focus of these first planning experiences was mostly urban expansion. The built environment in Western Europe has urbanized rapidly the past centuries. In the early medieval times only a small percentage of the population lived in the few cities that were already founded in Western Europe. Nowadays about three-quarters of the population of Western Europe are city-dwellers, excluding the many millions that come to the cities for business or pleasure and return home afterwards (Antrop, 2004). Urbanization started under roman rule, also because of their war efforts that needed city-like encampments, which were left behind when the front moved on. The oldest cities of Western Europe are a result of such activities and although slightly stagnated after the Roman Empire fell apart the trend of urbanization continued (Jones, 1987).

2.2 The First Urban Developments

In the beginning of urbanization the cities developed in an organic manner usually around a central location. As a result most of these cities have a concentric ground plan. Moreover, activities within the cities were numerous. One of the few activities that were not practiced in the city was agriculture but livestock however was held within cities. For a long time this mix of activities was maintained (Hohenberg & Holen Lees, 1995). One could state that in relation to the economic principle of supply and demand the urban development was demand-driven during these early centuries of the existence of cities. When people for example required a form of housing, workshop or stable it was build on the next available location without contemplating the influence of the different activities on each other (Hohenberg & Holen Lees, 1995).

With the beginning of the industrial era the mixing of functions became a problem. Not only did the role of hygiene began to be understood but also the nuisance of the loud and smelly factories was being addressed. The result of these developments was that many cities moved their industrial functions to the edges of the city (Hohenberg & Holen Lees, 1995). Although the heavy polluting industry was moved there was still an intensive mix of functions in the city centres. At the beginning of the 20th century the developments of cities slightly changed, the first metropolises with more than a million inhabitants emerged and with it the problematic issues such as overpopulation and traffic congestion became inevitable. Aimed at economic growth the city centres became marketplaces for a wide variety of service providing and commercial businesses. It is during this era that the first suburban boroughs were founded and the idea of the separating functions emerges (Hohenberg & Holen Lees, 1995). Due to the Second World War the rising importance of spatial planning and urban development became side-tracked for some years but after 1945 the destroyed city centres of many European cities provided the perfect canvas for large-scale urban development in which the automobile played a bigger role (Antrop, 2004).

2.3 The Beginning of Spatial Planning

Although spatial planning theories and concepts existed and were applied for some time in Western Europe the 1960s and 1970s marked the beginning of spatial planning systems on administrative levels (Albrecht, 2004). Especially in the Netherlands spatial planning became somewhat of an art in which the Dutch excelled (Faludi & van der Valk, 1994). Although the beginning of the 1960s spatial planning was still focussed on the reconstruction of rural areas and urban development, the 1970s gave way to other urban principles (Hayer & Zonneveld, 2000). These principles were related to the compact city concept by Dantzig and Saaty (1973) and promote high density and mixed land-uses facilitated by an efficient network of infrastructures and public transportation. These compact cities were often located on a moderate distance from the main city. This resulted in satellite-like cities were people lived while working in the city or on the fringes of these new cities that accommodated industrial areas and office districts. The decisions that determined the locations where these cities were to be developed were usually formed by a top down process (Haccoû & Feddes, 2007). In that sense the connection with the concept of supply and demand could be made again by arguing that the government was determining the supply of housing. Moreover, the decision processes that lead to the determining of the residential locations was strongly influenced by political factors since the Ministry of Housing and Spatial Planning became a significant participant in urban development. Furthermore, the influence of economical factors grew in determining where one could live since the districts became more homogeneous in terms of social economical status (van Kempen & Bolt, 2009).

Going into the 1990s however there was a new shift. The division of functions and land-uses in cities had lead to a fragmented urban environment, spatial as well as social (Robinson, 2005; van Kempen & Bolt, 2009). The negative effects of this fragmentation such as; traffic congestion, air pollution and the loss of community sense are numerous (Song & Knaap, 2004). This so-called urban sprawl was only becoming a bigger problem due to rapid transportation, that made it possible for people to live further away from their workplaces. It needed to be contained before the whole landscape became urbanized (Antrop, 2004). According to the American planning Association (1998) the antidote for urban sprawl was mixed land-uses since as they stated that a greater mixture of complimentary land use types can be beneficial for multiple social-economical issues in the fragmented cities. Additionally with an increase in sustainability attention at the end of the 20th century the importance of mixed land-uses became even more eminent because of the potential advantages it could have for a sustainable urban form (Jabareen, 2006). From a environmental point of view mixed land-uses and functions reduces the number of cars used for commuting and leisure trips, since offices, shopping stores and leisure facilities are located nearby (Van and Senior, 2000).

The reasons for implementation of mixed land-uses are social, economical and environmental (Rowley, 1996). Furthermore another analogy with the economical principle of supply and demand could be made by arguing that the development model is once again becoming a demand driven market model since the functions or a specific location are depending on what is useful i.e. demanded by the public. This argument is further justified by the paradigm switch towards a more collaborative development processes in the urban environment in which the inhabitants or users become involved in the developments of their surroundings (Jiang, Huang & Vasek, 2003).

2.4 Mixing of Land-Uses and Functions

Simply sliding uses into another or stacking them cannot accomplish the mixing of functions. Instead of thinking in spatially distribution of functions a paradigm shift towards thinking about the combined use of space and its users is needed (Spit, 2000). Apart from that the zoning plans of past governments have lead to rigidity, exclusion or displacement of functions, which made mixed functions difficult to realise (Weebers, 2007). This phenomenon was started in the Netherlands by the housing plan of 1901, which was one of the first forms of spatial planning in Western Europe. In effect, the housing plan was a reaction on the societal discontent with overcrowding cities and the lack of light, air and green within the cities. The housing plan therefore imposed a separation of industrial activities and residential activities. (Haccoû & Feddes, 2007).

One can imagine that more than hundred years of planning conform a certain paradigm is not easily changed. Although the paradigm of urban development is changing since the users have become developers, developers became facilitators and the governmental institutions are slowly loosening their grip on the built environment the new paradigm has not been determined (Eraydin, 2013). The transition that is needed according to Teisman (2007) to make mixed land-uses and functions possible starts with a transition from mono-use zoning plans on paper to the mixed-use spatial reality and the tension between creating order in the city and mixed use developments or opportunities.

Within this new urban planning paradigm there would still be an enormous amount of possibilities to devise an urban environment but no subjective manner to asses the plans or design. Landry (2000) stated that the vitality of a city would form a new source for urban competitiveness or benchmark. Since the concept of urban vitality can be used to compare several cities in order to state which one surpasses the other, the concept could also be used to compare different scenarios that are devised within the Citymaker tool. However, before doing so the concept of urban vitality should be explained.

3. Aspects of a Vital Urban Environment

3.1 Urban Vitality

According to Landry (2000) Urban vitality is the raw power and energy within a city. When focussing and directing it towards a purpose the city becomes viable. Urban vitality is the result of a long-term process of appreciation of the users of urban space. Eventually the users and private investors give impulses and content to the public and private locations within the urban environment (de Bois, 2010). According to de Bois (2010) a vital city has not only the ability to facilitate the slow physical spatial transition of the city over time but also keep it going. Only then can there be and effective and sustainable social-economical relationship between suppliers and users of the city, which in turn conditions an evolution of the urban environment. Nonetheless a vital city is not per se a modern city, planned according the ruling paradigms. It is a city that keeps renewing itself and it's users.

Apart from the fact that urban vitality could be used as a adequate benchmark for comparing scenarios within the Citymaker tool, additional arguments for the implementation of urban vitality are found in policy documents concerning urban planning. A case study of the Randstad metropolitan area vision document shows that vitality of the urban space is a relevant aspect of the future vision. Vitality is referred to in relation to the infrastructural accessibility; when adequately connected to the infrastructural networks surrounding the city, vitality rises. Moreover vitality is also refereed to in relation to redevelopment and transformation. The vision document states that with a higher mix of functions the vitality should increase. Additionally the same is stated concerning the mix of social-economical groups within a city. With a mix of both aspects more facilities becomes viable to exploit and will therefore be developed, which in turn increases urban vitality (Ministry of Housing, Spatial Planning and Environment, 2008). Obviously there is a potential maximum of functions that can be combined according to Montgomery (1998) this maximum is defined by the adaptability of the several functions. When the separate functions can no longer adapt to each other the resulted tension diminishes urban vitality.

According to de Bois (2010) the processes described above begins with the vitality of the urban space, which exists in the physical domain that facilitates and defines the interactions in the social domain. The interactions in turn effectuate investments, which are part of the economical domain. This thesis will focus mostly on the physical urban vitality, however some variables may be needed from the social and economical domain. In order to effectively examine the physical domain the Citymaker tool has to be a representation of the complete urban environment. Therefore additional aspects should be researched.

3.2 RGBG method and VROM-approach

With regard to urban vitality the different land-uses and functions within an area are of significance since several urban vitality factors are related to the division of land-uses and functions. Concerning inner-city developments, the complexity of the separate land-uses and functions could become a problem. According to De Bruijn, et al. (2002) one must not want to try to control the processes in the urban environment. The complexity that is characteristic for spatial issues should be respected and rather than trying to understand this complexity one should make it manageable by dissecting it into several parts of reduced complexity. In order to avert complexity this thesis will use a division into four main function clusters inspired by the RGBG scenario analysis and design method of De Bois and Buurmans (2006).

RGBG stands for Red, Green, Blue and Grey. The red cluster consists of the built programme and residential dwellings land-use. Functions such as green public space, nature and recreation are grouped in the green cluster. The blue cluster relates to all the water related land-use, from a small pond to a lake and other linear elements. The grey cluster consists of all public infrastructural land-uses such as roads, rails, bridges and flood defences. According to the developers of the RGBG method there are two sides to the method. The first side is an instrument for the division of space in the colour clusters and the point (function), linear (structure) and plane (form) elements as described by Jakle (1987). The other side of the method is using this knowledge of the location of the elements in relation to the interests of stakeholders. The method of the RGBG method is based on non-verbal cooperation between participants. Discussion will trigger the need to convince opponents in order to make deals and end with a possible -presupposed- optimized opinion, concept or approach. This will create just one result, one concept or strategy instead of a collection of possible developments generating different possibilities of optimisations or concepts and business cases where stakeholders meet. Based on the assumption that an urban environment is a combination of socioeconomic and spatial interactions, urban flows and places the method generates visions regarding the most adequate locations, assignment, design and maintenance for the several land-uses in order to develop a vital urban environment accommodating the different stakeholders. (de Bois & Buurmans, 2006).

Apart from the relation between the clusters the balance of accessibility is also of relevance. According to Carr, et al. (1992) every space that is used by multiple persons has a balance between public and private. The remaining space, which is neither private nor public, is usually privately owned but publicly accessible and defined as collective space (Carr, et al, 1992). The balance that is desired depends heavily on the existing culture. Carr, et al. (1992) state that lower social-economical groups desire more public space than more empowered social economical groups. Moreover, this balance is not applicable in every RGBG cluster, the red and green land-use clusters are usually divided in private and public areas whereas grey and blue land-uses are predominantly public.

However, apart from the land-uses in an area that needs to be regenerated the area itself and its present condition are also of importance. Most dwelling areas that are suitable for urban renewal or redevelopment are post-war housing areas. They have deteriorated the past decades because of a multitude of problems (Posthumus, Bolt & van Kempen, 2013). Slob, Bolt and van Kempen (2008) identify poor maintenance of building resulting in physical deterioration. Also the flow of low-income households, and ethnic minority groups towards these dwelling areas kept increasing over the past decades. In combination with the high unemployment levels this social economical mix resulted in a lack of public safety related to an increase in criminality. The strategy of the governments to stimulate mixed population revealed to be inadequate since the original inhabitants moved away from these dwelling when economically possible (Musterd, 2008).

In order to renew or redevelop these post-war dwelling areas the former Dutch ministry of Housing, Spatial Planning and Environment often mentioned with the Dutch acronym VROM devised an approach concerning post-war dwelling areas. After extensive research VROM determined four elements that are applicable to most post-war dwelling areas. (**1**) The core, often an urban core with high-rises and commercial businesses or a green core such as a district park. (**2**) The edge, often defining the boundary of the area by high-rises or green buffers. (**3**) The networks, concerning which division has been made between, roads, squares and pathways on one hand and parks, green verges and waterways on the other hand. (**4**) The living fields, related to the type of urban structure (Josselin de Jong & van der Knaap, 2005). The VROM-approach further defines three manners how renewal or redevelopment can be attempted; (**1**) Redesign, where no changes will be made to the structural element but the aesthetic properties can be changed, demolition could be possible as long as the urban structure remains intact. (**2**) Transformation, changes can be made within the structural elements, streets and buildings can be changed entirely but also their function. (**3**) Replacement, when a structural element is interchanged by another element (Josselin de Jong & van der Knaap, 2005).

The use of both the RGBG method and the VROM-approach can further be justified by the fact that the Citymaker tool was developed for a more efficient and effective dissection of urban space in mind. The changing urban planning paradigm asks for a more efficient division of urban space and the combination of structural element should be as effective as possible since the recession reduces the available resources (Lovering, 2010). Where the RGBG method focussed on defining the existing or potential use of land and the effects and assets for strategic relations and utilization of this on the functionality and vitality of the urban environment, the VROM-approach focuses on the combination of structural elements in the urban environment and the efficiency of this combination. In relation to the Citymaker tool the VROM-approach could be used to assess the efficiency of the existing situation. The RGBG method in turn could be used to assess the effect of the land-use division and whether or not this effect is the desired situation. In addition, both methods are in effect a legend for certain aspects of the urban environment; both methods have different visual representations for specific characteristics of the urban environment. Furthermore, there is also a hierarchy between the aspects of the two methods that connects them. The role of a structural element can have different land-uses, e.g. a green core or grey network. A land-use in turn can have different functions, e.g. housing and industry are both built up (red) land-use.

Although not explicitly mentioned in either method the role of public or private relevance is also an aspect that should be taken into account when dividing land-uses and functions. However, a distinction between public and private will not be sufficient. Within this thesis public space is defined as accessible to everyone and the space in which everyday life takes place (Carr, et al, 1992). Private space is privately owned. The owners do not agree upon anyone entering their space. Additionally the distinction of collective space should be made, which lies in between public and private space. These are defined public spaces with a very specific goal. These goals make them uninviting to access for strangers.

The manner of urban renewal and redevelopment within post-war dwelling areas is of significance since the research will be related to expanding the possibilities for the Citymaker tool. This could be used to determine the consequences of interventions in the urban environment. The Citymaker tool is a tool that can calculate the consequences of changes in the urban environment concerning multiple aspects of area development such as; sustainability, declining demographics, temporary uses and the overarching paradigm shift of developing several scenarios in order to determine the most adequate one in stead of one fixed masterplan. Understandably more rudimentary aspects such as real estate and parking issues are also incorporated in the tool (Hoffmann and Engels, 2013).

3.3 Green and Blue Aspects of Inner Cities

Before going into the aspects of the green and blue clusters a demarcation concerning the relevant urban typology should be made. In the previous decade a shift became visible within urban development from greenfield developments of suburban neighbourhoods to inner-city redevelopment in the form of revitalization of housing or brownfield development (de Roo, 1998). This thesis will focus on inner-cities, partly because of the trends and developments in urban planning mentioned above. But also because systematically approaching the urban environment and dissecting it a better understanding of the urban system could deliver a significant contribution to this urban typology regarding the complexity of inner-cities urban systems.

As mentioned the Citymaker tool also facilitates sustainable urban development. According to Shemirani & Moztarzadeh (2013) the sustainable urban development paradigm is the most relevant planning paradigm of this decade. The relevant aspects of urban development within this paradigm are adequate urban infrastructures, new models for financing and managing urban infrastructures. Urban infrastructures are divided in social, ecological and spatial networks (Newton, 2007) and according to Newton and Bai (2008) issues surrounding water management and habitat preservation are of importance. The connection to green urban elements and water elements is therefore relatively obvious. Furthermore, the relation to the social network and especially liveability is also mentioned as a significant factor within sustainable urban development (Newton & Bai, 2008). The choice within this thesis for the addition of water management issues, green public space and green urban elements is further acknowledged by Kenworthty (2006) who states that these aspects are part of the systems within a city that function as the life support systems.

Although several green and blue aspects are mentioned in the sustainable development theories it is desirable to acknowledge these outcomes within the three case studies. Concerning the green and blue clusters the several mentioned municipalities have a different focus, partly because of the geographical location of the municipality but also because of the businesses the municipality accommodates. Hereunder the several structural concepts of the municipalities will be addressed in order to create an adequate view of the primary aspects concerning the blue and green clusters form which possible additions to the Citymaker tool could be derived. The municipality of Amsterdam (2011) distinguishes the advantages of more green and blue land-uses, concerning green land use these advantages are; the evaporation of moisture in the air, reducing carbon dioxide, nitro dioxide and particulates in the air and more biodiversity. The advantage of more blue land-uses is the retention of water, mostly during heavy precipitation but also the rising sea levels that influence Amsterdam because of the open connection to the North Sea. In order to realize the wish for more green and blue land-uses the municipality of Amsterdam (2011) defined several examples of spatial interventions that would facilitate this wish such as; Rooftop gardens, small street parks, urban trees and urban farming.

The public officials in Rotterdam put more focus on the blue land-uses than Amsterdam since the most important business activity in Rotterdam is the harbour. The municipality does not only intervene in the spatial environment to facilitate water retention but the buildings and infrastructures are increasingly being constructed to be able to function with higher water levels. Concerning the green land-uses the municipality of Rotterdam (2011) states that the urban environment should be adapted in order to provide more trees filled avenues, green facades and rooftop gardens. Another important aspect according to the municipality of Rotterdam (2011) is the presence of an adequate green network through which the flora and fauna can develop and the development of urban farming within the city.

Within the municipality of Utrecht the vision document focuses on the presence of an adequate network. The connection and experience of the green and blue land-uses is an important factor for the municipality of Utrecht (2004). As with the municipality of Rotterdam the connection of the green land-uses is related to the biodiversity in the city. However, the importance of the experience of the green land-uses makes the accessibility and aesthetic aspects of the green land-uses a significant focus. Concerning the blue land-uses the focus of the municipality of Utrecht (2004) lies with the retention of water of precipitation and run off water from the nearby Utrechtse Heuvelrug. The municipality of Utrecht (2004) defines the focus of the interventions concerning the green and blue land-uses as; the creation of a robust green-blue network within the city and the region.

3.4 Conclusion

Derived from sustainable urban development theories and acknowledged by the several vision documents of the three cities table 1 depicts the predominant spatial interventions within the existing Citymaker tool urban environment of Dutch inner cities.

Amsterdam	Rotterdam	Utrecht
Water retention areas	Water retention areas	Green network
Rooftop gardens	Tree filled avenues	Blue network
Small street parks	Green facades	
Urban trees	Rooftop gardens	
Urban farming		

Table 1 Green and blue aspects of inner cities (de Koe, 2013)

Concerning the blue cluster this thesis defines one aspect of significance, which is the retention of water or **blue public space**. However, other influences of urban water in cities could be the cooling effect (Nakayama & Fujita, 2010) and the positive perception of naturalness (Roos-Klein Lankhorst, 2012). Concerning the green cluster this thesis defines two aspects that are of significance. The first aspect is the **green public space** embodied by the spatial elements; urban trees and small street parks. Secondly, this thesis defines the **green building package** consisting of (rooftop) gardens and green facades. These aspects can also be related to the previous mentioned blue aspects since the green surfaces are beneficial for the retention of water (Mentens, Raes & Hermy, 2006) and green elements in the urban environment can also lower the temperature (Shashua-Bar & Hoffman, 2000).

4. Relevant Parameters, Variables and Norms

4.1 Description and Selection

In order to create a clear view of the relevant parameters, variables and norms a clear definition of these terms for the remainder of this thesis is needed. **(1)** Parameters are defined by the Oxford English dictionary as; *'A numerical or other measurable factor forming one of a set that defines a system or sets the conditions of its operation.'* Within this thesis the calculated value will therefore be defined as a parameter. However, every parameter is a variable when not being the subject of the calculation. **(2)** Variables are defined as independent, measurable values, both quantitative and qualitative. They are a numerical image of the urban environment. **(3)** Norms are defined as a pre-set value and can be determined by three different factors; policy related, qualitatively induced or scientific research.

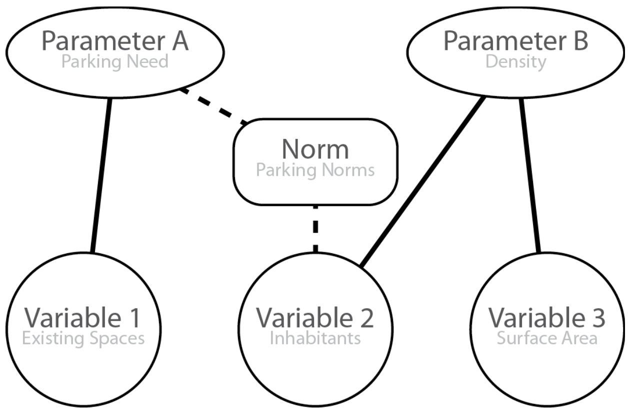

Fig. 1 Relation between parameters, variables and norms (de Koe, 2013)

In figure 1 the relation between these terms are further explained. A parameter is connected to variables or norms. For each parameter multiple variables could be of relevance but not every parameter has a relevant norm. The combination of a variable and a norm are able to calculate a parameter. As depicted in figure 1 a variable such as the number of inhabitants could be decisive for multiple parameters. For example; density is defined as the number of inhabitants per square kilometre. However, the parking need is determined by the combination of the number of inhabitants, which is multiplied by the parking norm and reduced by the already existing parking spaces. An important issue concerning the variables is that there is a difference between determining and depending variables or a combination of both. The surface area for example is a determining variable in relation to the density. The number of inhabitants in turn is dependent of the number of households but also determining for the density. The existing parking spaces however are not dependent of any other variable but only determining.

In order to connect additional variables to the Citymaker tool an adequate variable has to be pinpointed within the existing variables in the existing Citymaker tool. Appendix A depicts a schematic representation of the variables in the existing Citymaker tool. Within the Citymaker tool a division can be made between determining and dependent variables, additionally a thematic division can be made. When doing this there are four groups of variables present; **(1)** Determining Spatial Variables, **(2)** Depending Spatial Variables**, (3)** Depending User**/**Usage Variables and **(4)** Depending Financial Variables.

The presented scheme in Appendix A will be used to depict the relation between additional parameters, variables or norms and the existing Citymaker tool. The choice of what variables should be added to the existing Citymaker tool proved to be more difficult especially when a working example is required. Previous research (de Koe, 2013) indicated that the addition of variables needs substantial amounts of research and additional data. Although the previous chapter defined several relevant aspects of the urban environment this thesis will not attempt to devise additional parameters within these aspects. However, with the expansion of the green and blue elements that can be implemented in the tool the model will be able to define more of the urban environment. When the tool defines smaller green and blue elements within the urban environment, more precise statements about mixed land-use are possible.

4.2 Measuring Vitality

As explained in section 3.2 the RGBG method is not only an instrument for dividing de urban environment in four clusters but also an analysis method for an adequate positioning of land-uses in an area in such a way that they complement each other. According to Landry (2000) these complementary properties are not limited to the physical environment. He states that the vitality of a city depends on the manner in which the social, economical and physical factors complement each other. Since section 3.4 defined several green and blue aspects that are of relevance in the urban environment all clusters can be adequately represented in the Citymaker tool and it should be possible to measure the vitality. However, before doing so a number of relevant parameters should be determined. Laundry defined multiple variables that are of significance for urban vitality. De Bois (2010) combined these variables into a matrix and determined several success factors in the physical, economical and social domain. Concerning the physical domain de Bois (2010) defined the level of; adhesion, reachability, connectivity, range and accessibility as success factors. The level of; uniqueness, functional variation and density determine the success of the economical domain. The level of meaning and identity of a place determine the success within the cultural domain. However, as stated the urban vitality is determined by the complementary properties of the four clusters in the physical, social and economical domain.

4.3 Conclusion

This thesis defines five parameters that were determined since they relate to the urban vitality success factors of de Bois (2010). The choice for these parameters was made with the relation to the existing Citymaker tool in mind. The five additional parameters that should be able to determine the urban vitality are; **(1)** population density, **(2)** usage intensity **(3)** mixed land-use, **(4)** public – private ratio and **(5)** variety of functions. Most of variables and norms needed for calculating these parameters are already present in the existing Citymaker tool. However, there are some other variables and norms needed.

The choice for these parameters can be related to the cognitive profile of urban structures of Buurmans (2006). Within this theory three levels are defined; frame, pattern and circuit. These three levels are related to each other and can make a city function poorly when not properly supported by each other. Buurmans (2006) defines frame as the complete network of streets, squares and parks, pattern is defined as all possible destinations and landmark and circuit is defined as the chosen system of routes and networks. Another possible analogy is that the frame embodies the collective and public hardware whereas the pattern and circuit embodies the private user systems or software. Within this theory a certain conditionality between the three levels is apparent since software cannot function without hardware. The same is true for destination and landmarks since they cannot be used without an adequate infrastructural network.

In relation to the urban planning and design process frame can be defined as the plan area for example as seen on a topographical map, pattern consist of the program of facilities, destinations and places. Circuit relates to the actual use of the program. Figure 2 depicts the conditionality between the five chosen parameters in relation to the cognitive profile.

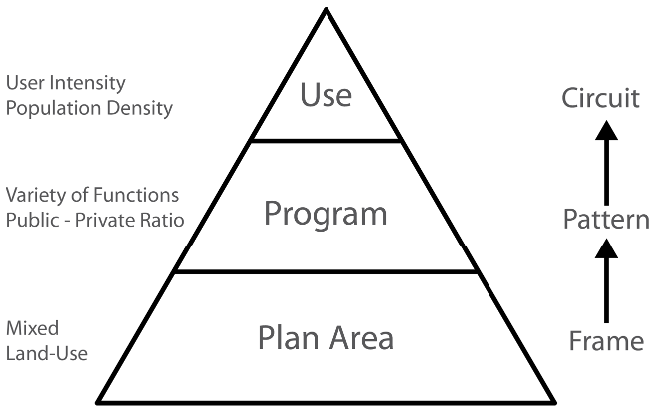

Fig. 2 The chosen variables in relation to the cognitive profile of urban structures (de Koe, 2013)

As depicted in figure 2 the mixed land-use represents the plan area since the land-use determines the layout of an area. Concerning the program the variety of functions parameter represents the elements of the program and public – private ratio the ownership. In relation to the use of the built environment the population density represents the use of the built up area and the user intensity represents the use of public space. As depicted in figure 2 the chosen variables represent all three levels and are therefore conditional for each other. Without a plan area there would be no program let alone usage of the space.

In relation to urban vitality the five chosen parameters are suggested to cover the physical, social and economical domain (de Bois, 2010) and could therefore gauge the urban vitality of an area. The population density is related to the physical and social domain since it is related to the inhabitants and the area's size. Usage intensity in turn is related to the physical and economical domain because physical space is being used and often in the close relation with economical activities. Mixed land-use can obviously be related to the physical domain but also to the economical domain since mixed land-use could generate value (van Rooy, 2011) as does a variety of functions. Lastly, the public – private ratio is related to the physical domain and the social domain since it has to do with the accessibility of space and the related choices of inhabitants.

5. New Parameters in Relation to The Citymaker

5.1 Comparing Scenarios and Devising Formulas

Since the use for the new parameters is related to the comparison of scenarios the relation to the existing Citymaker tool variables will be made concerning the planned situation. This demarcation has been made in order to reduce the complexity of adding the necessary variables to the existing Citymaker tool. However, thought has been given to the situation in which a scenario is requested which represents doing nothing, the so-called 'laissez faire' scenario. According to Hoffmann (2013b) such a scenario can be simulated within the Citymaker tool with extensive input on the existing situation and withholding any input concerning the future scenario. This will result into a planned scenario that is similar to the existing situation, which can in turn be compared to other scenarios concerning urban vitality with the five new parameters.

In order to connect the new parameter to the existing Citymaker tool this thesis will devise a formula for every new parameter. The needed variables within the formula will be color-coded in order to visualise whether or not the variables are present in the existing Citymaker tool. When present in the existing Citymaker tool the variable will be blue and variables that need to be added will be red. In order to further describe and visualise the new parameters and its workings Appendix B will consist of a spreadsheet with the outcome of working formulas concerning the new parameters and the relevant variables.

5.2 Population Density

The definition this thesis has for population density is the number of people per square kilometre as is commonly used in the Netherlands. Every new parameter within the Citymaker tool model needs to be connected to existing variables and when possible extracted from existing variables. The first parameter, population density, needs no additional variables and can be extracted by dividing the number of inhabitants by the square kilometres of plan area. A schematic representation of this formula can be found in Appendix C. For population density the formula would be;

=(# INHABITANTS / (KM2 PLANAREA))

However, apart from being able to compare the density there should also be a scale that gives these density levels meaning. Concerning the density levels Gleaser (2000) states that higher density levels will continue to be valuable for the vitality of cities since the fuel creativity and productiveness. Too high levels, however, make a monotonous city that does not have any identity. Pont and Haupt (2010) defined four thresholds concerning population density. **(1)** 4000 inhabitants per square kilometre (difficult to provide community thus low vitality), **(2)** 26000 inhabitants per square kilometre (wide variety of facilities thus moderate vitality), **(3)** 35000 inhabitants per square kilometre (urbanity thus high vitality) **(4)** 70000 inhabitants per square kilometre (standardization and absence of diversity thus low vitality). With this classification one can compare the scenarios and relate it to the urban vitality. However, these values are related to American cities, which are not comparable with Dutch cities. Although the classification above gives some insight in the role of density concerning urban vitality a value that represents a Dutch vital city is necessary. In a study that compared Chinese and Dutch cities related to urban vitality Zhou (2012) states that a population density comparable to that of Amsterdam-Zuid seems to be an adequate value for urban vitality in Dutch cities. According to the Municipality of Amsterdam (2010) the population density in Amsterdam-Zuid is 8624 inhabitants per square kilometre. This value will therefore be applied as an ideal population density value within the comparison of scenarios.

5.3 User Intensity

According to Gehl (2011) the quality of the urban environment influences the number of activities that takes place. This acknowledges the connection between the use and the physical features of space. In order to determine the usage intensity the existing Citymaker tool needs to be expanded with several variables. First, every function in the existing Citymaker tool needs to be related to the generation of urban flows. Secondly, the generation of flows per function needs to be determined. Although considerable time was spend finding these usage intervals the available time within this research proved to be inadequate. Therefore the usage intervals are an assumption based on the average opening hours of the several functions.

With these values the intervals of flows in the plan area can be calculated. Appendix D depicts the values in relation to the existing Citymaker tool. The calculation that can determine the user intensity will be related to the 24 hours per day. Therefore the usage intensity is defined as the hours the area is used, presented as a percentage of the day. In order to make this calculation the usage or lack of usage of urban space on every hour of the day should be defined. In the spreadsheet of Appendix B a ‘Y’ for usage and a ‘N’ for no usage facilitates this. When using a pre-conditional formula to add the usage hours together and dividing this by the total hours in a day the usage percentage is calculated. The formula would thus be;

=(SUM.IF(HOURS OF THE DAY,"Y")/24)

The percentage that is calculated by the formula is relative simple to interpret since the higher the usage intensity the more vital an area is (Montgomery, 1998). So when comparing different scenarios the highest percentage adds the most value to the area.

5.4 Mixed Land-Use

Montgomery (1998) states that a precondition for vital urban areas is that it serves multiple purposes. Although he is mostly referring to multiple functions, the mix of land-uses is another factor that facilitates urban vitality. A lot on which more than one land-use is represented could be able to provide more functions, which also increases urban vitality. According to Hoppenbrouwer and Louw (2005) mixed land-use can exist in multiple dimensions. They define four dimensions **(1)** the shared premise dimension, when two uses are located in the same building, **(2)** the horizontal dimension, when different land-uses share the same lot, **(3)** the vertical dimension, when different land-uses are stacked on each other and **(4)** the time dimension, when the uses changes over time. For this thesis the shared premises, vertical dimension and time dimension are of significance since the shared premises dimension relates to the land-use mixed concerning green and blue cluster (e.g. green facades). The vertical dimension can be related to the mix with the grey cluster (e.g. subterranean parking). The time dimension relates to the periodically change in use of green or grey cluster elements (e.g. water retention).

In order to connect this new parameter to the existing Citymaker tool several new variables should be devised. Since defining land-use mixes in the existing Citymaker tool is limited to parking facilities or the grey cluster the green and blue cluster should be added. The mixed-use variable of the green cluster will consist of the choice for green rooftops, green facades and parking garages under green land-uses. The mixed-use variable of the blue cluster will consist of the water retention areas, either in grey land-uses (e.g. water squares) or green land-uses (e.g. flow fields). In Appendix E these additional variables and their relation to the existing variables are depicted. To determine the level of mixed-use in a plan area the new parameter will be a calculation of the lot sizes of the different mixed land-uses divided by the total plan area. The formula for this parameter would be:

=(SUM(M2 FUNCTION MIX GREY, M2 FUNCTION MIX GREEN, M2 FUNCTION MIX BLUE) / M2 PLAN AREA)

The outcome of this formula will be a percentage of the surface area that has mixed use. The choice for a percentage is related to the MXI method of Van den Hoek (2008) who also uses a percentage to classify an area. The higher this percentage, the more vital an area likely is according to Evans and Foord (2007) who state that a physical land-use mix is one of several drivers of urban vitality through urban sustainability.

5.5 Public - Private Ratio

Important concerning this parameter are the definitions of public and private space. As stated in section 3.2 this thesis defines three types of spaces; public, private and collective space. The variables within the existing Citymaker tool that are of significance are also divided among these three types of spaces. In relation to the public space the variables of the surface area of green, water, parking, streets and squares are of importance. Concerning private space the percentage of allocable land is the significant variable. The surface area of significant function areas (e.g. embankments) and the environmental zones (e.g. dune filtration areas) will determine the collective space since these spaces are often nor public nor private. Banerjee (2007) would describe similar spaces as publicized private space or privatized public space depending on the ownership arrangements. Since the collective space is publically accessible these areas will be added to the public space. A schematic representation of these variables is depicted in Appendix F. The formula of this public – private ratio will be devised by adding the public and collective space and dividing this by the private space and would be as follows;

=SUM((M2 PUBLIC SPACES),(M2 COLLECTIVE SPACES)) / M2 PRIVATE SPACES

The outcome of this calculation will be a ratio that represents the balance between public and private space. Since social interaction takes place in public spaces an area with more public space than private space is probably a vital area. The use of public space will result in users frequently coming into contact with one another and will support phenomena like social cohesion and safety (Holland, et al. 2007). The higher the ratio the better effect is has on urban vitality.

5.6 Variety of Functions

This new parameter is relatively simple since the existing Citymaker tool defines several functions and the variety of functions addresses the number of functions present in the area. In relation to the existing Citymaker tool three groups of variables are of significance. The possible facilities, housing types, divided in stacked dwellings and ground bound dwelling and the several public spaces functions. When connecting these variables to their presence in the scenario it becomes possible to extract the number functions present in the scenario from the existing model. In Appendix G this is schematically depicted. The formula for this parameter would be:

=SUM((LIST OF FACILITIES),(HOUSING TYPES),(PUBLIC SPACES))/PLAN AREA

When addressing the outcome of the formula the meaning needs explanation. According to Zukin (1998) the more functions present in an area the more people and the more different lifestyles are using the space for their activities over longer periods of time. Consequently the public space of multifunctional scenarios will be more attractive both during the day as by night. Accordingly, the higher the value of the formula outcome the more vital the scenario is.

5.7 Determining Urban Vitality

With the five parameters presented in chapter 5 the several scenarios a can be compared. In Appendix B (page 7) the outcomes of three scenarios are presented. However, in order to be able to state which scenario is the most adequate concerning urban vitality a method of distribution of points should be devised for every parameter. Although the individual parameters are already classified the urban vitality value depends on the relation between the classifications.

This thesis proposes that the scores of the different scenarios will be compared and each scenario receives points for every parameter. In order to adequately illustrate the mutual differences a classification of ten steps was devised with a minimum of one point and a maximum of 10 points.

The density parameter has been calculated through the number of inhabitants per kilometre where 8624 inhabitants is an ideal score. The comparison is made with the percentual deviation of the scenario score in relation the ideal. Hereby 0% deviation will receive ten points and every five percent deviation will reduce the score by one. This means that more than 50% deviation will always receives one point. However, although the deviation can be positive or negative this should not affect the score since both a too high a density and too low densities are both negative for urban vitality.

Concerning the user intensity parameter the higher the percentage the more vital the urban environment is. Hereby every 10% of user intensity will receive one point. For example, 79% will receive eight points and 83% percent will receive nine points.

With the mixed land-use parameter the total surface area with mixed land-use is determining for urban vitality. Hereby every 10% of surface area with mixed land-use will receive one point. For example, 40% will receive four points and 60% percent will receive six points.

In relation to urban vitality the height of the public private ratio defines the level of vitality. Since a ratio of one represents a balance the scenario ratios are classified between 0.5 and 1.5 and divided in ten classes. Ratios of 0.5 and lower receive one point and ratios of 1.5 and higher receive ten points. The steps therefore have a magnitude of 0.1. A ratio of, for example 0.77, receives three points.

The variety of functions in relation to urban vitality is calculated as the higher the variety, the more vital the environment is. Within the existing Citymaker tool 22 functions are defined. Since an urban area always has at least one function supported by an infrastructure network in order to connect it to surrounding areas there are 20 functions left to determine the variety of functions. In order to get the proposed ten-step classification every two present functions will receive one point. For example, nine functions present in the area will receive five points and six functions present in the area will receive 3 points.

In order to determine which scenario is the more vital the scores of all parameters are combined and the scenario of scenarios with the most points will be labelled the 'More Vital Scenario'. The Scenario with the second highest score will be labelled 'Second Vital Variable' and the lowest score will be labelled 'Less Vital Variable'. When the two lowest scores are equal both scenarios will be labelled 'Less Vital Variable'. Obviously the more vital scenario does not necessarily mean is the most adequate scenario for the plan area. Since so many variables are being calculated the most adequate scenario does not only depends on the urban vitality. However, when several scenarios are similar on multiple aspects the urban vitality parameter could be determining for the final choice of the developers of the plan area.

6. Lessons Learned

During the course of this research several issues have became apparent. Although the existing Citymaker tool gives a good insight in the process of (re)developing a area insights in the system of that area proved to be a enormous task that will probably never end since the current demographic and climatic trends will lead to even more complex cities with numerous innovative solutions. The risks of too complex systems and failure to understand them is acknowledged by Holling (2001) who states that complex human systems of which are present in the urban system is one, are distinguished by three features; foresight, communication and technology. Foresight in relation to the urban system can be defined as predicting certain aspects of the process within a city or the behaviour of its users. However, when strictly planning on these predictions a false prediction could have significant consequences. Communication is an important factor in planning processes (Cheng, Kruger & Daniels, 2003) but also has its pitfalls. Since experience and knowledge are transferred, tested and stored over periods of time the possibility of distorted information becomes a reality and systems relying on this information will therefore also be inadequate. The relevant information on which a system relies should therefore be adequately monitored and be kept up to date. The last feature of complex human systems is technology. Because of technology every aspect that is or becomes present in the system can be very quickly spread out through the whole system and in time this will only be quicker. The risk of course is that malicious aspects are also swiftly spread out with all its consequences (Holing, 2001). This research however has generated the notion that although the urban system is very complex, an approach in which you focus on a specific subsystem and closely watch that system can lead to an adequate understanding and management of said subsystem.

Another issue that was encountered is that of the power of classification when comparing spatial processes or plans. During this research the comparison of the several scenarios became an important factor. Although this comparison grew to its current form, the initial phase the classification was not as extended and it became clear that this was insufficient. Classification allows us to arrange a thematic message, how adequately this is done depends largely on the ability to understand the phenomenon. The knowledge of the phenomenon therefore needs to be transferred, especially when analysing several phenomena or scenarios this classification is needed in order to visualize the differences (Dent, 1999). Since this research compares three scenarios in which five urban aspects are combined it became apparent that a classification was needed in order to gives enough weight to the different aspects. And although the users of the tool will not directly perceive the classification the weight will be visible and that is the knowledge that has to be adequately transferred from the model to the user.

7. Discussion

At the start of this research the absence of a method for the gauging of several scenarios was the main reason for researching the existing Citymaker tool and the possibilities is has for expansion. During the research it became apparent that this is indeed possible through the concept of urban vitality. Since the concept of urban vitality consists of multiple aspects of the urban environment has demonstrated to be an adequate benchmark for comparing the different scenarios devised with the existing Citymaker tool. Furthermore the role of green and blue aspects within the urban environment has also been demonstrated both by its presence in the vision documents of the case studies as well as their significance within the additional model concerning mixed uses. This significance is further justified by the influence of green and blue aspects on housing prices in the Netherlands as Luttink (2000) illustrates in his research. Merely a view of either aspect in the built environment can raise prices with more than ten percent. This relation between urban vitality through blue and green urban space and real estate is an important one. Moreover Sternberg (2000) recognises the importance of a free real estate market in relation to a vital urban environment as he states that an unhealthy market can potentially destroy an up to then vital urban environment. This interaction should therefore not be downplayed.

In line with these relations the devised model also has some shortcomings that could be the subject of further research. Every intervention and/or aspect in an area also has financial consequences be it in terms of development or maintenance. These consequences are also a part of the real estate calculations of the stakeholders that in part determine whether or not a project is feasible. These consequences can be divided in financial consequences and environmental consequences. The latter are also of influence for the financial aspect of a development for example in the form of energy consumption. The additional variables of the green and blue package and green building packages will have consequences when planned in a project. Determining what these consequences are could be a significant enhancement for the Citymaker tool according to Wolting, Bregman & Pool (2006) who states that the financial framework concerning area development becomes more and more important. Not in the last place since the complex forms of project management, which combine public and private parties into one project, require a different focus concerning the budget.

Another aspect that deserves attention are the several assumptions that were made concerning data used in the additional model. For reasons related to time pressure or inaccessibility of data these assumptions were necessary to complete al the needed variables in order to devise a working additional model. The validation of these assumptions can be reached through usage of the devised tool by end-users, which was an important reason for devising a working model (Willemen et al., 2008). However, further research is also needed to acknowledge or adjusting other variables with adequate data. The further research will consist of locating data sources, assimilating the data and devising methods to browse and quavering this data (Shadbolt et al., 2012).

Conclusively the outcome of this thesis the existing Citymaker tool can be expanded in order to model more aspects of the built environment and transfer this knowledge to its users. However, the excel-based model that was developed during this research can also be used without the Citymaker tool in comparing planning scenarios provided the data on the required variables is available. However, it is important to recognise that the outcome of the scenario comparison is a mere benchmark against several different theories. Although the scenarios are devised in the same program there will be differences that do not relate to each other. According Pèrez-Lombard et al. (2009) these differences can result in an unsatisfactory benchmark process. Which makes the comparison less valid or at the least it should not be taken for granted. It is therefore important that the end-user will always keep in mind that the outcome of a benchmark is only as reliable as the comparability of the scenarios and that the level of urban vitality of a scenario should not be seen as a decisive factor. The most adequate plan for an urban development will consist out of a balance between several factors of which urban vitality is one.

List of Tables and Figures

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[6] Appendix F: Schematic relation of the public – private ratio parameter to the existing Citymaker tool.
[7] Appendix G: Schematic relation of the variety of functions parameter to the existing Citymaker tool.
[8] Appendix H: Microsoft Excel Sheet; New parameters and variables Citymaker D.M. de koe.xlsx

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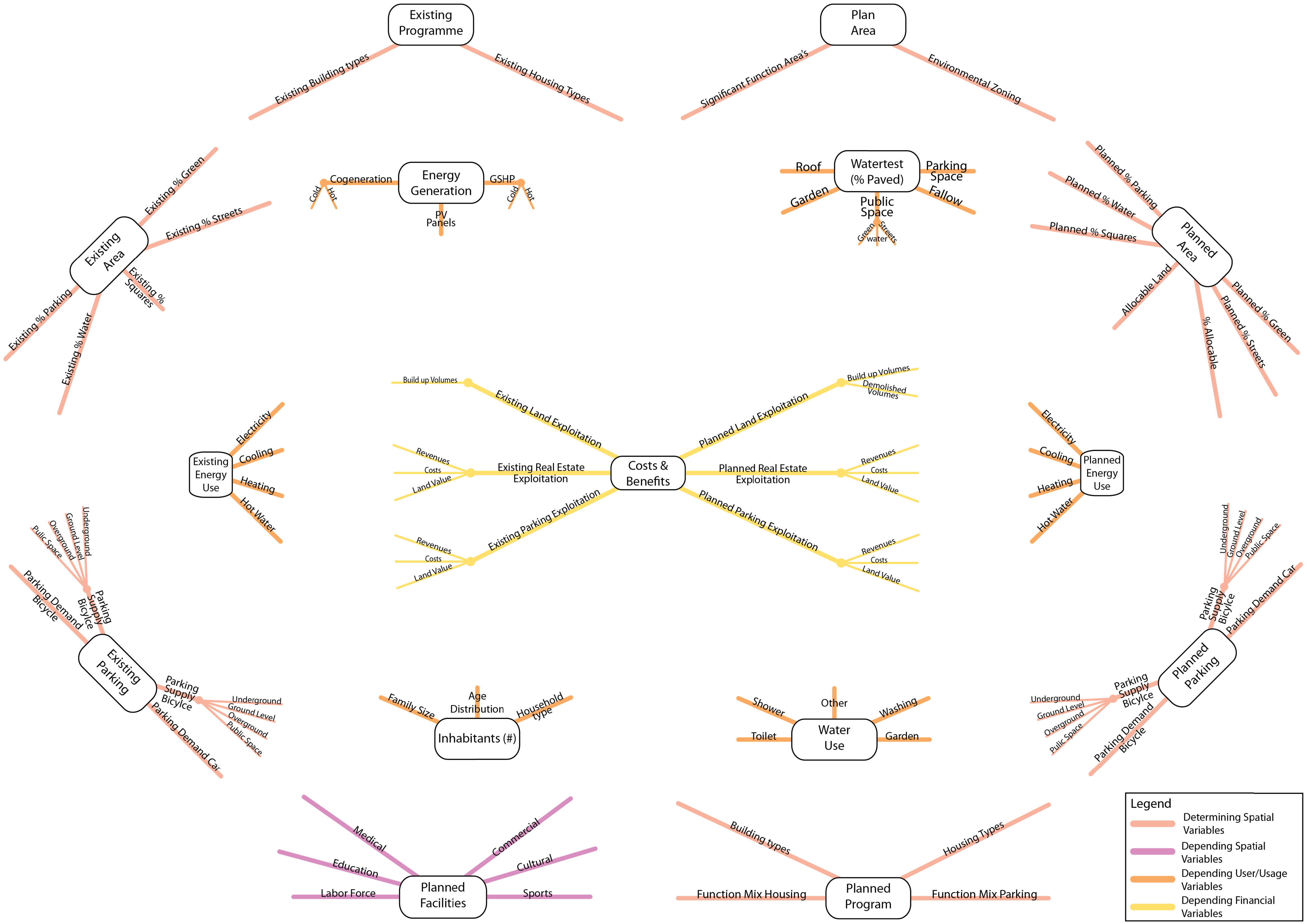
Appendix A: Schematic representation of the existing Citymaker tool.



Appendix B: Citymaker's New Parameters and Variables Spreadsheet.

SCENARIO 1

Variables present in existing citymaker are depicted in BLUE
Variables absent in existing citymaker are depicted in RED

Population Density

Number of inhabitants ÷ M2 Plan area / 1000000

543 ÷ 0.05 = **10860 Inhabitants per square kilometre**

User Intensity

Facilities	*Present*	*Usage interval*			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24		
					Hours of the day																									
Retailers	1	9	until	18	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0		
Offices	0	8	until	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	0	16	until	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Industry	0	7	until	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	0	16	until	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Social cultural	0	15	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Social medical	0	1	until	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Primary education	1	8	until	9	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
	1	12	until	13	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0		
	1	15	until	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0		
Secondary education	0	9	until	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Hotel	0	6	until	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Library	0	9	until	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Restaurant	0	12	until	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Cafe	1	15	until	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	1		
(Movie)theater	0	18	until	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Sports center	0	9	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Fitness school	0	9	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Pool	0	7	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
					Y	Y	Y	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	**83%**	**User Intensity**

Mixed Land-use

Land-uses	*Lot size*	*Total plan area*
Function mix parking	10000	50000
Function mix green	10000	
-Rooftop Gardens	10000	
-Green Facades	-	
Function mix water	0	**Mixed land use percentage: 40.00%**
-Water Squares	-	
-Flow fields	-	

Public - Private Ratio

		% in Model	m2
Public	Green Public Space	2	1000
	Public Water	3	1500
	Streets	20	10000
	Squares	10	5000
	Parking	10	5000
Private	Allocable	55	27500
Collective	Environmental Zoning	-	1000
	Significant funtion Areas	-	2000
	Total Plan Area	-	50000

Incomplete percentage distribution:
Ok

Public - Private Ratio: **0.93**

Variety of Functions

Facilities	*Present*	*Housing types*	*Present*	Public Spaces	*Present*
Retailers	**1**	Stacked	**1**	Parking	**1**
Offices	0	Groudbound	**1**	Water	**1**
Industry	0	- Terraced house	0	Squares	0
Social cultural	0	- Semidetached	**1**	Streets	**1**
Social medical	0	- Detached	0	Green	**1**
Primary education	**1**				
Secondary education	0				
Hotel	0				
Library	0				
Restaurant	0				
Cafe	**1**				
(Movie)theater	0				
Sports center	0				
Fitness school	0				
Pool	0				

Variety of Functions: **9**

SCENARIO 2

Variables present in existing citymaker are depicted in BLUE
Variables absent in existing citymaker are depicted in RED

Population Density

Number of inhabitants ÷ *M2 Plan area / 1000000*

345 ÷ 0.05 = **6900** **Inhabitants per square kilometre**

User Intensity

Hours of the day

Facilities	*Present*	*Usage interval*			*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*23*	*24*
Retailers	0	10	until	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Offices	0	8	until	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	16	until	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industry	0	7	until	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	16	until	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social cultural	0	15	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social medical	0	1	until	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Primary education	1	8	until	9	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	12	until	13	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	1	15	until	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Secondary education	0	9	until	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	6	until	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Library	0	9	until	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Restaurant	0	12	until	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cafe	0	15	until	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Movie)theater	0	18	until	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sports center	0	9	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fitness school	0	9	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	7	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
					N	N	N	N	N	N	N	Y	Y	N	N	Y	Y	N	Y	Y	N	N	N	N	N	N	N	N

25% **User Intensity**

Mixed Land-use

Land-uses	*Lot size*	*Total plan area*
Function mix parking	20000	50000
Function mix green	10000	
-Rooftop Gardens	10000	
-Green Facades	-	
Function mix water	0	
-Water Squares	-	
-Flow fields	-	

Mixed land use percentage: **60.00%**

Public - Private Ratio

		% in Model	*m2*	*Incomplete percentage distribution:*
Public	Green Public Space	2	1000	Ok
	Public Water	0	0	
	Streets	23	11500	
	Squares	10	5000	
	Parking	15	7500	
Private	Allocable	50	25000	
Collective	Environmental Zoning	-	1000	
	Significant funtion Areas	-	2000	
	Total Plan Area	-	50000	**Public - Private Ratio: 1.12**

Variety of Functions

Facilities	*Present*	*Housing types*	*Present*	Public Spaces	*Present*
Retailers	0	Stacked	**1**	Parking	**1**
Offices	0	Groudbound	**1**	Water	0
Industry	0	- Terraced house	0	Squares	0
Social cultural	0	- Semidetached	**1**	Streets	**1**
Social medical	0	- Detached	0	Green	**1**
Primary education	**1**				
Secondary education	0				
Hotel	0				
Library	0				
Restaurant	0				
Cafe	0				
(Movie)theater	0				
Sports center	0				
Fitness school	0				
Pool	0				

Variety of Functions: 6

SCENARIO 3

Variables present in existing citymaker are depicted in BLUE
Variables absent in existing citymaker are depicted in RED

Population Density

Number of inhabitants ÷ M2 Plan area / 1000000

525 ÷ 0.05 = **10500** **Inhabitants per square kilometre**

User Intensity

Hours of the day

Facilities	*Present*	*Usage interval*			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Retailers	1	10	until	18	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	1	0	0	0	0	0	0
Offices	0	8	until	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	16	until	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Industry	0	7	until	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	0	16	until	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social cultural	0	15	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Social medical	0	1	until	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Primary education	1	8	until	9	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	12	until	13	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0
	1	15	until	16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
Secondary education	0	9	until	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hotel	0	6	until	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Library	0	9	until	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Restaurant	0	12	until	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cafe	0	15	until	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(Movie)theater	0	18	until	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sports center	0	9	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fitness school	0	9	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pool	0	7	until	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
					N	N	N	N	N	N	N	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N

46% **User Intensity**

Mixed Land-use

Land-uses	*Lot size*	*Total plan area*
Function mix parking	5000	50000
Function mix green	10000	
-Rooftop Gardens	10000	
-Green Facades	-	
Function mix water	0	

Mixed land use percentage: **30.00%**

Public - Private Ratio

		% in Model	m2
Public	Green Public Space	2	1000
	Public Water	3	1500
	Streets	20	10000
	Squares	10	5000
	Parking	5	2500
Private	Allocable	60	30000
Collective	Environmental Zoning	-	1000
	Significant funtion Areas	-	2000
	Total Plan Area	-	50000

Incomplete percentage distribution:
Ok

Public - Private Ratio: 0.77

Variety of Functions

Facilities	*Present*
Retailers	1
Offices	0
Industry	0
Social cultural	0
Social medical	0
Primary education	1
Secondary education	0
Hotel	0
Library	0
Restaurant	0
Cafe	0
(Movie)theater	0
Sports center	0
Fitness school	0
Pool	0

Housing types	*Present*
Stacked	1
Groudbound	0
- Terraced house	0
- Semidetached	0
- Detached	0

Public Spaces	*Present*
Parking	1
Water	1
Squares	1
Streets	1
Green	1

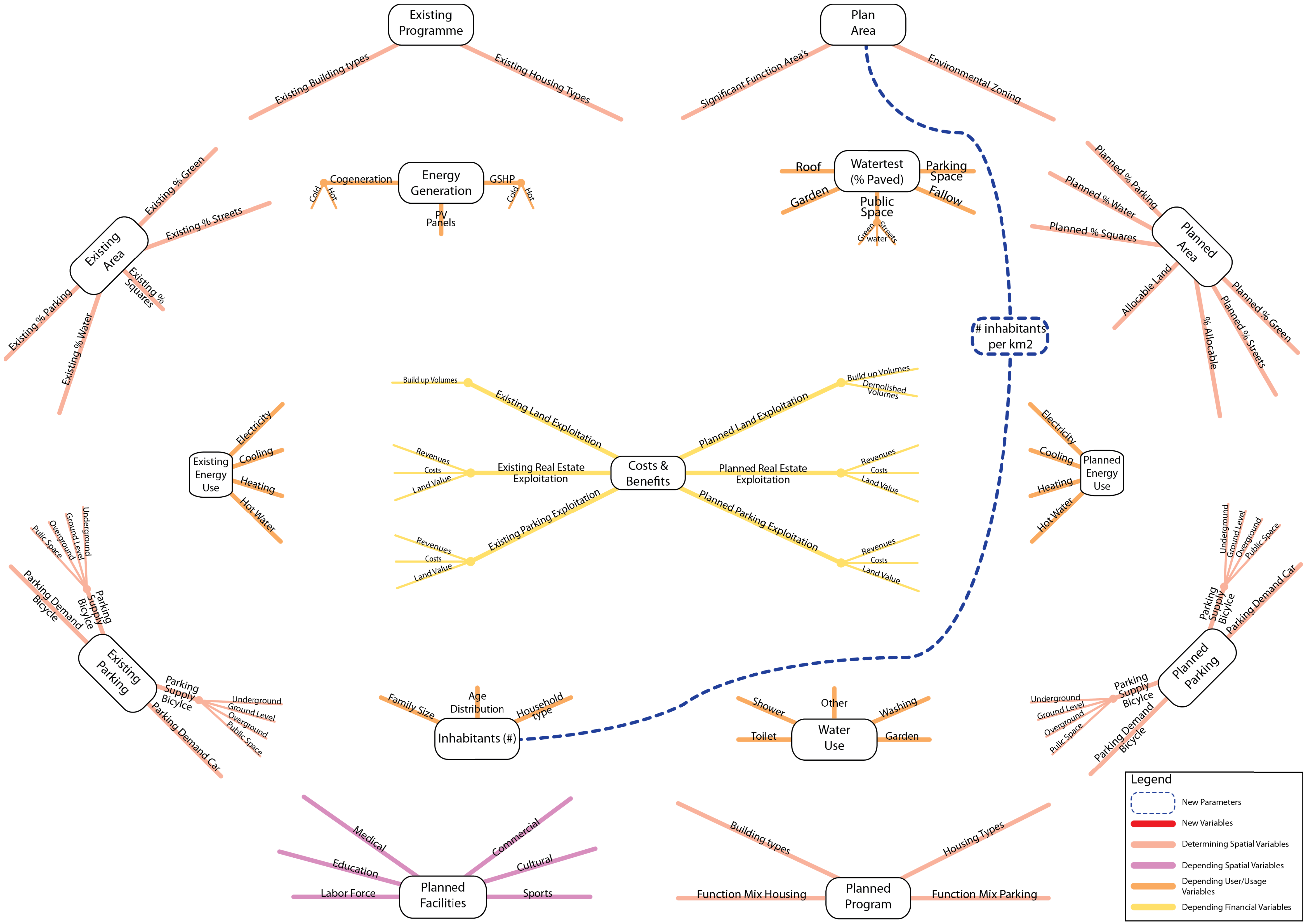
Variety of Functions: 8

Urban Vitality Comparison

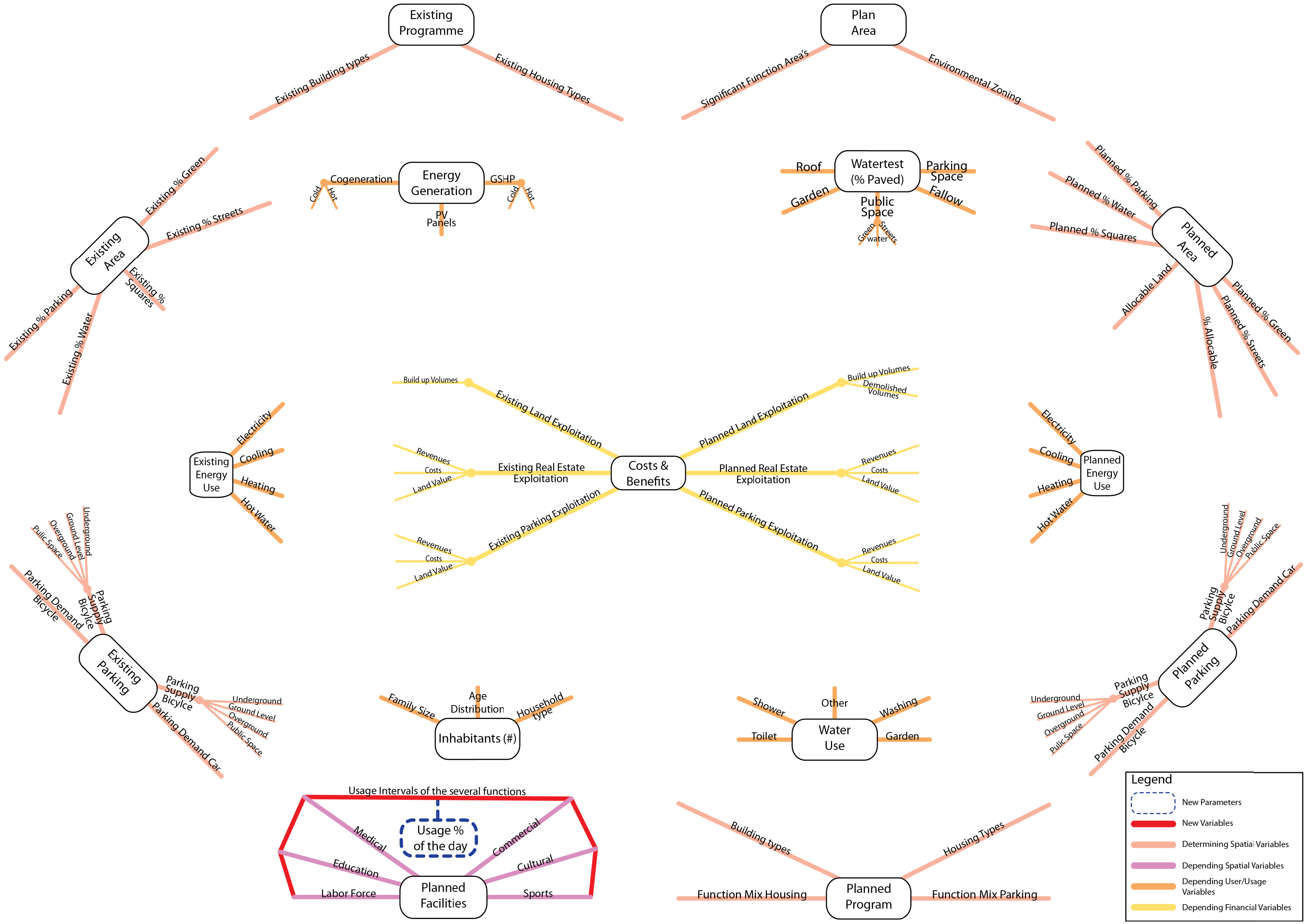
Population Density / Scenario Comparison

	Scenario 1	*Scenario 2*	*Scenario 3*	Comparison *Scenario 1*	Comparison *Scenario 2*	Comparison *Scenario 3*
Population Density	10860	6900	10500			
deviation	26%	20%	22%	5	7	6
User Intensity	83%	25%	46%	9	3	5
Mixed Land-use	40%	60%	30%	4	6	3
Public - Private Ratio	0.93	1.12	0.77	5	7	3
Variety of Functions	9	6	8	5	3	4
				More Vital Scenario	Second Vital Scenario	Less Vital Scenario
				28	26	21

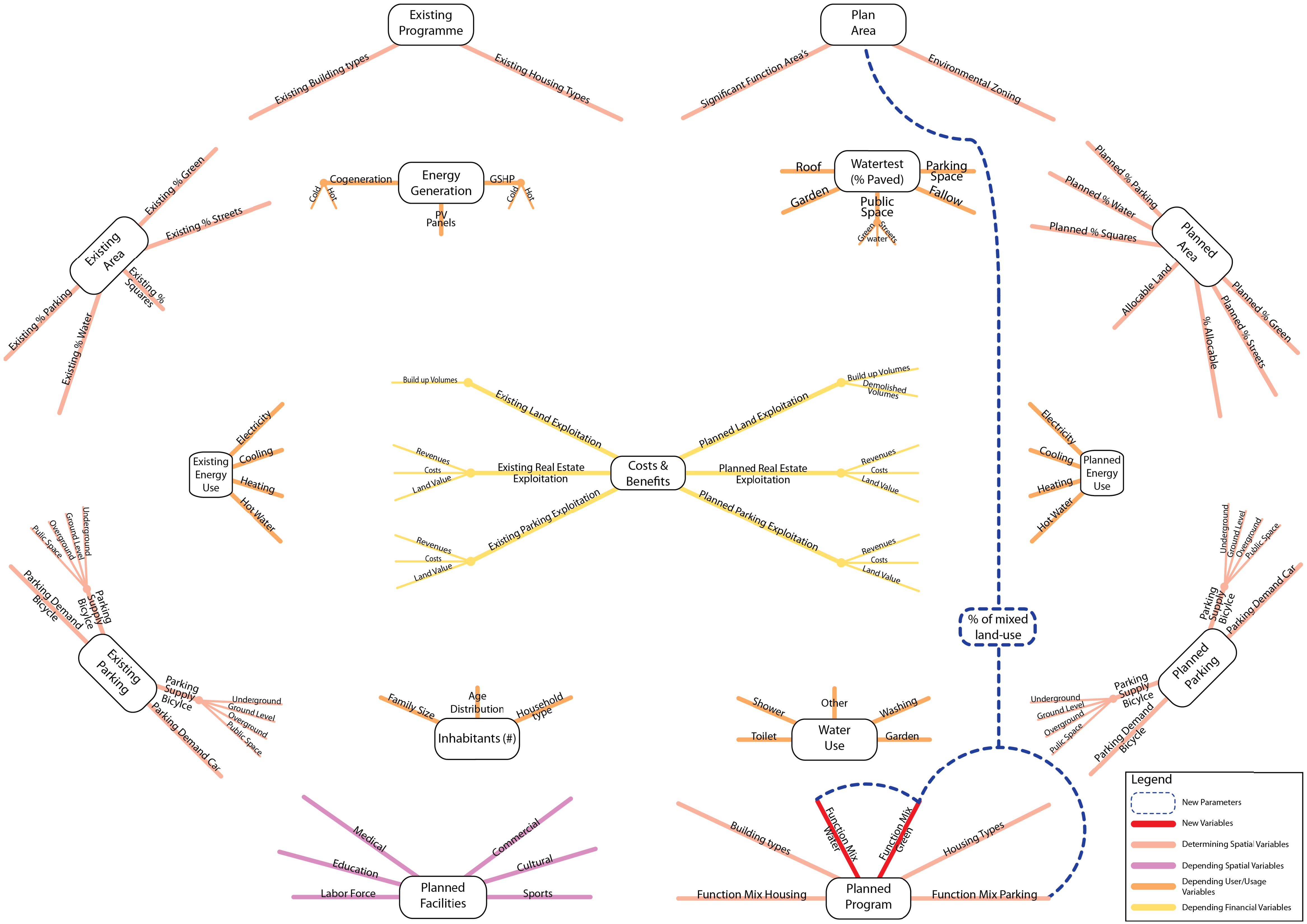
Appendix C: Schematic Relation of the Population Density Parameter to the Existing Citymaker Tool.



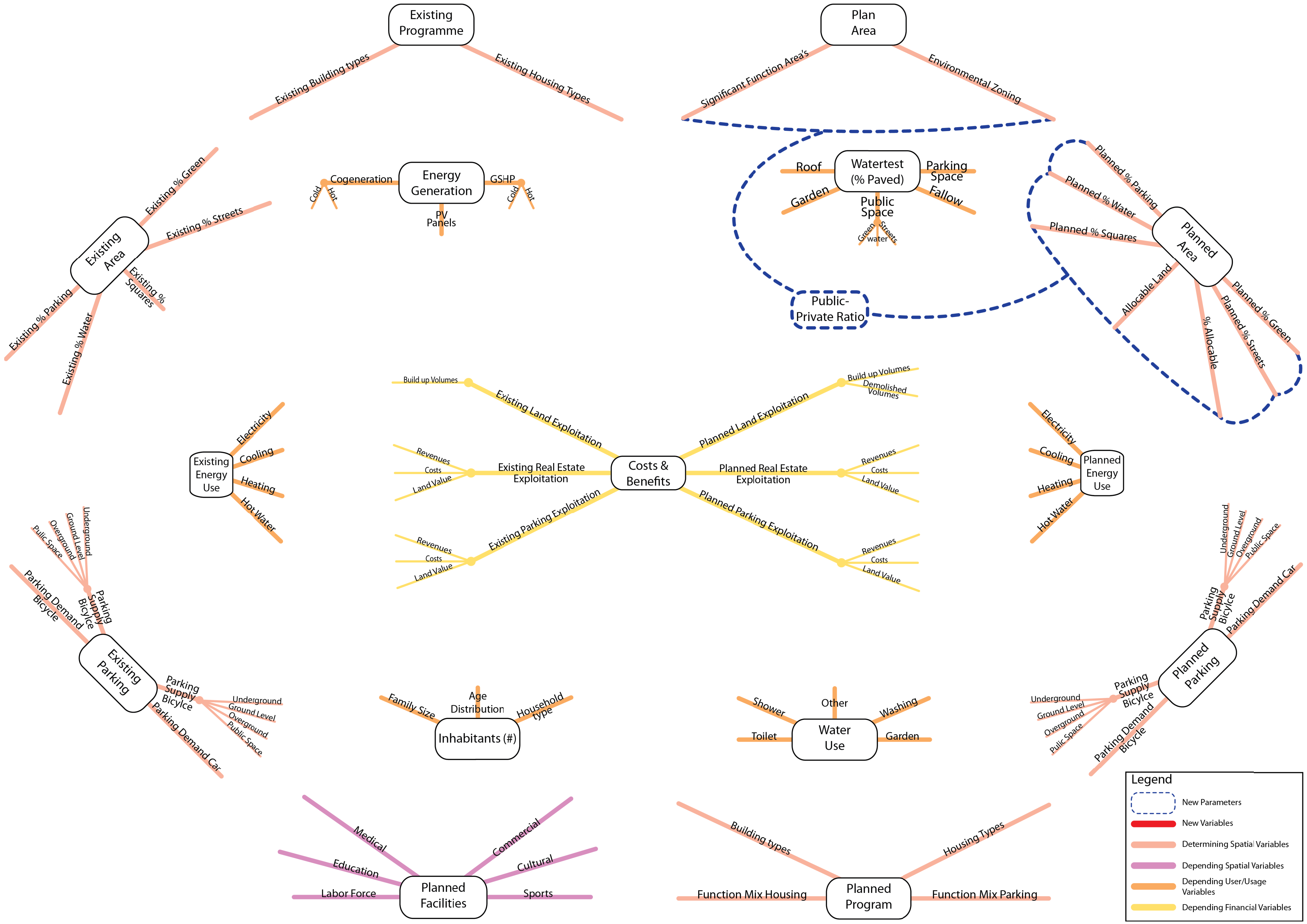
Appendix D: Schematic Relation of the User Intensity Parameter to the Existing Citymaker Tool.



Appendix E: Schematic Relation of the Mixed Land-Use Parameter to the Existing Citymaker Tool.



Appendix F: Schematic Relation of the Public – Private Ratio Parameter to the Existing Citymaker Tool.



Appendix G: Schematic Relation of the Variety of Functions Parameter to the Existing Citymaker Tool.