Transit-Oriented Development in Phoenix:

How the implementation of Transit-Oriented Development within the Light-Rail Corridor in Phoenix, Arizona can benefit from the insights gained from transition management and from TOD design principles.

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Preface

This thesis is the end product of a five month stay in Tempe, Arizona, where I have conducted my research at the Arizona State University as a participant of the NEURUS-ICURD program. Living in the United States of America, a country so different compared to the Netherlands was a very interesting experience and enabled me to study different urban phenomena like urban sprawl and urban mobility systems.

In the beginning of January 2012 I was warmly welcomed at the Arizona State University. I especially want to thank NEURUS coordinator Kathy Crewe for arranging a personal office space which I shared with two other NEURUS participants. The fact that I had my own office space within the School of Geographical Sciences and Urban Planning gave me extra motivation to work on my research. Next to Kathy Crewe I also want to thank assistant professor Aaron Golub who brought me in contact with urban planners of different government organizations. Eventually this resulted in six interview appointments. I would like to thank these planners from the City of Phoenix, the MPO Maricopa Association of Governments and the Valley Metro transit agency for their enthusiasm and interesting and helpful answers to all of my questions.

After setting up my research and collecting all the necessary data, I flew back to the Netherlands on the 1st of June. Here I started the writing of my thesis. I would like to thank my supervisor Taede Tillema for the great supervision during the whole process.

It is a great feeling that with the completion of my master thesis my life as a student will come to an end. It was a great time where doing research in the United States was one of the highlights. I am looking forward to start my working life where I can bring my knowledge into practice.

Peter Hovestad

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Abstract

After half of a century where the car became an icon, more attention is given to the serious downsides of car-use (Banister, 2005). It is argued that any increase in car-use is resulting in more urban sprawl and therefore greater consumption of land and more material consumption overall. In addition, car-use is also related to; local and global pollution, oil dependency, traffic congestion and accidents, noise pollution and parking subsidies (Parry et al, 2007). A search for solutions is necessary because the car related externalities have substantial implications for social welfare, environmental quality and peoples health (Banister, 2007). Sustainable mobility is seen as a suitable solution and provides a paradigm which focuses on the complexity of cities and tries to improve the connection between land-use and transportation (Banister, 2008). The concept of the five Dimensions of the built environment (5Ds) provides 'ingredients' to create sustainable and livable neighborhoods with a high degree of mixed-use developments, bicycle and pedestrian friendly design, and a high concentration of developments around accessible public transport stations (Cervero, Murakmai, 2008). These neighborhoods are also known as Transit-Oriented Developments (TODs) (Calthorpe, 1993). These developments show that the current car-based mobility system should change. Transition management is seen as a promising tool/model for change towards sustainability and provides governance guidelines for system-innovation (Kemp, Parto, 2005; Kemp et al, 2009; Kemp, Loorbach, 2003; Geels, 2002).

Looking at the case of Phoenix, Arizona it became clear that Phoenix is also facing the negative externalities of car-use. Therefore, this research focuses on the question how the implementation of TOD within the LRC in Phoenix, Arizona can benefit from the insights gained from the concept of the 5Ds of the built environment, which are respectively; Density, Diversity, Design, Distance to transit and Destination accessibility, and the theory of transition management, in which Kemp and Loorbach (2003) describe barriers for making systems more sustainable. To do so, a case study was conducted. Six semi-structured interviews with planners from the city of Phoenix (4), Transit-agency; Valley Metro (1) and the MPO; Maricopa Association of Governments (1) were used to reveal the barriers for implementation of TOD within the Light-Rail Corridor (LRC) in Phoenix, Arizona, and to find solutions to overcome them. In addition, the current status of the 5 dimensions of the built environment within Downtown Phoenix, which is located within the LRC, is analyzed through field observations (like location visits) and GIS analyses. Further, the outcomes of the case study are compared to the theoretical framework which consists of a literature review on the theories of TOD and transition management.

Firstly, a Multi-Level Perspective, which consists of three different levels; technical-niches, socio-technical regimes and a socio-technical landscape whereby the lowest level (niches) is embedded into the middle level (regime) and where the middle level is embedded into the highest level (landscape),

was used to explain the relationship between the current mobility system (socio-technical regime) and the new city design based on the concept of the 5Ds and the development of the Light-Rail system in the Phoenix region (new novelties). These novelties should get more attention within the different dimensions of the regime-level and the desired result is that these new novelties will get a permanent place within the regime. In other words; these novelties, such as a new kind of city design which is based on the concept of the 5Ds introduced by Cervero and Murakami (2008), should influence policy-making, the culture, science and market and user preferences with respect to mobility. This will only happen if sustainability will get more attention within the socio-technical landscape; which is the exogenous context of the socio-technical regime. The analyses indicate that this is currently happening; there is a growing interest in sustainability and also within the Phoenix region there is a growing awareness of the impact of negative externalities of car-use. If more attention is given to these developments within the landscape and niche-level, the pressure on the car-based mobility system will start to grow and finally the socio-technical regime will open-up. At the same time we have seen that the presence of different barriers (institutional, financial, zoning-policy and mind-set) make it more difficult for developments on the landscape and niche-level to break through and therefore Transit-oriented Development (TOD) and more sustainable transportation modes (transit, cycling and walking) do not have a prominent position within the mobility system in Phoenix. An example of an important barrier is the fact that multiple lots within the LRC in Phoenix allow high-rise buildings, which is defined by a zoning regulation, but where from a TOD perspective 5 to 6 story buildings are desired. Because the zoning is allowing developers to develop a high-rise tower on a specific lot, this lot represents a certain value which is considerably higher for a high-rise tower then for a 5 to 6 story mixed-use project. A lot of developers are therefore waiting until there is a better market for high-rise. Another barrier is that redevelopment in Phoenix is harder and more expensive then developing from scratch because of applicable regulations and the construction of new utilities like new sewers and other infrastructure.

To overcome these barriers, the cyclic framework for transition management is seen as a promising tool to unlock/change the current socio-technical regime. If the phases of the framework (organizing a multi-level actor network, developing sustainability visions and transition-agendas, mobilizing actors and executing projects and experiments and evaluating, monitoring and learning) are followed as intended by Grin et al. (2010), the pressure on the current car-based mobility system is growing, and finally this will result in a transition of the mobility system. Looking at Phoenix, the TOD working group (a collaboration between the city of Phoenix, the MPO Maricopa Association of Governments and the transit agency Valley Metro), community meetings and the stakeholder meetings organized by the Maricopa Association of Governments (MAG) show that a lot of time and effort is put into the process of negotiation, networking and coalition building. In addition, the introductions of plans such as; the sustainable transportation & land-use integration study (MAG) together with the Phoenix

general plan update (transitioning to a sustainable future) shows that there is a strong focus on sustainability and that there is a clear vision for the Phoenix region as well for the city of Phoenix. These developments show that multiple stakeholders are brought together and that all stakeholders were involved in the plan-making process and that the stakeholders agree on the idea that a transition towards a more sustainable mobility is needed. This focus indicates that in the Phoenix case initiatives are introduced to support TOD and to change the current car-based mobility system. Because Phoenix is still half way the process of the framework for transition management the next step should be that the government organizations in Phoenix should mobilize actors and should build coalitions to develop pilot projects and start experiments. Next, an evaluation of the whole process and the implemented TOD example projects is needed to see if the implementation can be improved. This will result in an improved vision and this will result in more and better TOD pilot projects/experiments.

The field observations and the GIS analyses showed that the built environment within the Downtown area (located within the LRC) in Phoenix does not meet all recommendations which are part of the concept of the five Dimensions of the built environment. Especially, the density of the area is low and should be increased to make streets livelier and to increase the ridership. In contrast to the low density, the research area contains a great amount and variety of land-uses and destinations. But the problem is that these land-uses are mixed in a wrong way; the research area contains a lot of vacant and parking lot which are mixed together. From a TOD perspective this mix of land-uses should be avoided and preferably changed into some sort of mixed-use project which should contain different residential, commercial and retail uses. A positive diversity aspect, is the great variety of destinations, such as sport arenas, museums, parks, commercial and retail uses and different kind of schools, which are all easily accessible by Light-Rail. The analysis also showed that, sidewalks are present but they are often not really comfortable because the sidewalks are not shaded and not safe; cyclists bike on the sidewalks because there are no bike paths. We can therefore say that the research area is currently not designed with a focus on the human scale; Downtown Phoenix can therefore still be seen as a car-oriented area.

Therefore, recommendations on all three levels, of the MLP, are given to increase the pressure on the current car-based mobility system in Phoenix, Arizona. First, the awareness of the impacts of the negative externalities of car-use should be increase through a stronger focus on the positive effects of more sustainable and affordable alternatives for the automobile. Through better education, people will be more aware of the need for sustainability.

Further, in response to the outcome; that the decision makers in Phoenix are not making clear choices with respect to sustainable mobility, an ‘administrative straight back’ is needed to create a credible government. This will also contribute to the level of trust between residents and the government. In

addition, integrated policies are needed to increase the chance that a transition will take place. Related to transportation and mobility, a multimodal perspective, where the sustainable and non-sustainable transportation modes will be aligned, should be used to create a clear and holistic vision for the city of Phoenix and it should be used as basis for policy-making. A recommendation regarding to the fact that redevelopment projects are harder and more expensive then developing from scratch is that the cooperation between the city of Phoenix and the developers should be improved. In this case, the city should facilitate better by the construction of new utilities and making regulations (parking requirements) more flexible, to make it easier for developers to do infill and redevelopment projects. Next to a better cooperation between the city of Phoenix and property developers, incentives should be created to stimulate developers to start developing the vacant lots. For example; a penalty tax for lots within the LRC if, despite a demand for 5-6 story mixed-use, the developer/land-owner does not want to develop the vacant lot.

An opportunity to overcome, the zoning-policy and mindset barriers, can be found in the fact that the city owns quite some land within the LRC (see Appendix 2). These lots are perfect for the development of TOD pilot projects (based on the concept of the 5Ds), because there is no land-owner who can obstruct the development of these projects. As a result, the pilot project can inform/educate residents and developers about the benefits of TOD projects, and these pilot projects also show that TOD projects can 'work' in Phoenix. Furthermore, these projects will attract new development and will therefore work as catalysts. An advantage of developing city owned land is that the land-use plan and zoning-policy will not hinder the developments because the city has the land-use authority and if accepted by the land-owner, in this case the city itself, they can also change the zoning.

1. Introduction

1.1 Background

During the postwar period the degree of wealth increased which resulted in an increasing demand for mobility. As a result, there was an exponential growth of car use during the 20th century, and the car became an icon of his century (Banister, 2005). But car use has a serious downside. Banister (2005) is arguing that any increase in car ownership will result in more urban sprawl and therefore greater consumption of land for transport and more material consumption overall. Urban sprawl is described by Nelson and Duncan (1995) as, the pattern of low-density suburban development that had spread out around most cities in the United States. Additionally, Downs (1989) is arguing that, urban sprawl is centered on the auto-dependent and low-density suburban housing model. This idea is based on four pillars: (1) ownership of single family homes on large lots; (2) ownership of a private automobile, with a highway system that accommodates traffic without congestion; (3) low-rise workplaces on land-extensive arrangements with plenty of free parking; and highly decentralized governance of public facilities and services (Downs, 1989).

In addition to urban sprawl, Parry et al. (2007) are pointing out different automobile related externalities: local and global pollution, oil dependency, traffic congestion and accidents and other externalities like noise pollution and parking subsidies. Looking to the price of these externalities, Parry et al. (2007) conclude that the price per Vehicle Miles Travelled (VMT) varies per externality (Table 1.1). The externalities of traffic accidents (social costs) are considered as the most expensive with about 16 cents per VMT. Further, Delucci (1996) argues that many people are not aware of the social costs of car use. Particularly, motor vehicles cost society much more than what drivers spend on explicitly priced goods and services like cars, maintenance, repair, insurance, parking and tolls. For example, people can park their car for 'free' at the shopping mall, but the costs of this 'free' parking is not priceless, the costs are bundled into the prices of the goods and services of the shopping mall (Delucci, 1996).

The search for solutions for the externalities caused by the car use is necessary because the car related externalities which are described above have substantial implications for social welfare, environmental quality, and health (Banister, 2007). Furthermore, transport's (especially car use) share of the total global emissions of CO2, which causes global warming, increased to 28.9 per cent in 2001 (Banister, 2005). In addition, transport is almost totally dependent on oil, and because resources are running out it is necessary to find suitable solutions. Banister et al. (2000) therefore argues that there is a serious need for sustainable mobility. Sustainable mobility provides a paradigm which focuses on the complexity of cities, and tries to improve the connection between land-use and transportation (Banister, 2008). Hence, a solution is given by Banister (2007) and Cervero and Kockelmans (1997). Particularly, they suggest the development of high-quality neighborhoods with a high degree of

mixed-use developments (Diversity), bicycle and pedestrian friendly designs (Design) and a high concentration (Density) of development around accessible public transport stations (Distance to transit, Destination accessibility). These '5Ds' are seen as the main characteristics for sustainable and livable built environments (Cervero, Murakami, 2008). Cervero and Kockelmans (1997) argue that these neighborhoods: *"can 'degenerate' vehicle trips, reduce VMT per capita, and encourage non-motorized travel"*. Further, Banister (2007) stated that the intention of this solution is: "*to reduce the need to travel (particularly by car), to encourage greater use of public transport (and walking and cycling), and to reduce travel distances. The key here is to provide quality, with access to local services and facilities, so that people do not need to travel long distances"*.

Sears (2011) argues that public transport is a more efficient and affordable alternative option to the personal automobile. In addition, retrofitting empty parcels into walkable, dense communities with a wide variety of land-uses should be implemented alongside a good public transportation system. An example of a place where sustainable mobility is really needed is the city of Phoenix, Arizona. Phoenix is an interesting case for research in the field of sustainability because Phoenix is seen as the world's least sustainable city (Ross, 2011). Besides the alarming title of the book written by Andrew Ross (2011), continuing growth in population and car-ownership in the Phoenix area, traffic congestion and other car-related externalities are still growing. The increase in car-related externalities together with the rising prices of gasoline ask for more transportation alternatives to develop more equal, sustainable and healthier built environments. Phoenix has great potential to implement these walkable, mixed-use and dense communities because Phoenix has a relatively new Light-Rail system (a 32km line with 27 stations opened in December 2008), and a lot of empty parcels around the light-rail stops (Figure 1.1 and 1.2). The suggested development around accessible public transport stations is also known as Transit-Oriented Development (TOD) (Tiwari et. al, 2011; Atkinson-Palombo, Kuby, 2011). In addition, in the case of Phoenix, the total walkable buffer around the Light-Rail (which consists of multiple TODs) is known as the Light-Rail Corridor (Talen, 2011).

Table 1.1: Costs per VMT of automobile Externalities in the USA - Parry et al. (2007) (Own calculations)

Externalities	Costs per VMT
Local air Pollution	2.3 cents
Global air Pollution	0.2, 0.48 and 2.88 cents
Oil dependency (Market power)	0.28-0.98 cents
Oil dependency (Military and Geopolitical costs)	0.02-0.24 cents
Traffic congestion	5 and 6.5 cents
Traffic accidents (social costs)	15.8 cents
Traffic accidents (Marginal externalities of traffic accidents)	2-7 cents
Other externalities (Noise)	0.06 cents
Other externalities (Highway Maintenance Costs)	0.06-0.08 cents
Other externalities (Parking Subsidies)	3-10 cents

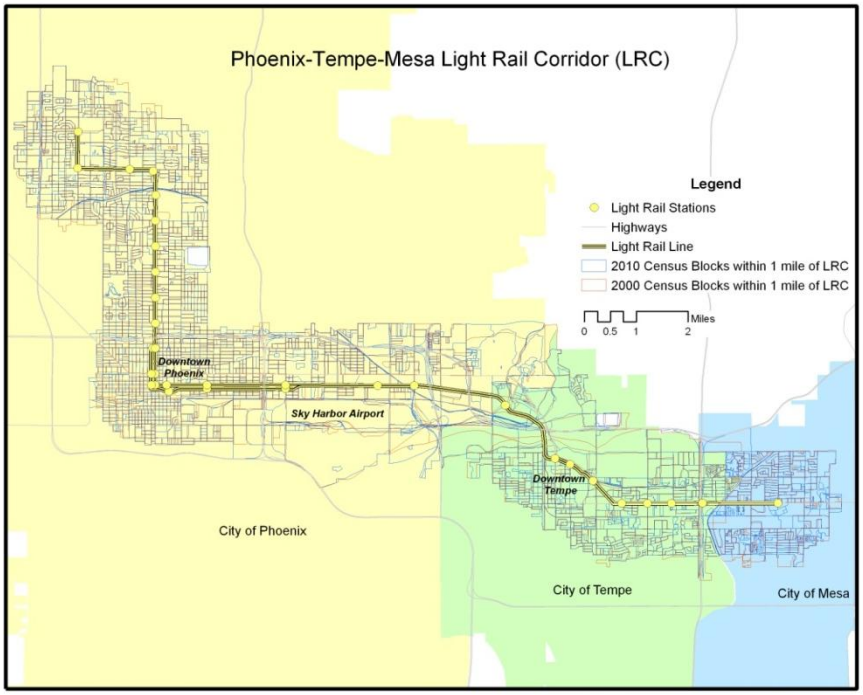

Figure 1.1: Phoenix Light-Rail Corridor with the 18 Phoenix Light-Rail stations.

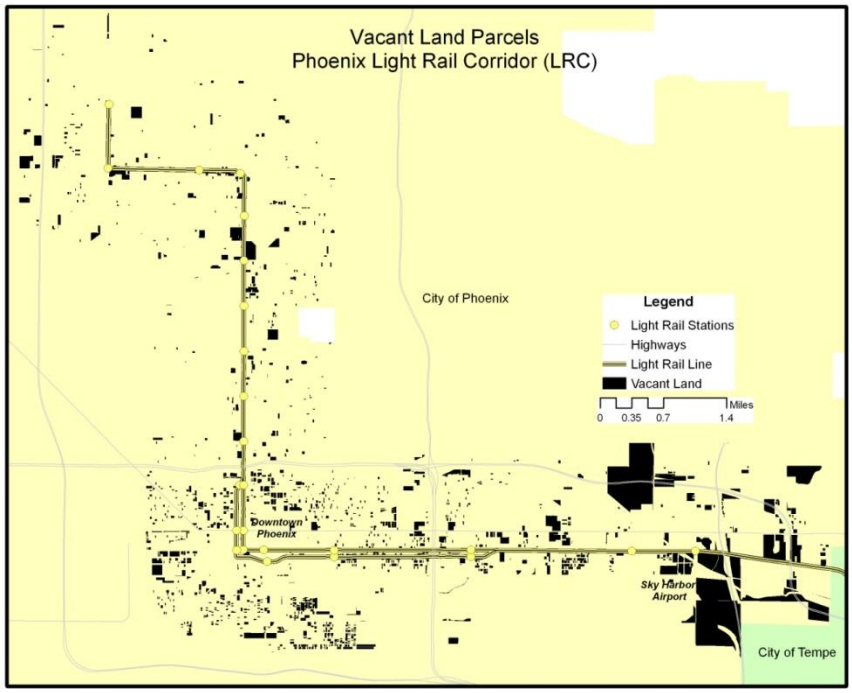

Figure 1.2: Phoenix Light-Rail Corridor with all the vacant land within the LRC.

1.2 Problem statement, research goal and questions

"More than any other U.S. metropolis in the postwar period, Phoenix has channeled the national appetite for unrestrained growth, and American growth still consumes a vastly disproportionate share of earth's resources, including its carbon allotment and is a clear threat to life and land."

Ross (2011)

Ross (2011) refers to the fast growth of the Phoenix Metropolitan area. As a result of this rapid growth the Phoenix Metropolitan area is the 12th largest metropolitan area in the United States, with an estimated population of 4.3 million (Atkinson-Palombo, Kuby, 2011). The population of Phoenix increased from 160.000 in 1950 to 1.4 million in 2010 (Heim, 2001; Census, 2010). As a result, the size of Phoenix increased from approximately 45 km² in 1950 to 1.400 km² by the year 2010 (Census, 2010). In addition, the total amount of vacant land in Phoenix is around 520 km² (Pagano, Bowman, 2000). This expansion of Phoenix, also known as urban sprawl (Banister, 2005; Nelson, Duncan, 1995; Downs, 1989) can be explained by the lower land costs in outlying areas (Heim, 2001), the car-dependence and the high demand for low-density suburban housing (Downs, 1989). In addition, Talen (2011) shows that in contradiction to the growth of Phoenix, the population and the population density within the Light-Rail Corridor (LRC)[1] decreased with respectively 9% and 10% from 2000 to 2010. From a sustainable mobility perspective this is a problem because an element of the sustainable mobility paradigm is to develop high-quality neighborhoods (with a high population density and high concentration of development) which are located around accessible public transport stations (so within for example the Light-Rail Corridor). Further, there is approximately 3 km² of vacant land and approximately 12.000 vacant housing units within the LRC (Talen, 2011). In addition to the increase of land consumption, the city of Phoenix possesses the 23th place on the list of most congested cities in the US. The list produced by the Texas Transportation Institute shows that the average delay per car is 35 hours a year. For the costs of the delay, Phoenix is ranked 16th with 821 dollar per car per year. Furthermore, the Phoenix region has serious air quality problems. Especially the year-round particle pollution mainly caused by transportation is causing serious air quality problems which can cause different health problems (MAG, 2012). The combination of increasing land consumption (urban sprawl), air quality problems and resources which are running out, shows that sustainable solutions are needed.

The presence of the Light-Rail, which has 28 stops, makes LRC areas perfect places for TOD. But, in addition to the presence, the stations should be easily accessible within a walkable and cycle-able distance. Dittmar and Ohland (2004) argue that the optimal walking distance between a transit station and a workplace is 500 to 1.000 feet (150m and 300m). Residents are willing to walk between 0.25

[1] Light-Rail Corridor (LRC) is defined as the area within 1 mile of both sides of the Light-Rail.

and 0.5 mile (400m and 800m) to a transit station, which corresponds with approximately a 10-15min. walk (Dittmar, Ohland, 2004). A cycle-able distance corresponds with a trip length of less than 2 miles. In addition to the accepted walking and cycling distance (to a transit station), a positive shift in the appreciation of pedestrian-scale urbanism has occurred during the last decade within the United States. Leinberger (2007) argues that 30 to 40% of the Americans prefer walkable urbanism over drivable sub-urbanism.

It's clear that the current built environment within the LRC in Phoenix needs to change if more sustainable and livable built environments (like Transit-Oriented Developments) are desired. The question then is: how can we achieve this change? The goal of the research will be to analyze how the implementation of Transit-Oriented Development in Phoenix, Arizona could be improved as a solution to urban sprawl and car-dependence and its related externalities. The goals and objectives related to Transit-Oriented Development can be seen as the physical criteria for sustainability and sustainable development. This because TOD is focusing on the design and planning of cities, in other words: how people 'physically' experience the city. Next to the physical criteria, governance guidelines are needed to accomplish the physical criteria for a sustainable built environment. Transition management is seen as a promising tool/model for change towards sustainability and provides governance guidelines for system-innovation, like for instance the current car-based mobility system (Kemp, Parto, 2005; Kemp et al, 2009; Kemp, Loorbach, 2003; Geels, 2002). The related main research question therefore is:

- How can the implementation of TOD within the LRC in Phoenix, Arizona benefit from the insights gained from transition management and from TOD design principles.

The following research questions will be discussed in the following chapters and together they will answer the main research question:

- What is transition management and what are the governance guidelines for transitions towards sustainability?

- What is Transit-Oriented Development and what are the related goals and objectives?

- How are the governance guidelines for transitions towards sustainability, used to support TOD within the Light-Rail Corridor in Phoenix, Arizona?

- What is the current status of the five Dimensions of the built environment (5Ds) within the Light-Rail Corridor in Phoenix, Arizona?

1.3 Research method and outline

During this research, a mixed-method methodology will be used to answer the research questions. This methodology will combine quantitative and qualitative approaches (Tashakkori, Teddlie, 1998). The mixed-method methodology is chosen because during the research both quantitative data (like data on Density) and qualitative data (like Design elements of the build environment) and perspectives from 'experts' are used to answer the main research question. Table 1.2 shows the research design and how the data for answering the research questions are collected and analyzed. In addition, Figure 1.3 shows the conceptual framework which gives an overview of the relationship between the different chapters.

The basis for the research will consist of a literature review which will be divided into chapters 2 and 3. In chapter 2 the governance guidelines for sustainable development will be described. Chapter 3 will describe the physical part of sustainable development through the use of Transit-Oriented Development and its related goals and objectives. The chapters 2-3 will emerge into a theoretical framework about the relation between the TOD and the governance guidelines for transitions towards sustainability and how these governance guidelines can contribute to a better implementation of TOD. Subsequently, this framework will be used to analyze how the implementation of TOD within the LRC in Phoenix, Arizona can be improved.

The case study consists of 2 chapters. First in chapter 4, 6 semi-structured interviews with planners from the city of Phoenix (4), Valley Metro (Transit-Agency) (1) and the Maricopa Association of Governments (MPO) (1) together with the theoretical framework, will be used to discover how the governance guidelines for sustainable development can be used to improve the implementation of TOD projects within the LRC in Phoenix, Arizona. The interviewees were asked to give their perspective on TOD in Phoenix, Arizona and how they, as experts, think to overcome the barriers for implementing TOD. Therefore, topics such as uncertainty, cooperation between government organizations, public participation, short and long term strategies and learning capacity were addressed during the interviews. Secondly, through observations within the LRC, the current status of the 5 dimensions of the built environment within the Light-Rail Corridor will be analyzed (personal observations and GIS analyses) and then compared to the theory about TOD in chapter 5. Chapter 6 will describe the conclusions and recommendations to improve the planning and implementation process of TOD within the LRC in Phoenix. The theoretical framework together with the case study will give an answer to the main research question; how can the implementation of TOD within the LRC in Phoenix, Arizona benefit from the insights gained from transition management and from TOD design principles.

Table 1.2 Research Design.

Research question	Data collection	Data analysis
What is transition management and what are the governance guidelines for transitions towards sustainability?	Scientific literature about transition management.	Literature review
What is Transit-Oriented Development and what are the related goals and objectives?	Scientific literature and government documents about TOD.	Literature review
How are the governance guidelines for transitions towards sustainability, used to support TOD within the Light-Rail Corridor in Phoenix, Arizona	Semi-structured interviews with different government planners.	A qualitative based comparison between the theory of governance guidelines for transitions towards sustainability and the case study in Phoenix, Arizona.
What is the current status of the five Dimensions of the built environment (5Ds) within the Light-Rail Corridor in Phoenix, Arizona?	GIS data and field observations (field work).	Comparison between the current status of the built env. in Phoenix and the concept of the 5Ds.

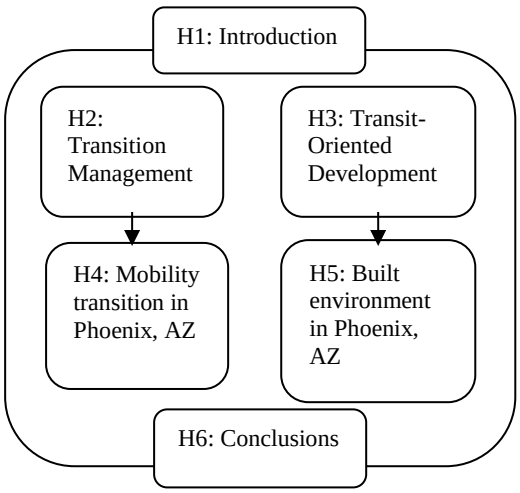

Figure 1.3: Conceptual framework: the relationship between the different chapters.

2. Transition management

2.1 Introduction

To deal with the negative externalities of car-use, the concept of Transit-Oriented Development is proposed as a promising solution (Cervero, Kockelmans, 1997; Calthorpe, 2005; Banister, 2008; Cervero, Sullivan, 2011). The concept of TOD is trying to develop a more equal, sustainable and healthier built environment. Chapter 1 shows that the current situation needs to change. The question thus is: how can we change the current car-based mobility system into a more sustainable mobility system? Thus a system which is more focused on the use of transit, cycling and walking. A promising strategy for change towards sustainability is transition management (Kemp, Parto, 2005; Kemp et al, 2009; Kemp, Loorbach, 2003; Geels, 2002). Therefore, section 2.2 will explain the need to change the current car-based mobility system and will describe the related barriers for implementation. Next, the term transition is described in section 2.3 together with the introduction of the Multi-Level Perspective, which is a perspective on system change. In addition, section 2.4 will give an overview on the application of the Multi-Level Perspective. Finally, section 2.5 will clarify how actors can manage or influence transitions.

2.2 The need for change and barriers for implementation

Despite the great amount of solutions to reduce car-use, the current mobility system is still mainly based on the car. In addition, the document Commuting in America III is showing that the share of commuters who are driving a car alone is increasing and that people who are using public transport or non-motorized transportation is decreasing (Pisarski, 2006). The solutions of supporting public transportation together with other solutions are therefore not making big differences, in the way they are currently proposed and implemented. The question than is why is it so difficult to change the car-based mobility system, despite the evidence that car-use has multiple negative effects? Kemp et al. (2009) are arguing that society is locked-in to the use of cars. A reason for this is the possibility to combine different tasks like, going to work, dropping off children at school, picking them up and filling the trunk of the car with groceries. Even when car-use is creating problems for the users themselves, by for example higher costs or time delays, still the majority of the people are not willing to give up their car (Kemp et al, 2009). The car is just too deeply embedded in to our lives and in addition people think cars are just too comfortable, enjoyable and exciting to give up. In addition, Kemp and Loorbach (2003) also raise the question: "*why is society not able to deal with big environmental problems (externalities of car-use), despite the fact of the acknowledgement of the seriousness of these environmental problems*". They describe these problems as system inherent weaving faults; solutions therefore should focus on designing new systems or transforming current systems (Kemp, Loorbach, 2003). But transforming the current car-based mobility system into a more transit, bike able and walkable (more sustainable) mobility system is a very difficult process because sustainability issues are now, compared to the postwar period, more societally situated. In addition to

the argument that society is locked-in to the use of cars, Kemp and Loorbach (2003) describe 7 barriers for making systems more sustainable:

- Unequal distribution: poverty causing irresponsible environmental management.
- Short-term thinking (in politics and business)
- Fragmented policies and institutional deficits
- Prices do not reflect external costs of environmental degradation
- Actors causing problems do not own the problem (they are not responsible for the solution of those problems)
- Solutions involving system changes are surrounded with great uncertainty
- Insufficient precaution

The authors are pointing out that the 6th barrier (solutions involving system changes are surrounded with great uncertainty) is the most interesting barrier because the other barriers are not new and barrier 6 is concerned with transforming systems. The transformation of a current system is also known as system innovation, Kemp and Loorbach (2003) are describing this as: a fundamental change in functional systems and product chains besides system improvement. The notion of system innovation is thus seen as a serious barrier for changing systems, like the current car-based mobility system. System innovation can take various forms and can cover large time periods. A system innovation can for example ask for a transformation of society as a whole which can cover a time period of one generation or more (Kemp, Loorbach, 2003). This also explains why short term thinking is not in favor of system innovation towards sustainability. Further, societal changes alone are not sufficient for system innovation. Kemp and Parto (2005) are for example describing the transformation of the current car-based mobility system into an integrated mobility system, this is a system where users are using different modes of transportation (transit, biking, walking), and are arguing that these kinds of system innovations need a wide range of changes. In addition to societal changes like reducing the ownership and use of cars, there are changes needed in infrastructure (park and ride stations), technology (light-rail in urban areas) and organizations like for example the creation of mobility agencies which offer inter-modal services.

2.3 Transitions and the Multi-Level Perspective

Before we take a closer look at governance of 'system innovation' of the current car-based mobility system, it is necessary to first clarify the term transition. The term transition is described by Rotmans et al. (2000) as: *a gradual process of societal change in which society or an important subsystem of society structurally changes*. In addition, the Dutch Research Institution For Transitions (DRIFT) points out that there are 3 major dimensions within a subsystem which are changing during a transition: culture (collective set of values, norms, perspective and paradigms), structure (physical

infrastructure, institutions, rules and regulations) and practices (behavior, operation and implementation). A comparable explanation is given by Kemp and Loorbach (2003), which argue that a transition is an outcome of system innovation and the interaction between different changing subsystems, like technical change, cultural change, behavioral change and economic change. The processes of the ongoing change which are causing a transition can be described as non-linear. This means that the changes are unpredictable: slow change can be followed by rapid change (when changes reinforce each other) and the period of rapid change is followed again by a period of slow change (Kemp, Loorbach, 2003). In addition, Rotmans et al. (2000) argues that a transition consists of 4 phases (see Figure 2.1), wherein the nature and speed of change are different:

- The first phase is known as the predevelopment phase, and can be characterized by slow and little visible change, and within this phase there is a lot of experimentation.
- Secondly, the take-off phase wherein the process of change starts and the state of the system starts to shift.
- Within the third phase, the breakthrough, the serious structural changes take place through the interaction between the continuing changing subsystems. During this phase, collective learning processes, diffusion and embedding processes take place.
- After the period of structural change within the breakthrough phase, the speed of change decreases within the stabilization phase and a new dynamic equilibrium is reached.

In addition to the notion of co-evolution processes and the 4 phases of the transition model, Grin et al. (2010) argue that transitions have the following characteristics:

- Transitions are multi-actor processes, during these processes a great variety of social groups, like scientists, social movements, policymakers, interest groups and businesses, are involved and interact with each other.
- Transitions can be characterized by radical shifts, whereby a system is changing into a different system. This change can be sudden (creative destruction) but it can also take place in a slow and step-wise way.
- Transitions are long-term processes, looking to the 4 phases, the total transition process will cover a time period of 40 to 50 years. Within the transition process, the predevelopment phase, the phase where new socio-technical systems slowly emerge will normally cover 20 to 30 years. The breakthrough phase characterized by the serious structural system changes is relatively faster with an average time period of 10 years.

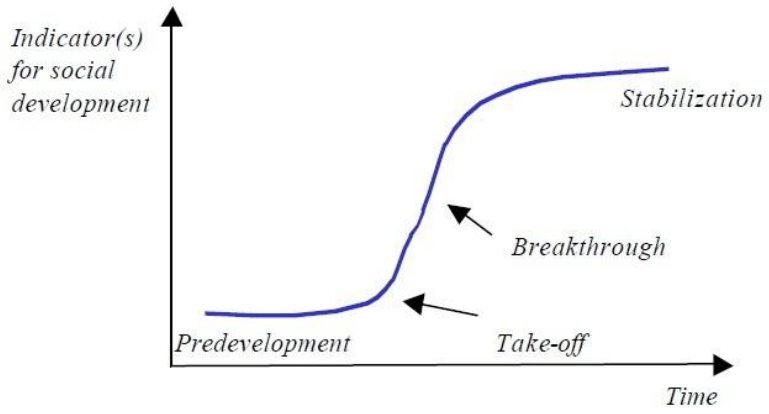

Figure 2.1: The four phases of a transition (Rotmans et al. 2000).

Kemp and Loorbach (2003) are pointing out that the (theoretical) transition model, which is described above, is very abstract and therefore difficult to use for society, decision-makers and for the development of new policies. In addition, Grin et al. (2010) ask themselves the question: "*how can we understand long-term and complex socio-technical transitions?*". This question can be answered through the use of a Multi-Level Perspective (MLP) on transitions (Grin et al, 2010). To get a better understanding of the MLP, Grin et al. (2010) start with some general comments. The first comment is that the MLP consists of three different levels; technical-niches, socio-technical regimes and a socio-technical landscape whereby the lowest level (niches) is embedded into the middle level (regime) and where the middle level is embedded into the highest level (landscape) (see Figure 2.2). The development of the electric bike and for example new higher efficient light-rail designs can be seen as technical niches which are interacting with the current socio-technical regime (mobility system, which currently is mainly focused on cars). Therefore, they argue that the MLP is concerned with the question how the alignment of trajectories, within levels and also between levels, are producing transitions. This relationship and how exactly the alignment of trajectories cause a transition will be explained later in this chapter. The second comment explains some basic notions about the three different levels:

- Every individual level can be seen as a heterogeneous socio-technical configuration.
- The three different levels of the MLP provide different kinds of coordination and structuration to activities in local practices, because the levels differ in terms of size and stability. For example, the lowest level: niches are characterized by, small social networks, are unstable, rules are diffuse, there is limited structuration of activities and there is much uncertainty and fluidity. As a result, a lot of effort is needed to uphold niches. The middle level: socio-technical regimes are on the other hand more stable and larger than niches and rules are more clear and structured. In comparison to the other two levels the highest level: socio-technical

landscape does not have a sociological structure but forms a broad exogenous environment and provide gradients for action.

- The alignment between the different levels have evolutionary characteristics: within the niche level, radical novelties are created but the selection and broader diffusion can only take place within the regime and landscape levels.

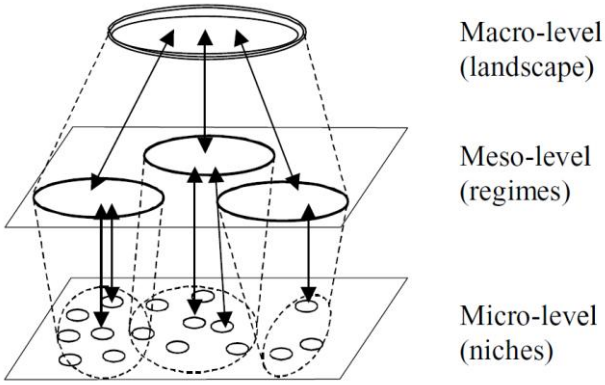

Figure 2.2: Relationship between the multiple levels.

2.4 Application of the Multi-Level Perspective

In addition to the general comments described above, a closer look at the three individual levels and the interaction between the levels, is needed to explain how exactly transitions are caused. As mentioned before in this chapter by Kemp et al. (2009), society is locked-in to the use of cars. From a Multi-Level Perspective, this phenomenon can be explained as the lock-in of a socio-technical regime. In this example, the associated car-based mobility system can be seen as the socio-technical regime which is locked-in because the mobility system is stabilized in many ways (the car is just too deeply embedded in to peoples life). As a result, transitions do not come around easily. The lock-in of society can be seen as the answer on the question raised by Kemp and Loorbach (2003), why society isn't able to deal with the negative externalities of car-use, despite the acknowledgement of the effects of these externalities. A socio-technical regime contains a set of rules which consists of three different types: cognitive, regulative and normative. These types of rules stand for the belief systems, guiding principles, goals (cognitive), regulations, standards, laws (regulative), role relationships, values and behavioral norms (normative) concerning the current socio-technical regime. Grin et al. (2010) argue that the set of rules of a regime is causing the lock-in and the stability of a system (car-based mobility system). As a result of this lock-in, the current car-based mobility system is dynamically stable. What means that despite the lock-in of the regime, ongoing processes still take place but these processes have the wrong outcome. Instead of changing the system at its foundation, these processes have an incremental character and create cumulative trajectories (for example policies, science and markets which are related to the mobility system) within a regime. These cumulative trajectories don't shape

an ‘environment’ where transitions can take place. The questions than is: how can trajectories shape an ‘environment’ where transitions can happen and therefore can change the existing socio-technical regime? The answer can be found in the relationship between tensions and the interdependence of trajectories. The different trajectories within the regime are controlled by social groups; these groups interact with each other and form networks with mutual dependencies. In other words, these trajectories are interdependent and are shaping but not determining each other (Kemp et al, 2009). Sometimes the internal changes of a trajectory are so powerful that it causes tensions between the different trajectories. As a result, windows of opportunity for transitions are created (Grin et al, 2010).

Next to the windows of opportunity, Grin et al. (2010) argue that transitions are also taking place through the interaction between the three different levels (see Figure 2.3). To explain the interaction between the socio-technical landscape and the socio-technical regime a closer look at the creation of tensions between trajectories within the socio-technical regime is needed. As mentioned before, windows of opportunity are created by tensions between trajectories and these tensions are created by internal changes within a specific trajectory. But the question than is; how are these internal changes created? Grin et al. (2010) argues that the socio-technical landscape is putting pressure on the existing regime and this pressure leads to tensions within and between trajectories. The socio-technical landscape is also described as the wider context of practices and consists of infrastructure and other physical aspects, systems of governance, political associations, regulations, societal values, beliefs and concerns (Kemp et al, 2009). The pressure from the socio-technical landscape and the tensions between the trajectories opens up the existing regime and creates windows of opportunity.

At the same time, at the niche-level, a level where novelties are invented and tested by small social groups (Kemp, Loorbach, 2003). The novelties may be new practices, new technologies or special government interventions. These novelties are strongly influenced by on-going dynamics on the socio-technical regime and landscape levels. An example is given by Kemp et al. (2009): “the use of bicycles is shaped by the road infrastructure, priority rules, fiscal measures, climate change concerns and the economics of using other means of transport”. If an existing regime is opening up and windows of opportunity are created, well developed novelties within the niche-level can take advantage of this window of opportunity, what may lead to competition with the existing regime. If the novelty will end up as the winner of the competition, a new socio-technical regime will be created. Over time this new ‘system’ may also contribute to broader socio- technical landscape changes (Grin et al, 2010).

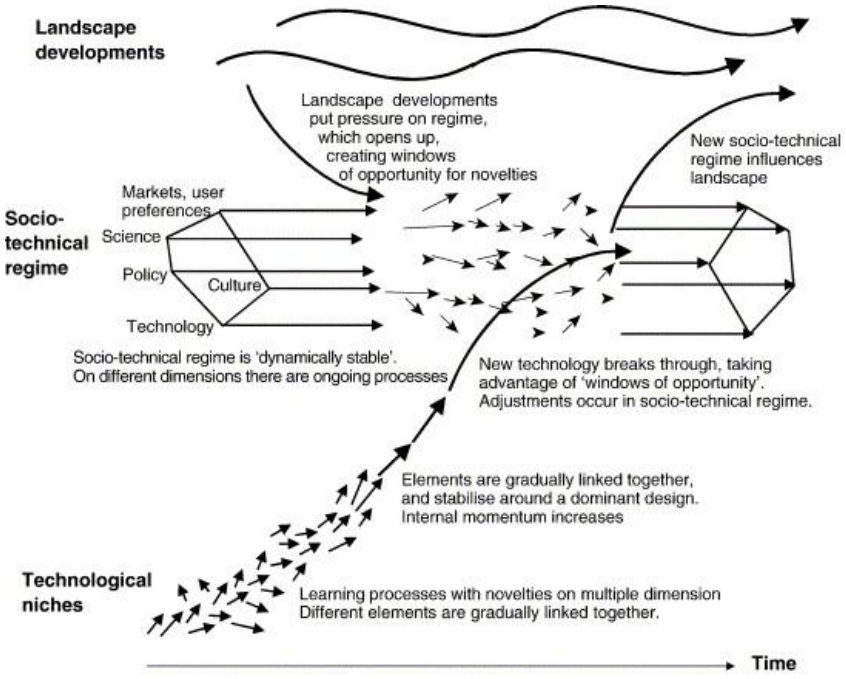

Figure 2.3: Multi-Level Perspective on transitions.

2.5 Governance of transitions

In addition to the process of system-innovation through transitions, Kemp and Loorbach (2003) ask themselves the question: can transitions be managed? They argue that transitions cannot be managed because transitions are the result of the interplay of many unlike processes, whereby the majority of these processes are uncontrollable. Does this mean that actors cannot do anything to influence transitions? The answer is no, instead of controlling transitions, actors can influence the direction and speed of transitions and thereby actors can change the chance that a transitions will occur (Kemp, Loorbach, 2003). Despite the non-controllability of transition processes, transition management is seen as a promising tool for system change towards sustainability. When using transition management as a tool for change towards sustainability, four basic rules need special attention (Kemp et al, 2005): be careful not get locked-in into sub-optimal solutions, transition policy should be included within current decision-making frameworks and transition management should be politically accepted, take the long view of a dynamic mechanism of change and make use of a multi-level coordination.

Next, the process of transition management should be explored to give special attention to the four basic rules mentioned above, and to influence transitions to create a system-innovation. The activities related to the process of transition management are generally described because they are dependent on the kind of transition problem. Grin et al. (2010) discuss a cyclic framework for transition management, which subdivide the activities into four phases (see Figure 2.4): (1) structure the problem in question and establish and organize the transition arena; (2) develop a transition agenda, a vision of

sustainability development, and derive the necessary transition paths; (3) establish and carry out transitions experiments and mobilize the resulting transition networks and monitor; (4) evaluate and learn lessons from the transition experiments, and, based on these, make adjustments in the vision, agenda and coalitions.

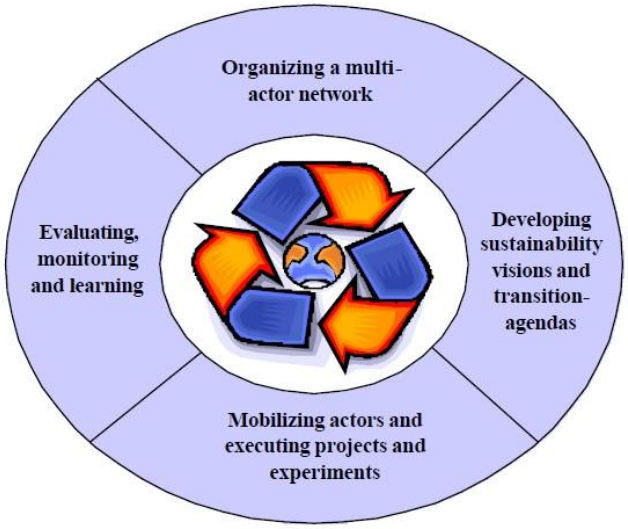

Figure 2.4: Framework for transition management and its four activity clusters.

In addition, every activity phase has its own typology. The process of problem-definition is characterized by Grin et al. (2010) as strategic. Further, developing a transition agenda can be seen as a tactical activity where negotiating, networking and coalition building is important. The third activity is mainly operational because the focus is on implementing projects and experiments. Finally, the process of evaluating, monitoring and learning is described as a reflexive activity. In addition to the different typology of the four main activities of transition management, each type of activity has its own group of actors. As mentioned before, these groups interact with each other and form networks with mutual dependencies. Transitions are seen as the outcome of these interactions, which occur within a level and between levels. Diversity is playing an important role within these interactions. To successfully create transition processes for change, a diverse set of perspectives and backgrounds (knowledge) is needed. The diversity in actors and the different activities of the transition management process reinforce each other, what results in a stronger position in starting transitions. A conclusion about the framework of transition management is given by Grin et al. (2010, p.157): "activities related to the content (system analysis, envisioning, agenda building and experiments) are linked to activities related to the process (network and coalition building, executing experiments and process structuring). The preferred actors to be involved (based on the necessary competencies) and instruments (like scenarios, transition-agendas, monitoring instruments, etc.) are derived from this framework".

2.6 Relationship theory and case study

Within this chapter the theory of transition management is addressed, and provides a management strategy for transitions towards sustainability. Three main aspects can be distinguished: MLP context description, clarification of barriers for implementation and the deployment of the cyclic framework for transition management. These three aspects are used to analyze the case in Phoenix, Arizona in chapter 4. First a MLP context description is made whereby the three different levels (landscape, regimes and niches) are described. This description provides a clear overview of the context and the relationship between the three levels in the specific case of Phoenix, Arizona. Secondly the barriers for implementation are clarified, the barriers described by Kemp and Loorbach (2003) can, based on the analysis of the interviews, be classified in four categories: Institutional, financial, zoning-policy and mindset barriers. Subsequently, the four phases of the cyclic framework for transition management will be used as guidelines to overcome the barriers to achieve the desired system-innovation. Hereby both the negative as well the positive aspects are described. In section 2.5 the conceptual framework will give an overview of the relationship between the different chapters.

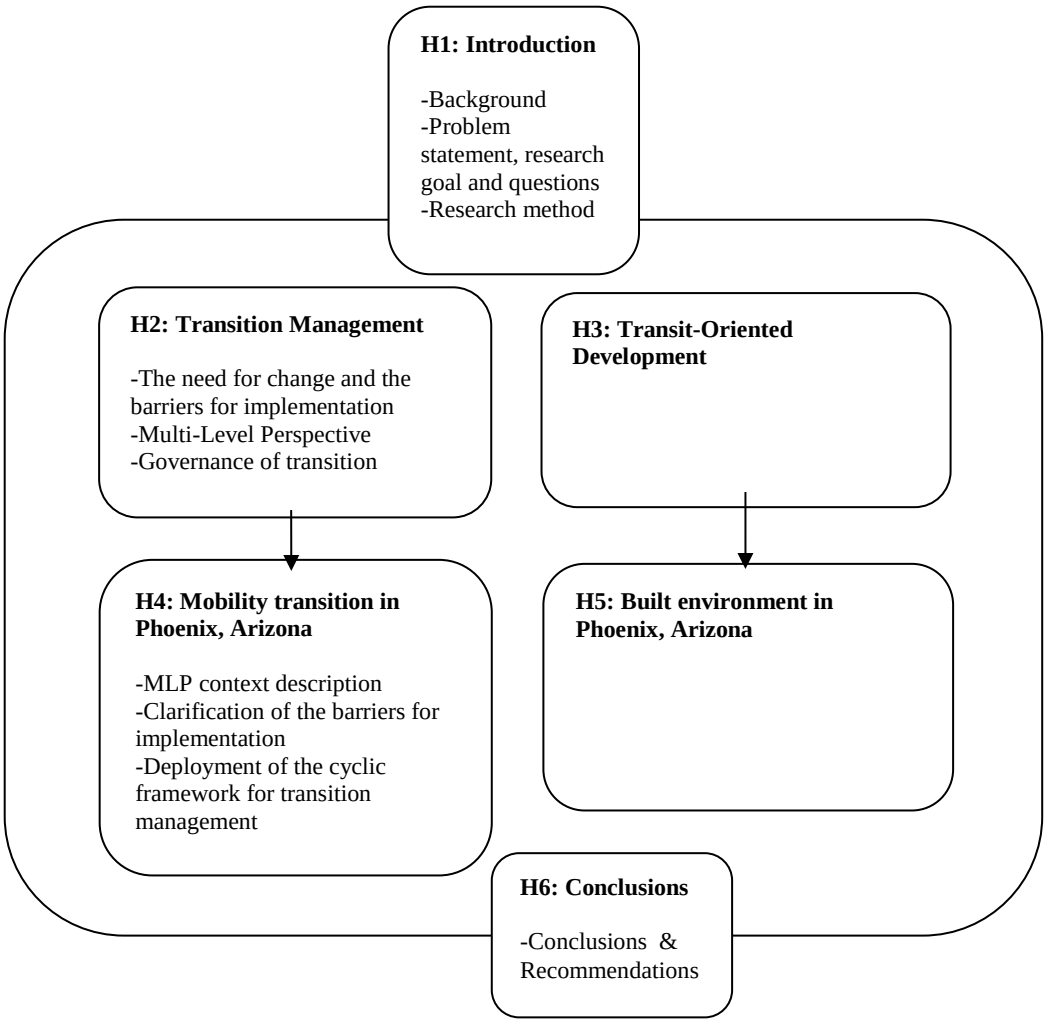

Figure 2.4: Conceptual framework: the relationship between the different chapters.

3. Transit-Oriented Development

3.1 Introduction

Chapter 1 described that the American society is to a great extent dependent on the automobile. The car-dependency of America is causing lots of problems, like urban sprawl, environmental and social problems. As a response to the negative externalities of car-use, a new paradigm is introduced. Sustainable mobility is seen as the solution to reduce the negative externalities of car-use and as a result, cities will become more sustainable and livable. This new paradigm is focusing on a better connection between land-use and transportation. The concept of Transit-Oriented Development is a tool for implementing the ideas of sustainable mobility paradigm. Therefore, this chapter will explore the concept of TOD. Section 3.2 will give an introduction of the goals and content of TOD; this will be done by a comparison between American government documents and scientific literature about TOD. In addition, section 3.3 will take a closer look at the concept of the five dimensions of the built environment, which is seen as the basis for good TOD implementation.

3.2 The concept of Transit-Oriented Development

During the end of the 20th century the negative effects of urban sprawl and car-dependence became clear. Transit-Oriented Development is seen as a promising tool for breaking with built environments characterized by urban sprawl and car-dependence (Cervero, Sullivan, 2011). Nevertheless, there is no universally accepted definition of TOD because of the differences in contexts (TCRP, 2004). For example, TOD in Phoenix is quite different than in the heart of Manhattan. The Transit Cooperative Research Program (TCRP) is showing these definition differences, of transit agencies, in their report 102, Transit-Oriented Development in the United States: Experiences, Challenges, and Prospects. The Utah Transit Authority (UTA) in Salt Lake City described TOD as: "*Projects that enhance transit use, improve the quality of service provided to authority riders, or generate revenue for the purpose of supporting public transit*". The TOD definition of the UTA is mainly focused on the ridership of public transit. In addition to an increase of the ridership of public transit, the Charlotte Area Transit System is describing TOD as: "*High-quality urban environments that are carefully planned and designed to attract and retain ridership. Typically, TODs provide for a pedestrian-friendly environment*". The definition of the transit agency from the Charlotte area emphasized the connection between planning and design of the urban or built environment on the one hand and the ridership of public transit on the other.

A more detailed definition of the 'planning and design' of TOD areas is formulated in the TOD definitions of the transit agencies, Valley Metro in Phoenix and the Bay Area Rapid Transit Authority in San Francisco (BART). Valley Metro described TOD as: "*a pattern of development characterized by a mix of uses surrounding a transit station where streets have a high level of connectivity, blocks*

are small, and buildings and uses cater to the pedestrian" (Valley Metro, 2012). TOD in San Francisco is described as: "*Moderate-to higher-density development, located within easy walk of major transit stops, generally with a mix of residential, employment, and shopping opportunities designed for pedestrians without excluding the automobile. TOD can be new construction or redevelopment of one or more buildings whose design and orientation facilitate transit-use*" (TCRP, 2004).

The definitions from Phoenix and San Francisco show that TOD should include different design elements like; small blocks, a network system of streets without the so called cul-de-sacs and the design should be pedestrian and bicycle friendly. These small blocks, which should be located near a transit-stop, should contain compact, mixed-use developments. Concerning the point made by the BART, that TOD could be new construction or redevelopment, Duany et al. (2010) are arguing, in their Smart Growth Manual, that urban revitalization, infill and urban extension are the smartest choices for new developments. In contrast, new neighborhoods which require 'new infrastructure' and which are planned in environmentally sensitive areas are described as the 'dumbest' growth alternatives (Duany et al, 2010).

In addition to the definitions from the transit agencies the scientific literature about TOD shows a lot of similarities. For example Atkinson-Palombo and Kuby (2011) describe TOD as: "*high density, pedestrian-friendly, mixed-use neighborhoods*". This description of TOD is similar to the '3Ds' given by Cervero and Kockelman (1997). They argue that TOD is strongly connected to three common transportation objections: (1) reduce the amount of motorized-trips; (2) increase the share of trips made by non-motorized modes; and (3) for all motorized trips made, reduce travel distances and encourage the trips made by public transit. To achieve these objectives three dimensions, Density, Diversity and Design (3Ds), of the built environment play an important role. In addition, Calthorpe (2005) argues that there are four main principles concerning TODs: Diversity, human scale (which is similar to pedestrian and bicycle friendly Design), conservation (which refers to the question: develop on virgin land or choose for infill and redevelopment) and regionalism, which according to Calthorpe (2005) is the most fundamental principle, because people don't live in isolated neighborhoods anymore. Further, Calthorpe (2005) argues that: "*Your job opportunities, the quality of the environment, the air you breathe, the water that's flowing through your neighborhood, the traffic congestion that constrains your life – all these things are regional in scale*".

The Density of the built environment, proposed by Cervero and Kockelmans (1997) and others, means that there should be enough residents, employees and shoppers within a walkable and bike-able distance, which are respectively < 0.5 mile and < 2 miles (800m and 3200m) to get to a public transit station (Dittmar, Ohland, 2004). The second dimension, Diversity can be explained as the mixture of

different functions, like land-uses, housing types, building vernaculars, and ways of circulating within neighborhoods (Cervero, Murakami, 2008). The Design aspect of the built environment consists of physical features, site layout, aesthetics and amenities that encourage social interaction, walking, biking and use of public transit (Cervero, Murakami, 2008). The three dimensions of the built environment are strongly interconnected. Most neighborhoods which contain mixed-uses are designed in a pedestrian and bike friendly way and therefore are mostly compact.

In their article: Rail + Property Development: A model of sustainable transit finance and urbanism, Cervero and Murakami (2008) introduce two additional dimensions, Distance to transit and Destination accessibility, to the 3Ds of the built environment introduced by Cervero and Kockelmans (1997) (See Figure 3.1). They argue that the ridership among residents and workers is strongly connected to the distance from a transit station, which means that how shorter the distance the higher the ridership. Finally, the last dimension of the built environment, Destination accessibility refers to how well a TOD is connected to the shops, offices, public parks and other popular destinations. The last dimension therefore shows the degree to which public transport efficiently connects a TOD to destinations throughout the region.

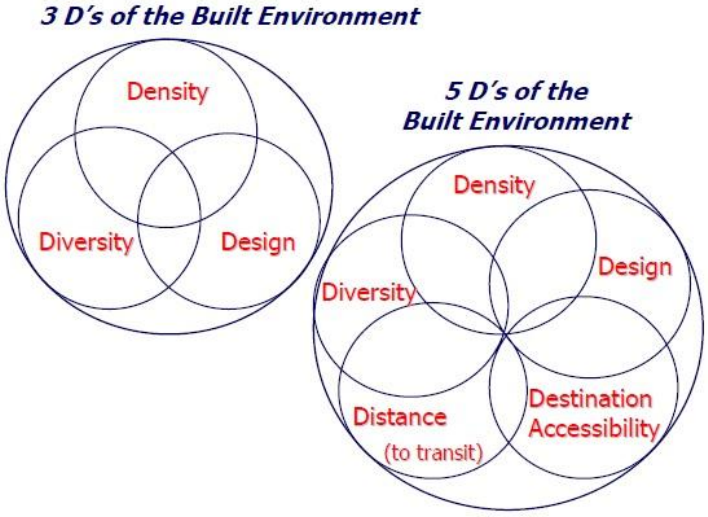

Figure 3.1: The three and five Dimensions of the built environment: Density, Diversity, Design, Distance to transit and Destination accessibility (Cervero, Murakami, 2008).

The definitions of TOD, formulated by different transit agencies, in combination with the five dimensions of the built environment provide a clear overview of the concept of TOD. The questions which than arises is: what is the goal of TOD? Atkinson-Palombo and Kuby (2011) and Cervero and Murakami (2008) are arguing that TOD will result in a more sustainable built environment, where people are less dependent on cars and where it is healthier to live, work and spent leisure time. The TCRP (2004), however, shows in their report that despite the presence of social objectives, such as the

improvement of the quality of life and increasing housing, transit agencies prioritize high ridership numbers and other economic objectives. (TCRP, 2004).

In conclusion, the scientific literature about Transit-Oriented Development shows a different perspective. Where increasing ridership seems to be the main goal of transit agencies, scholars are more focused on changing the urban form, from a scattered urban form towards a more compact and sustainable built environment. For example, the concept of the 5 dimensions of the built environment (5Ds) which are described above could be seen as a tool to change the urban form into a more sustainable built environment. In this context, the concept of sustainability represents the proposed pedestrian and bicycle friendly, mixed-use and dense communities where people are less car-dependent and have access to multiple transportation modes. As a result of this, fewer resources will be used and car-related externalities, like congestion, pollution, traffic accidents, will be reduced. Concluding, the secondary objectives described by the transit agencies show a lot of similarities with the main objectives which are advocated by different scholars.

3.3 Elaboration on the dimensions of the built environment

Now that the definition(s) and goal(s) of TOD are clear, the next step will be to implement the theory about TOD in the 'real world'. Therefore, the five dimensions of the built environment described by Cervero and Murakami (2008) should be further elaborated. For this The Smart Growth Manual written by Duany et al. (2010) will be used because TOD can be seen as a concept based on the theory of Smart Growth. The manual provides elements[2] of the built environment which contribute to 'smarter growth' to improve the state of the environment and the quality of our lives (Duany et al, 2010). The elements are distinguished in four urban levels namely, the region, the neighborhood, the street and the building, which correspond with the ideas of Calthorpe (2005): "*That the regional connections are as important as the individual places, that where we develop is as important as what we develop, that new neighborhoods, districts and urban centers fit together is as important as the urban designs of a block or a building*". The five dimensions of the built environment are in their turn again part of the four urban levels.

Growth is inevitable, because the population of the United States is expected to grow by 30 million over the next 20 years, due to higher live expectancy and higher net immigration (Census, 2010). Hence, non-growth campaigns are untenable. Duany et al. (2010) are therefore arguing that no-growth should be replaced by good growth. Good growth can be seen as the achievement of the goal(s) of TOD. Concerning the inevitable growth, urban revitalization, infill and urban extension are seen as the most preferable growth alternatives (Duany et al, 2010; Pollard, 2001). In addition to good growth,

[2] Only the elements of the built environment which are connected to TOD are described in this chapter.

another important principle, on the regional level, is that planning should be carried out according to the logic of a rural-to-urban transect. This rural-to-urban transect includes a sequence of zones of increasing density and complexity, from rural areas (low density, low complexity) to the urban core (high density, high complexity) (see Figure 3.2). Duany et al. (2010) argue that the design at every scale should correspond to the logic of the transect zone. For example, the design of the buildings and pedestrian measures in the natural zone should be designed differently than in the urban core zone. This logic of place dependent design will lead to more sustainable urban environments, which in turn facilitate the variety of lifestyles that Americans desire (Duany et al, 2010; Calthorpe, 2005). More details about the design will be given further on in this chapter.

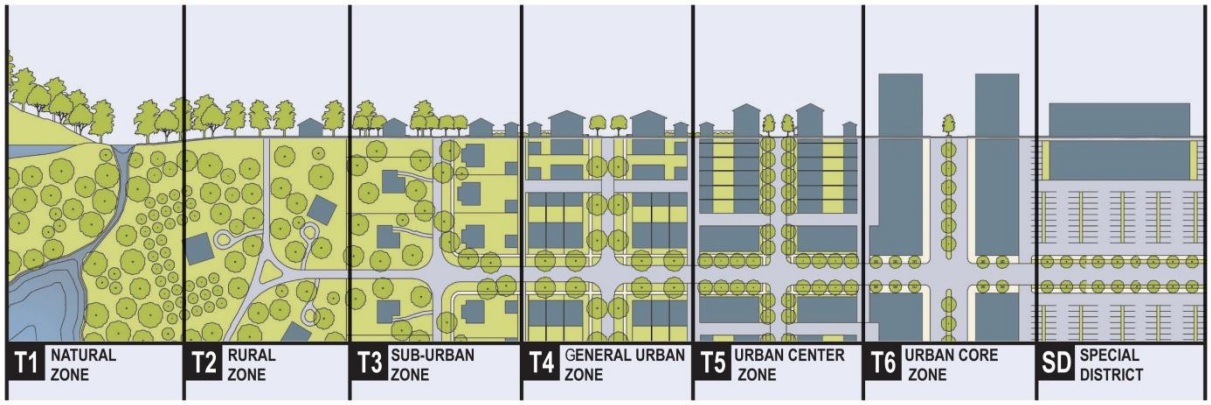

Figure 3.2: The six rural-to-urban transect zones (Duany et al, 2010).

A higher density, the first dimension of the built environment, is seen as an important aspect of TOD (Atkinson-Palombo, Kuby, 2011; Stead, Banister, 2011; Banister, 2007; Dittmar, Ohland, 2004; Cervero and Kockelman, 1997). The question, concerning TODs, than is: what is an appropriate density? The six rural-to-urban transect zones introduced by Duany et al. (2010) already reveals that there is no clear answer to this question. In addition, Flint (2005) argues that the success of dense development projects depends on the local context, existing land use and regional mindset. In his paper about the density dilemma of TODs he described different residential densities of TOD 'success stories'. Mockingbird Station and Addison Circle in Dallas, are two of these 'success stories' and have respectively, a residential density of 21 (lofts) and 54 (apartment) units per acre. Further, the projects: Pleasant Hill in the San Francisco Bay Area and Fruitvale in Portland, Oregon contain residential densities of 17 (single-family homes) and 21 (apartment) units per acre. In addition to Stead and Banister (2011), which recommend a residential density of 16 units per acre, the TCRP (2004) is showing that the TOD guidelines for Light-Rail served TODs in San Diego require a minimum residential density of 18 units per acre. Furthermore, the TOD guidelines for Portland, Oregon are dependent on the distance from a Light-Rail station: 30 units/acre within 0 – 1/8 mile, 24 units/acre within 1/8 – ¼ mile and finally, 12 units/acre within a ¼ - ½ mile (TCRP, 2004). In their example

about the Mountain View project in California the TCRP (2004) shows a difference in residential density for different housing types: single-family homes: 12 units/acre, townhouses and row houses: 30 units/acre and 50 units/acre for apartments. The average residential density for the Mountain View project is 22 units/acre (TCRP, 2004).

The difference in housing types also covers the second dimension of the built environment, Diversity. Duany et al. (2010) argues that healthy neighborhoods should include a wide range of housing types, this because: communities are dependent on the presence of a variety of age groups, multi-racial and income groups among their residents. The concentration of affordable housing should be avoided, and the focus should be aimed on a neighborhood with a mixture of housing types. The mixture of housing types creates a possibility for residents to move up economically without moving out of the neighborhood and therefore TODs should include different types of housing: rental apartments, condominiums, lofts, live/work buildings, townhouses and row houses, cottages, single-family homes and mansions (Duany et al, 2010; Flint, 2005). In addition, residential development should be mixed with other land-uses, where people can work, shop and spent their leisure time. About the balance between the amount of residents and jobs within TODs, the TCRP (2004) argues that the amount of jobs should not exceed the number of residents by more than three to one. In addition, industrial uses are often discouraged in TODs because such uses have few workers per acre. A multimodal balance and therefore, providing different transportation choices can be seen as another element which contributes to the Diversity (Duany et al, 2010). Duany et al. (2010) argue that the car should not be prioritized over other modes of transportation like: walking, cycling and public transportation. In addition, Calthorpe (2005) is arguing that: "*I think it's a much more interesting ... question of how you integrate the pedestrian and human scale environments with the car and the automobile scale*". A diverse choice of transportation modes is therefore necessary for TODs.

Now that we have a better overview of what is meant by the first two dimensions of the built environment, Density and Diversity, we should ask ourselves the question; how should the Density and Diversity be Designed? Further, how does a pedestrian and bicycle friendly environment look like, and how does this environment relate to the facilities needed for the automobile, like streets and parking facilities? These questions show that the dimensions of the built environment are closely related and interconnected (see also Figure 3.2). The third dimension of the built environment, Design, is closely related to the street level. This is due to the pedestrian and bicycle friendly focus of TOD. Duany et al. (2010) describe a great variety measures which contribute to a more pedestrian and bicycle friendly neighborhood, one of which is safety. As long as pedestrians and cyclists do not feel safe, they will not walk or use their bicycle and continue to use their cars. In the United States street designs are mainly focused on cars and the safety of pedestrians and bicyclists is not taken into account. Duany et al. (2010) argue that streets, within neighborhoods, should be designed not only for

automobiles but also for pedestrians and bicyclists. These street should provide narrow slower-speed travel lanes, bicycle facilities (parking and bicycle-lanes), on-street parking (shields pedestrians from traffic), continues tree cover (shade), appropriate street furniture and lighting and ample sidewalks with commercial uses alongside these sidewalks. Because, if the streets are becoming a pleasant and safe place to walk or cycle, people will choose more sustainable modes of transportation. In addition, Duany et al. (2010) argue that sidewalks in urban areas should be at least 10 feet wide. Sidewalks which are interacting with commercial/retail uses should be from building to curb 15- to 25-foot. In addition, buildings in urban areas (houses and commercial uses) should be located closer to the street (short setback) which contributes to the sense of enclosure (Duany et al, 2010). Further, the entrees of the commercial/retail uses should be inviting, transparent and they should face the sidewalks. In addition to the short setback, the height of the buildings also contributes to the sense of enclosure. Building heights should follow the rural-urban transect, for urban areas like TODs counts that the buildings should be three stories or more. Further for esthetic reasons, buildings on block corners and buildings which are placed at larger public spaces should be taller than adjacent buildings (Duany et al, 2010).

The two last Ds, Distance to transit and Destination accessibility, really show the close relationship and interconnectivity between the five Dimensions of the built environment. For example, TODs, which are organized around a transit stop should be designed in a pedestrian and bicycle friendly way, as a result distances (to a transit stop) are short (< 0.5 mile and < 2 miles), this in combination with a higher Density ensures that more people are in walkable or bike-able distance from a transit stop. If the area around a transit stop, include a lot of different land-uses, the area will be more diverse and therefore the amount of destinations within a walkable and bike-able distance will increase. A last remark, Dittmar and Ohland (2004) point out that TOD and transit are essential parts of the toolkit for healthy metropolitan economies and improved quality of life, but automobiles, highways and suburbs are also part of this toolkit. A return to the era of streetcar suburbs is not only impossible but also not desirable (Dittmar, Ohland, 2004).

3.4 Relationship theory and case study

This chapter has given a clear overview of the goals and objectives of Transit-Oriented Development. But the next question is; how can the theory about TOD be used for the analysis of the case study in Phoenix, Arizona? The answer can be found in the combination of the idea of the five dimensions of the built environment (Density, Diversity, Design, Distance to transit and Destination accessibility) described by Cervero and Murakami (2008) together with the idea of rural-to-urban transect zones introduced by Duany et al. (2010). The idea of these transect zones is that the content of the 5Ds depends on the location of the station. The 5Ds for a station area located in an urban core zone will be different than for a station area which is located in a more general urban zone (see Figure 3.2). In

addition, the city of Phoenix developed different place types for every station area within the LRC in Phoenix, AZ. Each station area place type has their own characteristics (land-use mix, scale/intensity and housing types). This diversity of different station areas can be found in Downtown Phoenix. Further, this area is also interesting because of the establishment of the Downtown Phoenix Community Development Corporation (DPCDC). The DPCDC is: *"a nonprofit organization formed in 2001 under the umbrella of the Partnership to attract affordably and attainably priced housing to the Downtown Phoenix area" (DowntownPhoenix.com).* The underlying idea is to increase the amount of people who are living in the Downtown area. In addition, some of the interviewees were mentioning some interesting TOD projects which were situated in the Downtown Phoenix area. Therefore the 5Ds for the Downtown stations within the Light-Rail Corridor in Phoenix, Arizona will be analyzed and compared to the theory about Transit-Oriented Development.

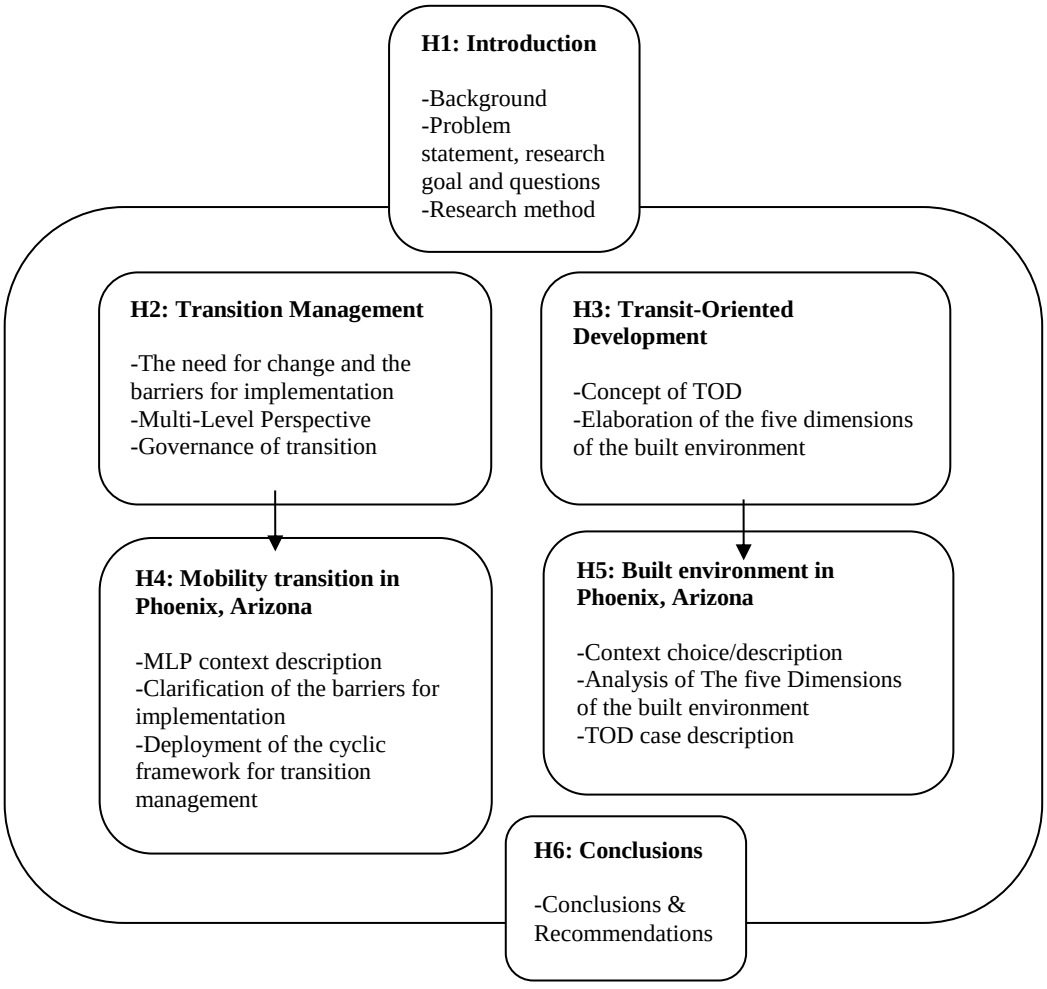

Figure 3.3: Conceptual framework: the relationship between the different chapters.

4. Mobility transition in Phoenix, Arizona

4.1 Introduction

In section 1.2 the problem concerning car-dependency in Phoenix, Arizona was already explained, especially the decrease in population and population density within the Light-Rail Corridor (LRC). Together with growing suburbs, air quality problems and limited resources, is seen as a serious problem for the city of Phoenix. As written in chapter 3, Transit-Oriented Development is seen as a potential solution to deal with these problems and therefore create a more sustainable and livable built environment within the LRC in the city of Phoenix. The implementation of TOD is easier said than done. The development of more sustainable built environments is a complex and prolonged process and a transition from the current car-based mobility system is necessary. As described in chapter 2, transition management is using a Multi-Level Perspective (MLP) to explain how this transition can be understood and how a transition can be influenced by the involved actors. Therefore, first the context of the mobility system in Phoenix, Arizona is explored and described with the use of the three levels (landscape, regime, and niche) of the MLP. Secondly, the barriers for implementation or barriers for change for the specific case in Phoenix are described in section 4.3. Finally section 4.4, describes the comparison between the four phases of the cyclic framework for transition management and the methods, procedures and strategies used by government organizations in Phoenix. The similarities as well the differences are described.

4.2 Multiple Level Perspective - contextual description

As mentioned before in chapter 2, society is locked-in to the use of cars. This phenomenon is also present in Phoenix, Arizona. A city planner from Phoenix said: *"our population loves their cars"*, later as a reaction on a failed attempt to eliminate a car lane she said: *"we did not have the momentum and we are still married to our cars and we still have those lanes".* These statements contribute to the fact that Phoenix has a mobility system which is mainly focused on the use of 'their beloved' cars. To improve the implementation of Transit-Oriented Development within the Light-Rail Corridor in Phoenix, Arizona, the focus should change towards transit, cycling and walking. This not only means a change of the mobility system itself, but also the relationship between society and cars. Therefore, a transition is needed. The description of Rotmans et al. (2000) shows why a transition is appropriate in this case: *"a transition is a gradual process of social change in which society or an important subsystem of society structurally changes".* The social change in the description can be seen as the needed 'divorce' between the people in Phoenix and their cars. Furthermore, the important subsystem of society which structurally changes stands for the mobility system, which needs to change from a car-based system into a more sustainable system with a stronger focus on multi-modal transportation where next to the car, transit, biking and walking get more attention. From a Multi-Level Perspective, we can say that the locked-in car-based mobility system is really stable and hard to change and therefore the car-based mobility system can be seen as a socio-technical regime (see Figure 4.1). Now

we know which subsystem (i.e. the mobility system) of society needs to change, a closer look at the content, like related markets, user preferences, policies, culture and technology, of this regime is necessary.

Traditionally, Phoenix is a car-oriented city. It all started with the planning and construction of the Interstate Highway System, which was authorized by the Federal Aid Highway Act (1956). This act approved the construction of 66.000 km of the Interstate Highway System divided all over the country. The timeframe for the at that time largest public works project was 10 years. The city of Phoenix opened her first freeway in 1958. Because of this, long distances could be covered in a shorter amount of time and thus people were able to live further away in suburbs. The demand for low-density suburban housing grew rapidly. Because more and more people wanted to own a single family home on a large lot, the size of Phoenix also grew. As mentioned before, the size of Phoenix grew from 45 km² in 1950 to 1.400 km² in 2010. To accommodate this rapid growth, new streets, freeways and highways were built, whereby the road system in Phoenix became one of the largest and fasted growing road systems in the United States of America. This short historic overview can be seen as the start of the car-dependency of Phoenix. People were moving to the suburbs, the road system was growing as fast as the city itself, owning and driving a car was relatively cheap; the car became an icon of the 20th century. The public transit system received little or no attention because: *"the bus system here is not really loved" (employee city of Phoenix).* In addition, the interviewee adds: *"if you walk in to one of these office towers and ask them what do you think about the light-rail? They will answer: that stupid train it is such a waste of money no one rides it, it messes up all the traffic".* Next to the bad image of transit, distances between people's (single family) home, people's jobs and the gigantic grocery stores became bigger, which resulted in the fact that walking or biking is not seen as a serious transportation mode. Mode share statistics about Phoenix show that only 6% of all commuters make use of transit, bike or walk to their work. Because of recent events (described above), the people in Phoenix are locked-in to a car-oriented mobility system and the accessory urban form. Changing/unlocking this socio-technical regime is very difficult. The next section will explain the specific barriers for the Phoenix case. First the two other MLP levels of the Phoenix case will be explored and described, i.e.: the recent developments on the socio-technical landscape level and the niche-level.

The current car-based mobility system of Phoenix arose from actions by the Federal government (determination of the Federal Aid Highway Act) together with a high demand for; *"huge pieces of land and huge homes (..) way out in the middle of nowhere, they want their big trucks and their cars"(employee city of Phoenix).* During the post-war period, the start of the 'car-boom', people and government organizations were not aware of the car-related externalities. The majority thought cars were comfortable, enjoyable and exciting. People were not thinking about the long-term impacts on

the environment and their social health (car related externalities). We can say that the current car-based mobility system in Phoenix, Arizona is dynamically stable. This means that changes take place within the mobility system (regime), but these ongoing processes have the wrong outcome (cumulative trajectories). An example is single policy implementation, like raising parking rates: *"we raised the parking rates because we did a study and it said yes raise parking rates so we did and we also raised the parking times (no free parking after 5PM), but than all the business communities started to complain about it and they told the city council, and you know what the city council does? They put it back how it was" (employee city of Phoenix)*. This example shows the importance of the acceptance of the problem. The important social groups need to accept or need to be aware of the negative externalities of car-use. The example therefore shows that the majority of the social groups in Phoenix are not jet aware of the seriousness of the problem. This acceptance of the problem is really important part of changing the current car-based mobility system. To understand the importance of this acceptance, the socio-technical landscape of the mobility system in Phoenix needs to be explored. This is because the pressure from the landscape can open up the existing regime and creates windows of opportunity.

During the post-war period the socio-technical landscape was characterized by the planning and the construction of the Interstate Highway System, which stands for the infrastructure and other physical aspects of the landscape level. Furthermore, there was a great belief in cars and a high demand for suburban homes. The socio-technical landscape started to change in 1987 when the report "Our Common Future" was introduced. The Commission on Environment and Development, led by Gro Harlem Brundlandt, warned for the negative impacts on the global environment caused by unsustainable consumption and production. The most important recommendation of the report was the call for sustainable development. From that point more and more attention was given to the unsustainable consumption and production and the impact on the environment. Subjects like climate change by increasing CO2 emissions and recourse depletion, which refers to the exhaustion of raw materials like oil got more and more attention. In 1992 this even led to an agreement between all UN-member states to develop policies aimed at sustainable development. Around the same time Peter Calthorpe (1993) introduced the concept of Transit-Oriented Development when he published his paper 'The New American Metropolis' (Calthorpe, 1993). As described in chapter 3, the goal of the concept of Transit-Oriented Development aims at creating a more sustainable built environment, where people are less dependent on cars and where it is healthier to live, work and spend leisure time. In addition, TOD is even described as a promising tool to "redefine the American Dream" (Carlton, 2007). This can be interpreted as; that through the introduction and implementation of TOD the car(ownership) will play a less important role within the American Dream. These global and national 'developments' show that there is more attention given to the negative externalities of car-use. Looking at the socio-technical landscape we can say that the social values, beliefs and concerns about

the externalities of car-use are changing, the pressure on the existing socio-technical regime is growing.

Due to the growing interest in and the agreement on the need for more sustainable mobility, even the traditionally car-oriented city Phoenix is starting to 'change'. The use of public transport is seen as one of the measures of sustainable mobility, the implementation/construction of the Light-Rail system in Phoenix in the winter of 2008 (a 32km line with 27 stations) can therefore be seen as an important milestone in the transition towards a more sustainable mobility system. An example of the change towards sustainable mobility is given by a planner from the city of Phoenix: *"I was pleasantly surprised when we gone out for the general plan, people way up north care about the I-17 and they say maybe we can have light-rail up here, and if you had that conversation 8 years ago, no way!".* Next to this the same planner mentioned:

"Neighborhoods are becoming a little more open to maybe a light-rail line next to them instead of a freeway down the street, so that certainly you know, there are people from Scottsdale there that traditionally have been against having light-rail, even they were open, they were like: we do not want to see an expansion of the freeway, that is a dramatic impact on our community".

But the Light-Rail system was only the first step in the right direction, from a sustainable mobility perspective the light-rail cannot be seen separately from the surrounding built environment. Looking at the connection between land-use and transportation, especially the efforts of the government organizations are really promising. For example the Maricopa Association of Governments (MAG), which is the metropolitan planning organization (MPO) for transportation planning in the Phoenix region, is working on a study for sustainable transportation and land use integration by which they try to 'move the needle' towards regional objectives (MAG, 2011). Hereby, the MAG is focusing on seven performance factors:

- Neighborhood street network
- Housing and employment density
- Mixed-use neighborhoods
- Regional Accessibility
- Frequent and convenient transit service
- Demand Management and Incentives
- TOD Affordable Housing
- Demographics

These performance factors have the same focus as the five dimensions of the built environment, which are described in chapter 3. Under influence of the growing awareness of the effects of climate change, scholars and society started to think about more sustainable ways of transportation (Light-Rail system) and ways to design cities (5Ds). These two components can be seen as new novelties, within the *niche-level*, which over time may link together and stabilize around a dominant design (see Figure 2.3 and Figure 4.1). This dominant design (the connection of a Light-Rail and the 5Ds) is waiting for a 'window of opportunity' to start the competition with the existing car-based mobility system (regime). Especially the linkage between the new novelties, new Light-Rail systems and the new design principles is really important because this will increase the chance of "winning" the competition with the existing regime. Now that we have a clear overview of the three different MLP levels and the interaction between them the next question is: what barriers make a transition of the mobility system in Phoenix so difficult?

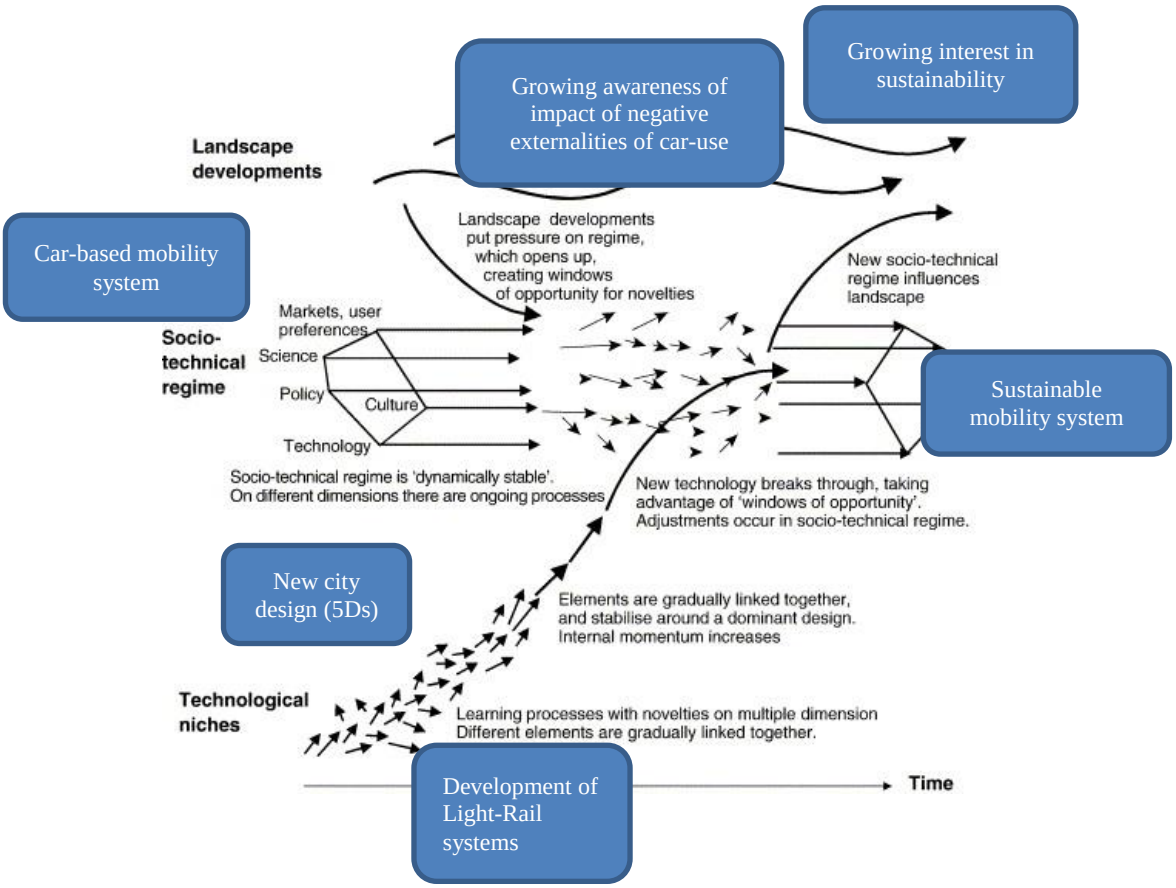

Figure 4.1: Multi-Level Perspective on the transition of the mobility system in Phoenix, Arizona.

4.3 Clarification of the barriers for implementation

As described in section 2.2, Kemp and Loorbach (2003) describe seven barriers for making systems more sustainable. These barriers can, based on the analysis of the interviews, be classified into four

categories: Institutional, financial, zoning policy and mindset barriers. These groups will be used to analyze the barriers, which were encountered in the Phoenix case.

4.3.1 Institutional barriers

As mentioned in chapter 3, Banister (2008) argues that the sustainable mobility paradigm is focusing on the complexity of cities, and tries to improve the connection between land-use and transportation. A barrier related to the realization of this connection, is the distribution of authority between government organizations. A transportation planner from the MAG said: "*The State of Arizona gives all land-use decisions to the city or the towns, they do not give any land-use authority to the region, nor to the State, so I think this is really important to understand if it comes to regional planning, because we only have one part of the answer, (..) therefore cooperation between MAG and the city is really important*." This quote shows that there is a miss-match between the scale of the problem and the responsible 'authority'. For example, the car-dependency is not only a problem for the city of Phoenix but for the whole Metropolitan area. In addition, Calthorpe (2005) argues that the most fundamental principle of Transit-Oriented Development is regionalism, this because people don't live in isolated neighborhoods anymore, they cross boundaries. The planner from the MAG said that it would be really helpful, for creating more and better TODs, if the MAG would get land-use authority. She refers to Salt Lake City, where they have a regional land-use plan. But at the same time she admits that this will be a difficult process: *"it will be hard to change because no one wants to give up their leverage; no one wants to give away their power to another organization".* Therefore, good cooperation between the stakeholders is necessary.

Currently, the cooperation between the government organizations, with regard to TOD and regional planning, is good. The planner from the MAG said: *"we created a TOD working group with the goal to bring all the governmental organizations together and work on regional policies".* In Phoenix, especially the cooperation between the MAG, Valley Metro (transit agency) and the planners from the city of Phoenix is really good. The problems occur in the cooperation between the planning organizations and the State, city officials, citizens and developers. One example about the cooperation between the city and the State was given by an employee from the city of Phoenix: *"Right, it is so challenging because you would think, the city being a government organization and the State being a government organization, we would be able to work together and come to an agreement on a great solution and a plan (..) it is almost that we operate in silos".* Problems with the cooperation between the stakeholders arise because some stakeholders don't accept the negative effects of car-use, and that they don't believe in sustainable mobility and other sustainability solutions. In relation to this a planner from the MAG stated that:

"I think for a lot of our officials, sustainability is not on their radar, as in land-use and transportation, (..) for example, we do not talk about greenhouse gas emissions here".

Next to the concerns of the MAG, also the planners from the city of Phoenix are concerned about the fact that some stakeholders don't believe in sustainability: *"Well we went to a speech held by the mayor, (..) I think he mentioned sustainability a couple of times in his speech, they all want Phoenix to be a nice place but they are also political and their terms are four years".*

The quote shows that there is a mismatch between politics and sustainability. For example, politicians want to change things during their political career, they want to achieve significant results because this will increase the probability of reelection. As a result politicians are less focused on sustainability issues because these issues often have a long-term character. In addition, another example is given by an employee of the city of Phoenix: *"The city council, yes they support, or they say that they support TOD and they support light-rail but they do not support it by not changing the parking meters, so it is counterproductive, you know, the only reason they do not support the parking meters is that they need to keep the business owners happy because the business owners are the ones that elected them into the office".*

4.3.2 Financial barriers

A financial barrier which came forward during the interview with the MAG and Valley Metro was that side preparation for infill and redevelopment projects is more expensive and harder than developing from scratch. According to the planner from MAG: *"Infill in this region is twenty times harder to do than new development, because of the construction of utilities like power lines and sewers, the current system is not built to handle the new development"*. In connection to this, the transportation planners from the MAG and the Valley Metro argue that the city of Phoenix should help developers with the realization of infill and redevelopment projects. They argue that the city needs to facilitate better, to make it easier and cheaper for developers to do infill and redevelopment projects. The parking requirements for new developments are seen as a subject where the city could facilitate better. The problem here is that the official parking requirements for new developments within for example the LRC are still too high. These infill/redevelopment projects are less car-dependent and could therefore have lower parking requirements. For example, a suburban project should contain 1,5 parking places per housing unit. But one parking place could be enough for a project located close to a transit stop. As a result, the developer will spend less money on the development of parking places. The planners from the MAG and the Valley Metro said:

"If you are doing high-rise or anything not single-family, I think a lot of the planning regulations are not set-up for that, I know that a lot of developers we have heard, they say that uhm, parking

standards are still put on infill developments with single family standards, (..) this goes back to the costs of the development, if the developer can reduce parking places he can reduce the total costs of the development".

In addition, all the interviewees were mentioning the housing crisis and the economic crisis as important financial barrier to get more residents to live in the inner cities:

"Right now it is so cheap to buy a big house in the suburbs; it is like half of what you pay in a central city". This quote by a planner from the city of Phoenix reveals a problem caused by the housing and economic crisis. The goal is to get more people (from the suburbs) to live within a walkable and bike-able distance from a transit station, but because of the crisis fewer new developments are built and the prices of the suburban houses go down and this attracts people to live in the suburbs. An example of this 'market' problem is given by an employee of the city of Phoenix:

In a conversation about mixed-use projects: *"This project is completed 2 years ago and if you go there now, the retail is still empty, so it is like, and then the developer is mad: City you told me that I had to build this ground floor retail and the residents who live here will use it".*

Another barrier is the way the State of Arizona is funding their transportation: *"in Arizona the tax highway user revenue funds are only a dollar amount of every gallon, it is 20 cents, so if gas is 4 dollar a gallon the tax is 20 cents if the gas price is 2,5 dollar a gallon it is still 20 cents, so no matter what people are paying for gas it is a flat rate, so it is not adjusting, so now the miles driven has gone down we are in really bad shape"(city of Phoenix)*. The problem with this tax system is that it does not matter if the gas price goes up; the tax revenue will stay the same. If the goal is to reduce car-use, the current system will cause in a decreasing revenue because the amount of tax revenue is connected to the amount of miles driven. Therefore, less miles driven means that the tax revenue will decrease.

4.3.3 Zoning-policy barrier

Another barrier is the gap between the market and the zoning, a planner from the city of Phoenix stated: *"Yes, there is no money and no market, you know what, (..) what is approved there through zoning is up to 300-feet and probably what needs to happen is more 5 to 6 stories, but there is a gap in price, and so if you are a rich guy in California you are waiting to get your high-rise money".*

This last quote contains a combination of a financial barrier and a zoning-policy barrier. The zoning policy is seen as an important barrier and is maintained by the way of taxing. This because the tax, which a land-owner needs to pay for a vacant parcel, is much lower than the tax he needs to pay for a developed parcel. So instead of building a 5 or 6 story mix-used project (which is more appropriate

from a TOD perspective) they wait until they can benefit from the high-rise zoning so that they can build a high-rise tower. The investor therefore accepts that he will lose money during the time he is waiting, but this loss will be lower than the differences in profit of developing a high-rise tower instead of developing a 5 or 6 story mix-used projects. The zoning-policy is therefore a barrier because the zoning allows land-owners/developers to build a high-rise tower on their lot. But despite the fact that more high-rise towers will probably increase the ridership of the Light-Rail, from a TOD perspective mixed-use projects are more appropriate because these projects contribute to a more 'cozy' and livable built environment. In addition, the planners from the city of Phoenix said: *"A lot of that vacant land has high-rise zoning on it, (..) like this really big square that has high-rise on it, well so the land owner wants high-rise money for it, so if somebody came in and said, wow that is just steps from the light-rail I wanna put six stories of multi-use residential there, what a great location, but he is not gonna pay a high-rise price for it*". This quote also reveals that it can be assumed that the high-rise zoning is one of the reason why there are so many vacant parcels within the LRC in Phoenix. A additional problem is that the owner of that vacant parcel is probably not living in Phoenix and therefore: *"they do not care, for them it is an asset, it is in a portfolio of lots of other assets, if somebody opens it up and says, high-rise land in a high-rise corridor in Phoenix, great that has value now that makes the portfolio worth something, they are just waiting for the market".* In addition, a planner of the city of Phoenix stated: *"he (land-owner) is probably losing money but that might not be a bad thing from a tax perspective".*

From this perspective the zoning policy can be seen as a barrier but one planner from the city of Phoenix are arguing: *"I do not think it is a barrier because if they wanna change it they get it changed, the barrier is a little bit of time, to do that, uhm, (..) I also think that people use that as a cut-out sometimes, that they say that zoning is the barrier".* Overall, the zoning policy is not really the barrier, the intentions and involvement of the property and land-owners is seen as the barrier. But the fact is that: *"realistically the ones we will see develop are the ones that do not have that (high-rise) zoning".*

4.3.4 Mindset barrier

As a response on the discussion about the questions if zoning is a barrier or not, both the planners from the city of Phoenix, Valley Metro and the MAG stated that the mindset of residents but especially of developers can also be seen as an important barrier. In this the mindset of the people is seen as part of the Arizona 'culture'. In relation to this mind-set problem a planner from the city of Phoenix stated that: *"It does not fit with how they are used to develop, that is a bigger barrier than zoning if you ask me, (..) and I would say the developers always gonna look to the city to blame, because it is a real easy target".*

In addition, another planner from the city of Phoenix added: *"Talking about barriers, I think first of all we are a suburban city, so most of our developers are suburban in how they think".*

Next to the planners from the city of Phoenix, the planner from the MAG gave an example of the mind-set of a developer from Arizona: *"I talked to a developer and he told me that he will continue the way he was developing before, so I ask him what are you doing when gas prices double and you did not build a walkable community so that your only option is the car? He answered that person should just buy a new fuel efficient car, I said that cannot be the answer".*
These quotes show that the mind-set of the people (in this case the developers) in Arizona plays an important role in the realization of TOD projects. Because if the stakeholders do not 'believe' in the need for more sustainable transportation and development, the result will be that the mobility system will stay the same (i.e. car-based).

4.4 Deployment of the cyclic framework for transition management

The next question is: how to overcome these barriers, for example how can we change the mind-set of the people in Phoenix? The framework for transition management by Grin et al. (2010) will be used to analyze the methods used by the government organizations in Phoenix to overcome the barriers which are described in section 4.3. The four phases of the cyclic framework will be used as guidelines for the analysis.

4.4.1 Organizing a multi-actor network

The first step is to organize a multi-level actor network and to define the problem. Concerning the planning of Light-Rail and Transit-Oriented Development in Phoenix, Arizona, the main stakeholders are: the city of Phoenix, Maricopa Association of Governments (MAG), Valley Metro, developers and the residents or communities. Kemp and Loorbach (2003) argue that actors can influence the direction and speed of transitions. Because of the interdependence of the stakeholders, the stakeholders need to work together to start a transition. As mentioned earlier in this chapter a TOD working group is created with the idea to bring all the government organizations together and work on regional policies. This is a good first step in creating a stable and diverse group of actors which, according to Grin et al. (2010) is necessary to create transition processes. To increase the diversity of perspectives and backgrounds (knowledge), the city of Phoenix strongly involved the residents/communities in the process of the general plan update. In order to find out what Phoenix residents appreciate about their city and what they want to see in the future, a series of workshops were held in 2009. During these workshops residents were asked to imagine the best version of Phoenix in 2050 – the city of our children and grandchildren: How do they live in our city? After the workshops in 2009 the city of Phoenix was concerned with the attendance of the workshops. A planner from the city of Phoenix said:

"There was some concern about the number of people we were able to involve in that process, and as a result there was some concern about some of the themes that you saw pop-up".

Next to the concerns about the attendance of the residents, the new mayor and council expressed the wish to also have this conversation with the community. Therefore, it was decided to do the whole process of the 'values and vision events' again. As a result of the involvement of the new mayor and city council, the city of Phoenix expects that there will be more people who are willing to participate in the value and vision events. A planner from the city of Phoenix said:

"With the mayor and council involved, they will help us to get more people to the table, (..) we already had a meeting up here, two Saturdays ago with the council man and Williams (the new mayor) to talk about the General Plan for just this area, it was a Saturday morning and we had 50 people because the mayor sent out the invites, if we were running the meeting we would have maybe gotten 5 or 10, (..) they carry some weight, (..) so I think that residents will be rather excited to come to a meeting like this".

The update process of the General Plan shows a growing will to involve the residents in plan making processes. Moreover, the involvement of the communities in the first phases of the process can be seen as a positive development. This is because the residents don't only need to accept a plan but they are part of the planning process. As a result the acceptance (of the residents) of a plan will be much higher. Another positive aspect is the choice to redo the workshops which were held in 2009. This shows that the intentions of the city of Phoenix are serious and that they really want to work together with the communities. The higher attendance of the new meeting, mentioned by a planner from the city of Phoenix, shows that it was a good choice to redo the workshops.

A specific example of these value and vision events (see Appendix 1 for the result of these events) which is related to TOD is described and explained by an employee from the city of Phoenix:

"We are developing station place types right now (..) for every station area we are meeting with the community (..) and asking them you know what, what do you feel your area needs? What type of development does it need? Does it need more commercial? More retail? Does it need more grocery stores? Does it need housing? And what type of housing? Is it condos, apartments, single family? and so we pool all of the different stakeholders in the area together and the first actual step in the process is, we have a giant map, like this one here and let's say this is your station area and usually we do a quarter mile radius and a half a mile radius (..) so within this radius what should be preserved?".

4.4.2 Developing sustainability visions and transition-agendas

The process of community involvement, during the general plan update, also covers the second phase of the framework for transition management: developing sustainability visions. The first thing that stands out is the title of the general plan update. The chosen title was: Phoenix General Plan Update, Transitioning to a Sustainable Future. In addition, the city's goal is to significantly change the city of Phoenix. The city of Phoenix is using an anticipatory governance process (see Figure 4.2). Figure 4.2 shows that the change towards sustainability plays a vitally important role in the general plan update for Phoenix. The foundation of the plan existed of four focus areas: community, economy, environment and infrastructure. These areas are based on the three pillars of sustainability – equity, economy and environment – along with an area that addresses built form and infrastructure. The focus of the General Plan Update on sustainability shows a resemblance with the second phase of the framework for transition management.

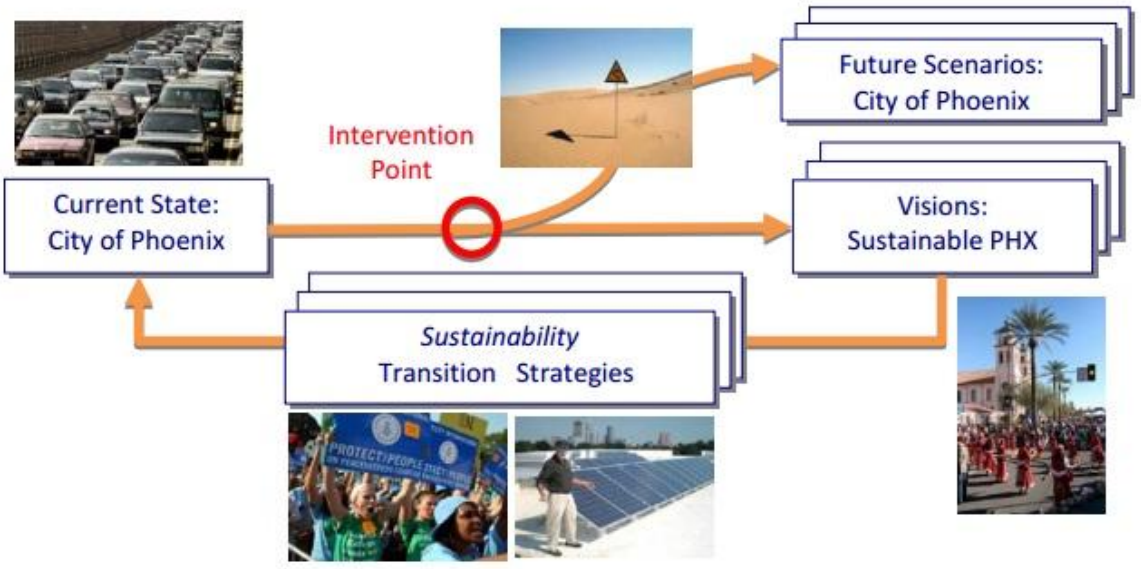

Figure 4.2: Anticipatory Governance Process used in Phoenix, Arizona.

Next to the general plan update, set up by the city of Phoenix, the MAG is also working on a comprehensive study for the Phoenix region. This sustainable transportation & land-use integration study shows a strong relation with the sustainable mobility paradigm (Banister, 2008). The MAG also organized a meeting with the community organizations; the meeting was focused on prioritizing themes relevant to sustainable transportation. The result (themes and tools) shows similarities with the ideas of Transit-Oriented Development. The following themes received great support from the participants:

- Walkable communities
- Multi-modal mobility

- Access to destinations
- Light-Rail
- High Density corridors
- Bicycle/pedestrian network

As a result of the study together with the result from the workshop, the MAG describes sustainable transportation as: "A transportation system that provides a variety of options, offers attractive facilities for people who walk or bike, and locates high capacity transit in places that will be chosen by households and businesses seeking excellent access to local and regional destinations as well as to walkable communities" (MAG, 2011). The topics (equity, economy, and environment) which can be seen as the foundation of this study are similar to pillars of sustainability which are used in the general plan update for the city of Phoenix (see Figure 4.3). The sustainable transportation & land-use integration study together with the Phoenix general plan update shows that there is a strong focus on sustainability and that there is a clear vision (based on the pillars of sustainability) for the Phoenix region as well for the city of Phoenix. In addition, both plans are developed with the use of community involvement.

Figure 4.3: The three pillars of sustainability used by the MAG as the foundation for the sustainable transportation & land use integration study.

4.4.3 Mobilizing actors and executing projects and experiments

The TOD working group, community meetings (general plan update) and the stakeholder (community) meetings organized by the MAG show that a lot of time and effort is put into the process of negotiation, networking and coalition building. These processes are covered by the first phase (organizing a multi-actor network) of the framework for transition management. This does not mean that it is perfect. Next to the good cooperation between the community and the governmental planning organizations, the cooperation with the developers can still be improved. The necessary improvement of the cooperation with developers fits into the third phase; which is more focused on mobilizing actors and to build coalitions to develop new projects and start experiments. About improving the cooperation with the developers the MAG argues that the city should help the developers with developing TODs. This means that the city should facilitate better. The city should for example help with the improvement of the infrastructure and other utilities alongside possible infill/redevelopment locations. This can stimulate the developers to start more infill/redevelopment projects. A good cooperation between the city of Phoenix and its developers is therefore really important. This also connects to the second part of the third phase (implementing projects and experiments); a better cooperation between the city and the developers can result in more pilot projects. About the importance of these TOD pilot projects, the employee from the city of Phoenix said:

"A lot of people did not know what TOD was, they did not know what light-rail was and so they would not make a very informed decision, I think a lot people would have said, we want nothing, we want all one-story because most people are afraid of density and height, (..) and so I think by having it operational and they see the benefits of it and there are some projects which came in, uhm, and most of the neighborhoods like those projects".

These pilot projects / experiments are really needed because examples from other cities were not accepted by the residents of Phoenix: *"a lot of them you know did not really understand it and so we used examples from Denver"*, but despite the good examples the reaction of the residents was: *"we are not Colorado! we are Phoenix we are different".* Therefore pilot and experimental projects, which are based on the five dimensions of the built environment (Cervero, Kockelmans, 1997; Cervero, Murakami, 2008), are needed to show the residents, and also some developers, the benefits of Light-Rail and TOD in Phoenix. An employee from the city of Phoenix said: *"it's really important to teach them, to educate them about light-rail and tell them all the benefits and all the good things it can do"* We now know that it does not work to bring in examples from other cities and therefore Phoenix should create its own examples. For example, if a developer wants to develop a mixed-use project on a vacant plot close to a Light-Rail station and the developer is experiencing problems, the city should help this developer to solve the problems. If the city assumes the role as facilitator, more TOD projects will be realized. In addition, the implementation of the Light-Rail system in Phoenix can be seen as a

successful experiment and pilot project, because there are already new initiatives to extent the current line. In addition, the employee from the city of Phoenix stated that: *"sometimes people need to see something before they are willing to support such a project"*.

4.4.4 Evaluating, monitoring and learning

During the interviews no specific answer was given to the question if there are specific programs to educate the people about sustainability (only one example of a TOD project within the LRC was given). The lack of a good answer can be explained by the fact that the city of Phoenix is still in the middle of the process of change towards sustainability. Looking at the framework for transition management we can say that Phoenix currently can be situated somewhere in between phase two and three. The plans which are made by the city of Phoenix and the MAG show a strong wish to make Phoenix and its region a more sustainable place. Therefore, sustainability visions are developed; despite the place types there aren't a lot of specific programs to implement the visions. The next step should be to implement some TOD pilot or experimental projects to inform/educate people that TOD projects also 'work' in Phoenix. These projects will attract new development and these projects will therefore work as a catalyst. Next, an evaluation of the whole process and the implemented TOD example projects is needed to see if the implementation can be improved. This will result in an improved vision and this will result in more and better TOD (pilot) projects/experiments. This process of evaluation and monitoring should take place in the same context and with the same people as during the development of the General Plan Update (city of Phoenix) and the sustainable transportation & land-use integration study (MAG). Because Phoenix is still halfway the process, an analysis of the current evaluation and monitoring process is not possible. The optimal situation will be that a continuous process will arise, after the evaluation and monitoring process a learning process should take place whereby the sustainability vision for Phoenix will be tightened and as a result the content and the implementation of new TOD (pilot) projects will also be improved. This repetition of the four phases of the framework of transition management will result in a growing pressure on the socio-technical regime, and this will finally result in a transition of the mobility system (from a car-based system into a more sustainable system with a stronger focus on the use of transit, walking and biking). In addition, the planners from the city of Phoenix argue that: *"Something will begin to happen, but it is a matter of being patient".*

4.5 Conclusions

As stated in the introduction, the implementation of TOD is easier said than done, the development of more sustainable built environments is a very complex and prolonged process and a transition of the current car-based mobility system is necessary. With the use of a Multi-Level Perspective context description it became clear that the mobility system in Phoenix is really car-focused. As a result the car-based mobility system is stable and hard to change. Nevertheless, the MLP context description

also showed some good developments on the landscape and niche levels. The increasing interest in sustainability together with the growing awareness of the impact of the negative externalities of car-use, are important developments within the landscape-level which increases the pressure on the mobility-system in Phoenix. In addition, the development of the Light-Rail is another good development towards a more sustainable mobility system in Phoenix, Arizona.

The MLP context description provides a clear overview of how a socio-technical regime, in this case the car-based mobility system, can be changed or unlocked. In addition, a more detailed look is necessary to discover why changing or unlocking the car-based mobility system in Phoenix is so difficult. Therefore, the following question is raised within section 4.3: what barriers make a transition of the mobility system in Phoenix so difficult? Through the analysis of the interviews, which were held with local and regional governmental planning organizations, it became clear that within the Phoenix context, the barriers can be classified into four categories; institutional, financial, zoning policy and mind-set barriers. These barriers, explain why the transition of the mobility system and the implementation of TOD in Phoenix are so difficult.

The question than is how to overcome these barriers to improve the implementation of TOD within the LRC in Phoenix. The cyclic framework for transition management was used to give an answer to this question. The framework contains four phases which provide different methods, procedures and strategies to stimulate the change/unlocking of the car-based mobility system and therefore, improve the implementation of TOD. Phoenix is still in the middle of the process of change towards sustainability and is consequently at the start of the third phase; mobilizing actors and executing projects and experiments. An opportunity to overcome, for example the zoning-policy and mindset barriers, can be found in the fact that the city owns quite some land within the LRC (see Appendix 2). These lots are perfect for the development of TOD pilot projects, because there is no land-owner who can obstruct the development of these projects. As a result, the pilot project can inform/educate people about the benefits of TOD projects, and these pilot projects also show that TOD projects can ‘work’ in Phoenix. Furthermore, these projects will attract new development and will therefore work as catalysts. Next, all the different methods, procedures and strategies which are used during the transition process should be evaluated and monitored. As mentioned within section 4.4.4, at the ‘end’, a learning process should take place which provides new input to re-start the cyclic framework for transition management. This repetition of the four phases of the framework of transition management will result in a growing pressure on the socio-technical regime, and this will result in a transition of the mobility system (from a car-based system into a more sustainable system with a stronger focus on the use of transit, walking and biking). Because of this focus, it can be expected that more TOD projects will be implemented because the ‘new’ regime which has a stronger focus on sustainable transportation modes will create a higher demand for dwellings close to a transit stop and were people

can safely bike and walk to for example coffeeshops, retail stores, parks and the local grocery store. The fact is that Phoenix is still in the middle of the cyclic framework for transition management and therefore it is not possible to give a reflection on the how Phoenix is dealing with the 'second' part of the framework. On the other hand, clear steps has been given to proceed the transition towards a more sustainable mobility system in Phoenix, Arizona.

5. The five Dimensions of the built environment in Phoenix, AZ

5.1 Introduction

In chapter 1 and 3 it is mentioned that Transit-Oriented Development is seen as a solution to reduce the negative externalities of car-use and create a more sustainable and livable built environment. Next to this, Dittmar and Ohland (2004) have pointed out that TOD and transit are essential parts of the toolkit for healthy metropolitan economies and improved quality of life. In addition, chapter 4 explained the complexity of changing mobility systems (towards more sustainable systems) and the difficulty of implementing TOD projects in Phoenix, Arizona. Despite all the difficulties, a few projects have been developed. During the interviews it became clear that these (TOD) projects can be found in the Downtown area of Phoenix. This area is also interesting because of the establishment of the Downtown Phoenix Community Development Corporation (DPCDC). The DPCDC is: *"a nonprofit organization formed in 2001 under the umbrella of the Partnership to attract affordably and attainably priced housing to the Downtown Phoenix area" (DowntownPhoenix.com).* The underlying idea is to increase the amount of people who are living in the Downtown area. The DPCDC is part of the Downtown Phoenix Partnership (DPP) which can be seen as some kind of advocacy group[3] which consist of a cross-section of the downtown stakeholders[4]. Further, the Downtown area is the only location within the LRC in Phoenix which has a redevelopment area. Because of these recent initiatives the 5Ds for the Downtown stations within the Light-Rail Corridor in Phoenix, Arizona will be analyzed and compared to the concept of the five Dimensions of the built environment. First a short introduction on the research area will be given in section 5.2. Secondly, the five Dimensions of the built environment around the Downtown stations will be analyzed in section 5.3. Next, section 5.4 will describe the 5Ds for a specific 'success' case within the research area. Section 5.5 will give a concluding statement about Transit-Oriented Development in Phoenix, Arizona.

5.2 Context choice/description

The Downtown area of Phoenix is used as a research area to analyze the five Dimensions of the built environment. There are a number of reasons to justify this choice. The first reason is that the interviewees pointed out some good examples of Transit-Oriented Developments. Beside these good examples, through personal observations it became clear that from a TOD perspective, Downtown Phoenix also contains really 'poor' examples. The presence of these 'extremes' makes it interesting to analyze this area. Secondly, Downtown Phoenix is chosen as research area because of the availability

[3] The partnership exists to strengthen Downtown Phoenix development and to encourage an environment of activity, energy and vitality. To accomplish this, the Partnership provides a variety of enhanced services to this core area through the provision of direct services, marketing, and economic development.

[4] DPP is guided by a volunteer board of directors representing a cross-section of downtown stakeholders, including property owners, tenants, merchants, cultural and nonprofit organizations, city and county management, and elected officials.

of GIS data. Now the choice for the research area is justified, the next step is to define the demarcation of the area. In relation to TOD and the Light-Rail system, it is important to know which stations will be taken into account. Looking at the Downtown Redevelopment area, determined by the city of Phoenix, we see that the redevelopment area contains 9 Light-Rail stations (Appendix 2). Figure 5.1 shows the stations which are located within the Downtown (redevelopment) area. This area can be seen as a priority area where redevelopment is wanted. The names of these stations are from north to south;

- McDowell & Central Ave
- Roosevelt St & Central Ave and Roosevelt St & 1st Avenue
- Van Buren & Central Ave and Van Buren & 1st Ave
- Jefferson St & 1st Ave and Washington St & Central Ave
- 3rd St & Jefferson St and 3rd St & Washington St

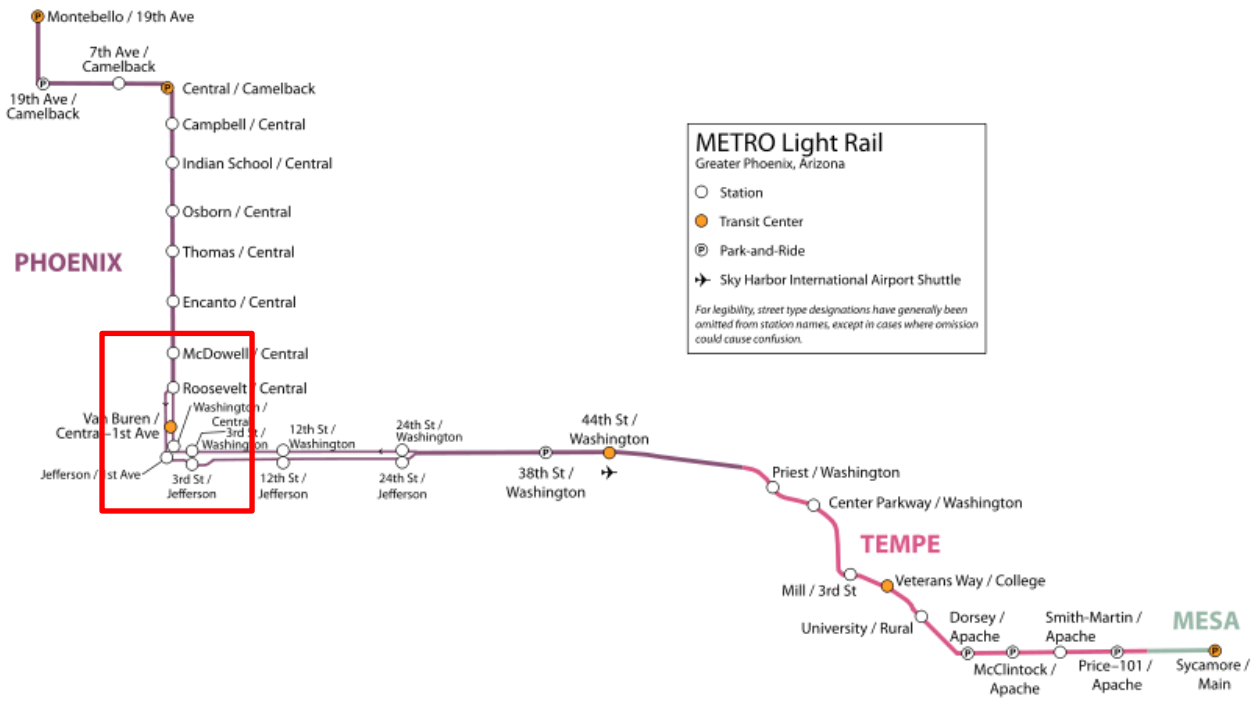

Figure 5.1: METRO Light-Rail with Downtown stations within the red box (Source: valleymetro.org).

With respect to the analysis of the 5Ds within the Downtown area in Phoenix, a 0,5 mile buffer, which is an acceptable walking distance (Dittmar, Ohland, 2004), is drawn around all Light-Rail stations accept the station McDowell & Central Ave. This is because only the south side of this station is located within Downtown Phoenix. However, this station is part of the research area because it is situated within the buffer which is drawn around the Roosevelt stations.

5.3 The five Dimensions of the built environment

5.3.1 Density and Distance to transit

In chapter 1, different scholars emphasize the need for sustainable mobility. The main focus of this paradigm is to improve the connection between land-use and transportation by developing high-quality neighborhoods (Cervero, Kockelmans, 1997; Banister et al, 2000; Banister, 2007; Banister, 2008). Cervero and Murakami (2008) argue that these neighborhoods should contain the so called five dimensions of the built environment. These 5Ds are seen as the main characteristics for sustainable and livable built environments. In addition, these neighborhoods can degenerate vehicle trips, reduce VMT per capita and encourage non-motorized travel (Cervero, Kockelmans, 1997). The intention therefore is to reduce the need to travel, encourage greater use of public transport, walking and cycling (sustainable transportation modes) and reduce travel distances. It is therefore necessary that enough residents are living within a walkable and bikeable distance from a public transit station (Dittmar, Ohland, 2004). The recommendation of Dittmar and Ohland contains two of the 5Ds; Density and Distance to transit. In chapter 3, the Density (residential and population) was concretized by different scholars. Duany et al. (2010) argue that there is no clear answer on the question; what is an appropriate density? Therefore, success stories are used to give an impression of appropriate densities of some good examples of TOD projects. These TODs in cities as; Dallas, Portland and San Diego have or require respectively a residential density of 54 (apartments), 12-30 and 18 units per acre (TCRP, 2004). An acre is equal to approximately 0,4 ha. Further, the TCRP (2004) recommends a residential density of 30 units per acre for townhouses and approximately 50 units per acre for apartments. Next to the residential density, Calthorpe (1993) and Dittmar and Ohland (2004) recommend an average TOD population density of respectively 32 and 60 persons per acre. Dittmar and Ohland (2004) argue that these densities should be located within a walkable (0,5 mile) and bikeable (2 mile) distance from a transit stops/station. If people live within walking distance from a transit-stop, use of the sustainable transportation modes (walking, cycling and transit) will be higher.

Table 5.1: Summary of the Density and Distance to transit recommendations

Population Density

- 32-60 persons per acre **(Calthorpe, 1993; Dittmar and Oland, 2004)**

Residential Density (TCRP, 2004; Duany et al, 2010)

- 10-20 units (single-family dwellings)
- 20-30 units (townhouses)
- 30-60 units (apartments)

Distance to Transit (Dittmar and Ohland, 2004)

- < 0,5 mile (walkable distance)
- < 2miles (bikeable distance)

To analyze the density within downtown Phoenix, the research area is divided into quadrants separated by a vertical line starting at Light-Rail station McDowell & Central Ave and a horizontal line which include the Van Buren stations (see Figure 5.2). Furthermore, census block data (2010) is used to define how many and where people are living within the different quadrants. A census block is described as the smallest geographic unit which is used by the United States Census Bureau, and often corresponds with a normal city block. Further, data of the building footprints within the LRC in Phoenix are added because the combination of the population per census block and the building footprints provides a clear overview of the density and the distribution of the population. The building footprint is also used to analyze the number of housing units within the research area. Looking at the Density map (Appendix 3), several things attract the attention. The first thing that stands out is the distribution of the population; the map shows that most populated census blocks are located in the north-west of the research area. The average population density within this quadrant is approximately; 8 persons per acre. The other quadrants have respectively a population density of; 4 (north-east), 3 (south-east) and 10 (south-west) persons per acre. The population density of the south-west quadrant gives a wrong impression because 1740 out of the total of 2251 people who are living in this quadrant are prisoners. The total research area only accommodates 7700 persons which are divided over 1200 acres of land. In contrast to the north-west and to a lesser extent the north-east, both south quadrants contain a lot of 'empty' lots, which means that there are no people living within these census blocks, where the north side of the research area shows a gradual distribution of empty, low, middle and high occupied census blocks. The south side stands out due to the predominantly empty blocks with a few highly occupied blocks. The great amount of empty blocks can be explained by the fact that the Central Business District (CBD) is located north of the two southern quadrants. Historically seen people in the Phoenix region were living in the suburbs instead of living within or close to the CBD.

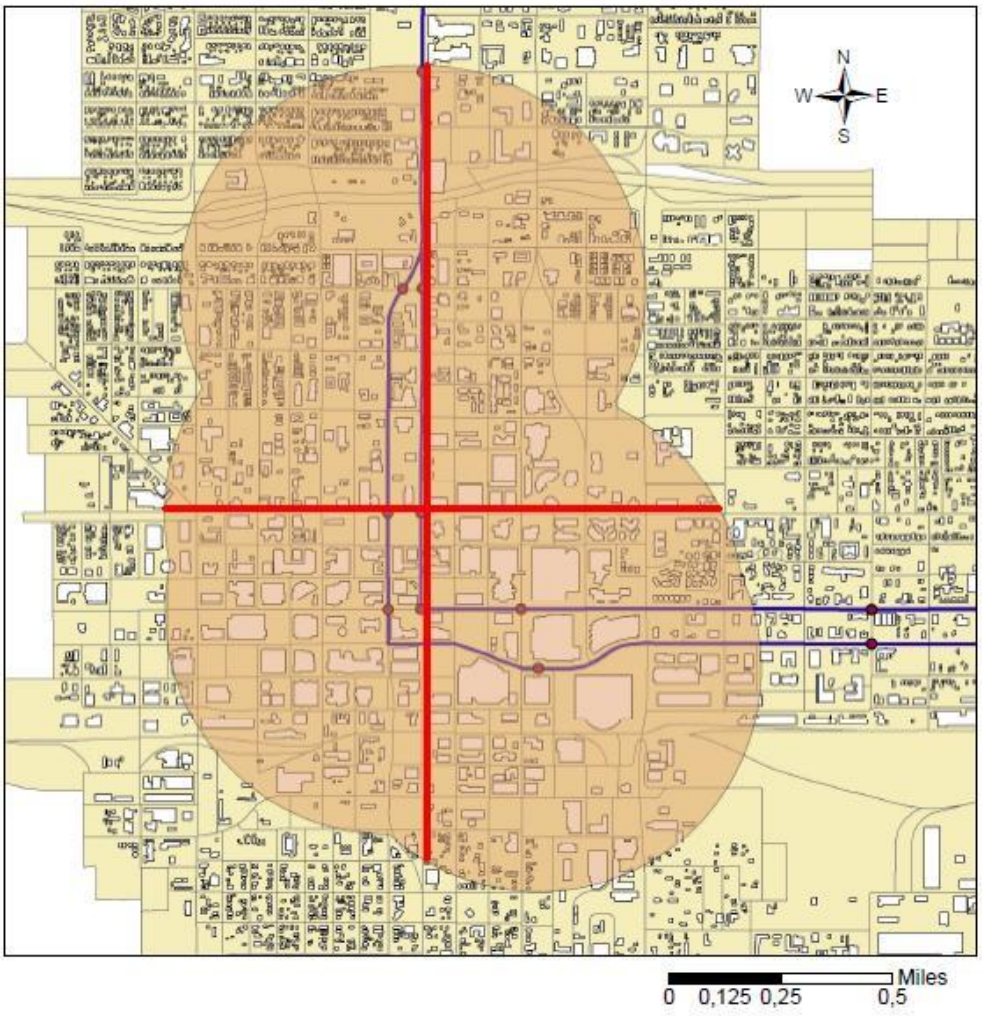

Figure 5.2: The four quadrants within the research area.

Concluding, we can say that all four quadrants don't meet the population density recommendations for TODs given by Calthorpe (1993) and Dittmar and Ohland (2004). The north-west quadrant, which has the highest population density of all quadrants, comes with an average of 8 persons per acre, not even close to the recommended 32-60 person per acre. Despite some 'significant' census blocks which meet the recommended population density, overall we can say that the walkable area around the Downtown Light-Rail stations has to attract more residents to increase the population density. As a result the ridership of the Light-Rail will also increase. Due to incorrect data of the specific amount of housing units, it is not possible to give a clear overview of the residential density within the four quadrants. Despite this, the northern quadrants contain some projects with a residential density between 10-20 units per acre. The residential density of some of the denser projects in the southern quadrants lays somewhere in between; 20-55 units per acre. These numbers show that the research area contains some projects which meet the recommendations for TODs. But despite this, the amount of these good projects is disappointing.

5.3.2 Diversity and Destination accessibility

Next to a high density within a walkable distance from a transit station, multiple scholars argue that these station areas also need to contain a high mix of different functions, like land-uses, housing types and destinations (Cervero, Murakami, 2008). Diversity is seen as an important 'ingredient' for healthy neighborhoods (Duany et al, 2010). These neighborhoods should contain a mix of residential developments with other land-uses, where people can work, shop and spend their leisure time (TCRP, 2004). To make this possible, the station areas should contain different kind of functions. For example, Flint (2005) argues that TODs should contain different residential developments like; apartments, condominiums, townhouses, and single-family dwellings. In addition, these TODs should contain different office and retail developments where people can work and shop. Next to the diversity of functions, destination accessibility is another important characteristic of TODs (Cervero, Murakmai, 2008). Therefore, these areas should also contain parks, museums and other places where people can spend their leisure time (within a walkable distance from a transit stop). The key here is to provide quality, with access to local services and facilities, so that people do not need to travel long distances (Banister, 2007).

Table 5.2: Summary of the Diversity and Destination accessibility recommendations

Diversity

- Station areas should contain a high mix of different functions, like land-uses (residential, commercial, open space and education) and housing types like single-family, condominiums, townhouses and apartments **(Cervero, Murakami, 2008; Flint, 2005; TCRP, 2004; Duany et al, 2010)**.

Destination accessibility

- Station areas should contain multiple different destinations (parks, museums and other destinations where people can work, live and spend their leisure time) **(Cervero, Murakmai, 2008; Banister, 2007)**.

The quadrants used for the analysis of the Density (and Distance to transit) are also used for the Diversity and Destination accessibility analysis of the research area. Looking at the land-use map (Appendix 4), the first thing that stands out is the difference in plot size. If we compare the north side of the research area with the south side it's clear that the south side contains mainly large lots and the north side mainly smaller lots. A closer look, at the north side of the research area, reveals that the predominant land-uses are; residential, vehicle parking, vacant land and some commercial/retail uses. The great amount of residential land-uses in the north-west also explains the great amount of 'colored' blocks, which represent the population density in this area. Looking at the diversity of residential

developments the total research area contains almost the same amount of single-family residential lots (219) as apartments and condominiums (212). The commercial land-uses which are located in the north of the research area are mainly small office buildings and retail businesses. Looking at the land-use map again, it is striking that the northern quadrants contain so many parking facilities. In addition, the large amounts of parking facilities are often mixed with vacant lots. This combination is causing a grim and deserted atmosphere. A remarkable fact is that the majority of the vacant lots and parking facilities are located within the residential areas in the northern quadrants of the research area. In total the downtown area contains 411 vacant lots and 180 lots with a vehicle parking land-use description. In contradiction to the residential developments in the south of the research area, three other land-uses are relatively dominant within this area. The first thing that stands out is the horizontal 'blue corridor' in the center of the research area. These blue lots contain commercial uses, like offices, restaurants, bars and some retail stores. The second land-use which stands out is the 'cluster' of yellow lots in the south-west. These lots contain government buildings like; the city hall, post offices, the federal courthouse and the office of the Maricopa Association of Governments (MAG). Further, looking at the south-east part of the research area it stands out that this quadrant contains a lot of warehouses. The warehouses located in the south side of the south-east quadrant are mixed together with vacant lots and parking facilities. As mentioned before, this mix is causing a grim and deserted atmosphere and therefore these areas are not pleasant places to stay at.

The success of a light-rail system (i.e. high ridership) also strongly depends on the different destinations within the Light-Rail corridor. Looking at the different destinations within the research area it stands out that the CBD (horizontal line between the north and east quadrants) contains the main destinations. If you take the eastbound train from Tempe, just before you enter the downtown area you will pass Phoenix Sky Harbor International Airport. Phoenix is one of the cities where the Airport is located next to the downtown area. Furthermore, the south-east quadrant contains different high-rise office buildings, Phoenix convention center, Arizona science center, the Case field Baseball stadium, the US Airways Center (NBA Basketball arena) and a relatively new high-rise mixed-use development which contains different restaurants and bars, a gym, entertainment like stand up live, a hotel, different retail stores and a grocery store. The other south quadrant (south-west) contains mainly government and high-rise office buildings. Some of these office towers have small restaurants and cafes situated on the ground floor. Looking at the north-west quadrant it stands out that this area doesn't contain major destinations, the only notable destination is a park which is located on top of the I-10 highway. Compared to the north-west, the other northern quadrant contains more major destinations; the Phoenix Biomedical Center, a shopping mall, Phoenix public library and the Civic Space Park which is connected with the Arizona State University (ASU) Downtown Campus. This park is a really unique place for Downtown Phoenix, because you do not expect a 'green' park in a

city which is located in the middle of the desert. The park is increasing the 'coziness' and the livability of Downtown Phoenix.

Concluding, looking at the Diversity and Destination accessibility of the Phoenix Downtown area; one of the most important findings is the presence of a reasonable amount of different land-uses. But an (maybe more) important remark here is that the land-uses are too much separated and the wrong land-uses are 'mixed'. Appendix 4 clearly shows the poor mix of commercial and residential land-uses. Most commercial land-uses are located in the center of the research area, where the residential land-uses are mainly located in the north and south part of the research area. The area contains different kind of residential developments; single-family dwellings, townhouses, condominiums and apartments, which contributes to the diversity of the research area. As mentioned earlier, the mix of the residential developments, parking facilities and vacant lots should be avoided. On the other hand, the clustering of government buildings isn't a bad thing because the different government organizations know where to find each other what can result in a better cooperation between these organizations. Furthermore, the outcomes of the destination accessibility correspond with the outcomes of the diversity analysis. The research area contains a great amount of different destinations; convention centers, parks, hotels, sport stadiums, schools, office buildings, small and big retail stores. The presence of these different destinations within the research area will attract more people (visitors and residents) to the Downtown area. Looking at opportunities for improvement, we can say that the northern quadrants have a greater potential compared to the southern quadrants. There are more opportunities to create a more dense and diverse area because of the presence of smaller lots. Because of the current economic landscape, it is more likely that smaller lots will be development instead of large lots because of the higher investment costs of larger developments. Good coordination is therefore playing a very important role because these smaller developments should be aligned to create a synergy; instead of the same uses you want a mix of land-uses which complement each other . In addition, it can be expected that with the development of smaller lots more land-owners are involved, to achieve the goal of creating a more dense and diverse area, bottom-up coordination together with a good cooperation between these stakeholders is therefore of great importance.

5.3.3 Design

The important aspect of the design dimension is the focus on the human scale. For example; station areas (like the research area in Phoenix) should be designed to stimulate people to walk and bike more. Because of the fact that physical activity is good for your health, the focus on bicyclists and pedestrians will also contribute to a higher livability of the area. Important therefore is that the facilities for walking and biking are present and besides this, the facilities should also be save and should be located in an attractive environment. As mentioned in Chapter 3, people will only start to walk and bike more if the streets are pleasant and safe places to walk and bike. One aspect related to

making streets more pleasant and save is mentioned by Duany et al. (2010), he argues that the combination and interaction between commercial/retail uses and sidewalks will contribute to pedestrian and bicycle friendly streets. The entrees of the commercial/retail uses should be inviting, transparent and they should face the sidewalks (Duany et al, 2010). In addition, multiple scholars and transit agencies mention that TODs should be designed in a pedestrian and bicycle friendly way and TODs will therefore result in a more sustainable built environment and the quality of life will be improved (TCRP, 2004; Dittmar, Ohland, 2004; Cervero, Murakami, 2008; Duany et al, 2010).

Table 5.3: Summary of the Design recommendations

Design

- TODs should be designed in way that stimulates people to bike and walk. Facilities should be present and these facilities should be located in a save and pleasant environment. As a result people will start to use more sustainable transportation modes and this will contribute to the livability and the quality of life **(TCRP, 2004; Dittmar, Ohland, 2004; Cervero, Murakami, 2008; Duany et al, 2010)**.

Figure 5.3 shows a bicycle map with the different bike paths in the city of Phoenix. Looking at the bike paths within the research area, the bike paths at Jefferson St and Washington St stand out. These bike paths are situated alongside the Light-Rail tracks which are coming from the east. The amazing thing is, despite enough space, that as soon you enter the Downtown area the bike paths all of a sudden disappear and bikers are forced to bike on the sidewalks. This mix of pedestrians and cyclists is causing dangerous situations because sidewalks are not designed to accommodate these two transportation modes. Perhaps even more stunning than the fact that the bike paths stop when you enter Downtown, is the fact that the bike paths all of a sudden pop-up when you leave Downtown. The bicycle map is also showing this 'gap'. Furthermore, the bicycle map also shows a positive development. Within the two northern quadrants, at Fillmore St, the city of Phoenix has developed its first bike boulevard; *Bicycle boulevards are specifically designated routes for bicycles on existing streets.* The bike boulevard on Fillmore St is connecting the historic neighborhoods; Roosevelt, Garfield and North Garfield with are located in the two northern quadrants.

In contrast to the bike facilities the facilities for pedestrians within the research area are much better. Almost all the streets have spacious sidewalks. But, the sidewalks are kind of dangerous because of the fact that there are almost no bike paths and that cyclists need to bike on the sidewalks. Another important aspect of sidewalks, especially in Phoenix is shading. This is related to the geographical location of the city of Phoenix; because Phoenix is located in the desert, pedestrians and cyclists are facing high temperatures. Especially in the summer, temperatures of 40+ degrees Celsius are common and can therefore be a barrier to walk and bike. More shaded sidewalk and bike paths make walking

and biking more comfortable during ‘hot’ days. Looking at the sidewalks in Downtown Phoenix a lot of sidewalks lay in shaded areas because of adjacent high-rise towers. In addition, a lot of these towers have a ‘notch’ on the ground floor where people are basically covered and protected from the sun.

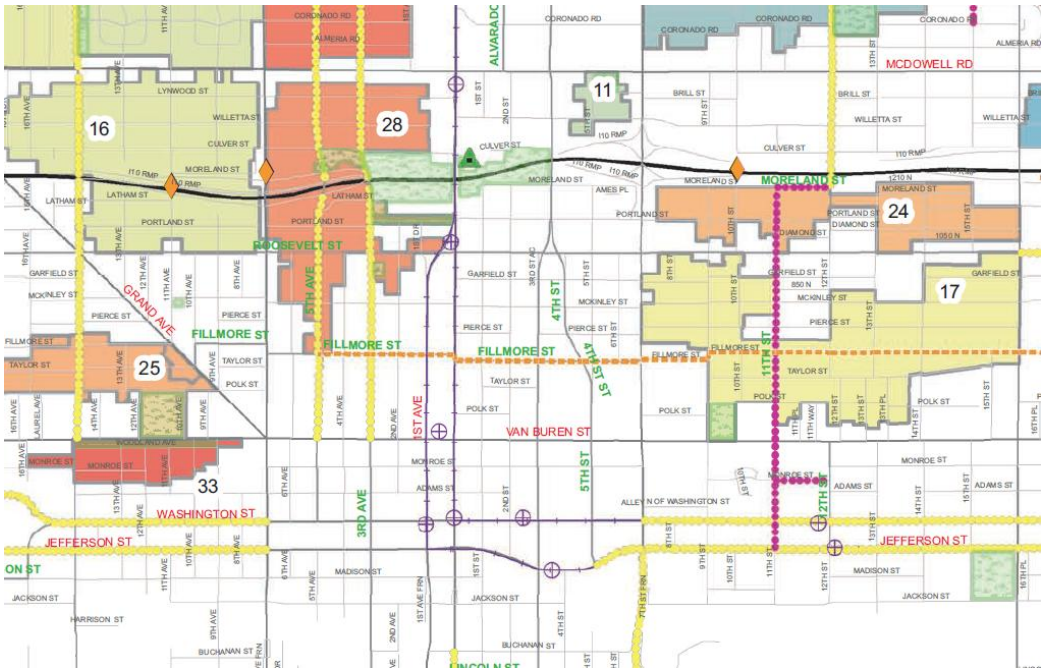

Figure 5.3: A section of the Bicycle map of Phoenix, Arizona (With in orange the bike boulevard and in the south the ‘gap’ within the bike paths on Jefferson and Washington St).

Concluding, despite some good initiatives, the biking facilities in the downtown area are kind of poor. From a TOD perspective, the connection with the Light-Rail stops should be improved. A better connection will stimulate people to bike to the stations and continue their trip by Light-Rail (it is even possible to take your bike into the Light-Rail). The connection between Light-Rail and bike paths will probably result in lower ridership numbers for ‘short’ trips within the Downtown area, because people can then safely bike to their destination. But the ridership for ‘longer’ trips will probably start to grow. Therefore, from a ridership perspective the growing bike share can be seen as a competitor of the Light-Rail. But from a livability perspective the lower ridership is not a bad thing because instead of taking the Light-Rail, people will walk or use their bike. Looking at the improvement of bike paths within the research area we can say that improvements within the northern quadrants are more appropriate. The stronger focus on the improvement and development of bike paths in this area is more appropriate because the northern quadrants can be seen as departure area because more residents are living in this area. Besides, the southern quadrants contain more commercial uses and other destinations instead of residential uses, therefore the south side can be seen as the arrival area. Because most destinations are within walking distance good sidewalks are more important within this area than bike paths. So this means that for the area outside Downtown but still within the LRC, good bike paths

are needed to connect the residential areas with the Light-Rail stations so that these people can bike to the closest station step on the train and after arrival they can walk to their destination within Downtown Phoenix. If the final destination is not located within walking distance from a Light-Rail station, people can bring their bike on the train and bike to your destination. An important asset which needs to be present if you want to improve the combination between the use of the bicycle and the Light-Rail are good bike parking facilities. If people cannot park their bike on a save place close to the Light-Rail stop, people will be discouraged to use their bikes. Overall we can say that a better connection between bike paths and the Light-Rail stations will stimulate the use of sustainable transportation modes. Beside the discussion about ridership, more and better bike paths and sidewalks will contribute to a more sustainable and healthier built environment and it will increase the livability of the area.

5.4 TOD case description

Table 5.4: Success-case: Roosevelt square apartments

The project; Roosevelt square is seen as a successful TOD. During the interviews, both planners from the MAG and the city of Phoenix were mentioning this project as a good example of TOD. The Roosevelt square is located west of the Light-Rail stations; Roosevelt St & Central Ave and Roosevelt St & 1st Avenue (see Figure 5.4). The project is situated within the north-west quadrant which has a population density of 8 persons per acre (An acre is equal to approximately 0,4 ha). Compared to the quadrant, the Roosevelt square is a highly dense project; the project is located within two census blocks with a total size of approximately 8 acres and accommodates a little more than 400 people (population density; 51 persons per acre). As mentioned earlier in this chapter Calthorpe (1993) and Dittmar and Ohland (2004) recommend an average TOD population density of respectively; 32 and 60 persons per acre. Besides the population density there is another way to express the density of a project. Within the literature about TOD, scholars are also expressing the density by the number of units per acre (residential density). The 400 people who are living in the Roosevelt square are divided over approximately 170 units and therefore the project has a residential density of 22 units per acre.

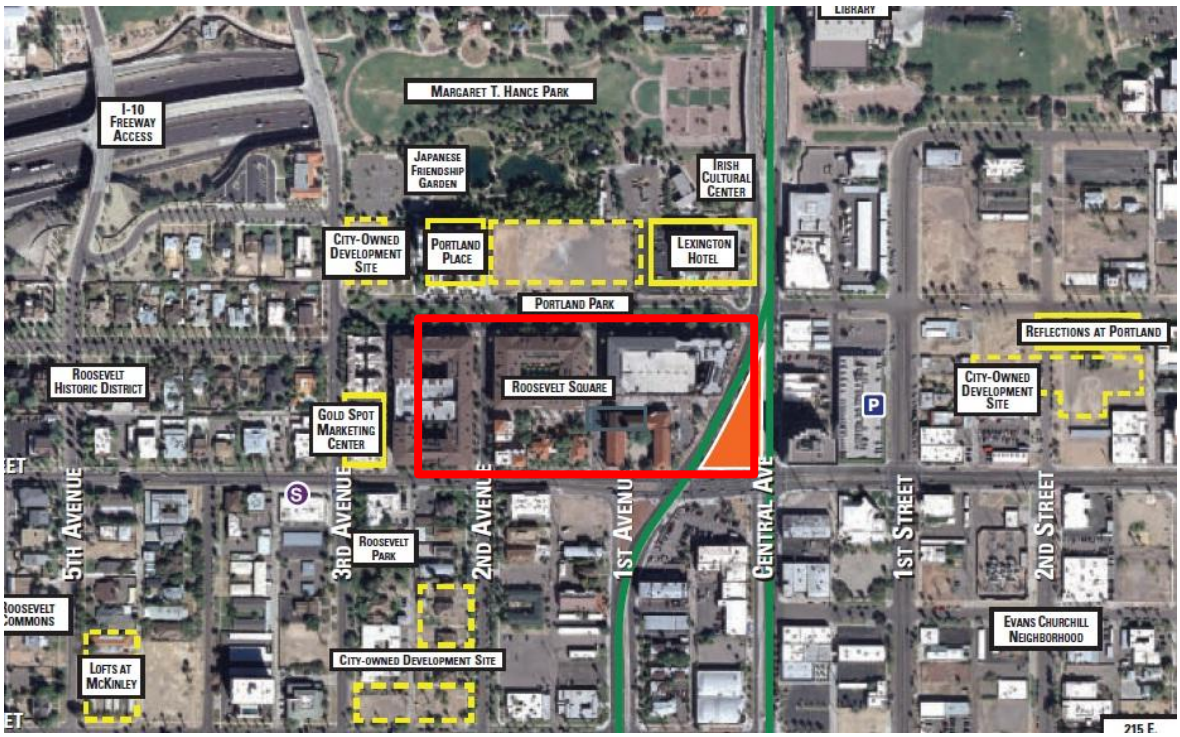

Figure 5.4: Roosevelt square apartments located west of the Roosevelt Light-Rail stations (Orange triangle).

In addition to the residential density, the diversity of the property types is another important aspect of TOD. Scholars argue that TODs should contain different kind of property types like; apartments, condominiums, townhouses, and single-family dwellings. Looking at the Roosevelt square we can say that this project contains a mix of apartments and townhouses. In addition, the adjacent blocks contain multiple single-family dwellings which ensure that the neighborhood is very diverse. Besides the

diversity in property types, the Roosevelt square complex contains different kind of ‘uses’. The mix of townhouses, apartments, restaurants, bars, coffee shops and smaller retail stores is creating a very ‘cozy’ and vital area. And it’s also easy for residents of the Roosevelt complex to eat, shop or spend their leisure time somewhere else because a lot of different destinations in Downtown Phoenix are very easily accessible by Light-Rail.

To adapt to the high temperatures in Phoenix, the Roosevelt square project is providing shaded sidewalks through the use of shorter setbacks, higher buildings and more tree cover (see Figure 5.5). As a result it is more comfortable to walk outside during hot days. The project not only contains shaded sidewalks, they are also integrated with the commercial/retail uses on the ground floor (see Figure 5.5).

This case description shows that the project; Roosevelt square apartments meets the recommendations which are described in chapter 3. Therefore, we can say that it is appropriate to see this project as a TOD success-case.

Figure 5.5: Roosevelt square apartments: shaded sidewalks which are connected to commercial/retail uses.

5.5 Conclusion

This chapter analyzed and described the five dimensions of the built environment within a walkable distance from the Downtown Phoenix Light-Rail stations. It is clear that from a TOD perspective, the built environment within the research area does not meet all the recommendations. Especially, the density of the area is really low. The amount of residents should be increased for multiple reasons. First, streets will be livelier and secondly it can be expected that the ridership of the Light-Rail will also increase. A important remark here is that the Light-rail stations should be easily accessible by foot and or bike. In contrast to the low density, the research area contains a great amount of different land-uses. As mentioned earlier the problem is that these land-uses are mixed in a wrong way (residential with vacant and parking lots). Within the research area, the great amount of empty lots and parking facilities should be avoided and preferably changed into some sort of mixed-use project. These mixed-use projects will contribute to a more livable and 'cozy' built environments because more social interaction will take please because people will go to the coffee shop which is located on the ground floor of their apartment complex. Besides the wrong mix of land-uses, the amount of the different land-uses should also be increased. For example, there are some good examples of TOD projects but more should be built. Another diversity aspect which is really well developed within the research area is the diversity of different destinations. All these destinations are easily accessible with the Light-Rail. This brings us to the question: how pedestrian and bicycle friendly is the research area? The analysis showed that sidewalks are present but they are often not really comfortable because the sidewalks are not shaded and not safe enough. The safety problem has everything to do with the fact that there are almost no bike paths in Downtown Phoenix. Therefore, cyclists are biking on the sidewalks and are causing dangerous situations when they need to pass a pedestrian. The research area is currently not designed with a focus on the human scale; Downtown Phoenix is therefore still a car-oriented area.

In response to the findings described the following questions can be raised; why does the research area contains so many empty lots? Is there a market to build (more) TODs? As mentioned in chapter 1 a positive shift in the appreciation of pedestrian-scale urbanism has occurred during the last decade within the United States. Leinberger (2007) argues that 30 to 40% of the Americans prefers walkable urbanism over car-oriented sub urbanism. In addition, the MAG expects a growth in households with greater demand for transit access (MAG, 2011). Because of changing demographics the demand for TODs will also start to grow especially; *"the Downtown Phoenix, Downtown Tempe and the Camelback Corridor submarkets have the greatest near-term potential to attract Transit-Oriented (commercial) Development" (MAG, 2011).* Leinberger (2007) and the MAG (2011) both show that there is a growing market for Transit-Oriented Development. So why are there still so many empty lots instead of new TODs? An answer on this question is given in chapter 4. One of the reasons is the

current economic situation, developers are reticent to do major investments and the city of Phoenix has no financial assets to help. Next to this, the higher costs for infill/redevelopment projects, the zoning-policy, the mind-set of stakeholders and the interest of some of the government officials and organizations can be seen as important barriers to develop more TODs in Phoenix. And as a result the empty lots stay empty.

In addition, New projects and plans should have a stronger focus on the integration of the five dimensions of the built environment. As we have seen in the case of Phoenix, all five dimensions should be present and implemented in an appropriate way. Otherwise the end result will not satisfy the goals and objectives of TOD i.e.; to increase the ridership of the Light-Rail and to reduce the negative externalities of car-use and to create more sustainable and livable built environments.

6. Conclusions and recommendations

6.1 Introduction

The research goal of this qualitative research was to analyze how the implementation of Transit-Oriented Development (TOD) within the LRC in Phoenix, Arizona can benefit from the insights gained from the transition towards a more sustainable mobility system in Phoenix. Here for a theoretical framework that describes the relationship between Transit-Oriented Development (with the concept of the five Dimensions of the built environment) and the theory of transition management. This framework is used to analyze how the governance guidelines for transitions towards sustainability are used to support TOD within the LRC in Phoenix, Arizona. For this analysis, 6 semi-structured interviews with planners from the city of Phoenix (4), Valley Metro (transit agency) (1), and the Maricopa Association of Governance (MPO) (1) are used. Further together with the theoretical framework, field observations and GIS analysis are used to analyze the current status of the five Dimensions of the built environment within the LRC in Phoenix. This chapter will describe the conclusions that can be drawn from the analyses. Section 6.2 gives an overview of the answers to the four research questions. Next, the insights gained from the answers on the sub questions are used to answer the main research question in section 6.3. In addition, section 6.4 describes some practical recommendations to improve the implementation of TOD within the LRC in Phoenix. Finally, section 6.5 reflects and gives directions for further research.

6.2 Answering the research questions

Within chapter 1, four research questions were given which are used to answer the main research question. Each of the four research questions is discussed in a separate chapter (chapters 2-5). Before answering the main research question, the sub questions will be answered by summarizing the discussions which are described in the chapters 2-5.

- What is transition management and what are the governance guidelines for transitions towards sustainability?

Because of the growing problems concerning car-dependency, a change towards more sustainable and livable built environments within the Light-Rail Corridor (LRC) in Phoenix is desired. Therefore the current car-based mobility system should change. Transition management is seen as a promising management strategy for change towards sustainability because the main focus of transition management is to transform current systems, which is also known as system innovation (Kemp, Parto, 2005; Kemp et al, 2009; Kemp, Loorbach, 2003; Geels, 2002). But transforming the current car-based mobility system into a more sustainable mobility system (focus on transit, biking and walking) is a difficult process because solutions involving system changes are surrounded with great uncertainty and changing a system takes a lot of time. Kemp and Loorbach (2003) argue that a transition is an

outcome of system innovation and the interaction between different changing subsystems, like technical change, cultural change, behavioral change and economic change. To get a better understanding of long-term and complex socio-technical transitions, a Multi-Level Perspective (MLP) on transition is provided by Grin et al. (2010). The MLP is concerned with the question how the alignment of trajectories, within levels and also between levels, are producing transitions. The MLP consists of three different levels; technical-niches, socio-technical regimes and a socio-technical landscape whereby the lowest level (niches) is embedded into the middle level (regime) and where the middle level is embedded into the highest level (landscape). The current car-based mobility system is seen as a socio-technical regime which is locked-in and therefore needs to change. Next, Grin et al. (2010) propose a framework for transition management to influence the direction and speed of transitions. With the use of the framework for transition management actors can change the chance that a transition will occur (Kemp, Loorbach, 2003). The cyclic framework consists of four phases; (1) structure the problem in questions and establish and organize the transition arena; (2) develop a transition agenda, a vision of sustainability development, and derive the necessary transition paths; (3) establish and carry out transition experiments and mobilize the resulting transition networks and monitor; (4) evaluate and learn lessons from the transition experiments, and, based on these make adjustments in the vision, agenda and coalitions.

- What is Transit-Oriented Development and what are the related goals and objectives?

As mentioned in the answer to the first sub question, change towards a more sustainable and livable built environment in Phoenix is desired and the change of the current car-based mobility system is needed. Transit-Oriented Development (TOD) is seen as a potential solution to deal with the negative car-related externalities and creates more sustainable and livable built environments (Cervero, Sullivan, 2011). Next to this, the concept of TOD is in line with the sustainable mobility paradigm introduced by Banister (2008) and therefore, TOD is focusing on a better integration between land-use and transportation. Despite the fact that there is no clear description of TOD, it can be described as; high density, pedestrian-friendly, mixed-use neighborhoods. In addition to the social objectives, such as the improvement of the quality of life and increasing affordable housing, transit agencies prioritize high ridership and other economic objectives (TCRP, 2004). In order to clarify TOD, Cervero and Murakami (2008) introduce the five Dimensions of the built environment. This concept contains five Ds; Density, Diversity, Design, Distance to transit and Destination accessibility which are the foundation of sustainable and livable neighborhoods. This is also reflected in the goals of TOD; Atkinson-Palombo and Kuby (2011) and Cervero and Murakami (2008) argue that TOD will result in a more sustainable built environment, where people are less dependent on cars and where it is healthier to live, work and spent your leisure time. As a result, people will have access to multiple

transportation modes and fewer resources will be used and car-related externalities, like congestion, pollution, traffic accidents, will be reduced.

- How are the governance guidelines for transitions towards sustainability, used to support TOD within the Light-Rail Corridor in Phoenix, Arizona?

As mentioned before the process of system innovation is very difficult and complex. In relation, the development of more sustainable built environments is also seen as a complex and prolonged process. The transition of the current car-based mobility system into a more sustainable system is necessary to improve the implementation of TOD in Phoenix, Arizona. To get a better understanding of the situation in Phoenix, the three levels of the MLP are described for the Phoenix case. The MLP contextual description showed that Phoenix currently still has a mobility system which is mainly focused on the use of 'their beloved' cars. From a Multi-Level Perspective we can say that Phoenix is locked-in and the car-based mobility system is stable and hard to change. Nevertheless, the MLP context description also showed some good developments on the landscape and niche levels. The increasing interest in sustainability together with the growing awareness of the impact of the negative externalities of car-use, are important developments at the landscape-level which increases the pressure on the mobility-system in Phoenix. The landscape-level here has a broader context than Phoenix. Therefore, developments which occur at this level are not specifically connected to Phoenix case. In addition, the development of the Light-Rail in Phoenix and the introduction of the concept of the 5Ds, within the field of urban planning, are good developments which occur within the niche-level. Next, the following question is raised; what barriers make a transition of the mobility system in Phoenix so difficult? It became clear that within the Phoenix context, four categories of barriers can be distinguished; institutional, financial, zoning policy and mind-set barriers. An example of a financial barrier which was found during the analysis is the fact that infill/redevelopment projects are more expensive than developing from scratch because of the costs involved in reconstructing utilities. A solution for this problem can be found in a better cooperation between the city of Phoenix and the developers; the city should help developers to overcome the problems which they face during the redevelopment projects. Furthermore, because Phoenix is a suburban city, a lot of developers in Phoenix are still suburban in how they think and they do not believe in the need for more sustainable transportation and development. As mentioned before the cyclic framework for transition management is seen as a promising tool to unlock/change the current socio-technical regime. As mentioned before Phoenix is still in the middle of the process of the cyclic framework for transition management. Looking at Phoenix, the TOD working group, community meetings and the stakeholder meetings organized by the Maricopa Association of Governments (MAG) show that a lot of time and effort is put into the process of negotiation, networking and coalition building. In addition, the introductions of plans such as; the sustainable transportation & land-use integration study (MAG) together with the

Phoenix general plan update (transitioning to a sustainable future) shows that there is a strong focus on sustainability and that there is a clear vision for the Phoenix region as well for the city of Phoenix. These developments show that multiple stakeholders are brought together and that all stakeholders were involved in the plan-making process and that the stakeholders agree on the idea that a transition towards a more sustainable mobility is needed. The next step would be that the government organizations in Phoenix should mobilize actors to build coalitions and to develop pilot projects and experiments. Next, an evaluation of the whole process and the implemented TOD example projects is needed to see if the implementation can be improved. This will result in an improved vision and therefore in more and better TOD pilot projects/experiments. The optimal situation will be that a continuous process will arise, after the evaluation and monitoring process a learning process should take place whereby the sustainability vision for Phoenix will be tightened and as a result the content and the implementation of new TOD (pilot) projects will be improved. This repetition of the four phases of the framework of transition management will result in a growing pressure on the socio-technical regime, and this will finally result in a transition of the mobility system (from a car-based system into a more sustainable system with a stronger focus on the use of transit, walking and biking).

- What is the current status of the five Dimensions of the built environment (5Ds) within the Light-Rail Corridor in Phoenix, Arizona?

The Downtown area of Phoenix was used as the research area to analyze the five Dimensions of the built environment within the LRC in Phoenix, Arizona. The presence of 'extreme' cases makes it interesting to analyze this area. With respect to the analysis of the 5Ds within the Downtown area in Phoenix, a 0,5 mile buffer, which is an acceptable walking distance (Dittmar, Ohland, 2004), was drawn around the Light-Rail stations. The analysis indicates that from a TOD perspective, the built environment within the research area does not meet all the recommendations. Especially, the density of the area is low and should be increased to make streets livelier and to increase the ridership numbers of the Light-Rail. In contrast to the low density, the research area contains a great amount and variety of land-uses and destinations. But the problem is that these land-uses are mixed in a wrong way. The mainly residential quadrants in the north also contain a lot of vacant and parking lots. From a TOD perspective this mix of land-uses should be avoided and preferably changed into some sort of mixed-use project which should contain different residential, commercial and retail uses. These mixed-use projects will contribute to more livable and 'cozy' built environments because more social interaction will take please. A positive Diversity aspect, are the destinations, such as sport arenas, museums, parks, commercial and retail uses and different kind of schools, which are all easily accessible by Light-Rail. This brings us to the question: how pedestrian and bicycle friendly is the research area? The analysis showed that sidewalks are present but they are often not comfortable because they are unsafe and not located in the shade. The safety problem has everything to do with the

fact that there are almost no bike paths in Downtown Phoenix. Therefore, cyclists are biking on the sidewalks and are causing dangerous situations when they need to pass a pedestrian. The research area is currently not designed with a focus on the human scale; Downtown Phoenix can therefore still be seen as a car-oriented area.

6.3 Answering the main research question

The answers which are given and described in section 6.2 are used to give an answer to the main research question;

- How can the implementation of TOD within the LRC in Phoenix, Arizona benefit from the insights gained from transition management and from TOD design principles.

The first and third research questions provided a clear overview on the transition towards sustainability; changing the car-based mobility system in Phoenix, Arizona, into a more sustainable mobility system which is more focused on the use of transit, cycling and walking. In relation to question 4 we can say that the built environment within the Downtown area (located within the LRC) in Phoenix does not meet all guidelines regarding the five Dimensions of the built environment (research question 2). A Multi-Level Perspective on this transition is showing the relationship between the current mobility system (socio-technical regime) and the new city design based on the concept of the 5Ds and the development of the Light-Rail system in the Phoenix region (new novelties). These novelties, such as the introduction and the development of the new Light-Rail system in Phoenix, should get more attention within the different dimensions within the regime-level. The desired result will be that these new novelties will get a permanent place within the socio-technical regime. In other words; these novelties, such as a new kind of city design which is based on the concept of the 5Ds introduced by Cervero and Murakami (2008), should influence policy-making, the culture, science and market and user preferences with respect to mobility. For example; the Light-Rail will get a more prominent position with respect to the car and public transport will get a more positive image instead of for example the idea that only homeless people use public transport. This will only happen if sustainability will get more attention within the socio-technical landscape. The analyses indicates that this is currently happening; there is a growing interest in sustainability and also within the Phoenix region there is a growing awareness of the impact of negative externalities of car-use. If more attention is given to these developments within the landscape and niche-level, the pressure on the car-based mobility system will start to grow and finally the socio-technical regime will open-up. At the same time we have seen that the presence of different barriers (institutional, financial, zoning-policy and mind-set) make it more difficult for developments on the landscape and niche-level to break through and therefore Transit-oriented Development (TOD) and more sustainable transportation modes (transit, cycling and walking) do not have a prominent position within the mobility system in Phoenix.

To overcome these barriers, the cyclic framework for transition management is seen as a promising tool to unlock/change the current socio-technical regime. If the phases of this framework are followed as intended by Grin et al. (2010), the pressure on the current car-based mobility system is growing, and finally this will result in a transition of the mobility system (from a car-based system into a more sustainable system with a stronger focus on the use of transit, walking and biking). This focus indicates that in the Phoenix case initiatives are introduced to support TOD and to change the current car-based mobility system. But despite these good developments, there are still multiple barriers which need to be solved. An example of an important barrier which was found during the analysis is the fact that multiple lots allow high-rise buildings but where from a TOD perspective 5 to 6 stories are desired. Another barrier which is mentioned before is that redevelopment is harder en more expensive because of the construction of new utilities. To overcome this barrier the cooperation between the city of Phoenix and the developers should be improved. In this case, the city should facilitate better by the construction of new utilities and making regulations (parking requirements) more flexible. Further we can say that despite the fact that a new Light-Rail system is developed the connection with TOD should be improved.

6.4 Recommendations

It is now clear how the implementation of TOD within the LRC in Phoenix can benefit from the insights which are gained from the transition towards a more sustainable mobility system. This section will give some practical recommendations.

Landscape-level

Increase the awareness of impacts of the negative externalities of car-use through a stronger focus on the positive effects of more sustainable and affordable alternatives for the automobile. Through better education, people will be more aware of the need for sustainability. The provided information should be outcome-oriented and it should be easy to understand. A solution for significant change in the long-run is the introduction of sustainability classes for young children. This solution will help to create a whole new mind-set and it will contribute to the growing pressure on the current car-based mobility system and will create windows of opportunity for novelties (niche-level).

Regime-level

The fact that the decision makers in Phoenix are not making clear choices with respect to sustainable mobility, is causing a ‘blurry’ situation. For instance, the city council says it supports TOD but at the same time does not want to raise parking prices,. As long as the ‘government’ has no clear long-term integrated vision on sustainability a transition of the car-based mobility system will not occur. Therefore, an ‘administrative straight back’ is needed to create a credible government. This will also contribute to the level of trust between residents and the government. In addition, the way Arizona is

raising gas taxes is not discouraging car-use. A switch from a fixed price per gallon towards a tax which is based on a certain percentage of the gallon price is a more appropriate solution. A higher gas price will therefore discourage people to use their car for short trips and this way of taxing will also yield more money for maintaining highways. In addition, this solution can only be implemented if there is an affordable and reliable alternative for the car. These two examples indicate that integrated policies are needed to increase the chance that a transition will take place. Related to transportation and mobility, a multimodal perspective, where the sustainable and non-sustainable transportation modes will be aligned, should be used to create a clear and holistic vision for the city of Phoenix and it should be used as basis for policy-making.

Concerning the fact that infill/redevelopment projects are harder and more expensive than developing from scratch, developers will probably stick to their habits and keep on developing new suburban developments. The city of Phoenix should help developers with the realization of infill and redevelopment projects. An outcome of the case study is that the city needs to facilitate better, to make it easier for developers to do infill and redevelopment projects. They could for example make regulations, such as parking requirements, more flexible and the city could help with the construction of new utilities.

A huge problem in Phoenix and also within the LRC in Phoenix is the prevention of vacant lots. This problem is mainly caused by the gap between the zoning-policy and the market. The problem, which is experienced by the planners from the city of Phoenix and the MAG, is that many vacant lots within the LRC are zoned for high-rise, which means that developers/land-owners are allowed to build a high-rise tower on the vacant lot. Despite the fact that there is a higher demand for 5 to 6 story mixed-use projects and that these projects are more desired from a TOD perspective (e.g. livability), developers are waiting for better times because they can earn more money with the development of a high-rise tower than with the development of the mixed-use projects. Next to a better cooperation between the city of Phoenix and property developers, incentives should be created to stimulate developers to start developing the vacant lots. For example; a penalty tax for lots within the LRC if, despite a demand for 5-6 story mixed-use, the developer/land-owner does not want to develop the vacant lot.

Niche-level

An opportunity to overcome, for example the zoning-policy and mindset barriers, can be found in the fact that the city owns quite some land within the LRC (see Appendix 2). These lots are perfect for the development of TOD pilot projects (based on the concept of the 5Ds), because there is no land-owner who can obstruct the development of these projects. As a result, the pilot project can inform/educate residents and developers about the benefits of TOD projects, and these pilot projects also show that TOD projects can ‘work’ in Phoenix. Furthermore, these projects will attract new development and

will therefore work as catalysts. An advantage of developing city owned land is that the land-use plan and zoning-policy will not hinder the developments because the city has the land-use authority and if accepted by the land-owner, in this case the city itself, they can also change the zoning.

The current Light-Rail system consists of only one line, but future extensions of the current system are already planned. The question is whether this is appropriate because of the huge investment costs in relation to the current economic crisis.

6.5 Further research

Before going into detail about the topics for further research, first a short reflection on the research will be given. A personal point of improvement which can be taken into account for a next research project is the amount of time for the set-up of the research. It took quite some time to create a clear picture of the aim of the research and of the relationship between the concept of Transit-Oriented Development and the theory about transitions. Therefore, the research questions remained uncertain for a long time. The uncertainty about the focus and the goal of the research (how does transition management fit into the research and how is it related to the TOD design principles) resulted in the fact that the preparation (defining questions for the interview) of the interviews was not optimal, but nevertheless the results of the interviews have given new insights that can be used to improve the implementation of TOD within the LRC in Phoenix, Arizona.

Further there are a number of topics which can contribute to this research. The first topic is related to Leinberger (2007) who argues that 30 to 40% of the Americans prefer walkable urbanism over drivable sub-urbanism. Because the US is a large and diverse country it can be assumed that there is a great variation in preferences related to the built environment and their attitude towards cars and public transportation. Therefore it would be good to also specifically analyze the preferences of the people who are living in the Phoenix region, because residents will get the feeling that the government is also listening to them and this could result in a higher public participation and a clearer picture on the question; to what extent TOD is desired in the Phoenix region. Besides, a more detailed analysis of the barriers, which are found during the analysis, for changing the current car-based mobility system could provide new insights which can be used to develop solutions to overcome these barriers. For example; if you know why people prefer drivable sub-urbanism you can use this information to development suitable solutions. A next topic for further research could then be to investigate the best way of starting/creating coalitions to implement TOD pilot projects. This is related to the idea of creating incentives to stimulate developers to start developing TOD projects.

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Appendices