Proceedings of the 7th International Conference on Economic Management and Green Development
DOI: 10.54254/2754-1169/32/20231584

Analysis of the Significance of Life Cycle Theory in Urban Sustainable Development

- Case Study of Resource-dependent Cities

Jingyi Xu[1,a,*], Zexi Chen[2], and Zhirui Yang[3]

[1]*Waldorf School of Garden City New York, 225 Cambridge Avenue, Garden City, NY, 11530，USA*
[2]*Ulink College of Shanghai, Shanghai Laketon School, 90 Puhong West Road, Pudong New Area, Shanghai*
[3]*Zhejiang University of Technology, 18 Chaowang Road, Gongshu District, Hangzhou City, Zhejiang Province, China*
a. jingyixu@email.adelphi.edu
**corresponding author*

Abstract: Taking resource-dependent cities as an example, because of their single industry and strong path dependence, they could be influenced by the life cycle more strongly. So, more attention should be paid to their decline stage and upgrading. When cities are in their development stage and maturity stage which seem to be prosperous, potential crises like urban disease also exist. After years of research, how does the urban life cycle make a great difference in the development of cities had been studied thoroughly. But there is seldom application of this theory to proactively avoid the crisis of urban decline. By contrasting two pairs of cases, this paper will illustrate different problems that cities with different development pattern or orientation may encounter. Failing in recognizing the coming of decline stage and making timely transitions, Flint and Detroit paid a heavy price. Conversely Beijing succeeded in tackling its environmental pollution in development stage kept it from stepping into decline stage. Pittsburgh’ s success in industrial upgrading also kept it from death stage. More attention should be attached to the life cycle theory in guiding cities’ sustainable development, especially industrial transformation, and urban regeneration.

Keywords: life cycle, path dependence, industrial upgrading, case study

1. Introduction

Life cycle theory was originally used in life science and environment science to illustrate the periodic change of the living things from birth to grown up, decline and finally death. This theory nowadays has been developed and applied in many other realms both in nature and human society to show their law of development, for example, renowned product life cycle raised by Raymond Vernon in 1966, and Urban life cycle theory was firstly introduced by the American scholar Luis Suazervilla in 1985 [1,2]. According to this theory, cities are just like living things and have their own life cycle. It contains activation stage, development stage, maturity stage, decline stage.

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The Life cycle of city is highly interactive to the development pattern it chose. Considering their future orientation, cities will have different preference in specific fields, for example, population structure, types of land use, industrial structure, and so on. These conditions will make a great difference in city's life cycle jointly. On the other hand, the life cycle is going to affect these specific fields in turn. As for cities with single industry, life cycle would be rather noteworthy for them. In the section 3, we are going to introduce cases of Detroit and Pittsburgh, two cities known for their history of decline as resource-dependent cities.

The key factors that influence a city's development may vary depending on the stage of the city's life cycle. Once people figure out which stage a city belongs to, relatively precise prediction could be made, and some adjustment could be implemented before it is too late to do so. People should also take a holistic approach to urban development, considering the interplay of various variables. It turns the development of the city more controllable, resilient, and sustainable. In the section 3 and section 4, we respectively introduced the cases of Pittsburgh and Beijing, which successfully realized the crisis they had been confronted with and responded to them before it was too late to do so.

2. Literature Review

Scholars represented by Aiqin ZHU had established relationship between city development and product life cycle theory [3]. Since one of the core functions of the cities is to provide its central products to its hinterland, their product categories and scale of production will decide the cities' development level to a great extent. Accordingly, once the product and its industry have life cycle, the city would have it. As for cities rely on single industry or resource, they are highly dependent on the resource exploitation and this kind of industry occupies a dominant position in their urban economy. Since their products are single and highly homogeneous, the transition of market demand in specific products will make a great difference in its development. The life cycle of these cities is highly overlapped with which of their core industry, which shows a more obvious periodic characteristic. Hence, life cycle would be rather noteworthy for these cities. During the decline period, if the resource-based cities could gradually change their pillar industry into non-resource-based ones and introduce emerging industries and tertiary industries to achieve transitions, it would be likely for them to get into a new round of life cycle [4].

Scholars represented by Changhong MIAO found out the relationship between the development of resource-based cities and path dependence. It could be regarded as a good explanation and extension for urban life cycle theory. As for cities which are of high path dependence, high vulnerability, and weak path creation ability, it would be more difficult for them to make transitions [5]. Under the positive feedback mechanism, the industrial structure, and the structure of the labor force of a resource-based city will gradually turn into a mode which are suitable for its resource exploitation. Over time, the city is highly likely to become too rigid to make transitions in line with new changes. When it comes to resource depletion or the resource is displaced by other optimal ones, they are going to decline. It would be harder for them to regenerate during their decline period or death period. The effects of path dependence, vulnerability and path creation on economic growth and transition will differ under different macroeconomic circumstances. After analyzing many cities in China as cases, they found out that when China's economy enters a new normal stage after achieving remarkable economic growth, those cities of strong path dependence and vulnerability would present to be hindered by their former advantages. Regions, resource types and evolutionary paths of those cities should be taken into consideration when the targeted policies and measures are newly introduced. And the inspiration their research gives us is not confined to the resource-based cities. The scientific and technical revolution is bringing about new industry, new product, new service, new post faster than ever. As for non-resource cities, new spatial arrangement and industrial structure are also required to keep pace with all these changes. And the path creation ability of non-

DOI: 10.54254/2754-1169/32/20231584

resource industry is affected by its openness degree. The introduction of path dependence and path creation to life cycle is insightful.

3. Long-Term Urban Degradation

The life cycle of resource-dependent cities (such as coal, oil, and heavy industry cities) is closely related to the cycle of the corresponding resource industry. Cities that depend on specific technologies or products are closely related to the cycles of the corresponding technologies and products. The alternation of cycles of multiple urban functions, in which the deterioration of the economic base and the loss of population will be the main factors leading to the decline phase [6].

3.1. Case Study of the Irreversible Decline of "Motor City-Detroit"

Detroit was once a thriving manufacturing hub, known as the "Motor City" and commanded the vast majority of American car manufacturing. Famous for its assembly line, Detroit used to have a strong path dependence on its automobile industry. Enjoying great success from the mechanized production of big scale and low-cost labor force, the city paid no attention in the introduction of talents.

However, in 1950s, the automotive industry began to decline due to international competition and changes in consumer preferences [7]. Due to the industry's great sensitivity to market supply and demand, automobile manufacturing companies drastically reduced labor expenses and relocated their plants [8].

After Detroit suffering great industrial transfer, many people migrate to other cities for the sake of work. Between 1949 and 1963, Detroit saw a total loss of 134000 manufacturing employment; further jobs were lost in the 1970s. Tax reduction was the immediate consequence of the loss of population. This decline was further exacerbated by the social and political upheaval of the 1960s and 1970s, including civil rights unrest and racial tensions. It made the maintenance of existing infrastructure and services unsustainable. Decreasing quality of life and increasing crime rate drove more people away. Recent data from the United States Census Bureau (USCB) indicated that the population of Detroit has declined by over 63% since its peak in 1950 [9]. Over time, divestment occurred causing Detroit to fail at creating a path and turning things around.

Vicious cycle is one of the significant characteristics of the decline stage. Nowadays, as globalization high-tech innovation and production, Detroit car industry encounters a more intense external competitive environment, which lead to a progressive closing of the technical advantage gap in the market. Additionally, the cost of manufacturing has increased continuously due to rising raw material costs, such as the price of oil, and the Detroit car industry's profit margin is constantly decreasing. Corporate orders have drastically fallen, real economy investment has declined, and funding for businesses has become more challenging since the financial crisis of 2008 [10].

The combination of all the above has made it difficult for Detroit to emerge from the recession. One of the most critical policies for controlling Detroit's urban degradation is the "Detroit Future City" strategic framework plan released in 2013. It outlines a vision for the city's future and specific strategies to achieve that vision, including blight elimination, land use planning, economic development, transportation, and community engagement [11]. Despite these efforts, Detroit's urban decay still has become a vicious cycle. Fully recognizing and capturing the importance of the life cycle is a critical step for a city in the early stages of decline.

3.2. Case Study of Pittsburgh's Regeneration

Pittsburgh was once a thriving industrial center where the steel and coal industries predominated but faced a decline in the 1980s and 1990s due to the collapse of the steel industry. It went through a recession like other cities with a single industrial structure and strong path dependence, such as

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Detroit. Unlike other declining cities, Pittsburgh was that it successfully seized the opportunity to keep up with the global innovation and transformation wave during the recession and implemented a successful industrial transformation into a new life cycle [12].

Pittsburgh's recovery from population loss has been greatly aided by its transformation from a heavily industrial metropolis to a hub of technology and innovation. It made a great success in path creation. The city set up a range of research institutions and startups focused on sustainability, including the Pittsburgh Green Building Alliance and the Energy Innovation Center. This growth has been supported by investments in research and development, as well as partnerships between local universities and private companies [13]. At the same time, Pittsburgh emphasizes support future technical talents and focuses equal emphasis on cultivating young people's technological literacy and innovative expertise.

Besides reshaping the city's core as an important part of the city's life cycle, preventing urban decline by enhancing the city's image is an important factor, and Pittsburgh's image and cultural appeal have suffered greatly during the decline of the life cycle. Data analysis remarkably demonstrates that Pittsburgh has many more jobs than it did just a few years ago. Between 2010 and 2020, the city's workforce grew by 8.7 percent, surpassing the national average of 6.8 percent [14]. In addition, high-tech employment in Pittsburgh is growing up 24 percent between 2014 and 2018 [15].

The application of modern technology and other tools to coordinate the efforts of all parties in the urban renewal process is an important step in the urban life cycle. The urban life cycle theory helps to identify the development stages of a city and provides guidance on the appropriate actions that need to be taken.

4. Urban Issues Exist in Growing Period or Mature Period

When people talk about different stages of a city, the main way to categorize it is to focus on the sustainability of its economy or the stage of development of its industry. This is certainly justified, as the dynamism of a city is highly correlated with its anchor industries. However, as cities enter the urban life cycle development phase, they will all face the challenge of striking a balance between short-term prosperity and sustainability. Even in the development or maturity phase, cascading problems in cities are inevitable.

Modern industrial development has occurred as cities prioritized short-term economic growth, such as new businesses and investment, over long-term impacts. The challenge of balancing short-term prosperity and sustainability requires cities to take a holistic approach to development. Additionally, many cities have declined not because of depleted resources or lost industrial potential but because of the urban disease that has made them uninhabitable.

4.1. Case Study of Flint: The Crisis Arrival was not Properly Detected During the Growth Period

As stated above, cities go through a developmental phase in which the inability to properly deal with hidden urban crises will have irreversible effects and cannot be recovered in a short period of time, thus becoming a critical crisis in the Urban life cycle.

Flint was once a thriving manufacturing city, known for its booming automotive industry. In 2014, it faced a significant water crisis during its growth phase, when the city switched its water source to the Flint River to save government budget. The water from the Flint River was not properly treated, leading to lead contamination in the drinking water supply, which posed a serious health risk to residents, especially children. This water crisis led to a public health emergency, a loss of trust in

DOI: 10.54254/2754-1169/32/20231584

local government, and a long-term negative impact on the city's reputation and the well-being of its residents [16].

As a result, the City of Flint faces social and economic challenges, including poverty, unemployment, and limited access to education and healthcare. These challenges have exacerbated the effects of the water crisis and urban decay, straining the city's resources and resilience [17].

4.2. Case Study of Beijing: Awareness of the Risks and Successful Solution

Urban areas characterized by high levels of air pollution and urban pollution is considered as a major challenge in the develop stage of cities, with a range of negative impacts on environment and public health, including CVDs, respiratory health, even aquatic ecosystems. Beijing has long been known for its severe air pollution, which is caused by a combination of factors, including industrial activity and transportation emissions [18]. According to data from the World Health Organization (WHO), in 2013, Beijing had an average annual PM2.5 concentration of 89.5 micrograms per cubic meter, which is nearly nine times higher than the WHO's recommended guideline of 10 micrograms per cubic meter [19].

Over time, the economic costs can undermine sustainable development goals by reducing economic growth and prosperity. It is critical to address environmental pollution impacts on sustainable development, which can undermine economic, social, and environmental goals in the long term. To ensure that economic growth is balanced with environmental protection and social well-being. The implications on the economy and the environment will depend on how effectively cities are implemented and how to balance with other priorities.

It takes all-encompassing action to overcome the worldwide problem of air pollution in urban growth. The quality of life for residents has declined, as evidenced by the facts and examples of air pollution and environmental contamination in Beijing that were previously presented. These are some methods to assist the air quality for Beijing in growing period of life cycle. Limit emissions from traffic and industry. The primary sources that can dramatically enhance air quality are factories and automobiles. The government can accomplish this aim by developing and putting into effect pertinent regulations, such as restricting the emission of certain pollutants or promoting the use of clean fuels. Enhancing the effectiveness of public transit can encourage individuals to drive less, which will lower traffic emissions. The government may promote the use of public transportation while enhancing its quality, including expanding routes and enhancing vehicle efficiency. Promote ideas for environmental protection. Urban air quality may be improved by increasing public knowledge of and sensitivity to air pollution, as well as by encouraging public environmental behavior such as energy saving, trash reduction, and the selection of ecologically friendly products. The external issues of environmental pollution might be considerably remedied by collecting the Pigou tax. Businesses that choose a green method of operation might potentially receive financial advantages like tax preferences [20].

5. Conclusion

The notion of the urban life cycle has emerged as a key resource for comprehending and forecasting urban growth. We also need to be aware of the concerns that might arise throughout the prosperous and mature periods as they relate to change and transformation. Knowing where a city is in its lifecycle allows one to change development tactics and considerably increase growth efficiency, making the city more manageable, robust, and sustainable in the face of new difficulties. A helpful framework for comprehending how cities grow and switch to sustainable development methods is the urban lifecycle. Corresponding problems may also arise during the urban development stage. For example, Beijing's urban air and environment are excessively polluted, and Detroit is unable to

transform due to the old industrial city, leading to population loss. Pittsburgh is transforming from a degraded industrial city to a new technology port. Addressing these issues requires a comprehensive approach that includes addressing economic, social, and political factors to create sustainable and prosperous communities. Cities can tackle these issues and create a more sustainable and just future by reducing industrial and transportation emissions, fostering urban greening and carbon sequestration, enhancing urban infrastructure, and attaining economic diversification. According to this article, sustainability and the importance of the urban life cycle are both ways to stop cities from entering a decline phase.

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