



True Smart and Green City?
8th Conference of the
International Forum on Urbanism



Conference Proceedings Paper

Towards Urban Mobility Transitions in Seoul: A Socio-Technical System Analysis and Identification of Policy Options for a Breakthrough of Cycling as a Commuting Mode

Junhan Kim

Department of Urban Planning and Engineering, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul, 120-749, Korea; E-Mail: joonhan0106@naver.com; Tel.: +82-2-2123-7721; Fax: +82-2-393-6298

Abstract: Cycling is a promising zero-emission mode in the mobility domain globally. In Seoul however, only 2.58% of trips are by cycle in 2012 despite krw 61.1 billion (\$ 56.5 million)¹ investment from 2008 to 2012 by Seoul Metropolitan Government. The number of bicycle users increased rapidly over a decade but this has mainly been for leisure activities. Considering that most travel in Seoul is for the purpose of commuting, it is highly desirable for Seoul to make cycling a key mode for commuting. This paper contributes to explore urban mobility transitions in an Asian megacity context. It analyzes the transition dynamics of the mobility system in Seoul from a socio-technical system viewpoint, drawing on the Multi-Level Perspective (MLP) to capture the current limits and potentials of cycling as an important future commuting mode. The main drivers and barriers of a system transition are identified, considering niche, regime and landscape interactions. Based on the findings, the paper then suggests alternative approaches in policy and planning to foster the use of cycling as a commuting mode. In conclusion, poorly designed infrastructure, lack of awareness and negative attitudes towards bicycles and lack of user participation in policy design are recognized as relevant barriers. While electric bicycles and mobile phone applications are highlighted as important technology niches to overcome certain barriers, infrastructure improvements like cycling track and/or bicycle parking lots need to be designed more thoughtfully to boost the modal share of cycling. Most importantly, however, various social and institutional aspects including users, policies, practices and cultures play a crucial role to promote and accelerate a breakthrough of cycling as a commuting mode.

¹ currency at 2015 April 21

Keywords: transition; socio-technical system; urban mobility; cycling; sustainability; Multi-Level Perspective MLP); commuting

1. Introduction

The urban population has shown rapid growth over decades. While only 30% of the world population resided in urban area in 1950, it has risen to 54% in 2014 and will further rise to 66% by 2050. The number of megacities will also increase from 28 in 2014 to 41 in 2030. Cities will suffer from increased and concentrated sustainability challenges [1]. This urges cities to cope with sustainable challenges. Transport is one of the key sustainability challenges, which cannot be resolved easily. The rapid urbanization and dominant automobiles cause high congestions and inefficient urban mobility, as well as environmental pollutions, Carbon emissions and traffic accidents. Without a fundamental system change, this will become even worse by 2050, being coupled with rapid urbanization.

Currently many cities address sustainable transportation policies in response to aforementioned challenges in mobility domain. Non-motorized vehicles and/or zero emission vehicles have received increasing attention [2]. Among them, cycling is a promising mode, which shows more than 10% of modal share in more than 100 cities [3]. In Seoul however, only 2.58% of trips are by bicycle in 2012 [4]. The number of bicycle users in Seoul increased rapidly over a decade but this has mainly been for leisure activities. Considering that most travel in Seoul is for the purpose of commuting, it is highly desirable to make cycling a key mode for commuting. A survey in 2009 found that 87.8% of Seoul citizens would use a bicycle as a transportation mode if the cycling infrastructure in Seoul were improved. In response to climate change and demand for sustainable transportation, Seoul made an ambitious goal in 2008 to raise the modal share of cycling from 1.6% to 10% by 2020 [5]. Krw 61.1 billion (\$ 56.5 million) were invested in cycling infrastructures between 2008 and 2012, but the share of cycling still remains far behind the target objective. This illustrates that the improvement of cycling infrastructure itself cannot enhance the modal share dramatically. Yet, further demand from civil society and the political will of the Seoul mayor present an opportunity that could lead to a breakthrough for cycling in Seoul. Currently, more than 600,000 people are members of an online community named "Commuting by bicycle" in South Korea. It is a considerable number, although this figure would include not only people who commute by bicycle, but also people who are just interested in riding a bike. They have actively discussed the current problems and possible solutions to make bicycle commuting easier. In its Transport Vision 2030 Seoul Metropolitan Government also announced to establish a bicycle-oriented transport policy, and to reduce the share of automobiles from 18.4% to 10% until 2030 [6]. A research question has thus been raised from here: How can Seoul make a breakthrough of cycling as a key commuting mode through effective policy approaches? And what makes it difficult for Seoul citizens to change their travel behavior?

2. Research methodologies

This paper analyzes the transition dynamics of the automobile-based mobility system in Seoul from a socio-technical system viewpoint, to capture the current limits and potentials of cycling as an important future commuting mode. Drawing on transition studies and behavioral change research in the context of mobility, an analytical framework is developed for the case study. [7] argued that conventional travel behavior research on cycling is based on the simple assumption that people are ready to change their behavior immediately, which cannot reflect the real procedure of individual travel decision. Instead, the authors use a stage model of behavioral change and socio-ecological factors, enhancing the explanatory strength of their approach. Still, this fails to capture the crucial role of new technology and how macro trends, the existing context of the cycling system and other novelties can influence people's travel behavior. In this regard, socio-technical system analysis and the Multi-Level Perspective (MLP) provide very useful tools as they enable a comprehensive consideration of individual, social, physical environment and technology factors in order to identify pathways for radical system transitions through interactions among landscape, regime and niches.

2.1 Socio-technical system transitions and MLP

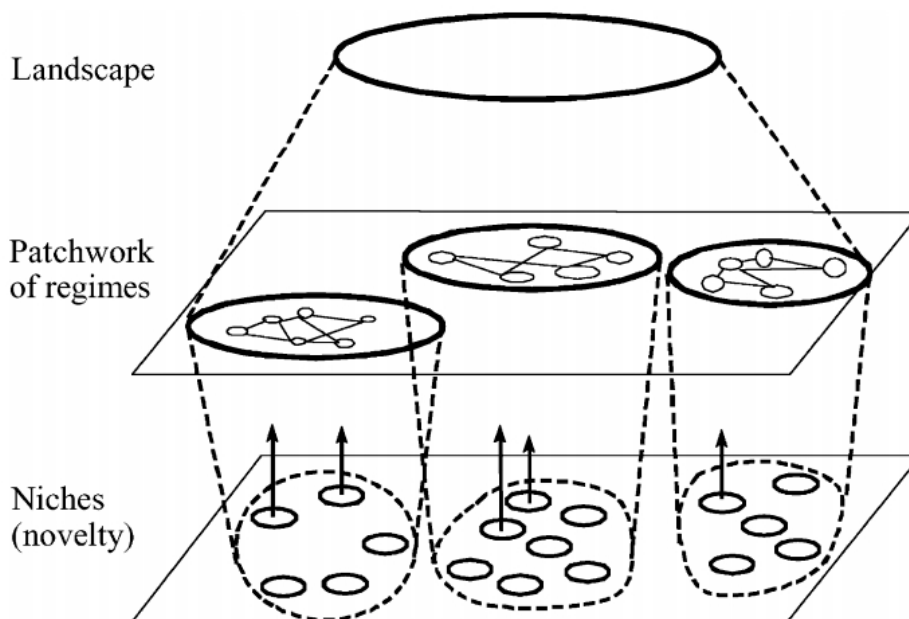
The research on socio-technical system transitions has received increasing attention over 20 years. Researchers of socio-technical system argued that social dimension, as well as technological dimension contribute to form technological development [8]. MLP provides a useful analytical framework to look into socio-technical transitions. It captures how a stable system can change radically to another stable, but fundamentally different system through looking at the interactions of three different levels: landscape, regime and niches [9]. (See figure 1)

Socio-technical regime consists of diverse social and technological elements. It is comprised of subsets of technological regime, policy regime, culture regime and market regime and so forth within which the actors form specific communities to share values, beliefs, problem agenda and aims [10]. The regime configuration is very stable as technologies, institutions, actors, values and beliefs are heavily interdependent [11]. Niches are translated in various ways, but mostly interpreted as a protected space for novelties. New sociotechnical configurations and practices are instable and cannot easily replace or realign a stable regime configuration due to the path-dependency and lock-in situations within regime [12] [13]. Landscapes, the external structure for regime and niches, provide windows of opportunities here for niches. Landscapes do not directly change something, but provides 'gradient of force' to induce some actions rather than others [8]; [13]. Finally, the socio-technical transitions occur when successful niches utilize the windows of opportunities and finally replace or realign the existing regime.

2.2 Operation: Interviews, literature reviews, news items, official documents, web page interactions,

This paper delimits car-based mobility system in Seoul as a unit of analysis. It however specifically focuses on the interactions with cycle commuting. The efficient multimodal transport system is considered as desirable and sustainable transport future in Seoul. To analyze the system, qualitative data collection was mainly conducted including interviews, interactions with users in online community as well as secondary literature reviews.

Figure 1. Multi-level perspectives [9].



The online community “Commuting by bicycle” played a key role to identify the barriers from user side. It has more than 0.6 million members (1.2% of total population of South Korea in 2010) between whom the active interaction can be found. Since its open in 2003, more than 1.6 millions of postings have been uploaded (397 postings per a day). 4,157 postings have been found during the last 1 month, indicating 419 postings per a day (Accessed 2015 April 25). Several barriers were identified from the board “Policy discussion”. Not only observing the opinions, the author also directly interacted with the users through posting three brief surveys on the community to understand the barriers comprehensively. Apart from this, two interviews were conducted to identify and deeply understand barriers and confirm the findings at the online community. Also, secondary literature reviews were used to firmly support the findings.

3. Possibilities of cycle transitions in Seoul

3.1 Bicycle policies in Seoul

SMG has made many efforts on cycling promotion after Cycling usage promotion ordinance legislated in 1995 [5]. It has a Department of Walking and Cycling under City Transportation Headquarter. The department has 6 teams: walking and cycling policy team & culture team, cycle facility team, public bicycle team, walking safety team and road space redesign team. Also Seoul provides a bicycle website (bike.seoul.go.kr) to provide comprehensive information regarding cycling in Seoul.

Seoul made an ambitious goal in 2008 to raise the modal share of cycling from 1.6% to 4.4% by 2012, 7.6% by 2016 and 10% by 2020 [14]. Krw 61.1 billion (\$ 56.5 million) were invested in cycling infrastructures between 2008 and 2012. 10 parking facilities had been established near metro station between 2007 and 2012 by using krw 9 billion (\$ 8.3 million). However it can only accommodate 2,259 bicycles [15], while some of the existing parking facilities are full of abandoned bicycles.

Recently SMG cycling policies deal with education and social activities [16]. SMG has recruited ‘cycling culture citizen lecturer’ from 2009 for educating children as well as adult regarding safety and regulations. Also, SMG nominated 100 citizens in 2015 for citizen volunteers. The role of the volunteers is to report any issues on cycling facilities and to lead safe cycling culture by wearing helmet. Also SMG initiated “Bicycle bus” on June 2011, a monthly campaign, to promote cycling as a commuting mode. Bicycle bus consists of 10 to 15 bicycle users, and this group of users travelled a certain route every month to raise awareness of the car drivers. However only 25-30 citizens participated every month and the participants felt difficulties in cycling on the road due to the negative attitude of car drivers [17]. Apart from previous policies, SMG has made a plan to invest additional krw 190 billion (\$ 175.7 million) on cycling until 2031 (SMG, 2014).

3.2 Demand for cycle commuting

The interests on cycle commuting increased since 2000s. The high oil price and increased interests on health contributed to this. With the internet provision and development of online community, people can share their interests on cycling through online communities. The online community “Commuting by bicycle” has more than 600 thousands members (1.2% of total population of South Korea in 2010). Not only sharing the interest, people gathered and performed campaign together. In addition to online communities, Korea Bicycle Council (KBC) was established in 2010. KBC address the importance of cycling in response to climate change and environmental problems [18].

4. MLP analysis

Despite aforementioned high possibilities, the modal share of cycling in Seoul is very frustrating. Why is it so difficult for Seoul citizens to commute by bicycles? What prevents cycling from being a key commuting mode? This chapter briefly investigates how a car based regime stabilized over decades from historical view. Then the existing regime was analyzed and key barriers for cycle commuting were identified through interviews and interactions with bicycle users. Landscape pressure, regime cracks and promising niches were found.

4.1 Emergence and stabilization of car-based mobility regime

Due to the rapid economic development, per capita GNI of South Korea soared from \$ 303 in 1970 to \$ 26,718 in 2013, which indicates a 88-fold increase in 43 years [19]. Seoul was rapidly urbanized during this development and the number of automobiles increased dramatically. The economic development during 1970s in South Korea was mainly driven by the president Park Jeong Hee. He was impressed by German Autobahn and started to construct Kyeongbu highway. In 1970 it is a turning point of automobile history in South Korea when the highway finally constructed. The first comprehensive car factory was established in 1973 just after he showed his will to boost car industries in South Korea at his speech, announcing that he wanted to open “My car” era. While only 193,927 cars were registered in 1975, the number of automobiles had been increased around 20% each year between 1980s and 1990s. In 1985, more than 1 million cars were being registered. It reached 10 million in 1997 and continuously increased by 19.4 million in 2014 [20].

The car industries and media in South Korea also contributed to create the existing regime. As car industries developed, car companies started to pour the money into media. The three major car companies (Hyundai, Daewoo, Kia) paid krw 122 billion (\$ 112.8 million) for commercial advertisements in 1996. This not only encouraged people to buy cars but also enabled car-based mobility culture to deeply intrude to people in South Korea through newspaper and television. The national government gained krw 13.5 trillion (\$ 12.4 billion) by tax revenue from automobiles. There was no reason for government not to promote car friendly policies. Car industries, government and media thus contributed to stabilize car-based mobility during 1990s (Kang 2006).

However it provoked inequalities in mobility right. Some people could obtain high mobility and accessibility, while the others could not. Soon, car possession became the symbol of the social position and social class in South Korea [21];[22]. Seoul, the capital of South Korea, accommodated around quarter of its population and showed the largest number of car users during 1980, contributing to shape the context above.

4.2 landscape pressure and destabilization of regime

As the infrastructure could not well accommodate the number of cars in Seoul due to the rapid urbanization and quick provisions of automobiles, government broadened the road to increase the road capacity. Not surprisingly, this lack of system perspective soon arose many problems in Seoul. The road became more congested however the road was broadened, as more capacities the road accommodated, more cars came into the roads. Soon the roads were full of cars again and millions of cars caused air pollutions. Lack of parking space was also

While people were able to comfortably access anywhere by automobiles, this convenience rather hampered the health of Seoul citizens. People took care of their health due to the increase of lifestyle related diseases. Combined with the economic boost, citizens started seeking out exercise and sports that can improve both quality of life and health. Cycling became one of key leisure activities in this regard.

Climate change requires sustainable transport policies that can reduce carbon emissions. As 39.6% of GHGs emissions within energy domain came from transportation, policy makers in Seoul started to consider the way to cope with climate change through dealing with transportation [23]. Also, Seoul citizens were quite tired of growth and missed the humanities due to the side effects of previous rapid growth. Demand on communities, human-centered and welfare policy increased. This influenced to the policy trend of human centered and sustainable transport policies. The oil price rise also contributed to make cracks on existing regime. People have tried to reduce the oil usage. Fuel efficiency became one of the significant criteria for people when selecting an automobile.

4.3 Regime realignment and emerging niches for cycle commuting

The landscape pressures destabilized car based mobility system. In 2004, Seoul Mayor Lee Myeong Bak reformed public transport services in response to high congestion, air pollution and traffic injuries [24]. The introduction of curbside bus lanes and free-transfer system between public transportation highly foster the usage of public transportation. Combined with smartphone applications that can tell the location of bus, punctuality and reliability of public transportation increased dramatically. Now the public transport system is one of the most beloved by Seoul citizens [25].

While public transport has been successfully reformed, cycling is still marginal. However, the novel movement can be found to make cycling a key commuting mode. The new transport policies of SMG recently promoted walking and cycling in response to climate change and high congestions. Many online and off-line communities for cycling emerged as people wanted to enjoy their lives and to improve quality of life. Starting from leisure activities, cycle commuting has been tried by some commuters.

Recently electric bicycle is being developed. It is marginal but quite a promising option in the future. Yet market, technology and regulations are not yet matured enough to foster electric bicycle. Smartphone applications are also very promising. Like the public transport reforms, ICT will bring innovations in various ways when linked to infrastructure. For example, it can be utilized to open and close the lockers or it can inform the nearest empty bicycle parking spaces. Also it can link to public bicycle system or transfer system.

Apart from cycling, anti-car users have also emerged. Those people consider health importantly and the term BMW (bus, metro and walking) was coined.² Although they are only using public transport right now, high potentials for cycle commuting can be found in the future.

However, these novelties are not configured well. Also, many barriers hinder emerging niches from competing with regime. Further systemic approaches to foster niches are urgently required to facilitate cycle commuting.

4.4 The barriers for cycle commuting

From the analysis above and interviews, three key relevant barriers for emerging niches were identified in the existing regime: poorly designed infrastructure, Lack of awareness and negative attitudes towards bicycles and lack of user participation in policy design. These three key barriers are intertwined and reinforcing each other stabilizing existing regime, which prevents cycle from being a key commuting mode. Various issues arose from those barriers including safety, bicycle theft, inconvenient infrastructure and policy gaps. In addition to these three key barriers, some others were also found: travel distance and time, air quality, weather and topography.

4.4.1 Poorly designed infrastructure

It turned out that despite the budget investment on cycle infrastructure, the cycle users are still very frustrated with the poor cycle infrastructure. The main problems are found at cycle roads and bicycle parking lots. Some cycle roads are discontinuous and narrow while some others show low-quality pavement. Trees were planted on some cycle roads while bus stop facility was constructed on some others, which is even difficult to say “cycle road”.

Another infrastructure problem is regarding bicycle parking facilities. The most serious problem is the lack of parking facilities, especially for the cycle commuters as they cannot find any proper parking spaces near their working places. But also the existing parking facilities are not working well. They have two problems. First, they do not restrict the parking periods. There are no restrictions on the bicycles

² The possession of car made by foreign companies, including BMW, is a symbol of wealth and luxurious life in South Korea. The term thus means that using bus, metro and walking is not a humble choice but a luxurious choice for improving health.

that are parked but never being taken again. Some bicycle parking lots are already full of abandoned bicycle. Bicycle theft is also another issue of parking facilities. To protect a bicycle from bicycle theft, bicycle lockers are preferred by users. At least the existing parking facilities require measures to lower the possibilities of bicycle theft.

Lastly, lack of shower facilities was identified as a barrier. After cycle commuting, people need to take a shower before they start their work. Also locker is needed to keep office suits. The working clothes are quite strict in Korean culture, so this needs to be considered.

4.4.2 Lack of awareness and negative attitudes towards bicycles

Aside from the infrastructure itself, lack of awareness and negative attitudes towards bicycles hinder a cyclist from making use of the existing infrastructure. The most significant barrier is pedestrians on the cycle road. 70.6% of cyclists responded that pedestrian on cycle road is the most problematic obstacle. Pedestrians do not distinguish cycle roads from pedestrian road. Not only pedestrians, but illegal and temporary car parking on cycle lane is a huge barrier for cyclist. Continuous cycling track becomes discontinuous due to the pedestrians and/or illegal car parking.

Secondly, automobile has a higher priority than bicycle on the road. Thus car drivers consider a cyclist as an annoying one who hinders their driving. A taxi driver even called cyclists “enemies of car drivers”[26]. It is almost impossible for a cyclist to drive on road cycle lane beside the automobiles as they highly threaten a cyclist. Some drivers even threaten a cyclist on purpose.

4.4.3 Lack of participation in policy design

Many criticisms can be found from the user side regarding the policy gaps. A Korean term “Tak-sang-haeng-jeong” refers to administration and policies that never reflect reality. It literally means “administration on desk”, criticizing the policy gaps created by decision makers and public officers. Many examples can be seen on the poorly designed infrastructures that are totally non-sense for the users. From the interactions within online community, many innovative and novel ideas were found. They discussed fruitfully on cycling policies by themselves. The linkage between users and policy makers should be necessarily considered.

4.4.4 Other barriers

The other barriers include travel distance and time, topography, air quality and weather. The far distance and long-time commuting as well as the steep topography were found to be other barriers. They make users be exhausted and difficult to commute. Air quality is another critical issue as air quality goes worse and worse in Seoul. Too cold or too hot weather and snow and rain are also other barriers.

5. Alternative Policy suggestions

Based on the findings, this paper suggests alternative policies that may achieve a cycling breakthrough for sustainable mobility future. Instead of suggesting solutions for each barrier, this paper adopts holistic and systemic views and suggests alternative policies to untie the tight knots of barriers. A best-fit strategy for all problems does not exist. Rather, the challenges can be resolved on the basis of

local contexts, real practices and learning process. Hence, instead of providing deterministic prescription, this paper suggests three core elements for helping to solve the challenges: *actors, strategies and processes*. This will answer the following questions: Who should be involved to solve the problems? What strategies should be utilized? What processes are required within actors to steer that? These are inter-related matters and do not have to consider one after another.

5.1 Processes: Integrated and reflexive cycle commuting governance

The well-designed, cooperative and innovative governance is required to align the novel configurations. The governance will deal with the problems on infrastructure, awareness and attitude and will foster emerging niches and conduct experiments. The governance actors should involve private companies, users, government and research institutes to minimize the policy gaps and maximize knowledge exchange and the impact of implementation. This integrated governance should ensure balance between the voices of actors.

Also, the reflexive governance is required as learning is crucial for novel experiments. The process to monitor and evaluate the proceedings has to be developed, and it has to be flexible to adjust directions from learning.

5.2 Actors: The role of each actor

Private companies play a key role here. It can be divided into 3 categories: the leading private companies in South Korea, bicycle companies and marketing companies. The leading companies are invited as a workplace. If the leading companies, Samsung, Hyundai, LG and/or other big companies agree to promote cycle commuting, it will directly influence to society, as well as other small and medium companies. Infrastructure within companies will take a crucial role. For instances, the shower facilities and cabinet in company for cycle commuter can produce a convenient cycle commuting. The bicycle companies should be also involved. They can hear the user voices to create innovations in their productions. Especially for electric bicycle, the research and development process have to reflect the user opinions, regulations and expertise to enhance the compatibility of new technology. Marketing company is suggested here. Media helps to overcome the awareness and attitude issue. The strategic marketing is necessary to change people's values and beliefs. Association of Public Advertisement in Korea Broadcast Advertising Corp. (KOBACO), a competitive public corporation is a promising option. This will be combined with regulations from government and constant campaigns from active users in practice.

The users are of crucial. The real practice is experienced from users, so their opinions have to be reflected. Not only the bicycle users, but also anti-bicycle users need to be engaged. The bus drivers, taxi drivers and citizens have to talk and understand each other. They are the ones who can create innovative solutions.

Government has to listen to the other's voices and decide the policies with the other actors. Some solutions were very innovative but cannot be feasible. Thus the role of government is to reflect the voices and discuss the possible policy options.

Research institute can participate to design the processes and moderate the actors. Some other expertise of technology, transport and psychology can be also utilized to foster new technologies, traffic design and behavioral changes.

5.3 Strategies: Fostering niches and appropriate pressures to regimes

Niches have to be protected, nurtured and empowered to realign existing regime as initial niches cannot threaten the regime [27]. The new configurations at niche level needs to be aligned well through this.

For example, the new lifestyle of cycle commuting can be nurtured. So the users should be selective. Those who are working at companies that have good cycling facilities are strongly recommended. Also, it is preferred to have moderate distances between home and workplace and high interests on cycle commuting. Those people can organize cycle commuting clubs within companies. SMG and companies have to take care of them and listen to their voices.

Another example is fostering electric bicycle. This new technology can be continuously tried by users. The bicycle companies and technology experts have to reflect their opinions. SMG and national government can provide incentives, infrastructure and regulation for promoting electric bicycle. Finally, these various actors can co-create and foster innovations.

5.4 For the other barriers

Other barriers can also be dealt with aforementioned actors, processes and strategies. However, some are not possibly solved right now. For instances, air quality has become a serious and critical barrier for cycle commuting but cannot be resolved within a short period. The long-term approach to improve the air quality is required. Cold and hot weather, snow and rain are also a persistent barrier. High-tech clothing and new types of tire could be possible future solutions. Travel distance and time seemed not to be resolved by conventional non-motorized bicycles. However electricity bicycles have emerged recently and show possibilities to reduce travel time dramatically and overcome travel distance and steep topography.

6. Conclusions

This paper delimits car-based mobility system as a unit of analysis, focusing on interactions with cycle commuting. The Multi-Level Perspectives provide useful insight through looking at landscapes, regime and niches levels. By navigating regime stability, landscape pressures and emerging niches, the paper investigates the dynamics of mobility system. Three key barriers were identified through literature reviews, interactions with online community and interviews. Then finally alternative policy options were suggested to enable breakthrough of cycling.

Further research is required to incorporate four strands of transition studies: Multi-Level Perspectives (MLP), Strategic Niche Management (SNM), Transition Management (TM) and Technological Innovation System (TIS) [28]. MLP can help to identify the historical context of regime stabilization. From theoretical background, it informs us what needs to be done to provide windows of opportunities to niches. However, it does not fully provide *how* this can be done. MLP has been criticized for

overlooking individual actors while researchers on MLP do not agree [8]. However the role of MLP seems more proper and useful to focus on identifying the interactions between three different levels. The individual actors and strategies can be complemented by Transition Management and Strategic Niche Management. TM focuses how individual actors can formulate a certain arena of actor groups to efficiently and successfully achieve transitions. SNM is more at strategic level and provide strategies to nurture and empower niches. TIS will provide an insight to foster novel technologies but can be embedded within a sub-process of TM. Those integrated approaches will function as a whole transition kit. Still, the future studies also need to be considered as transition researchers always focus on shaping the futures. The efficient way to shape desirable futures will take a crucial role within transition studies.

Acknowledgments

The author wants to thank Professor Marc Wolfram for his sincere advising and valuable comments. Also I would like to express my appreciation to the online community members and two interviewees, Mr. Hwang and Mr. Shin for kind cooperation.

Conflict of Interest

The author declares no conflict of interest.

References and Notes

1. UN, World urbanization prospects: the 2014 revision. United Nations: New York, 2014.
2. J. Na, “도시 교통의 미래, 거대한 모빌리티 생태계 (The future of urban transport, large mobility ecosystem),” LG Economic Research Institute: Seoul, 1291, 2014.
3. City Clock Magazine, “Cycling Mode Share Data for 700 Cities,” 2014.
4. KOTI, “KOTI Bicycle Transport Brief,” vol. 3, no. 1, 2012.
5. SI, “시민의 자전거 생활문화공간 (Living and cultural space of cycling for citizens),” Seoul: Seoul Institute, 2009.
6. SMG, “서울 교통비전 2030 (Seoul Transport Vision 2030).” 2013.
7. A. Nkurunziza, M. Zuidgeest, M. Brussel, and M. Van Maarseveen, “Examining the potential for modal change: Motivators and barriers for bicycle commuting in Dar-es-Salaam,” *Transp. Policy*, vol. 24, pp. 249–259, 2012.
8. F. W. Geels and J. Schot, “Typology of sociotechnical transition pathways,” *Res. Policy*, vol. 36, no. 3, pp. 399–417, 2007.
9. F. W. Geels, “Technological transitions as evolutionary reconfiguration processes: a multi-level perspective and a case-study,” *Res. Policy*, vol. 31, no. 8–9, pp. 1257–1274, 2002.
10. F. W. Geels and R. Kemp, “The Multi-Level Perspective as a New Perspective for Studying Soio-Technical Transitions,” in *Automobility in transition?: a socio-technical analysis of sustainable transport*, New York: Routledge, 2012.
11. G. Holtz, M. Brugnach, and C. Pahl-Wostl, “Specifying ‘regime’ — A framework for defining and describing regimes in transition research,” *Technol. Forecast. Soc. Change*, vol. 75, no. 5, pp. 623–643, Jun. 2008.

12. G. Seyfang and N. Longhurst, “Grassroots innovations and complementary currencies - testing niche theories in the social economy,” 2012.
13. A. Smith, J.-P. Voß, and J. Grin, “Innovation studies and sustainability transitions: The allure of the multi-level perspective and its challenges,” *Res. Policy*, vol. 39, no. 4, pp. 435–448, 2010.
14. J. I. Byeon, “주먹구구식 서울시 자전거도로정책 (Thoughtless cycle road policies in Seoul),” Seoul, 2012.
15. SMG, “서울특별시 도시교통정비 기본계획 (Seoul urban transport improvement basic plan),” Seoul Metropolitan Government: Seoul, 2014.
16. SMG, “Notices,” Seoul Cycling Webpage, 2015. [Online]. Available: <http://bike.seoul.go.kr/>.
17. W. Lee, “서울 ‘자전거버스’ 1년 200여명 참여 불과 (Only 200 participants in ‘Bicycle bus’ during a year),” *Seoultimes*, Seoultimes: Seoul, 2012.
18. KBC, “협의회 소개 (Introduction of KBC),” 2012. [Online]. Available: <http://www.koreabikecouncil.or.kr/>.
19. UN, “GNI, Per Capita GNI - US Dollars,” 2014. [Online]. Available: <http://unstats.un.org/unsd/snaama/resQuery.asp>. [Accessed: 04-May-2015].
20. MOLIT, “내년 자동차 누적등록 2천만대 돌파 (The number of registered car approaches to 20million),” Ministry of Land and Infrastructure: Seoul, 2014.
21. J. M. Kang, “한국 자동차의 역사, 1903~2006 자동차는 꿈을 싣고 달린다 (The history of Korean automobiles, 1903~2006 the dream of automobiles),” *인물과사상*, vol. 98, no. 6, pp. 131–164, 2006.
22. J. M. Kang, “한국 자전거 문화의 역사: 자전거를 ‘레저’로 만든 ‘자동차 공화국’ (The history of cycling culture in South Korea: The heaven of automobiles made Cycling a leisure activity),” *인물과사상*, vol. 119, no. 3, pp. 161–201, 2008.
23. SI, “서울시 온실가스, 에너지 감축사업 평가지표 개발 및 이행성과 평가방안 (A study on developing evaluation indicators and methods for reducing GHGs and energy usage in Seoul),” Seoul: Seoul Institute, 2012.
24. J. Pucher, H. Park, M. han Kim, and J. Song, “Public transport reforms in Seoul: innovations motivated by funding crisis,” *J. Public Transp.*, vol. 8, no. 5, pp. 41–62, 2005.
25. SMG, “2030 서울플랜 (2030 Seoulplan),” Seoul: Seoul Metropolitan Government, 2014.
26. H. Shin, “An interview with a taxi driver,” 2015.
27. A. Smith and R. Raven, “What is protective space? Reconsidering niches in transitions to sustainability,” *Res. Policy*, vol. 41, no. 6, pp. 1025–1036, Jul. 2012.
28. J. Markard, R. Raven, and B. Truffer, “Sustainability transitions: An emerging field of research and its prospects,” *Res. Policy*, vol. 41, no. 6, pp. 955–967, Jul. 2012.