Plan and Implementation of Korea Bicycle Infrastructure

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1. INTRODUCTION

As air pollutants increase under policies centered on motorized vehicles, there have been increasing calls for reduction of greenhouse gas emissions, and low-carbon green transportation means has emerged on the national agenda. This calls for the establishment of an environment-friendly, green transportation system such as a bicycle system. However, sustainable or green transportation has gained little attention in Korea.

The current automobile-oriented transport system has resulted in insufficient legal and institutional frameworks, poor linkage with public transportation and lack of bicycle-related facilities (i.e. bicycle parking facilities). In addition, the public has little interest in bicycles and recognizes them only as a means for leisure.

Bicycle paths and bicycle networks are lacking and only a few connections exist among established bicycle networks. The Korean government has a plan where bicycles will account for 5% of the modal share by 2012 from today's mere 1.2% by extending the existing 9,170km bicycle roads in 2009 to 17,600km by 2012 and increasing bicycle ownership from 16.6% to 30% over the same period.

2. CURRENT BIKE INFRASTRUCTURE ENVIRONMENTS IN KOREA

2.1 Oversea Bike Policies and Environments

Though Korean government has an ambitious plan, European experiences need to consider. New trend has emerged from several European countries to integrate non-motorized transport into overall transportation plan. Netherlands and Denmark have adopted an integrated approach and developed a master cycling plan in the early 1990s. Other European countries such as Germany, Finland, and France have also considered non-motorized transport as a vital mode of transport, and they are working toward to increase modal share (see Figure 1).
2.2 Successful case of bicycle policy and infrastructure

A bicycle route at national level has been put in place in many countries such as Netherlands, Denmark, and Germany. These European countries built up Euro-Velo, a cross-country bicycle network, and thereby connect many European nations. Euro-Velo is expected to contribute to diverse areas such as transportation, tourism, leisure, environment, regional development and cultural exchange. Over the past 25 years, 12 routes have been planned and implemented across the European continent, covering a total length of 63,500km.

Netherlands

Netherlands is considered as a cyclists’ paradise due to its strong commitment to bicycle policy. With 27 % modal share of bicycle, Netherlands tops the cycling use in the world.
Total of 18,000km of cycling network covers the entire country, and the state-of-the-art bicycle regulations and facilities exist to accommodate cyclists in almost every corner of the streets.1

Existence of bicycle-friendly policy in Netherlands is primarily due to its long-term, committed national support for non-motorized transport. From the early 1990s, Netherlands developed a national strategy for the promotion of bicycle, namely the Dutch Bicycle Master Plan (BMP) (1990-1997). The BMP consisted of 112 projects including 31 research projects and 41 pilot programs that covered the topics from improvement of bicycle network to safety and parking conditions in and around public areas as well as initiatives to reduce bicycle theft. (Ministry of Water Management and Public Works of the Netherlands, 1998)

**Denmark**

Denmark is also one of the leading nations in cycling. With the total length of 10,000km, Denmark maintains 18% mode share of bicycle, second highest cyclist nation to Netherlands.2 One of the most successful policies to promote bicycle use in urban areas is a physically separated, on-street bike path, and many studies confirm that most cyclists prefer separate facilities (Tolley, 2003; McClintock, 2002). Separate paths, in particular, are perceived as being much safer and more pleasant than cycling on the roadway, thus leading to significant growth in cycling volumes when such facilities are expanded.

**Germany**

Germany is a bicycle friendly country with over 30,000km of bicycle routes, accounting for 10% modal share of transport.3 Certain cities, such as Freiburg and Muenster compare with the best of European practice, but elsewhere both the quality of facilities and rates of cycling are variable. Since 1998, a modification in the German road traffic code officially permitted the use of bicycles in one-way streets. German traffic law also provides detail guidelines and regulatory measures for implementing bicycle related infrastructures including bicycle path, road signs and right of ways.

In 2002, the Federal Government presented the National Cycling Plan to concentrate its political and financial commitment to promoting cycling as part of a sustainable transport development (Federal Ministry of Transport, Building and Housing, 2002). The objective of the National Cycling Plan is to initiate new methods and implementation strategies, supply recommendation for actions, and in general, to make a contribution towards creating a bicycle-friendly environment.

### 2.3 Current bicycle using situations on Korea

Despite a number of benefits, non-motorized transport, especially bicycle transport has not seen significant increases in recent years and remains as a marginal transport mode in Korea. In a recent poll conducted by some local newspaper, 83% middle school student answered that “I am not going to use bicycle when I grow up because it doesn’t look cool.” This shows that car ownership represents wealth and social status in Korean culture, and bicycles are treated inferior to cars and not a serious means of transport in daily life.

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1 Data gathered from the Dutch National Cycling Platform [http://www.fietsplatform.nl/](http://www.fietsplatform.nl/)
3 Data gathered from German National Tourist Board [http://www.germany-tourism.de/ENG/nature_active_recreation/activity_cycling_experience.htm](http://www.germany-tourism.de/ENG/nature_active_recreation/activity_cycling_experience.htm)
Compared to walking which accounts for 27%, cycling is a minor form of transport in Korea, accounting for 1.2% of modal share (see Figure 3). This gap between cycling and walking suggests that transportation researchers and planners need to deepen their understanding on individual transportation patterns and behaviors in urban settings.

In fact, most of the new towns built in Korea have well organized bicycle and pedestrian paths. The survey confirms high rates of cycling for leisure in new towns, suggesting that cycling is a kind of culture and relaxation. It also suggests that even in new towns where bicycle infrastructures are well built, primary purpose of cycling is restricted to recreational cycling.

In terms of infrastructure, total length of the existing bicycle route in Korea is about 9,170km, very low number compared to Japan and other European countries. 90% of bicycle lanes are bicycle-pedestrian style, and only 10% of these routes are bicycle paths, accounting for only 1% of the entire road network (Shin, 2006). Most of these bicycle paths are built in riversides.
and parks, thus cyclists in urban areas are vulnerable to accidents as they are often disturbed by pedestrians and other facilities such as street lamps.

Table 1 Current bicycle facilities by city and province

(As of Dec. 2009, accumulated)

<table>
<thead>
<tr>
<th>City / Province</th>
<th>Bicycle Parking Facilities</th>
<th>Bicycle Safety Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number of locations</td>
<td>Number of facilities</td>
</tr>
<tr>
<td>Total</td>
<td>20,989</td>
<td>470,829</td>
</tr>
<tr>
<td>Seoul</td>
<td>3,372</td>
<td>103,000</td>
</tr>
<tr>
<td>Busan</td>
<td>431</td>
<td>7,603</td>
</tr>
<tr>
<td>Daegu</td>
<td>831</td>
<td>27,398</td>
</tr>
<tr>
<td>Incheon</td>
<td>268</td>
<td>3,759</td>
</tr>
<tr>
<td>Gwangju</td>
<td>665</td>
<td>11,348</td>
</tr>
<tr>
<td>Daejeon</td>
<td>1,390</td>
<td>35,806</td>
</tr>
<tr>
<td>Ulsan</td>
<td>370</td>
<td>3,204</td>
</tr>
<tr>
<td>Gyongbuk</td>
<td>3,387</td>
<td>85,806</td>
</tr>
<tr>
<td>Gyeongnam</td>
<td>611</td>
<td>24,103</td>
</tr>
<tr>
<td>Chungbuk</td>
<td>1,042</td>
<td>17,896</td>
</tr>
<tr>
<td>Chungnam</td>
<td>1,374</td>
<td>16,142</td>
</tr>
<tr>
<td>Jeonbuk</td>
<td>1,767</td>
<td>37,967</td>
</tr>
<tr>
<td>Jeonam</td>
<td>1,066</td>
<td>12,474</td>
</tr>
<tr>
<td>Gyungbuk</td>
<td>1,319</td>
<td>31,165</td>
</tr>
<tr>
<td>Gyungnam</td>
<td>2,246</td>
<td>40,521</td>
</tr>
<tr>
<td>Jeju</td>
<td>1,050</td>
<td>10,547</td>
</tr>
</tbody>
</table>

3. NATIONAL CYCLING BASIC PLAN ESTABLISHMENT

3.1 Vision of Korea’s Bicycle Policy

Korean government is spearheading a green transportation movement by advocating non-motorized transport. Since his inauguration in February 2008, President Myung-bak Lee has stressed that eco-friendly economic growth, green growth, is at the top of the government agenda, and focused on a cycling as a great symbol for low carbon and green growth society.

The concept for green growth with the comprehensive bicycle plan is focused on: infrastructure development. As discussed early, there is a great demand for improvement on bicycle infrastructure. Bicycle infrastructures include but are not limited to bicycle routes, parking facilities, signposts and signals, and transfer links with other transportation system.
The national project, however, focuses on building bicycle path for both daily commuters and recreational and occasional cyclists. Utility bicycle routes will be implemented in each municipality and national bicycle network will focus on constructing recreational bicycle routes along the coastline and linking the municipal routes to integrate the system as a whole. Under the supervision of Ministry of Public Administration and Security, about $2 million has been allocated to draft a national bicycle master plan. A consortium was established to develop the plan involving multiple stakeholders including a national research institute, civil engineering companies, universities, transportation authorities, and citizen groups. The Korea Transport Institute (KOTI) was central to the planning and oversight of all the participants in the planning process.

The master plan tries to establish proper direction and guidelines for the implementation of circular bicycle routes near De-Militarized Zone (DMZ) and along the coastline, and focuses on integration of regional and local routes being developed by each municipality in favor of tourism industry. Routes being developed along the four major rivers are also closely concerned with the master plan; however, there were difficulties to arrange cooperative work between two different government entities, such as Ministry of Public Administration and Security (MOPAS) and Ministry of Land, Transport, and Maritime Affairs (MLTM), which are in charge of designing and implementing bicycle route master plan for different part of the nation. Thus, four rivers route is separately designed and implemented by the MLTM, yet in close relationship with the master plan.

In selecting the route for the national bicycle network, the master plan suggests several basic principles that are summarized in the following:

![Figure 5 Visions of the National Bicycle Master Plan](image)

**3.2 Basic concept for Korea’s National Cycling Basic Plan**

In Korea, infrastructure development for national bicycle network is currently under implementation of two different government entities and each corresponding municipality. MOPAS is responsible for developing master plan for circular and regional route, and MLTM oversees designing and implementation of bicycle routes along the four major rivers. Each municipality is in charge of implementing its own local bicycle route in consultation with MOPAS (see Table 2).
Table 2 Context, responsibility, purpose of national bicycle network

<table>
<thead>
<tr>
<th>Type</th>
<th>Context</th>
<th>Responsibility</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>National Circular Route</td>
<td>Near DMZ and coastal lines</td>
<td>MOPAS</td>
<td>For connection and utility/leisure</td>
</tr>
<tr>
<td>Four Rivers Route</td>
<td>Along the four rivers</td>
<td>MLTM</td>
<td>For connection and leisure</td>
</tr>
<tr>
<td>Municipal Route</td>
<td>Urban and metropolitan areas</td>
<td>Municipality</td>
<td>For utility/leisure</td>
</tr>
<tr>
<td>Regional Route</td>
<td>Provincial border</td>
<td>MOPAS</td>
<td>For connection and leisure</td>
</tr>
</tbody>
</table>

Source: Shin, Hee Cheol, E-Sok Andy Hong, Infrastructure for Sustainable Transportation: Implementation of Non-motorized Transport in Korea, 2009

The key concepts of national bicycle network are ‘sustainability, safety, and seamlessness.’ The national bicycle network intends to contribute to low carbon, green transportation; to ensure safety through physical and regulatory measures; to increase connectivity of various regional and local bicycle paths; to incorporate regional, historical, and cultural traits for route development; and to provide institutional framework for continuous implementation and management of bicycle routes.

**National Circular Route**

Korea’s national circular route intends to construct a symbolic national route by linking municipal bicycle routes along the coastline and building a circular belt connecting coastal bicycle routes and bicycle routes near DMZ.

Total projected length of the route is about 3,200km, making a circular route along the coastline and DMZ. MOPAS will oversee the implementation of this route and take the leading role in completing the national bicycle network by connecting the route with other bicycle paths being constructed in four major rivers and each municipality. By taking advantage of the surrounding environment and cultural assets, the circular route will be constructed mainly for leisure, but the route that passes through major cities will also function as a utility bicycle path that serves as a connection between different municipalities.

**Four Rivers Route**

Four rivers bicycle route is to build a total of 1,297km bicycle route in connection with the Four Major Rivers Restoration Project (for Han River, Nakdong River, Geum River and Yeongsan River). Its development should focus on providing connection to the adjacent river network, enhancing its accessibility to the infrastructures along the river and nearby public transit, and preserving an environmental-friendly design.

To provide connection to the river network, bicycle route should be made along the river. One of the major obstacles is small streams that often break the link. A small bridge for bicycle will be made to overcome this obstacle. For enhancing accessibility to the existing river network, the routes should be linked to various facilities and activities on the skirts of the rivers and designed in connection with surrounding support facilities. In particular, appropriate design consideration will be developed to ensure ease of transfer to other public transportation as well as access to facilities nearby bicycle route. To ensure safety for both
cyclists and pedestrians, trees and blocks should be placed to separate cyclists from pedestrians. Necessary regulatory measures will be provided to prevent pedestrians from walking on a bike path and vice-versa.

Another important pre-requisite for this route is that it should factor in rivers and the surrounding natural environment. Bicycle path should be designed environmental-friendly from the planning to the design, construction, and the use of finishing materials. Flood drainage, an inherent function of a river, should also be considered in designing the bicycle path along the rivers.

**Regional Route**

Implementation of regional route is under the responsibility of Ministry of Public Administration and Security. Its primary purpose is to link independent route constructed in each municipality.

The regional route will focus on implementing inter-city path through optimized route selection. If the route passes through nearby tourist sites and natural amenities, however, the inter-city path will not necessarily be optimized for the quickest route available. Instead, the routes will be selected to make the most out of the surrounding environment.

Due to some administrative and procedural difficulties for connecting the routes in different local authorities, central government plays a vital role in coordination and mediation of possible conflict of interests among local governments, citizen groups, and businesses. The central government needs to develop institutional guidelines and standard operating procedures to deal with these issues in the beginning of the planning process. If the conflicting issues are not resolved in the early stage, local government and business could undermine the implementation, resulting in a serious delay of the whole project.

Selection of the regional bicycle route will reflect the demand from local municipalities; however, each route selection is fundamentally based on the basic principles for the national bicycle network discussed earlier in this chapter. The government will review a number of alternative routes to be considered in the selection process. The process should be transparent and reasonable to achieve consensus of all interested parties concerned.

**Municipal Route**

Promoting a daily use of bicycle requires an expansion of utility bicycle route in urban areas. Each municipality is responsible for designing and implementing this utility bicycle route in and around its municipal boundary. It is also planned in conjunction with the four rivers route, and regional and national circular route as part of the national bicycle network.

The municipal route intends to provide quickest and easiest inter-modal transportation for short trips in the city. Under the current road situation, yielding space for bicycles through road diet is the best way to secure bicycle lanes in the city. Other innovative measures could be applied to maximize the use of current road infrastructure such as time-sharing and traffic calming.

In addition, links with public transportation needs to be considered to provide cyclists with an easy access to public transit. This includes transformation of the current subway and bus systems into a more bicycle friendly system. Transit authority also needs to provide ample
space for parking and storage for bicycle as well as convenient facilities, so called ‘bike terminal’ that has a shower and a changing room.

At municipal level, land use element should be fully explored in conjunction with promotion of cycling in the city. As discussed earlier, mixed land use and higher urban density reduces the need to travel long distance. Local planners need to work directly with transportation planners in terms of planning and designing of the streets and urban infrastructure to make the environment more suitable for bicycle and pedestrian travel. Comprehensive guidelines should be developed and encouraged for building the city in favor of compact development and cyclist, pedestrian, and transit-oriented development.

4. IMPLEMENTATION OF NATIONAL BICYCLE NETWORKS

4.1 Evaluation criteria development through ANP

To implement the national cycling basic plan, we need to prepare optimal route selection principles to secure appropriateness and rationality of selected routes. Thus, after examining best practices of cycling route selection and needs of various cities, we induce evaluation criteria and reviewed their appropriateness by asking experts’ opinion through a survey with 5-score questions.

For the analysis, we applied an Analytic Network Process (ANP) to the survey outcome. The ANP is a process that helps decision makers to make best decision by analyzing relevant situation and listing ranks of alternatives in order of high score in consideration of various factors such as a goal, decision criteria, other alternatives and so on. We distributed survey questionnaires to 120 bike transport experts. Using the survey outcome, we clarified the relevance between selected evaluation criteria and induced evaluation criteria for bicycle route selection.

Under the premise that there are relevance between evaluation criteria such as potentiality, connectivity, security, eco-friendliness and convenience, we conducted weight score analysis using ANP. The process of weigh score analysis is as follows.

![Figure 6 A process of weight score analysis](image)
Using a SuperDecisions 1.6.0 program which is accountable to relevance between evaluation criteria, we calculate importance of each evaluation criterion for bicycle routes as it is in Table 3.

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Indicator of each evaluation criterion</th>
<th>Weight for a evaluation criterion</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Potentiality</td>
<td>Use of existing bike paths</td>
<td>0.250163</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Viability of projects</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Potential demands</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Connectivity</td>
<td>Intermodality with public transportation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Connectivity among regions</td>
<td>0.241977</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Accessibility to bicycle routes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Safety</td>
<td>Weather conditions</td>
<td>0.189926</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Environments of Road Transportation</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compatibility with pedestrian roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eco-friendliness</td>
<td>Compatibility with natural environments</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Compliance to natural terrain</td>
<td>0.16073</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Natural resources of regions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Convenience</td>
<td>Amenities</td>
<td>0.157202</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Linearization and diversification</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

### 4.2 Route selection for the national bicycle route networks

#### Process of route selection

To select optimal routes for national bicycle networks, to have structured and detailed route selection process is critical. In order to conduct main route selection process systematically through reflecting field trip report, opinions of local governments and route evaluation criteria, we developed route selection process (see Figure 7) and select the optimal route through step-by-step process.
Negotiations with local governments

Within frameworks suggested by the national cycling basic plan, we selected local governments whose bike paths are easy to be connected with those of other local governments and have high applicability as part of national bicycle routes. To survey routes in demand by local government, we held information sessions for local government officers and explain national cycling basic plan and how to suggest routes in demand.

We investigated sites on a final alternative route to file up basic data for optimal route selection, choose construction sections and calculate project costs. We divided investigation items into cross-sectional area and longitudinal slope of roads on the selected route, natural terrain alongside of the roads, obstacles, hierarchy of the roads and pictures and video clips.
Selection of optimal bicycle route

We went through the process of review of possible alternative routes, negotiation with local governments, final alternative route selection, site investigation, application of route evaluation criteria. We selected an optimal bicycle route in consideration of connectivity between the nation’s existing bicycle routes and other bicycle routes such as four rivers route, circular route nearby DMZ and existing local routes built by local governments. Future extension plan of the national bicycle networks is well shown in Figure 9.

![Optimal bicycle route for the nation](image)

Figure 9 Proposed bicycle route for the nation

5. CONCLUSION

In this paper, current bicycle usage and infrastructure of Korea was explained, and national cycling basic plan was mostly discussed. Route selection process for the national bicycle route networks was also described. National bicycle networks are being implemented nationwide in Korea now. Non-motorized transport could be an excellent alternative to motorized vehicles as it is energy-efficient and environment-friendly. In particular, cycling can be used for recreations and sports to improve the quality of life and health as well as practical means of transport for short trips. It could further contribute to urban transportation system with an improvement on connection to major transit such as bus and subway. Together with the infrastructure improvement, well thought-out soft policies could promote daily bicycle use and possibly change public attitudes.
The task is not simple as it seems. It is not just substituting one system with another, but it takes a paradigm shift from the traditional fuel-based culture into a more sustainable culture, involving many constituents of the society. This transformation could be tough and painful as it requires us to change the way we do things normally. Cars should be driven less, but cycling and walking should be encouraged for travelling short distance. Public transit should also be encouraged and integrated with non-motorized transport. Incentives should be given to public and private sectors to induce them to pursue a low carbon, energy saving system. When concerted effort and cooperation are established by all members of the society, the national agenda for low carbon and green growth could be achieved.

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