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Car-less Cities

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Abstract

The rapid growth of world population along with the sprawl growth of towns and suburbanization, has affected the human life and its surrounding nature dramatically. The fact is this level of growth is not sustainable with the current patterns of development. Most cities all around the world are designed in a way that encourages car dependency which is harming the environment and human health.

During the past decade, urban planners formulate new principles of land use development to preserve the environment and protect public health, safety and general welfare of the citizens. These concepts are characterized by some movements such as sustainable communities, new urbanism, green urbanism, and livable places, pedestrian and transit-oriented development, healthy communities, retrofitting suburbia, brownfield redevelopment, community revitalization, and smart growth. The goal of most these movements is to reduce the amount of reliance on motor vehicles to have a sustainable community. One of the newly developed ideologies which decreases the reliance on motor vehicles, is a Car-less city. A car-less city is a city that is designed to remove cars from the streets. This may sound unrealistic in the beginning, but in fact, many cities all around the world, are shifting their mobility solution away from automobile toward more environmentally friendly methods. The intent of this thesis is to study ways to minimize the use of motor vehicles and their negative effects on societies and propose different means of transportation that are environmentally friendly. The

materials were gathered from secondary sources and by reviewing similar cases in Iran, Europe and United States to analyze how these cities could help us to preserve the environment.

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Chapter 1: Background to the Study

1.1. Introduction:

The last five decades had seen unpredictable growth in both global population and land development. The world population has increased from 3 billion in 1960 to about 7 billion in 2016. (The World Bank, 2018) This rapid growth is affecting cities more than before. Obviously, this level of growth is not sustainable with current patterns of development. Urban sprawl is one of the most common patterns with undesirable features such as low density and separated land uses, isolated neighborhoods, automobile orientation, and falling pedestrian accessibility to commercial uses. With the growth of migration from villages to cities, cities are experiencing sprawl growth, which could harm the environment by invading farmlands and forests. (Knaap, Song, & Nedovic-Budic, 2007) Moreover, it will increase the consumption of fossil fuels and eventually causes climate warming. Besides, if there is not an adequate plan for immigrants, they may face some problems which can affect their welfare and safety, some problems like, finding jobs, affordable housing, access to adequate infrastructure, and easy access to health care and education services. (Brueckner, 2000) Nowadays, most urban planners are trying to create vibrant communities that attract jobs, improve economic developments and are attractive places for people to live, work, and play. During the past decade, urban planners formulate new principles of land use development to reach their goal and plan a city which all the residents from different level of society have equal access to these services. These concepts are characterized by some movements such as “sustainable communities”, “new urbanism”, “green urbanism”, and “livable places”, “pedestrian and transit-oriented

development", "healthy communities", "retrofitting suburbia", "brownfield redevelopment", "community revitalization", and "smart growth". These design approaches increasingly have caught the interest of the consumer market in the U.S. and have merged with objectives for public health, social justice, affordability, and green infrastructure.

One controversial issue in human life which threatens our health and our surrounding environment is automobiles. The automobile enabled sprawl growth and the sprawl growth is dependent on the automobile. In fact, with suburbanization, the dependence on cars has increased which causes environmental damage, with its direct links to urban air pollution, carbon emission, impervious surfaces for roads and parking, and traffic congestion. Reducing the amount of reliance on motor vehicles helps to have a sustainable community. (Urry, Leach, Dunn, Coulton, & the Liveable Cities Team 2017). One of the newly developed ideologies which decreases the reliance on motor vehicles, is the Car-less city. These societies will remove cars from the streets and instead will use different means of transportation like public transportation, cycling and walking. It's clear that decentralization is against this ideology, and first step to achieve this goal is to go back to centralized cities. (Patel, Gandhi, & Bhatt**,** 2016)

This might sound unrealistic in the beginning, but in fact, many cities all around the world, are shifting their mobility solution away from automobile toward more environmentally friendly methods. These means of transportation have a direct influence on the health of natural resources. Some cities such as Helsinki, Oslo, Hamburg, Isfahan, and Madrid have announced their plans to become partly free

private car cities. They believe implementing car free days, investing in cycling infrastructure and pedestrianization, restricting parking spaces, or increasing the price of parking along with considerable increases in public transport could help them to achieve their goal and decrease the carbon emission. By reducing parking spaces and road space, there are opportunities to increase green space and green network in cities, which in turn can lead to environmental preservation. (Nieuwenhuijsen & Khreis, 2016).

1.2. Purpose:

Excessive usage of private cars has affected both human life and our surrounding environment negatively. Irreparable damage to the environment such as air and water pollution, climate change, global warming, depleting natural resources by building more roads and using fossil fuels, and threatening human's life by increasing diseases caused by air and water pollution, climate change and loss of lives caused by car crashes. (Urry, Leach, Dunn, Coulton, & the Liveable Cities Team, 2017)

The intent of this thesis is to study ways to minimize the usage of motor vehicles and their negative effects on societies and propose different means of transportation that are environmentally friendly. The materials will be gathered from secondary sources and by reviewing similar cases in Iran, Europe and United States to analyze how these cities could help us to preserve the environment. What are the challenges in car-less cities and what methods of transportation can replace the private vehicles?

The hypothesis is that cities without cars can respond to their residence needs by providing walkable neighborhoods and green transit. The research questions are car-less cities are approachable? How they help us to preserve the environment? What are the means of transportation in carless cities?

It is expected to answer all these questions by the end of this research and find alternative ways for transportation to decrease the air and water pollution, minimize the car crashes and their fatality, and save the fossil fuel for the next generation.

Chapter 2: Literature review

2.1. Introduction:

This chapter reviewed the evolution of car-less cities in the world. It explained what a car-less city and its importance in modern urban planning and our surrounding environment is. Car-less cities will help to reach sustainable development and preserve natural resources for the next generation. In continuous, this chapter explains where the origin of this concept is and what are the challenges to switch from car-oriented cities to carless cities.

2.2. Definition of carless cities:

A carless city is a city that is designed specifically to function well, without the mass use of the private automobile. Car-less city, also known as car-free city or, auto-less city, is any city, old or new, large or small, that has adequately functioning transportation systems that citizens don't need a private vehicle to commute within the urban area. An auto-less city is compact, and transit and pedestrian oriented. In this type of cities, residents use different means of transportation. Such a town must be designed in the compact cluster development form which depends primarily on facilities of public transport, walking or cycling for movement within the urban area. It is important to mention that an auto-less city is not a city without vehicles, public transportation, emergency vehicles, delivery and services exist within the city limits. (Windes, 2017).

Car-free cities provide a much better quality of life for their residents, despite the danger, pollution and noise that a car bring. (Patel, Gandhi, & Bhatt**,** 2016)

2.3. Evolution of car-less city movement:

Criticizing of car-oriented cities have a long history, dated back to the post World War era, when the reconstruction and modernization of cities started, and suburbanization and urban sprawl became more common. One of the main consequences of decentralization was high dependency on automobiles, especially across the Western world.

Even though opposition against the automobile goes back to years ago, the roots of Car-free day movement goes back to 1950s. The origin of this movement started in Europe, but the activities were going on, mainly in U.S by local groups in order to protest the intrusions of cars in their neighborhoods.

In 1973 with the first oil crises and the rise of environmental movement all over the world, the idea of care-free cities became more popular. Then in 1990s after the anti-road protest movement in Britain in response to the building of the M3 extension in Twyford Down, Hampshire, the car free movement idea has morphed into a variety of programs in Europe, such as mobility week, green transport week, National car free day and the parking day, organized by municipalities and corporations.

Both governmental strategies and public movements contributed to creating the car-free city movement that we see nowadays. In today's world, the car is no longer a sign of modernity and planners and policy-makers are trying to find different means to replace the automobile. (Popan, 2018)

Car-less city has different forms. It can be a historical city that now is being located in the center of the new city after all the developments around it over the time.

(Windes, 2017). In order to preserve this area, and at the same time fight pollution and increase tourism, policy makers should ban cars from entering these neighborhoods such as what planners did in Fra- Roma in Italy (Picture 1) and Naghshe-Jahan in Isfahan, Iran (Picture 2)

Picture 1: Jean-Pierre Delbera, July 30th, 2011, Le Forum Romain (Rome, Italy). The ancient Rome located at the center of modern Rome. Cars are banned from entering this neighborhood. Since this neighborhood is historical and is being preserved by the government, only pedestrians whom purchased a ticket are allowed to walk in to this neighborhood. Retrieved from https://upload.wikimedia.org/wikipedia/commons/1/1a/Le_Forum_Romain_%28Rome%29_%285990686891%29.jpg

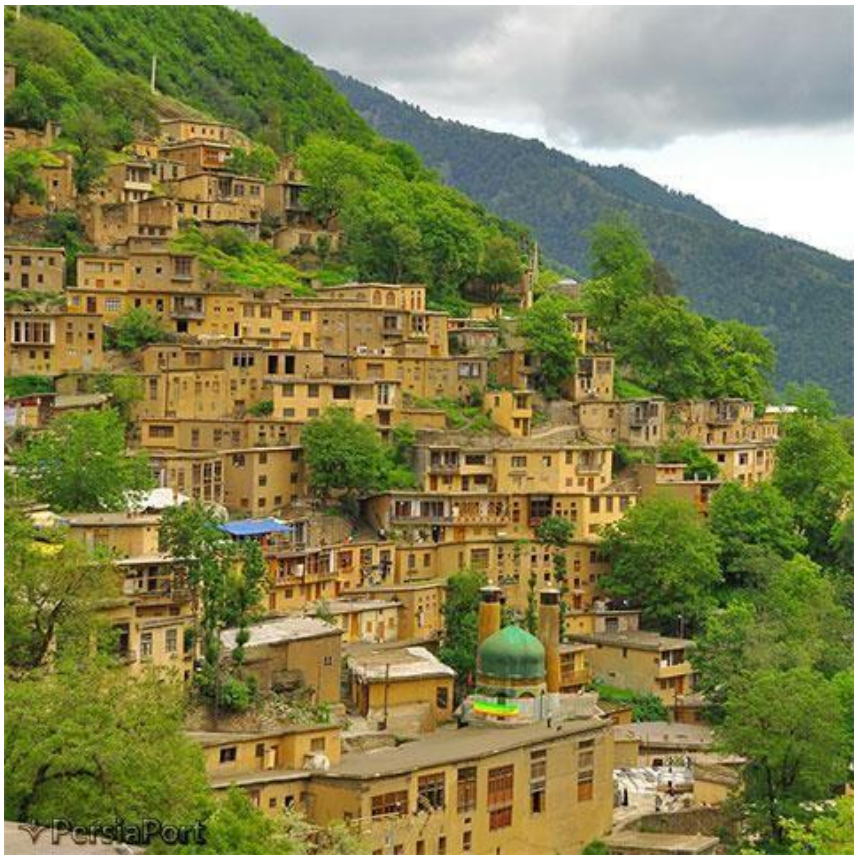
Picture 2: Mim Iran, March 18th, 2017, Naqshe Jahan Square. (Isfahan, Iran) This historical neighborhood is located in downtown Isfahan and cars are being banned from entering this neighborhood. Only pedestrians, cyclists, carriage services and emergency vehicles are permitted in this area. Drivers who enter this neighborhood will be fined. Retrieved from http://invitationtoiran.com/naghshe-jahan/

Some cities are car-free because of their nature. They can be small size cities with narrow streets which makes driving impossible, such as Fes-al-Bali in Morocco. (Windes, 2017)(Picture 3) The medieval streets of Fes-al-Bali are one of the largest contiguous car-free urban area in the world. (Barber**,** 2018)

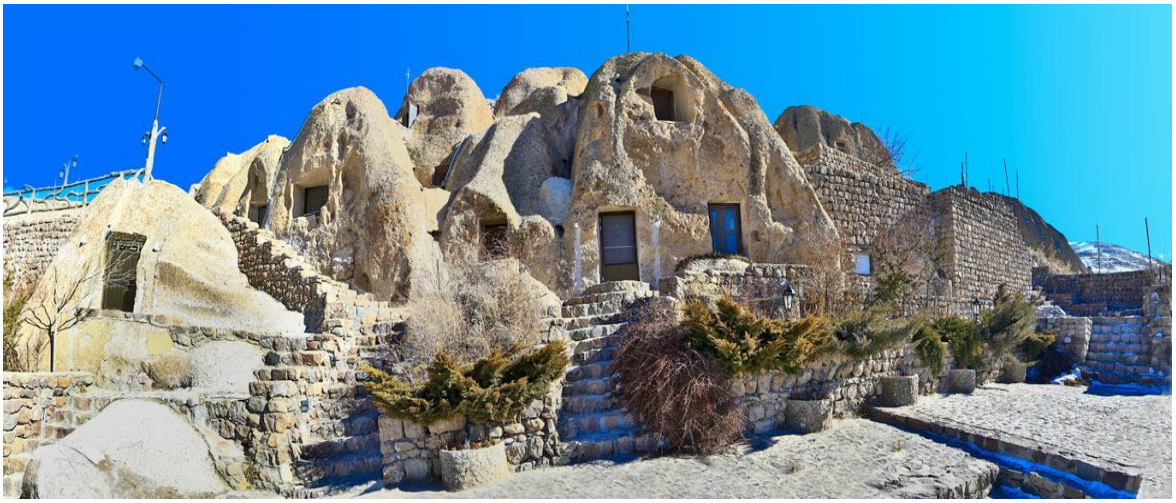
(Picture 3) Morocco: Mikhail Kokhnachikov, Aerial top view of the old Medina in Fes, Morocco. (Fes-al-Bali, Morocco) Because of the form of town and narrow streets, driving in this town is impossible and people travel by foot, donkey or cart traffic. Retrieved from https://www.123rf.com/photo_98829658_aerial-top-view-of-the-old-medina-in-fes-morocco-fes-el-bali-medina-.html

In some cities, because of their unique topography, people are using other means to get to their destinations. For example, in Venice, Italy, the entire city is functioning without the mass use of private cars. (Windes, 2017) Instead they're either walking, cycling or boating. There are number of 118 islands in a lagoon that's less than 50 feet deep. (Barber**,** 2018) On the other hand, in some smaller

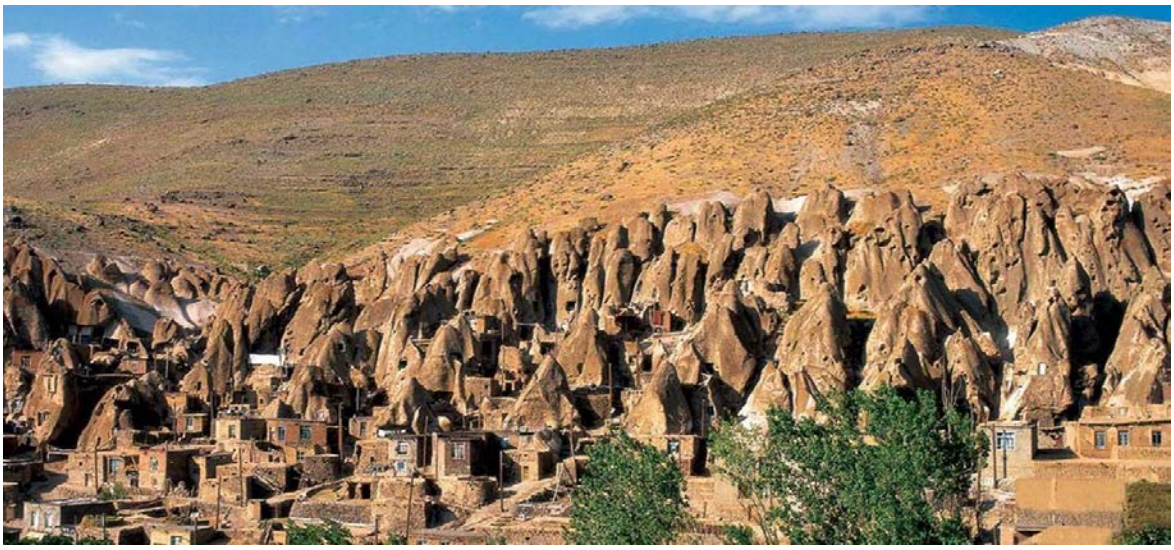
cities and villages people are walking, cycling or using animals to get to the destination. Good examples of this type are Masuleh, Gilan, Iran (Picture 4) and Kandovan, Azerbaijan, Iran. (Picture 5 & 6)



Picture 4: Hatef Homaie, 2017, (Masuleh Village-Gilan, Iran), Because of the special topography of the town, and the fact that streets are located on top of a row of houses, driving in this town is not permitted. Only pedestrians and animals are allowed. Retrieved from Retrieved from https://www.pinterest.com/pin/421790321337392600/



Picture 5: Shivar Siavoshan, December 10th, 2015, (Kandovan, Azerbaijan, Iran) Retrieved from https://en.shivar.org/laleh-kandovan-hotel-iran/



Picture 6: Iranian Historical Photographs Gallery, January 1st, 2012. Iran's Human Termite Colony Kandovan Village, (Kandovan, Azerbaijan, Iran). Because of the special topography of the town, and the fact that houses are located in the mountain, only pedestrians and animals can climb the mountain to get to their destinations. Retrieved from http://1host2u.com/?ez=5906

A car-less city can be an existing city that establishes a policy to gradually replace the private cars with different forms of transportation. Policies that help to change auto oriented land use pattern into the transit compatible arrangement. (Windes, 2017) The city government in Oslo, Norway has started a program in 2017 to make the city center more pedestrian friendly. An area of approximately 1.3 km2 will be transformed to a place with less car which provides more pleasant meeting area. Almost 700 parking spots will be eliminated to provide more space for residents to socialize. This freed space will be used by municipality, organizations, businesses, culture activities, art, bicycle stand and playgrounds to improve the quality of life. (Picture 7) (City of Oslo**,** 2018)

Picture 7: Morten Brakestad, 2017-2018, (Oslo, Norway) Retrieved from https://www.oslo.kommune.no/english/politics-and-administration/green-oslo/best-practices/car-free-city/

Some cities, however, can be entirely new cities. Cities that are being designed to answer the needs of their citizens with only public transportation and cycling, walking. This is yet a hypothetical example.

2.4. What are the challenges?

The main challenge is most people now use their private vehicles for transportation. (Beira˜ & Sarsfield Cabral, 2007) To change this habit and encourage people to use other ways of transportation, the replaced method should

be designed in a way that accommodates the levels of service required by the residents. Besides, the choice of transport is influenced by several factors such as individual preference and lifestyle, affordability, the type of journey, accessibility and situational variabilities. (Beira˜ & Sarsfield Cabral, 2007)

Studies show that the EU passenger car fleet grew by 4.5% over the past five years. The number of vehicles on the road increased from 241 to 252 million. The EU has reported the number of 494 cars per 1,000 inhabitants. In other word one car for every two people. Luxembourg has the highest number of cars per inhabitant in the EU while Romania has the lowest car density. (ACEA Report vehicles in use Europe, 2017)

The car ownership ratio in the United States is relatively higher than Europe. In 2010, there were over 242 million registered vehicles in U.S, which means 1.27 persons per vehicle. The same year the estimated number of vehicles in the world, has been reported over 1 billion. (Windes, 2017). These numbers can declare the importance of the cars in human life and its prominence economically, politically, physically and culturally. The car industry with its associated infrastructure and enterprises, play an important role in world's economy. In the U.S., almost ten percent of workers are working in auto and auto related businesses. Businesses related to infrastructure such as roads, highways, parking lots, parking structures, traffic signals and road signs, street lighting and street striping. Car sales, car insurance, car loans, advertising, parts and services, car maintenance, government licensing agencies are some of the auto support corporations and

institutions. These local, national and global enterprises are possibly equal or bigger than the world's military industrial complex. (Windes, 2017)

The other factor that makes car-less cities look unrealistic is urban sprawl. Population growth, rising incomes and falling commuting costs are encouraging urban sprawl.

Suburbanization is a controversial issue in today's society, especially in the United States. This made decision makers to adopt policies designed to deal with sprawl. The issue has even been placed on the national agenda, with the Clinton administration proposing to use federal money to preserve open spaces and agricultural lands adjacent to cities. Excessive urban expansion is putting our surrounding environment, endanger by invading the farmlands, damaging the aesthetic scenery of the open space and also is increasing the long commutes and therefore traffic congestion and air pollution caused by that.

Urban sprawl and automobile dependence are two of the most important reasons that make car-less cities look unrealistic and it is planners' duty to find alternatives to change the urban form and transport. (Brueckner, 2000)

2.5. Why should we switch to car-less cities?

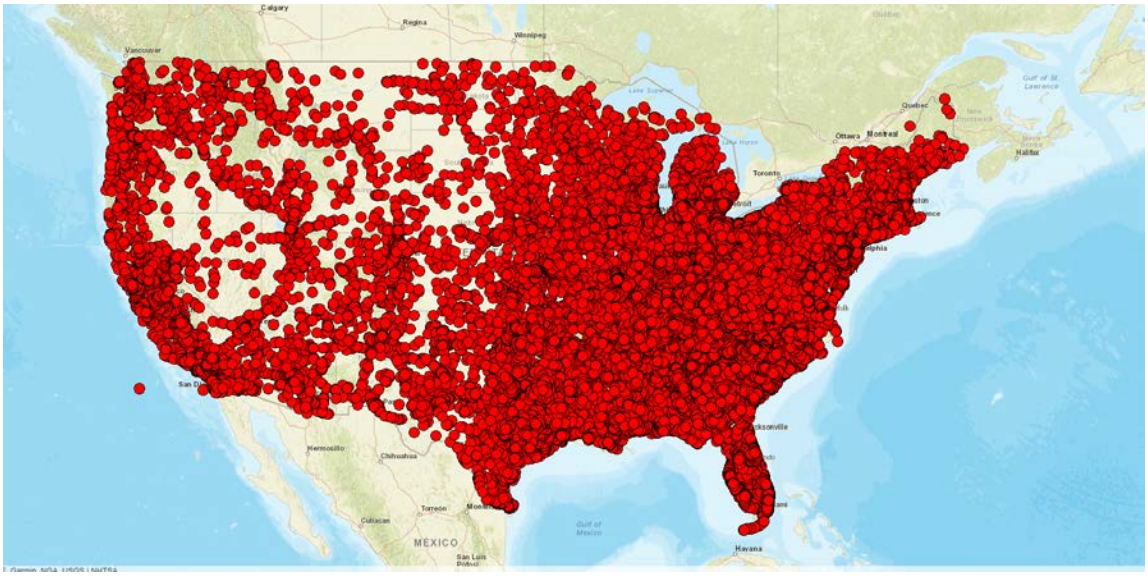
2.5.1. Damaging the natural resources

The automobile and its accompanying transportation system are putting the natural resources endanger. From the finite fossil fuel that is the primary natural resource that fuels the vehicles and is widely being used for the manufacturing of the automobile, and construction and maintenance of its infrastructure, to the metal

that is massively consumed for the manufacturing of automobiles along with significant amounts of lead, nickel and other trace alloys. In addition to the car itself, there are equally vast amounts used in the construction of the various auto infrastructure such as, bridges, highway, and parking structures which contain structural steel and reinforced bar. These all are in addition to the destruction of our land resources by paving the farmlands, forests, wetlands and etc. Between 1982 and 1997, around 1.6 million acres of land each year were taken over by urbanization. Since farmlands and timber lands are often adjacent to city limits, urban development has most of its negative impact on these land uses. (Windes, 2017)

2.5.2. Health hazards caused by the automobile

The automobile is one of the most important hazards to human life which some known is as equally as World war. The National Highway Traffic Safety Administration (NHTSA) has reported 34,439 death cause by car crashes in 2016. This number has increased by approximately 15% since 2014. Picture 8 shows the location of fatal car crashes along USA.



Picture 8: location of fatal car crashes in USA in 2016, The National Highway Traffic Safety Administration (NHTSA) official website. https://www.nhtsa.gov

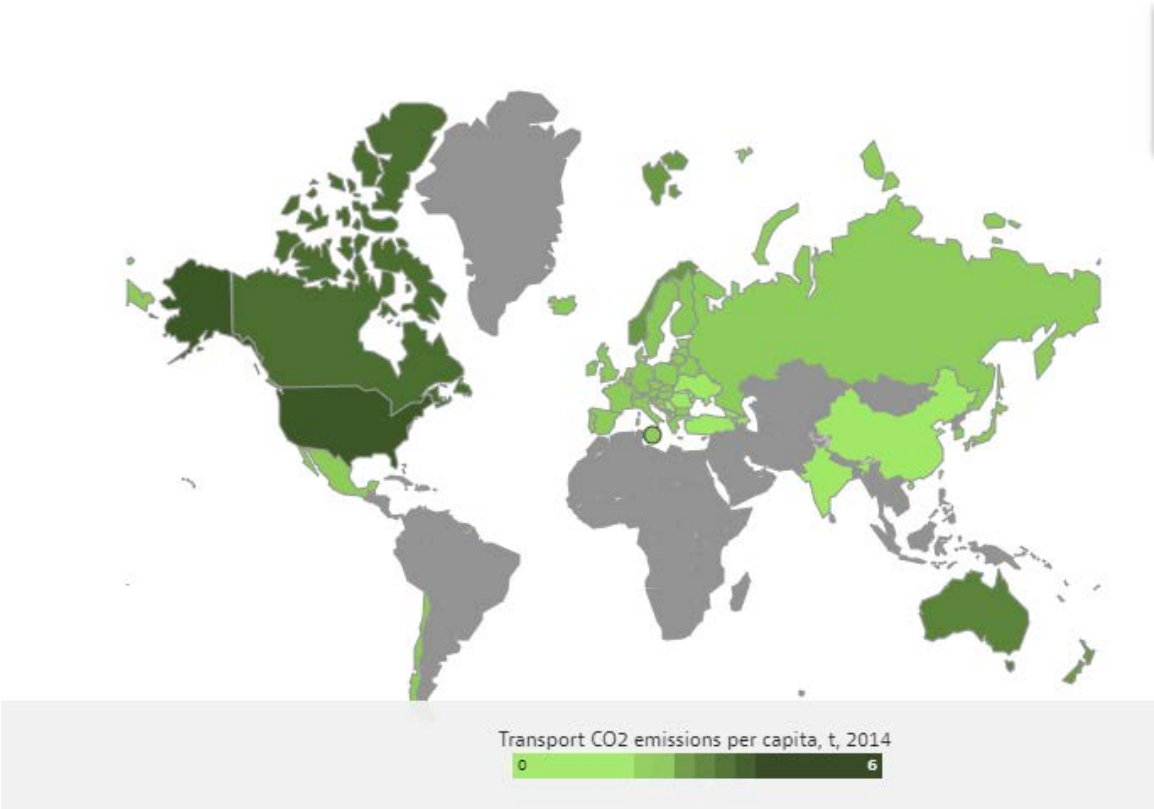
All these are besides the million injuries and billions of dollars financial losses caused by the car crashes. This is not only putting the people riding the car endanger, but also pedestrians, bicyclists and animals can be victims of car crashes. .(Windes, 2017)

2.5.3. Increasing Air Pollution

The automobile and its related manufacturing plants and factories can also harm humans from another perspective. Pollution.

Air pollution is one of the forms of pollution caused by automobile. They are the major producers of the toxic substances. Ozone, Sulfur Dioxide, Hydrocarbons, nitrogen dioxide, carbon monoxide, carbon dioxide, and other particulates are the

primary substances. Over 70% of the air pollution in the United States is produced by auto and auto related sources. Picture 9 illustrates the CO2 emissions of vehicles per capita in the world. (As cited in Windes, 2017. p. 25)



Picture 9: Transport CO2 emissions per capita in the world in 2014.

Air pollution also affects the water quality. Toxic substances transfer to water resources by rain or snow.

2.5.4. Increasing water pollution

The automobile is also a major contributor to water pollution. There are a noticeable number of tanker ships that are spilling oil into our surface water every year and kill millions of fish and aquatic life, damage fishing industries, destroy recreation opportunities and create health hazards. In addition to the major spills, oil lost from leaky engines, car crashes resulting in spilled fluids, or the used motor oil disposed to the storm drain also adding more contamination to the water resources. Studies show Approximately 40% of the pollution in America's waterway is by improperly disposing used motor oil. Americans who change their own motor oil, throw away 180 million gallons of motor oil every year. Considering each gallon of used motor oil can contaminate 1 million gallons of fresh water, which is a year supply of water for 50 persons, a simple math explains the destructive influence of using the car on the natural resources. (MDEQ, 2018)

In addition to surface water pollution, automobile contaminates the underground aquifer. Removing the pollutants from aquifers are time consuming and expensive, and in some instances the pollutants can never be completely removed, only diluted.

It is almost impossible to prevent all the accidental and deliberate spills of oil and chemical to the aquifers and surface waters in the car-oriented society. (Windes, 2017)

Water pollution same as air pollution kills millions of people every year or creates serious health problems for humans.

2.5.5. Increasing solid waste pollution

Another type of pollution that automobile contributes to, is solid waste pollution. Automobile industries and their accompanying industries produce the greatest abundance of consumable goods every year. This massive volume of cars and materials that are being used in their accompanying infrastructure, become old and nonfunctional and will remain as solid waste. The result is an enormous volume of refuse that is so expensive to recycle. This often leads to the less expensive option of throwing away the refuse into a landfill or abandoning it.

Tires are another disposal problem and roughly 80% of them are being recycled and the remaining are a disposal nightmare since many landfills don't accept old tires. All these are beside the negative impact of junkyards and landfills on the image of our city and our surrounding environment.

The toxic substance is also a huge disposal problem. Manufacturing process of automobile is producing noticeable amount of toxic waste such as antifreeze, engine additives, batteries, used mufflers and catalytic converters, motor oil, brake fluid, and paint and oil solvents. Among all of these, only some can be recycled, and the rest is going to landfills or end up into the environment. Since neutralization of these substances and parts are costly, they may pose a significant threat to the environment and cause serious health problem due to the illegal or accidental dumping.

However, most developed countries have strict regulations regarding the disposal of these substances. Thus, they’re exporting these wastes to undeveloped

countries with few or no regulations. Most of these nations don't have access to clean water and food and this issue adds significantly to the environmental woes of the recipient country and puts the health of the locals in jeopardy.

The number of landfills in the United States has declined considerably in the recent years. (Windes, 2017) In 1991, U.S Congress passed Subtitle D of RCRA and established a protective, practical system for disposing of trash in municipal solid waste landfills. These federal standards helped to reduce the total number of landfills in the U.S from an EPA estimate of 20,000 in the 1970s to less than 2,000 in 2014. (EPA, 2009). Although the number of landfills has declined, but the overall capacity of those remaining has increased. The world biggest landfill is located in Las Vegas, Nevada, USA with the total area of 2,200. (Picture 10)

Picture 10: Santosh, July 23rd, 2016, Apex regional landfill, Las Vegas, Nevada, USA. Retrieved from https://www.worldblaze.in/top-10-largest-trash-dumps-in-the-world/

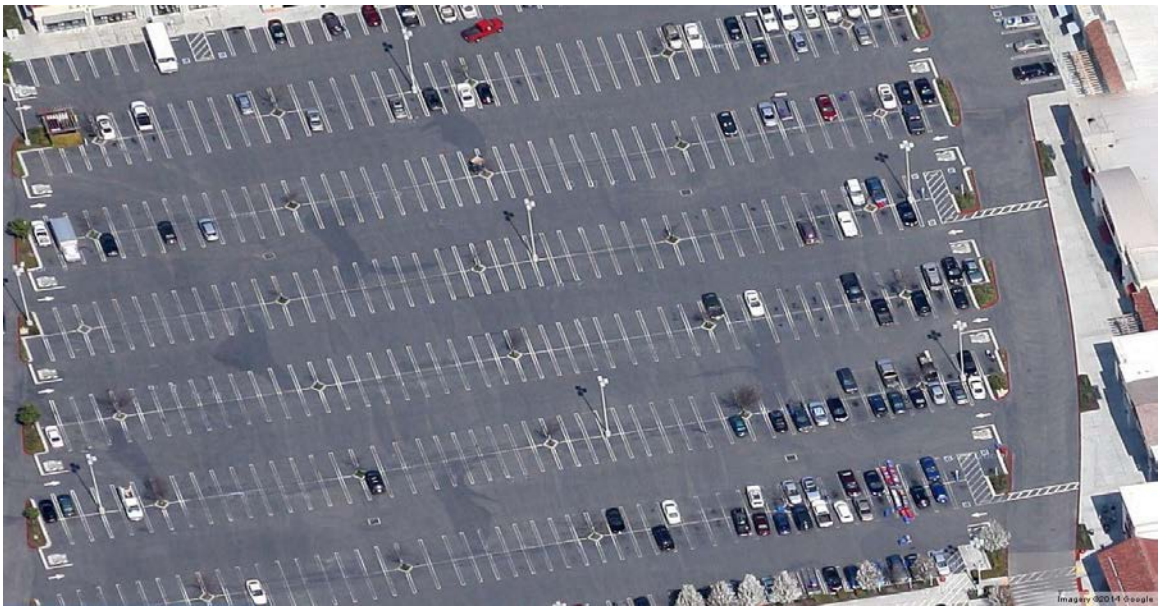
Disposal of the waste will continue to be a burden on the next generation. It is important to mention that despite the modern engineering and all the federal restrictions; these landfills will eventually fail and leak leachate into ground and surface water.(Santosh, 2016)

2.5.6. Noise and visual pollution

The other type of pollution caused by automobile is noise pollution. The dominant sound in big cities is the sounds of revving engines, squealing tires and brakes,

honking horns, and car alarms during the day and night. This affects the market value of those residential dwellings that are located next to the highways and major streets. Noise pollution may not be a major health danger like the items that were mentioned earlier, but it increases stress in the modern society. (Windes, 2017)

Visual pollution is the last type of pollution that automobile contributes to and has a direct effect on the image and beauty of our town. For the car transportation system to operate safely, enormous number of signings, striping, and signalization is required. Add the auto related billboard advertising various businesses, huge parking lots provided for the cars, (Picture 11) pedestrian unfriendly highways and streets, junk yards and even car repair shops, to realize the direct and indirect influence of the car on the beauty of the cities. (Windes, 2017)



Picture 11: Google aerial photo, 2014. enormous parking lots are replacing parks and green areas. https://stocktoncitylimits.com/2013/12/31/why-are-stocktons-parking-lots-so-big-and-empty/

2.5.7. The cost of the automobile, its maintenance and infrastructure

The economies of the industrialized countries and developing countries are greatly based upon the automobile industrial complex. In 2001, 10 percent of the U.S workers were working in auto and auto related industries. (as cited in Windes, 2017, p. 30) That might be one of the reasons that switching from car-oriented cities to car-less cities hasn't happened yet, knowing all the negative impacts that were discussed earlier, has on the public health and the surrounding environment. The fact is all the transactions related to the automobile industry and its accompanying infrastructure are a cost to society as a whole. These costs are divided into two categories:

1- direct cost

2- indirect cost

Direct costs are the perceptible costs that are easy to recognize such as the cost of owning the car, maintaining and operating it.

Indirect costs are harder to recognize, and they range from taxpayer funded infrastructures to the small portion of home ownership expenses to more unapparent social expenses such as national foreign policy, balance of payments, government regulations, and auto related research and development. (Windes, 2017)

U.S Bureau of Labor Statistics estimates transportation expenditures for a family with children in 2016 was 17.3%. Table 1 shows how consumers allocate their spending among the various components of average annual expenditures.

According to this table a single person and other consumer unit allocate less money for the transportation. Other married couple consumer units (those with married couples and persons other than children living in the consumer unit) allocated the highest share to transportation (18.6 percent). (Bureau of Labor Statistics, 2017)

Item	Married couple only	Married couple with children	Other married couple consumer units	One parent, at least one child under 18	Single person and other consumer units
Food	11.8	12.9	14.5	14.8	12.4
Housing	30.5	31.8	30.5	38	36.7
Transportation	17.5	17.3	18.6	17	15.9
Healthcare	10.3	7.3	7.8	5.1	7.3
Personal insurance and pensions	11.1	12.5	11.6	7.5	8.9

Table 1: Shares of average annual expenditures on selected major components by composition of consumer unit, 2016

https://www.bls.gov/news.release/cesan.nr0.htm

Based on the American Automobile Association research, the estimated cost of driving an average car was 47.6 cent per mile in 2010.

2.6. Conclusion:

According to the 2011 annual overview report of the International Transport Forum (ITF), the number of private car users are increasing yearly especially in developing countries. It is expected by 2050, the number of car users increases by 500% in developing countries. Besides, estimates indicate the world's population will reach 9 billion by 2050, and global passenger mobility and global freight transport volumes may triple.

The report concludes that this "would be reached only if mobility aspirations in emerging economies mimic those of advanced economies and if prices and policies accommodate these aspirations".

To be economically, socially and environmentally viable, cities have ultimately to reduce their reliance on cars and consumption of finite resources and instead increase the use of non-motorized travel modes. (World Transport Policy & Practice, 2012)

Chapter 3: Methodology

3.1. Introduction:

This chapter of the study focuses on the type of the research design that was selected by the author to conduct the research. It further discusses the reason that this method was chosen and explains the limitations of the study.

3.2. The research design:

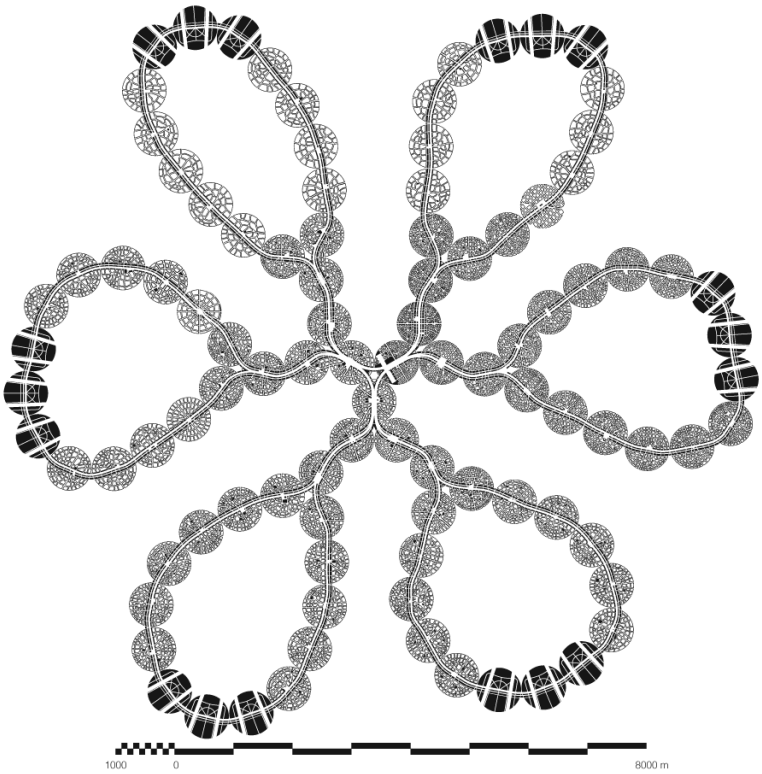
The exploratory design was adopted for this study. The University of Southern California libraries explains that this method is practical when there is a problem, but there are few or no earlier studies to refer to predict the outcome. (UCS, 2016) Since this concept is a relatively new topic in the world and by the day that this research was written there was no town specifically designed and built to remove the cars from human's life and at the same time offer the modern lifestyle for its residents, the author selected this method to review the current researches that were made to address this problem. This research introduces the basic details of the car-less city, provides a well-grounded picture of the car-oriented cities and their problems and the importance of the designing the car-less cities and switching to more environmentally friendly cities. The author analyzed a variety of hypothetical car-less cities that were done by other researchers and introduces the most popular one in this research. In the last section of this research, the feasibility of this study is determined, and it gives direction for the future researches in this area. The personal experience of the author along with the researches was made by her also helped with developing some theories to replace the personal vehicle as an alternative mean of transportation.

Since the research question involves why and how, the exploratory design method is flexible and relevant to provide hypothetical answers to these questions. The purpose of this research would explore the following:

- How car-less cities could help us to preserve the environment?
- What are the challenges in a car-less city?
- What methods of transportation can replace the private vehicles?

3.3. The selected mode:

The selected hypothetical model that is the focus of chapter 4, is developed by James Howard Crawford on 2002. This model is being designed for cities ranging in population between about 300,000 to 3,000,000. However, the population of the town can be considerably more or less by adding or removing the lobes.



Picture 12: J.Crawford, 1999, Reference Design for a six lobe city. Retrieved from http://carfree.com/topology.html

The recommendations that are provided in chapter 5, are inspired by Pedestria written by Doug Windes (2017), J. Crawford Car free cities (2002) and the personal experience of the author.

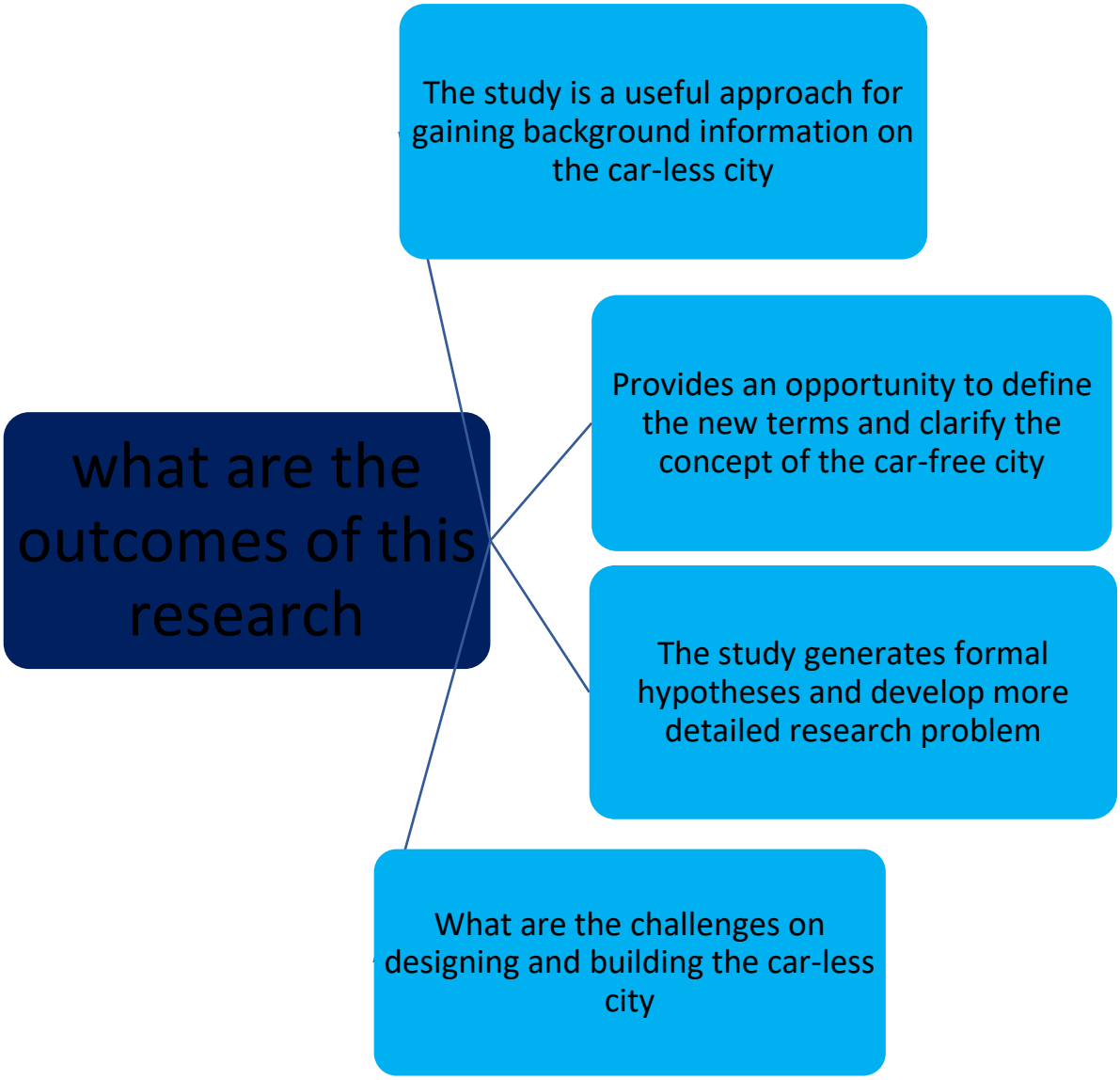


Figure 1: Research outcome

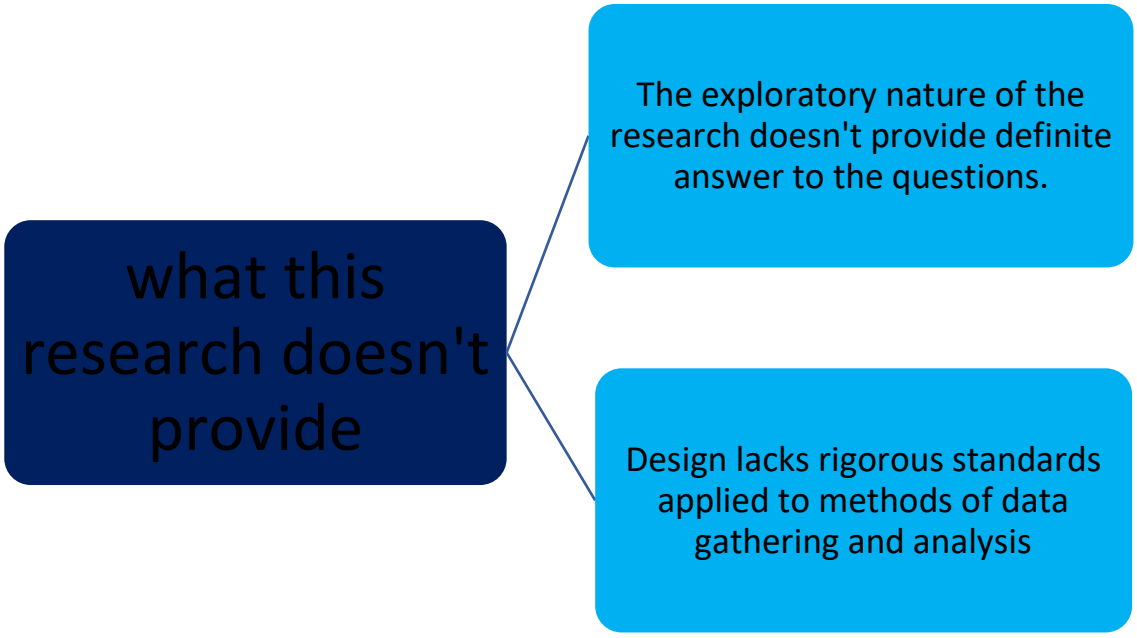


Figure 2: Research limitations

3.4. Limitations of study:

Since there is no car-less city designed and built from the bottom with the intention of removing cars from the cities and use alternative models of transportations instead of driving personal car, this research is based on a hypothesis and it is not clear that if the proposed model and other means of transportation can actually address the needs of the residents in the real world and also beat the kingdom of the car industry.

Chapter 4: Findings and Analysis

4.1. Introduction:

As we discussed in the previous chapter, automobile has its own advantages and disadvantages. Our quality of life is improved and deteriorated by the automobile However, because of the increasing problems caused by the automobile and its accompanying infrastructures, there is a need for a viable alternative. An alternative way that can function efficiently, conveniently and economically. Besides, it should be non-polluting, permanently sustainable, in human scale and be accessible for all the residents not just a wealthy minority. The fact is, our automobile-oriented cities have fewer options for those who don't own a car and can't operate one. There are few means of transportation available for them. Carpooling is typically limited to journeys to work, Taxis are expensive and not everyone can afford it, and public transportation systems are limited in the locations they serve and only operating in a certain schedule. Moreover, most cities' layout and roads are not pedestrian friendly and urban sprawl is increasing the difficulty of bicycling and walking to the destination. (Joseph Bara, 1994)

It's planners' duty to find an alternative way that a city function well in all the ways that a city is meant to function, but without a car. There must be an alternative to the car that is more than just a mere replacement, but an improvement that brings sustainability to our society. An Auto-less city!

This chapter reviewed a carless city and introduced alternative ways of transportation.

4.2. How to build a car free city:

In order to plan the car-free cities, it is required to define the goals of the city and set specific design standards for them. At the time of evaluating these standards, the planner should consider whether it is worth sacrificing an important element of the auto-oriented city to accomplish some other end. While it is true that car free cities will need some compromises with the convenience of the automobile-oriented city, still these compromises should not be large. (Crawford, 2002)

The table below proposes some goals that must be a priority in each car-free city. These goals are in four different categories, each goal focuses on one aspect of urban life. These aspects include: economic, environmental, social and transportation. Also, there are some recommended strategies to achieve these goals easier.

	Goal	**Strategy (design standards)**
Economic	Support strong, divers, healthy, and sustainable economies	– Provide opportunities for small businesses – Design workable sites for heavy industries – Provide adequate infrastructure to support innovation – Propose practical delivery of standard shipping containers

	Reduce the construction and operation costs	– Plan for cluster development which shortens runs for pipes and cables – Also, it shortens the transport lines – Design low per-capita paved surface area
Environmental	Minimize the consumption of energy and resources	– Locate basic services in every district – Plan cluster neighborhoods and short runs for utilities – Provide district heating – Use shared walls in designing the buildings – Build multiple stories buildings (vertical urban growth instead of the horizontal growth) – Provide efficient transportation means for people and goods
	Build beautiful and pedestrian friendly urban environment	– Put street furniture in the streets to give people the opportunity to socialize – Use human scale design – Introduce the car free streets and set policies to keep cars away – Focus on the façade of the buildings and be creative.

		– Use well-proportioned streets and squares in your design – Use plants and trees. Not only it provides shade for pedestrians, but also it makes the streets more beautiful and viable – Generate pedestrian friendly city to assure safe, lively streets
	Establish natural areas near the city. Invite nature to the urban life	– locate small gardens behind most buildings – Locate open natural areas adjacent to every district.

Social	Create a high quality of life for all the residents	– Provide regular opportunities for the informal social contact – Plan safe neighborhoods for children and elderlies. – All the amenities shall be accessible to all the residents, children, elderly or people with disabilities. – Routine destinations shall be located within the district, so residents can provide their daily needs easily – The city design shall be in a way to minimize the external transport costs. – Arrange mixed uses in every neighborhood – Decrease the noise pollution by providing environmentally friendly means of transportation – Bring the active street life in the city
Transportation	Provide quick, cheap and convenient passenger transport	– There must be maximum 5-minute walk to public transportation stops.

		– Increase the number of buses and trains if it's necessary. There should be frequent services. – Offer single- transfer journeys – Minimize the land occupation by transport – Decrease the capital & operating costs – Use energy- efficient transport in designing the city – Minimize externalized costs
	Fast and cheap deliver freight	– Design truck free city streets – Plan for fast and economical freight delivery – Minimize land occupation – Minimize externalized costs – Efficient use of energy – Use intermodal exchange with the global freight network

Table 2: The goals and strategies that helps to remove cars from cities

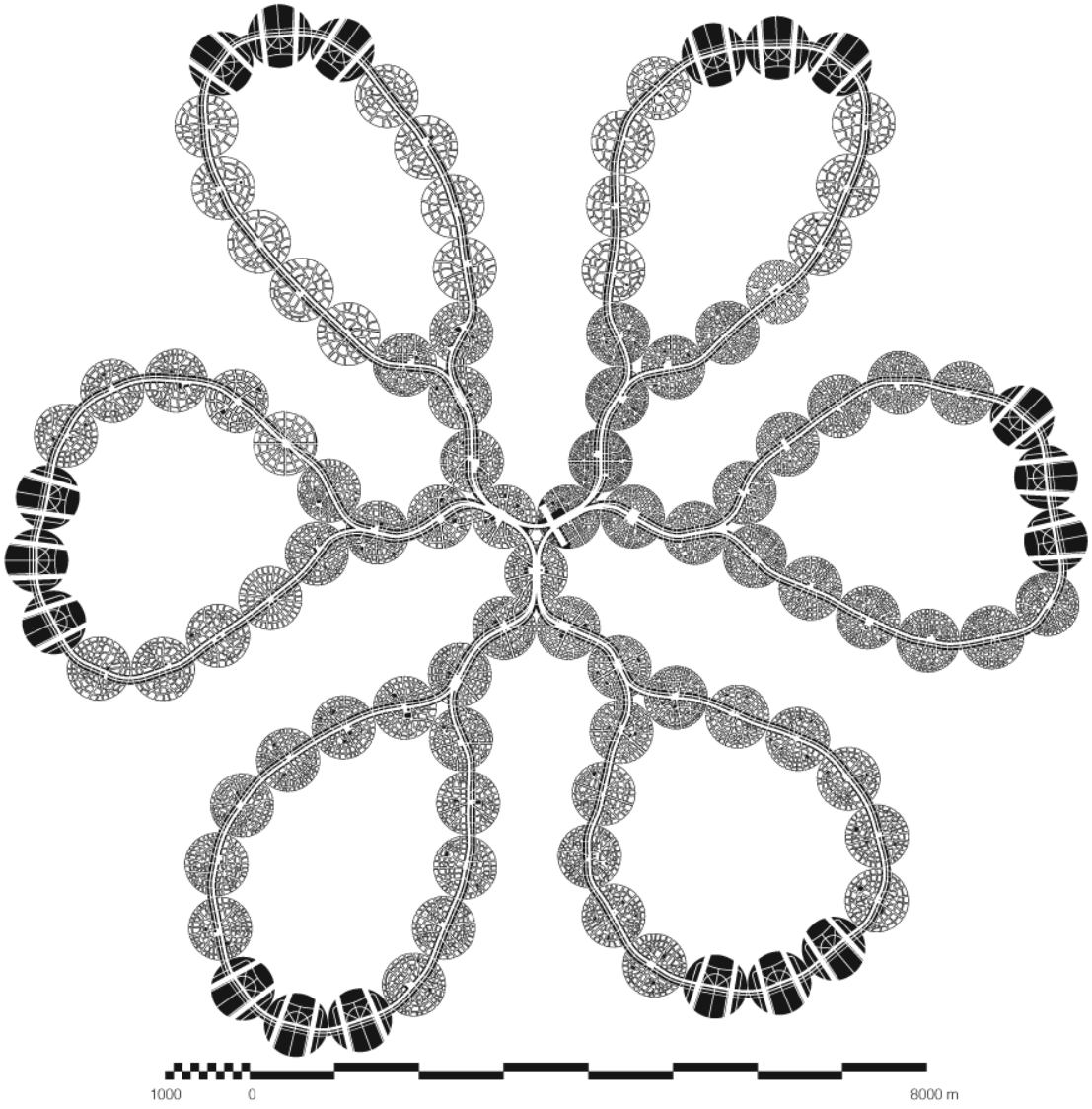
4.3. City topography:

The city topography is the study of the spatial arrangements of various urban elements in the relationship between these elements. Every aspect of the city life

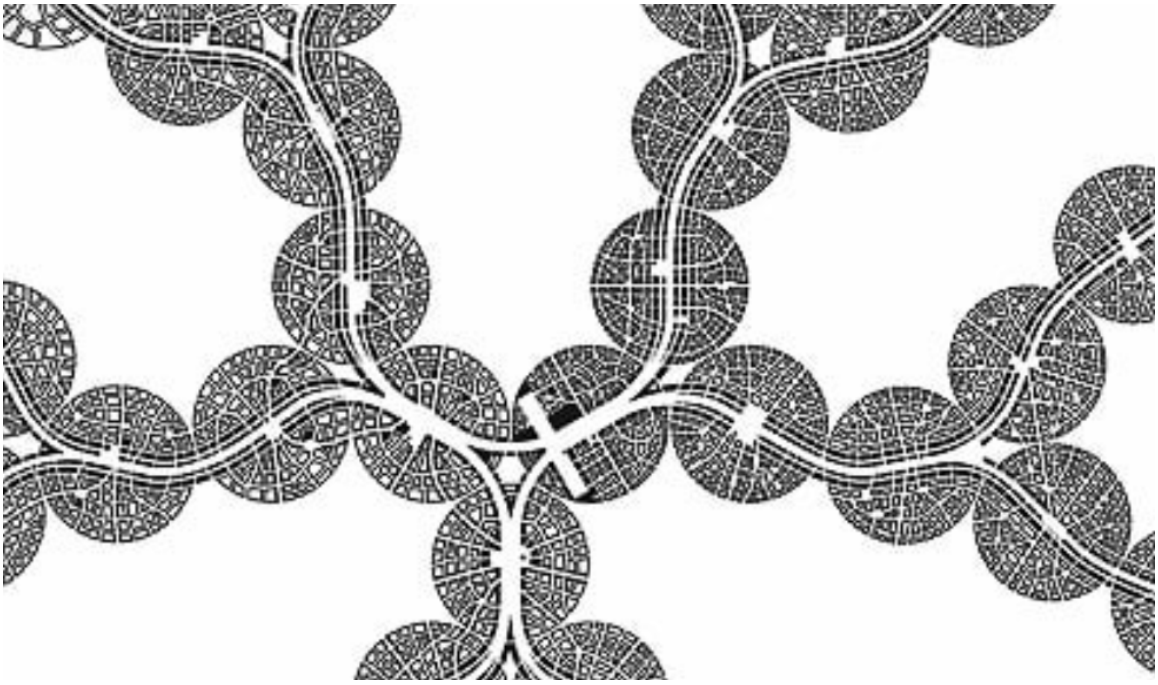
is affected by the topology selected for the city, especially the transport arrangement. (Crawford, 2002)

Crawford in his car free books, recommends using a model that the transportation system is the focal point. This model has 81 inhabited districts and each district has an open space in proximity and 18 utility units. The downtown area is well defined in this form of town.

The picture below illustrates the Crawford utopia. In his dream town, only 16% of the site is urban and the rest is devoted to a variety of open-space uses.

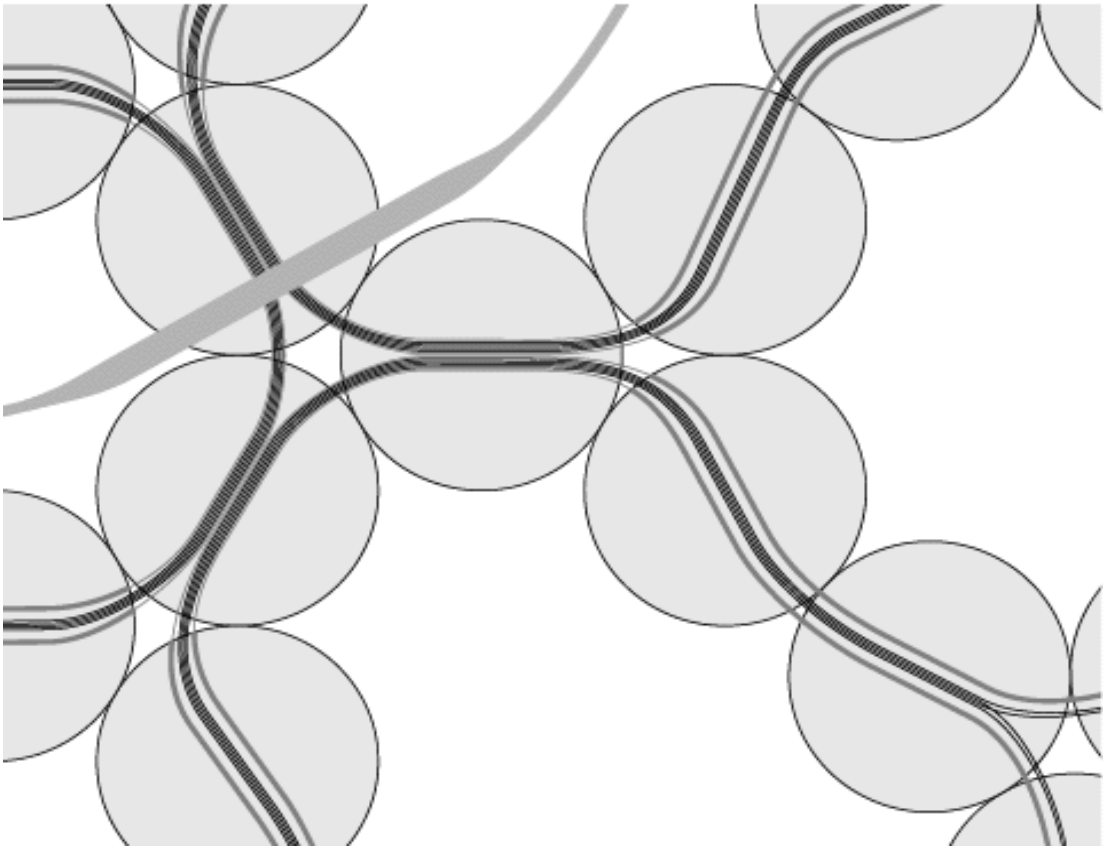


Picture 13: J.Crawford, 1999, Reference Design for a six lobe city. Retrieved from http://carfree.com/topology.html



Picture 14: J.Crawford, 1999, Crawford Utopia's Downtown District. Retrieved from http://carfree.com/topology.html

This picture shows the detail of the downtown area. buildings are shown in black and white areas are open spaces.



Picture 15: Major transport system in Crawford Utopia

http://carfree.com/topology.html

The grey line in this picture shows the rail line. This picture clearly shows that the intercity train station and tracks cut diagonally through the drawing.

The topology of this utopia was selected for multiple reasons, first to achieve the optimum arrangement of the transport system. Second, to create a clearly defined downtown area and third, to have easy access to green areas in each district. (Crawford, 2002)

The proposed transport system in this form of town is designed in a way that no trip requires more than one transfer. The dense utilization of the few transit lines,

allows frequent services and longer operating hours. Also, it directly affects the ticket prices and it reduces the operation costs.

4.3.1. Population:

The proposed utopia is being designed for cities ranging in population between about 300,000 to 3,000,000. The size and number of districts may change from town to town but still the basic 6-lobe topology shall stay the same for the cities within this range of the population.

4.3.2. Land Area:

The proposed utopia occupies roughly a 10-mile by 10-mile piece of land. (a 16 km by 16 km square) A parcel of this size gives the town the opportunity to be separated from adjoining uses by a greenbelt at least 1.5 miles wide.

In order to provide enough open space, only 16% of the town is devoted to buildings and the remaining will be open spaces such as parks, urban gardens, lakes, streams, playing fields, golf courses, farms, forests, nature reserves and wilderness with a small portion of land occupied by connections to the external rail and road systems.

The best location for parks and gardens is near to the city center, where is easily accessible by the residents. The distant areas are suitable for uses that will attract less population. (Crawford, 2002)

4.3.3. 6 City lobes:

As this chapter discussed earlier, the city is divided into 81 districts, that are arranged into “lobes”, which are similar in form and function. Six lobes that are forming the complete city. This arrangement has some benefits that a car-oriented city doesn’t have, such as:

1. All areas of the city are in proximity of city center and are quickly accessible.
2. Almost each district is surrounded by open space.
3. The entire town has only three metro routes, which starts from a lobe, goes to downtown and back out to an adjacent lobe.
4. The closed-loop metro arrangements provide extra service in case of an outage and all destinations remain accessible.
5. These metro routes never cross each other, but the stations can be close to each other, so people can walk to the other station to change their route. This design offers three transfer points instead of one crowded central location and only one transfer is ever required. Also, it provides efficient, densely utilized, and economically to construct, transport services and minimizes the travel time. (Crawford, 2002)

4.3.4. 81 districts:

This utopia is consisting of 81 districts. Faster public transport could be provided if the districts were fewer and instead larger, but it would increase the walking distances for each journey. This number of districts is actually the optimum number

of districts in the city of 1,000,000. In this model, the three most central districts are “downtown districts”. The districts between the downtown and the point where lobe splits is called “inner district”, and the rest is known as “outer districts”. (Crawford, 2002)

4.3.5. 18 utility areas:

There are some areas designated for non-residential utility areas that are reserved for various infrastructure requirements, heavy industry and parking for residents and guests’ parking. These areas are located on the edge of the city where they can have easy access to the external rail and road networks. This utopia is designed in a way where the areas with high traffic volume are kept away from the residential area and decreases the noise problems. It also saves the valuable land next to the city center for commercial purposes. The actual number if utility areas will be highly dependent on the needs of the particular city and it might be considerably more or less.

4.3.5. Short travel time:

If the underground metro is being selected as the main public transport mean, then the longest travel time between any points in the reference design will be 35 minutes. Since the basic shopping is located at the center of each district, thus the walking time from the doorstep to the district center doesn’t exceed 5 minutes and residents can meet their daily needs without wasting a long time in the traffic or

driving to the chain stores that are usually located far from the residential district. The typical trip outside the district is shorter than 15 minutes. To reduce the travel time, the popular destinations with many visitors are located near the metro stops. Many trips outside the district are for getting to the downtown district, and almost 70% of these trips don’t involve transfer so the average travel time won’t exceed 22 minutes. However, a transfer to reach the other downtown district doesn’t add more than 5 minutes. These predicted travel times are based on walking to the transport halt and use the public transportation. Which means these short travel times can still decrease in some case by bicycling.

Chapter 5: Summary of Findings and Recommendations

5.1. Introduction:

In designing the transportation system, planners must make sure that the proposed transport system is capable of meeting all transport needs during weather extremes. In Crawford utopia, bicycle is the main mean of transportation. Therefore, the needs of bicyclist are a high design priority along with the good transit system to provide all passenger needs. During the moderate weather, bicycling reduces the needs of public transportation, is pleasant and healthy, and usually provides the fastest door to door transport service especially within the district. In his utopia, trips are falling into three categories: within the district, between the districts and between the city and major roads connecting the city to other areas.

5.2. Transportation within the district:

The most popular transportation mean within the district is walking. The longest trip in the district from the primary point to the destination is 10 minutes' walk apart. However, walking is not feasible for all the residents, for instance, very young or very old individuals, or those with disabilities, an alternative way to get around is necessary. Overall the recommended means for traveling within the district are as follows:

1. Walking
2. cycling
3. Large wheeled pedal tricycles
4. Motorized wheelchairs/scooter

5. baby strollers
6. Radio-dispatched pedicabs
7. Slow battery powered taxis

Below there are some pictures of the tools that can replace the car for trips that are being made within the district.

1. Large wheeled pedal tricycles

Picture 16: Hulet Smith, Large wheeled pedal tricycles. Retrieved from https://www.rehabmart.com/post/product-review-the-top-5-adult-tricycles

2. Motorized wheelchairs/scooter

Picture 17: Hulet Smith, Motorized wheelchairs/scooter. Retrieved from https://www.amusementparkrentals.com/products/4-wheel-electric-mobility-scooter-rental

3. Radio-dispatched pedicabs

Picture 18: Tripadvisor LLC, September 2013. Radio-dispatched pedicabs. Washington D.C. USA. Retrieved from https://www.tripadvisor.com/Attraction_Review-g28970-d4758226-Reviews-National_Pedicabs-Washington_DC_District_of_Columbia.html

4. baby strollers
5. Slow battery powered taxis

Picture 19: Holden Frith, September 18th, 2014, Slow battery powered taxis.

Retrieved from https://www.pinterest.com/pin/505318020671435774

In order to reduce the conflict between pedestrians and those are using the alternative means, planners should consider right of way and designate a lane for non-pedestrian users. Crawford claimed that the following two general principles,

assure safe, pleasant and friendly user streets: pedestrians own the street while bicyclist own the central boulevard.

Pedestrians have priority over all other street users, the only exception is emergency vehicles. All other street users must stay out of the way of pedestrians. One factor to consider is that since the speed of these vehicles are very low, there would be no body injury in case of an accident. One way to reduce the speed limit other than using signals is designing narrow streets. Bicyclist may also be expected to ride at slow speed in the central boulevard and give the right to pedestrians at the intersections. In general, the speed of the vehicles should not be more than the speed of a fit runner. (Crawford, 2002)

It was mentioned earlier in the second chapter that Venice is a partly car-free city. One of the reasons that Venice is so relaxing is the complete absence of street traffic moving faster than a pedestrian. (Windes, 2017) Also consider the Isfahan city in Iran as an example, the “car-free Tuesdays” campaign started in 2016 in Isfahan and now most cities in Iran are following this campaign. This campaign is a 600-week program started by a 25-year-old architecture and supported by the Department of Environment in Iran with the goal of reducing the number of private vehicle users and air pollution. Ever since this program has started, drivers are so careful on Tuesdays. Department of Transportation has abandoned cars from entering certain streets, (Picture 20) especially in the downtown area. The Department of Environment also has negotiated with insurance companies to give discounts on third-party and body-part insurances to the drivers without traffic tickets on Tuesdays. Besides, municipalities have provided other amenities and

bike lane for this campaign, and all helped to have a relatively relaxing Tuesday in Iran. (Picture 21) In additions, there are some NGOs that are supporting this campaign and are providing free breakfast for those who are bicycling on Tuesdays with the goal of encouraging residents to minimize using their cars. (Picture 22) Also there are many events that are funded by municipality and NGOs along the streets that are being used only by pedestrians and cyclists with the aim of providing fun and friendly environment for people and give them the opportunity to interact with each other. (Picture 23)(Telli, 2016)

Picture 20: Azadeh Azizian, January 18,2017. Closing streets on Tuesdays to cars for walkers and cyclists. (Isfahan, Iran). Retrieved from http://khabarkashan.ir/pages/show?item=622/-سه-شنبه-های-بدون-خودرو-اقدامی-برای-نجات-اصفهان-از-آلودگی-و-ترافیک/-رضایت-90-درصدی-شهروندان-از-طرح

Picture 21: Spadana organization. 2016, Pedestrian/bicycle lane in Isfahan, Iran.Retrieved from http://www.talab.org/tourism/historical/isfahan-tourist-attractions.html

Picture 22: Heidari & Saraf & Qanbarzadeh, November 20th, 2015. Free food for walkers and cyclists. Retrieved from http://www.spadanabike.org/index.php/pics-memos/weeklycylingprogram/503-1-94

Picture 23: Farokh Norouzi, August 2nd, 2016, Events and performances funded by NGOs and municipality with the aim of encouraging people to stop using their cars. Retrieved from http://www.spadanabike.org/index.php/pics-memos/weeklycylingprogram/570-95-5-12

However, the fact is bicycles require some amenities same as cars. For example, bicyclists need considerable street space and there shall be adequate parking spaces for bikes all over the town especially close to the public transportation stations. Imagine how these bike parking may look next to the most popular destinations. They easily can turn to an eyesore. Moreover, bikes in poor conditions can make enough noise to be irritating. Besides, bikes can be

dangerous to both riders and pedestrians. (On Why Dockless Bike Share Systems are the Future**,** 2017)

In order to provide safe streets for both bicyclists and pedestrians, the best solution is to provide separate lanes for bicyclist as was discussed in the past previously in this paper. Crawford suggested these lanes can be in the center of streets and its width should be depends on the needs of the neighborhood, but five meters (16 ft.) in each direction should be adequate in most cases. Besides traffic signals, especially at the intersections should be installed.

5.3. Transportation between the districts:

The transport system between district shall be designed in a way that meets the residents' expectations and needs. The first step to determine what mode of public transportation is best for the town, is to analyze what portion of residents is going to the most popular destination in the busiest hour of the day. Therefore, detailed computer simulation of travel patterns will be necessary to determine what mode of transportation is suitable for each town. In general, the recommended means of transportation between districts are as follows:

1. Public Transportation (Bus, subway, BRT's, and etc.)
2. cycling
3. walking

Below are the factors that need to be considered in designing the transportation system between the district:

high speed transportation system:

The alternative mode of transportation shall be fast to accommodate adequate services for a huge number of residents in a short time. The distance between stops and the quality and quantity of the facilities, may affect the speed. Besides, the acceleration and speed must be tolerable by the passengers. For example, passengers can comfortably tolerate acceleration as high as 0.22 G and top speeds in the range of 100 km/h (65 mile/h). (Crawford, 2002)

24/7 service:

Since the public transportation is the only transport system besides bicycling that provides rapid access to all parts of the city and all the group of citizens can use it, it must be accessible at all time. For maintenance purposes part of the system can be taken out of service when less people are using the public transportation, but all the destinations shall remain accessible. The closed loop topology in Crawford car-free city makes it possible to shut down half of the system while still providing services to all destinations within the city. It may add more time to the normal trip times since users have to use indirect routes in some cases, but still the total travel time will be under 60 minutes. (Crawford, 2002)

Short travel time and waiting time:

The fact is, the majority of people prefer conveniency over preserving environment, clean air, and preserving the fossil resources for the next generation. Of course, it’s easier to leave home and drive your own car to work, school or a shopping mall

instead of walking to the bus stops or metro stations and wait there in hot and cold weather, to get into the bus or metro and change the route multiple times to finally get to your destination. If the purpose truly is to remove the cars from the cities, the alternative means of transportation shall be convenient. Thus, the travel time and the time that people are waiting for the metro/bus to get to their destination shall be short. This means the longest the person is waiting shall not exceed 4 minutes in daytime and 8 minutes at night. In Crawford car-free city, the average travel time and the longest travel time for people are 22 minutes and 35 minutes respectively. (Crawford, 2002)

Cheap public transportation:

To make the public transportation accessible to all the residents, the fare shall be cheap or at no cost. yes, that's right, free services for everyone! The municipalities can spend the tax dollars on public transportation, instead of maintaining streets for cars or providing subsidies for gas that are normally being used in car-oriented cities. (Crawford, 2002)

Economical operation

The alternative mode of transportation shall be economical to construct and maintain. For example, the design in Crawford car-free city, requires three densely-exploited routes with only 60 metro trains to provide services for the entire city. Moreover, using short routes, dense utilization and rail transport helps to efficiently use the energy and our fossil resources. (Crawford, 2002)

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