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A case study of sustainable urban planning principles in Curitiba (Brazil) and their applicability in Shiraz (Iran)

Ali Soltani ^{1*}, Ehsan Sharifi ²

¹ Faculty of Art and Architecture, Shiraz University, Shiraz, Iran

² School of Art, Architecture and Design, University of South Australia, Australia

Abstract

This paper investigates sustainability principles in the city of Curitiba, in Brazil, as a pioneer which has commenced its sustainability journey since the 1960s. Analyzing sustainability principles in Curitiba, the paper aims to study their applicability in the case of Shiraz in Iran. Considering the complexity of physical, social, cultural and environmental systems in urban planning, the research underlines the vitality of contextual studies, integration and implementation strategies in sustainability achievement in urban scale. It shows how and to what extent sustainability principles in a city can be adapted to other contexts. This comparative study benefits from interpretive methods of data collection and analysis based on primary and secondary resources. A theoretical framework of planning based on equity, economy and ecology is being utilized in data collection and analysis. The investigation indicates that Curitiba's sustainability agenda is based on a set of integration and implementation strategies which combine decision making, education, transportation, public welfare, heritage conservation and waste management. It is argued that although every urban environment has its specific opportunities and constraints, still there are many things to learn from others.

Keywords: Sustainable City, Integrated Approach, Curitiba, Shiraz

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* Corresponding author. E-mail address: soltani@shirazu.ac.ir

1. Introduction

The rapid rate of urbanization after the industrial revolution has caused a tremendous amount of change in the world (UNHS, 2011). Human effort to achieve a higher quality of life harms the environment in local and global scales. Following the global environmental crisis (i.e. global warming, climate change and widespread deforestation), the sustainability agenda has become one of the most controversial topics of the 20th and 21st centuries (UNHS, 2011). So far, there is a consensus that the conventional ways of resource consumption and waste production would not sustain for a long time; the state which originated from human-made changes over the natural landscape (Girardet and Mendonca, 2009). The variety of approaches in different scales towards sustainability makes new opportunities to learn from successful precedents taken towards sustainability achievement.

Cities, as the most compact settlements of people, have a tremendous effect in environmental changes (Girardet and Schumacher, 1999). Although industrial economy in contemporary cities has been replaced by service sector, the rate of resource consumption is still growing up (Lehmann and Crocker, 2012). The predicted 70 percent rate of urbanization and 7 billion world population by 2050 (UNHS 2011) reveals that sustainability of urban space is a key factor in global resilience to forthcoming changes. Cities, like Curitiba (Brazil), Austin (USA), Copenhagen (Denmark), Melbourne (Australia) and Frankfurt (Germany) are pioneers to represent some degree of sustainability in urban planning which can be studied in terms of applicability in other cities. The key point is that the proposals need to be contextualized based on local circumstances to become practically applicable.

Using a qualitative and descriptive approach, this paper gives an attempt to review the success story Curitiba (Brazil) in hope of learning sustainability practice for Shiraz (Iran). A descriptive-interpretive approach is chosen to allow further discussions about the applicability of sustainability strategies in the second case of study (Shiraz). The study benefits from primary documentations of two cities as well as secondary resources and descriptive peer-reviewed books and journal articles. In this way, the sustainability principles in Curitiba are being discussed and an adaptive proposal for Shiraz is being analyzed based on its contextual opportunities. The matching process of applying sustainability strategies is a proposal for the city of Shiraz, which addresses long-term sustainability education and practice.

2. Background

2.1. What is a sustainable city?

It is generally accepted that the trilogy of economy, environment and social equity are foremost components of the sustainability concept (Chan and Lee, 2008; Girardet and Mendonca, 2009). World Commission on Environment and Development (WCED) established the definition of sustainable development as "a development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs" (1987). Sustainable principles of urban development are categorized into management, social-economical and ecological subdivisions. Management principles include local

government responsibility with better environmental understanding, flexibility of environmental policies and long-term strategic visions. Socio-economical category includes appropriate technology and design, creating adequate environmental indicators, standard regulations, market connectedness, supporting by social acceptability and public participation. Ecological principles contain prevention-led actions, integrated activities, using minimum resources (renewable and recyclable), producing minimum waste, respecting the environmental diversity and expanding local environmental research (Haughton and Hunter, 1994). In this context, Moore (2007) claims that there is a triangular conflict among economy, ecology and equity as key sustainability contributors in terms of strategy achievement. A balance between development, property and resource discourses is required to achieve an integrated sustainability in an urban context. Such a balance has more opportunity to make the city more profitable, fairer and greener for stakeholders, developers and governors (Figure 1).

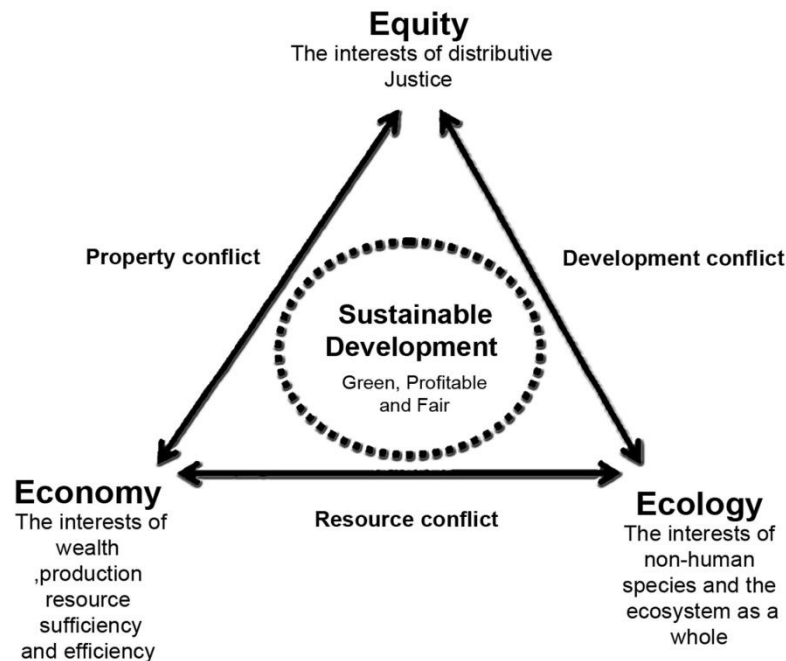


Figure 1. Triangular conflict among key contributors to achieve sustainability (Moore, 2007)

2.2. Approaches to sustainable urban planning

Sustainability notion in urban planning and design is relatively a new subject which has been developed since the 1980s. Traditional theories of reading/designing urban space used to be concentrated on the built environment as a physical matter. "Figure-Ground" theory underlines the values of open spaces and connectedness of urban solids and voids, whilst "Linkage Theory" gives more value to the streets and urban thoroughfares. The "Place Theory", however, has more emphasis on social aspects of the space which are

tangled with human activities (Jacobs, 1961; Lynch, 1984; Trancik, 1986). These conventional approaches towards urban planning hardly ever demonstrate explicit visions about sustainability in the urban context.

More recent approaches to urban sustainability, however, highlight environmental and social aspects of urban planning in more details. Among them, two major schools of thinking are New Urbanism and Green Urbanism. However, in practice of urban planning there is not such segregation in the ways of thinking about a city. In the context of cities, a set of localized sustainability and liveability strategies are more visible rather than branding the reality. Local opportunities and constraints of each city need to be addressed in more integrated approach considering the complex urban systems of social, economic and environmental life (Newman and Jennings, 2008). In real situations, transport systems play an important role in both sustainability and liveability of contemporary cities (Newman and Kenworthy, 1999; Tolley, 2003). Social integration is also a key responsibility (Beatley and Newman, 2009) and resource management in closed loops enhances durability and resilience of cities (Beatley et al., 2009; Clark, 2009). The Interrelationship between citizens, transport and amenities are argued as the vital elements of the micro-structure of a sustainable city (Frey, 1999). A sustainable city needs to provide social, economic, and environmental sustainability in an integrated process. Balancing these three basic factors needs an integrated decision making process in which citizens' participation has a fundamental role in sustainability objectives achievement.

3. Case study areas

3.1. Curitiba, a model for a sustainable city

3.1.1. History of Curitiba

Curitiba is the capital city of the Brazilian state of "Parana". It was founded in 1530 as a gold-mining camp and officially became a town in 1812. Its current metropolitan area comprises 26 municipalities with a total population of 3.2 million (IBGE estimate in 2011). The city sits on a plateau at 932 meters above the sea level. It is located 105 kilometers west of the sea port of Paranaguá. The humid Curitiba has a maritime temperate climate. It has flooded areas contribute to its mild and damp winter. The city has a surface of 432.17 km² with the population of 1.8 million people.

Curitiba is one of the most reputable cities in terms of sustainability achievements which can be categorized into six integrated subjects: integrated urban planning, effective public transport system, local environmental consciousness, pedestrian and public priority in the city, social justice concentration and local waste management system (Mills, 2006).

3.1.2. Integrated urban planning based on small changes

Since Curitiba was declared as the capital of Parana in 1854, the city has gone through several major urban planning projects to manage uncontrolled sprawl. In 1940s, Alfred Agache, cofounder of the French Society

for Urban Studies, had introduced the first city plan. The plan emphasized a star of boulevards, with most of the public services in downtown, an industrial district and sanitation infrastructures (Rabinovitch and Leitman, 1996). In 1964, Jaime Lerner led a team from the Universidad Federal do Parana for urban planning of Curitiba with a number of main objectives including strict controls on urban sprawl, a reduction of traffic in the downtown area, preservation of Curitiba's historical sector, and building a convenient and affordable public transport system based on express buses (Moore, 2007). This plan was adopted in 1968. Instead of a few large-scale planning proscriptions; hundreds of small-scale practical solutions were established to enhance urban qualities.

In 2010 the city was awarded with the "Globe Sustainable City Award". Integrated urban planning (political, social, environmental, economical, cultural and technical) and implementation of goals by utilizing practical design solutions are key points in this achievement. Curitiba's Master Plan has integrated urban development with transportation and land use planning. It limited the city area growth, whilst have encouraged commercial activities along five transport axes radiating out from the city centre (Rabinovitch, 1992). The city centre was partly closed to vehicular traffic and pedestrian streets were recreated.

Mixed land use based on high density residential buildings is allowed alongside to transport axes. The density limitation of an area is directly based on its availability to public transportation. Linear development along the "arteries" road cause a considerable decrease in downtown movement need as well as providing new opportunities for commercial and light industries to be located near fast transport thoroughfares. A new industrial city was built in the west side of the city near the sea shore where includes low-income public houses as well (Smith and Raemaekers, 1998).

3.1.3. Effective public bus system

The development of Curitiba is twisted with its public transport system which is based on buses. Bus transport system was selected because of its extremely low costs of installation and operation in addition to its fast and easy construction process. From 1974 to 1982, within eight years, the bus transport system was expanded from two express bus lanes to five express axes in addition to inter-district bus lines. The three-part road system in main axes has two one-way streets moving in opposite directions which surround a smaller two-lane street exclusive for express buses (Goldman and Gorham, 2006). Five of these roads form a star that converges near the city centre (Figure 2).

The bus system consists of three types of buses for different functions, distinguished by different colors (red for express, green for inter-district and yellow for conventional buses). In 1980s, the RIT (Rede Integrada de Transporte: Integrated Transport Network) was created, allowing transit between any points in the city by paying just one fare (Moore, 2007). The long express buses are split into three sections and stop at designated elevated tubes with disabled access. People pay for tickets at the bus stop so the urban travels become easier, faster and cheaper. The system is used by 85% of Curitiba's population (Smith and Raemaekers, 1998). It becomes the source of inspiration for many other cities around the world to use their local potentials for transportation instead of costly and time consuming large scale systems.

The population has doubled since 1974, yet car traffic has declined by 30%. The system reduces the fuel consumption and air pollution as well as environmental costs of urban mobility. Roads are categorized in four hierarchical types: structural (main axes), priority (traffic roads), collector (commercial streets) and connector (industrial connection to axes) (Rabinovitch, 1992). They have a hierarchy regarding to public transport accessibility and land use legislation. Urban terminals are built at the end of each express bus lane with social services and smaller terminals which are located every 1400 meters. The innovative and local public transport system is considered as the pioneer of urban development in Curitiba (Goldman and Gorham, 2006).



Figure 2. Five basic transport axes in Curitiba and development restrictions (solutions-site.org, 2010)

3.1.4. Local environmental consciousness and citizens' participation

In the early 1970s, when Brazil was welcoming mass industry, Curitiba accepted only non-polluting industries. It also has constructed an industrial district containing a considerable amount of green space that was called "Golf Course". Builders get tax breaks if their projects include green space (Rabinovitch and Leitman, 1996). Curitiba is referred as the ecological capital of Brazil, with a network of 28 parks and tree-planted areas (in 1970, there was less than 1 square meter of green space per person, but in 2010 there were 52 square meters). Citizens' participation has a great role in this greenery development movement (Brendan, 1998). They have planted 1.5 million trees along city streets. It is a highlighted example of citizens'

participation in urban environmental sustainability achievement. There is even a local environmental legislation to control industries, which are desired to be located in the industrial city, to serve environmental quality.

In order to achieve the goal of having 52 square meters of green space per inhabitant in 2010, the city has paid careful attention to preserving and improving its green areas. This greenery strategy implementation is closely related to legislations, long term environmental vision and citizens' participation (Goldman and Gorham, 2006).

3.1.5. Local waste management system

Combining waste management systems with social and environmental purposes provides multidiscipline sustainability for Curitiba. In the "garbage that is not garbage" program, 70% of the city's trash is recycled by residents. The city's paper recycling preserves the equivalent of 1,200 trees a day. The purchasing of garbage program (green exchange) focuses on social and environmental benefits. Low-income families, living in areas unreachable by trucks, bring their trash bags to neighborhood centres, where they exchange them for bus tickets, food and agricultural products. This means less litter, less disease and less garbage dumped in sensitive areas such as rivers. It provides a potential job for the poor. There's also a program for children where they can exchange recyclable garbage for school supplies, chocolate, toys and tickets for shows. The innovative 'Purchase of Garbage' program gives the opportunity of trading the waste for bus tickets, food and agriculture instruments to poor citizens who live in limited-access areas of the city (because of Curitiba's topography and high levels of underground water, some areas are not able to have sewage systems and some are not accessible by garbage track collectors). This strategy provides environmental responsibility as well as social and economical promotion for poor citizens (Thomas, 1992). The city environmental and ecological information centre and city botanical garden were established to enhance the local environmental awareness.

Curitiba's sewage treatment system utilizes the local lagoons (located near the river) as a water refreshing system (sewage is recycled in three steps: anaerobic, aerobic and discharging treatment). This system in addition to parallel open air canals is used to control the seasonal floods as well (Brendan, 1998). New lakes in public parks are designed to solve the problem of seasonal flood.

3.1.6. Pedestrian priority and heritage rehabilitation

Refurbishment of the city centre into a heritage realm in the authority of pedestrians has begun in 1970s. Old buildings were allowed to be rehabilitated with new functions, whilst the public squares were empowered by commercial and cultural facilities. Historical urban elements of Curitiba are used as shopping mall, theatre, creativity centre, cultural documentation service, museum; some operate 24 hours, 7 days a week. Downtown area was transformed into pedestrian public space with shops, restaurants and cafes, and the Flower Street (Rua das Flores) which was an urban recreational place (Brendan, 1998). As mentioned formerly, the priority had been given to public transport rather than private cars.

3.1.7. Social justice, quality of life and public health

Improving the quality of life has been a guideline for Curitiba's municipality. Since 1980s the city has begun a project called the Faróis de Saber (Lighthouses of Knowledge). These Lighthouses are free educational centres which include libraries, Internet facilities, and other social resources. Job providing programs and sustainable income policies are followed in the decision making process as well as action plans. The concentration of social programs is on poor citizens to provide social justice. The city's public housing program has built one of the largest plots of available lands as the home for 50,000 poor families called Novo Bairro (New Neighborhood) (Smith and Raemaekers, 1998).

Besides environmental benefits, money raised from selling materials goes into social programs. City employs the homeless and recovering addicted people in its garbage separation plants (Brendan, 1998). Sanitation and waste management programs are developed by utilizing local prescriptions to improve citizens' welfare and social justice. From the Curitiba example it becomes clear that social, environmental and economic solutions can be integrated with holistic approaches to promote the quality of life.

3.2. Shiraz: city of civilization, gardens, and poets

Shiraz is the sixth biggest city in Iran and is the capital of Fars Province. It is located in the southwest of the country on the 'Rudkhaneye Khoshk' seasonal river; 200K m from south seashore of Iran. It is built over a green plain of the Zagros Mountains, 1500 meters above sea level with a moderate climate and regular seasons.

Fars province is the origin of two biggest Persian empires from 550 BC to 630 AD (Achaemenian Empire from 550 BC to 330 BC and Sassanid Empire from 241 AD to 630 AD) and most of historical sites of these two dynasties are located in this area (Gershevitch, 1985). Shiraz has been a regional trade centre since the 8th century AD (the earliest reference to the city is dated on 500 BC). In the 13th century AD, it had become a leading centre of visual arts and publications for three centuries. Shiraz was the capital of Iran (historical Persia) during the Buwayhid dynasty in 11th century AD and the "Zand" dynasty in 18th century AD (Khoobnazar, 2001).

Shiraz has a population of 1.3 million in 2011 (Figure 4). According to an official survey, the shares of the different modes of travel in this city are as follows: private cars and taxis: 66 percent, buses: 19 percent and the other modes: 15 percent which is an unsustainable trend in a longer term. Therefore, the public bus is the main mode of public transportation (Soltani and Esmaeili Ivaki, 2011; Soltani and Marandi, 2011). For the time being, public transportation in Shiraz relies mainly on the bus network and the subway system is not opened yet. The metropolitan area consists of 9 Zones each of which has its own municipal authority. Shiraz historical zone consists of different public spaces and buildings such as bazaar, mosques, schools, houses and palaces as well as traditional squares and streets. Shiraz is known as the city of poets and flowers. It is also considered to be the "city of gardens", due to the numerous gardens and fruit trees existing in the city. Shiraz economy is based on agriculture, electronic industries and trade (crafts and electronics).

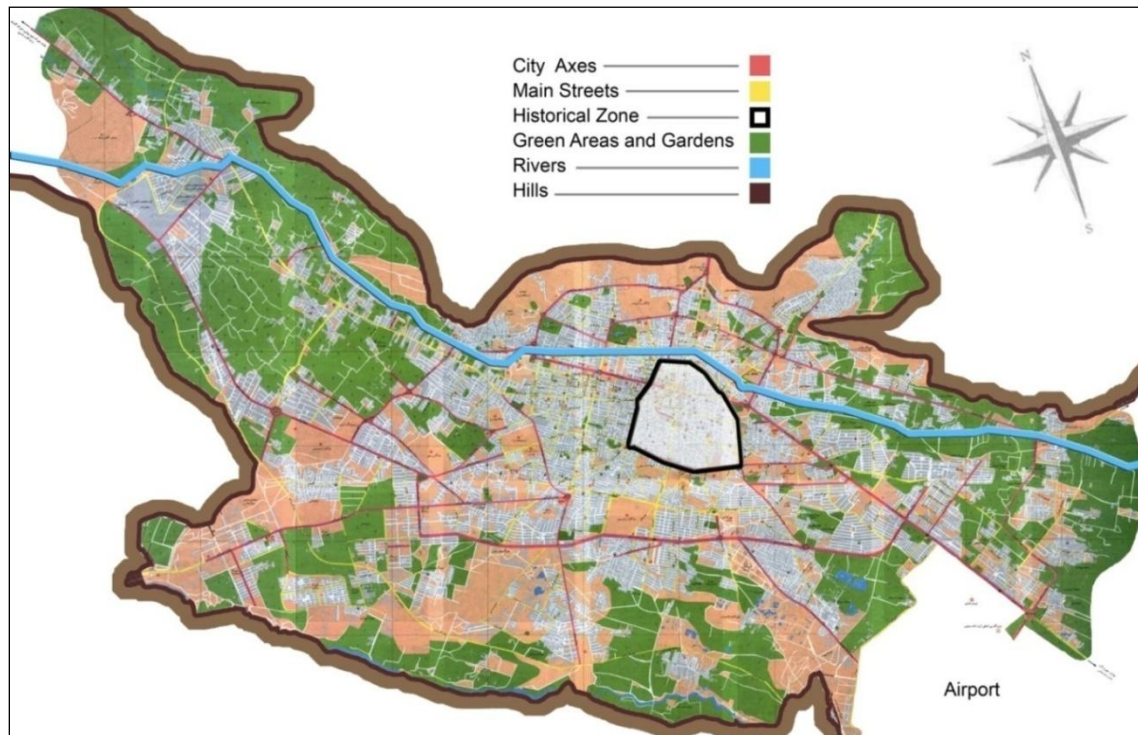


Figure 3. Shiraz urban structure

4. Learning from Curitiba

4.1. Comparative description

Table 1 compares the differences exist between Curitiba and Shiraz in terms of some basic urban and transport characteristics. It sounds that two cities are similar in density level, however, Curitiba has better figures in those items related to sustainability: Green space (per capita), recycled waste, public transport usage.

Table 1. Comparison of Curitiba and Shiraz

City	Population density (person per hectare)	Car ownership (per household)	Green space per capita (m ²)	Recycled waste (percent)	Public transport share
Curitiba	102	0.85	52	70	83
Shiraz	94	0.92	17	3	19

4.2. Integrated sustainability approach

The Integrated sustainability approach based on “social democracy” is the success point of Curitiba.

City sustainability achievement has three dynamic factors: sustainable decision making, environmental sustainability and social sustainability. Shifting the emphasis on transport system or economic is due to the context of each city. City as a unity needs an integrated sustainability approach with comprehensive and continuous long-term planning and practice.

4.3. Applying sustainability principles in Shiraz

Integration of planning process with concentration on local opportunities and small-scale changes are milestones of the proposed system, which aims to apply extracted sustainability Shiraz with the special consideration on its historical zone.

4.3.1. Historic district preservation and regeneration

There are several shortages in infrastructural services (sewage system, gas, etc.) and efficient public transportation especially in Shiraz historical zone. This shortage in addition to social problems and land development policies force original occupants to emigrate from the central zone. They are replaced by occasional resident as well as poor dwellers. These new occupants have not deep relationship with the local heritage and also have low incomes. So the area faces a serious social-economic situation.

There are more than 200 historical houses, 10 palaces, 7 historical gardens, and 30 famous mosques and schools in the historical zone of Shiraz. Although some of them have been used as museums and cultural organization, but the majority of these historical buildings are free of urban functions. Furthermore, the lack of appropriate accessibility affects the daily life.

Utilizing the tourism industry is considered as a multipurpose solution for a number of historical zone problems. In this proposal, historical houses are revitalized as small-scale hotels. Because of special pattern of the historical zone, there is an opportunity to combine a few houses to shape bigger tourist-oriented areas. Bazaar-Vakil is a 2 km sheltered-linear shopping area with the plenty of supporting small productive industries in the heart of the historical zone. It can be rehabilitated and empowered by a few number of small scale acupuncture changes in its entrances. Bazaar shops are mostly owned by original occupants of the old town, and it is an opportunity to utilize Bazaar as an activity generator in urban regeneration and citizens' participation. Tourist Oriented Planning (TOP) provides new job opportunities for occupants, which can lead to more sustainable and vibrant society and local economy.

The existing areas which have not spatial values can be redesigned to serve essential functions. Some related urban organizations such as architectural consultant companies, social welfare institutions, cultural organizations, traditional restaurants, souvenir shops, and small-scale educational centres can be relocated in this zone.

The TOP can be utilized in the whole city. Shiraz has a moderate climate; however, there is only one hour flight to rich Arab countries which have very hot and arid climate. Therefore Shiraz can be a destination for many travelers and this can bring new opportunities for the local economy. On the other hand, Fars province has lots of famous historical sites and natural tourism attractions. These all together make a potential ground

for tourism development. They can be considered as great heritage interests to promote local social and economical situations.

4.3.2. Pedestrian-oriented urban design

Shiraz has some problems to serve daily transportation. This causes some urban projects to widen the streets in the central zone. In reality, however, because of private ownership of surrounding properties, the strategy has not been implemented in many cases. Furthermore, the widespread patterns of physical growth have been acted as a motivator to use private cars more. So pedestrian and bike oriented strategies are practical solution for the long term.

In addition to opportunities for people to be connected to the identical built environment, it has some advantages to preserve old buildings from further damages. Car accessibility for emergency usage is available through "needle access". Pedestrian realm of the city is a great opportunity for citizens to reconnect to their history, environmental identity and cultural activities. It represents a different view of life to visitors which is safer, more beautiful and more convenient.

4.3.3. Integrated transport system

Shiraz city transportation needs to be equipped with collective fast modes such as BRT and subway. Construction of "Shiraz Metro System" (train access) has begun in 2002 to decline the traffic congestions and high mobility demand in the whole city. It is estimated to be operational by 2015. The needle-access streets will be connected to two city express lanes which consist of express buses in addition to the metro system. Each express lane will be supported by two slower traffic lines besides.

4.3.4. Environmental preservation, riverside and productive gardens

Shiraz has over 400 hectares of fruit productive inner-city gardens inside its metropolitan area. Most of these gardens are located in North- West of the city in "Ghasr-Dasht" area. A few of these gardens have expensive buildings within them. Lemon and orange trees are traditionally grown in private properties (e.g. Bagh-e-Eram) as well as public areas as. There are also local plantains trees grow up without any special care.

There is a cultural event in each February (Bahman) when people plant trees one month before the spring, the so called "planting ceremony" (jashn-e-derakhtkari). It is suggested that the city municipality must provide some tree plantation in this festival. Such location can be used as public green space and as mentioned formerly if local trees are utilized, they do not need special care to grow.

The city river that is a seasonal waterway has a landscape which needs to be promoted as a linear recreational space for citizens. The city bike line is currently stretched through the river and by some small changes in landscape design and safety promotion, it has potential to improve citizens' health.

4.3.5. Waste management system, agriculture and local industries

Environmental sustainability will not be achieved without separating waste in cities it is suggested that household waste must be separated into four section including food waste, paper waste, plastic waste, and material and glass waste. Food waste can be composed into garden fertilizers; paper waste can be recycled locally in paper industries; plastic waste can be recycled in packaging of goods; metal and glass waste can be reused in related industries (Lehmann and Crocker, 2012).

Shiraz has fertilized soil and is one of agricultural centres of the country. It has numerous food production industries, as well as the potential to improve it further. It is suggested that the waste management system, food production and packaging industries must be taken into consideration in an integrated manner.

The concluding diagram for how/what Sustainability principles in Curitiba can be practiced in Shiraz situation can be like Figure 4.

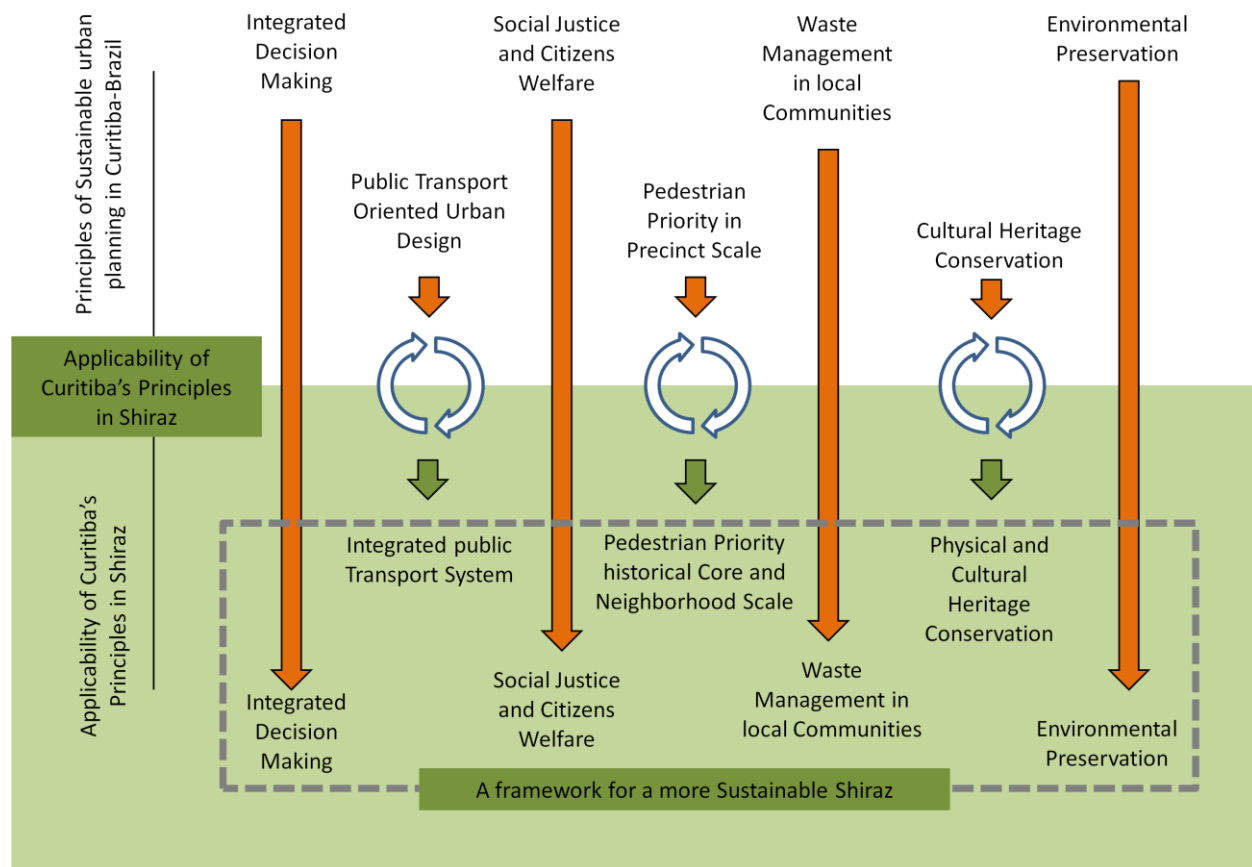


Figure 4. How sustainability principles in Curitiba can be practiced in Shiraz

In Iranian historical cities, because of their unique role in country's urban network and their heritage potentials (monuments, sites, and events), the role of social-cultural aspects are stronger. In practice, all of the sustainability aspects should be considered in an adaptive process. In Shiraz case, because of the specific environmental and building characteristics the sustainability framework was shaped along with tourism industry development. Although this sustainability framework can be applied to other historical areas, but it needs to be localized in each context. Priorities need to be changed due to contextual, social, and environmental specifications. The key points are integration of urban planning and implementation of effective actions.

5. Conclusion

Sustainability of cities can be achieved by balancing four integrated factors: sustainable decision making, sustainable society, sustainable environment and sustainable economy. The balance between these factors is totally related to the context potentials in local, regional and global scales.

Every urban environment has its specific opportunities and constraints, but still there are many things to learn from other cities'. Crucial is to investigate successful principles based on existing precedents, analyze them with the consideration of their local context and moderate them in order to apply in other contexts. In the case of Shiraz, it has developed from a historical core, which arise strong social, cultural and economic opportunities for the city. As such, the practiced sustainability principles in Curitiba need to be moderated to some extent to be able to match Shiraz specific context. It is also vital to consider limitations of case study research findings regarding to generalization and application of findings. Due to complexity of physical, social, cultural and environmental systems in sustainable urban planning, strategic planning for a city needs to inspire from several successful precedents and contextual opportunities and constraints. Implementation of strategies is the other vital criteria which need to be investigated locally.

This paper does open the door to interdisciplinary investigation of sustainability, but generally remains within the limited territory of physical planning. The most interesting hypothesis-"contextually" adapting planning principles appropriated from a unique urban context-is investigated indirectly. In other words, the "principles" behind Curitiba's many success stories are described as physical planning strategies. As a result, the application of Curitiba-like strategies to the context of Shiraz is theoretically limited. Curitiba and Shiraz are both governed and planned by technocracies, their political contexts are different. What emerges from this more critical strand of thinking is that Curitiba is not that different from other Brazilian metropolitan areas (in terms of its spatial and environmental contradictions). Moreover, considering the paper's emphasis on qualitative and context specific analysis, much analysis on actors, institutions and the planning and management framework in the city of Shiraz are possible through further research. These are crucial for a deeper understanding of the possibility of the Curitiba narrative "to travel" to Iran. In other words, it is important to identify the drivers which have positive and/or negative influences on the process in each of the two case studies. The sustainability principles need to be directed according to the identified drivers.

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