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Encouraging the use of non-motorized in Bangkok
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Abstract
This paper aims to study the important factors affecting the decision on bicycle usage in the short-distance trips. Questionnaire surveys of weight of various factors were carried out in the shared-use paths in seven communities in Bangkok. The related factors obtained from questionnaire surveys were grouped by using the Factor Analysis Method. Moreover Logistic Regression Analysis is used to develop the model to forecast the bicycle usage. The results show that there are three factors which influence the usage of bicycle: 1) traveling behavior factors which included travel cost, travel time, travel distance and monthly income; 2) the cycling promotion plans which included providing the privilege for cyclists, constructing the exclusive bikeway networks around Bangkok, preparing the related facilities for cyclists such as bathrooms and storage lockers, promote the use of cycling instead of using a private car.; and 3) legislation related to the bicycle usage influenced the decision of bicycle usage.

1. Introduction
Non-motorized transport modes are often considered as essential element of sustainable transport system. This includes walking, cycling, rickshaws, animal-drawn carts and rollerblading or skating. We focus on bicycle that is widely recognized as an environmentally friendly and healthy mode of transportation. Moreover, cycling is an individual mode with low access costs and high efficiency in the use of road space. Then, this bike has been popular for a short distance in the streets of the community, workplace, school and recreation [1].

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In Thailand, Bangkok Metropolitan Administration (BMA) has been constructing bike paths to solve traffic congestion and to encourage people to use bicycles to travel more. Some sidewalks were improved and modified to bikeway since bicycle traffic is not sufficiently considered in road planning processes. So, it is difficult to provide sufficient space for bicycle traffic on all sidewalks. Moreover, there are obstacles on the sidewalk that hinder for cyclists such as obstruction from physically features (phone boxes, column, bench, etc.) and the vendor's activities. Then, most of cyclists share a path with motorists along a road which can cause accidents especially at junction. Although, BMA has created in a several shared-use path, however the proportion of cycling is still declining. This paper aims to study the significant factors influencing the decision on bicycle usage in the short-distance trips in Bangkok. It is also useful in determining for the Government policy to encourage bicycle use.

The structure of the paper is as follows: in Section 2, we will present bicycle network in Bangkok and study areas of this paper. Then, in Section 3, we briefly discuss factors that influence bicycle use. In Section 4, data issues are discussed and the result from multivariate analyses will be presented. Finally, Section 5 summaries our conclusions.

2. Study Area

In 2008 [2], Bangkok Metropolitan Administration (BMA) has improved 23 routes of sidewalks for cyclists (total distance 184.56 kilometer), such as shown in Figure 1. Types of a bike path have 3 types: 1) Shared-used path; width of bicycle lane on sidewalk by 1.0 meters to provide for cyclists (16 paths). 2) Bicycle lanes on the road; provides bike lanes on the left side of the shoulder 1.2 meters wide (2 routes). And 3) Exclusive paths that the paths for cyclist only (5 paths). However, there are facilities for bicycle users such as a bicycle parking in many locations around the subway station. Furthermore, BMA has improved several roads located in tourist attraction to provide a path for cycling traveler. As well as the public park also offers bike rental for whom to recreational within the park during the weekends.
Selected areas of this study were seven different communities in Bangkok covering both downtown and outside the city areas. Table 1 shows the population density and number of household of seven communities in Bangkok [3]. From preliminary survey, it was observed that the main purpose of bicycle use is to go to the market nearby the residence. Survey areas were then set for observing the place that cyclist accessed in radius of 1-3 kilometers in the region such as fresh food market, schools and institutes.

| Areas                    | District        | Number of Households | Density (Person/Sq. Km.) | Bike Paths (Km.) |
|--------------------------|-----------------|----------------------|-------------------------|------------------|
| Charan Sanitwong         | Bangkhunsri     | 12,902               | 8,628                   | 14               |
| Ratchadamri              | Lumpini         | 12,049               | 5,879                   | 3.2              |
| Narathiwat Ratchanakarin | Thung wat don   | 15,843               | 14,185                  | 9                |
| Prachachuen              | Ladyao          | 20,970               | 4,583                   | 1.3              |
| Phetkasem               | Bangkae Nuea    | 17,662               | 4,568                   | 16               |
| Sukhapiban 5             | Saimai          | 27,363               | 3,735                   | 10.2             |
| Ramkhamheang            | Minburi         | 36,151               | 3,177                   | 15.6             |

3. Factors affecting propensity to cycling

In this section, we will present factors that have potential impacts on cycling (see Fig.2). Bicycle use depends on characteristic of populations as household size and population density. Moreover, it depends on personal features, such as income, occupation, age, vehicle ownership and activity patterns. However, the factors have impacts on the generalized cost of bicycle, i.e. travel time, travel cost, traffic safety and physical condition, such as flatness of surface, access point, weather and pollution. Furthermore, risk of bicycle theft is a major problem in Bangkok, while the generalized cost of other transport modes (tax of fuel, tolls, maintenance cost) affected the decision to use a bicycle [4].
Corresponding with the studies of [5] and [6], it was found that the main factors in decision to use a bicycle can be divided into 4 groups according to the characteristics of the population, the factors of travel behavior, physical characteristics of the area and Government policies to promote the use of bicycles, including other factors, such as weather conditions of each area and security for cyclists, as well as access points to other transport systems. These factors have been used to analyze in this paper.

4. Empirical results

4.1. Bicycle use and their attitude.

Results from the questionnaire surveys show that 84 respondents (42.4%) were male and 114 respondents (57.6%) were female (shown in Table 2). It was found that 107 respondents (54%) used bicycle. Most of the respondents were students (30.8%) with age between 21-30 years old (29.8%). Most of them had average monthly income of around 5,000-10,000 baht (41.4%).

Table 2. Respondent Characteristics Classified by Gender, Age, Income, and Occupation

| Respondent Characteristics | Opinions about using bicycles | Total (persons) |
|----------------------------|-------------------------------|-----------------|
|                            | Current Use (persons) (%), Current Not using (persons) (%) | (persons) |
| Gender                     |                               |                 |
| Male                       | 44 (47.6), 40 (52.4)          | 84              |
| Female                     | 63 (55.3), 51 (44.7)          | 114             |
| Age                        |                               |                 |
| < 20                       | 16 (45.7), 19 (54.3)          | 35              |
| 21 – 30                    | 30 (50.8), 29 (49.2)          | 59              |
| 31 – 40                    | 24 (58.5), 17 (41.5)          | 41              |
| 41 – 50                    | 17 (58.6), 12 (41.4)          | 29              |
| > 50                       | 20 (58.8), 14 (41.2)          | 34              |
| Monthly Income (Bath)      |                               |                 |
| < 5,000                    | 25 (51), 24 (49)              | 49              |
| 5,001 – 10,000             | 54 (65.9), 28 (34.1)          | 82              |
| 10,001 – 15,000            | 12 (36.4), 21 (63.6)          | 33              |
| 15,001 – 20,000            | 8 (80), 2 (20)                | 10              |
| 20,001 – 25,000            | 5 (41.7), 7 (58.3)            | 12              |
| > 25,000                   | 3 (25), 9 (75)                | 12              |
| Occupation                 |                               |                 |
| Government Official        | 5 (41.7), 7 (58.3)            | 12              |
| Private Officer            | 10 (43.5), 13 (56.5)          | 23              |
| Merchant                   | 30 (60), 20 (40)              | 50              |
| Student                    | 28 (45.9), 33 (54.1)          | 61              |
| Housewife                  | 21 (75), 7 (25)               | 28              |
| Others                     | 13 (54.2), 11 (45.8)          | 24              |

Table 3 presents respondent characteristics classified by car and bicycle ownership. It was found that 74% of people in the area have bicycles, while 60% of them owned car.
Table 3. Respondent Characteristics Classified by Car and Bicycle Ownership

| Respondent Characteristics | Opinions about using bicycles | Total (persons) |
|----------------------------|-------------------------------|----------------|
|                            | Current Use (persons) (%)     | Current Not using (persons) (%) |
| Car Ownership              |                               |                             |
| Yes                        | 49 41.18                      | 70 58.82                    | 119  |
| No                         | 36 45.57                      | 43 54.43                    | 79   |
| Bicycle Ownership          |                               |                             |
| Yes                        | 79 54.11                      | 67 45.89                    | 146  |
| No                         | 5 9.62                        | 47 90.38                    | 52   |

Table 4 shows respondent characteristics on preference of bikeway types. About 42.42% preferred the exclusive path rather than other bikeway types. It implies that people feel safe to ride on exclusive path. Moreover, they do not prefer shared-use path; there are many obstacles on the sidewalk as bike and pedestrian cannot be on the same path.

Table 4. Respondent Characteristics about Preference of Bikeway Types

| Type of Bikeway  | Frequency (Respondents) (%) |
|-----------------|-----------------------------|
| Bike Lane       | 69 34.85                    |
| Shared-use Path | 44 22.22                    |
| Exclusive Path  | 84 42.42                    |
| Not Clarified   | 1 0.51                      |

4.2. Important factors by factor analysis.

The survey questionnaire comprises 45 items in seven different areas: (a) individual features and attitude (gender, age, occupation, education level, monthly incomes, travel time, travel cost and vehicle ownership), (b) geometric of roadways (c) sidewalk performance and (d) government policy. In the last parts of the questionnaire, respondents were asked to indicate the requirements for policy that encourage cyclists; it used a four-point Likert scale, with one of them is strongly disagree and four are strongly agree.

Applying exploratory factor analysis, 20 items of factor in the questionnaires were categorized into 6 groups to develop the bicycle usage model based on the Logistic Regression Analysis Method [7]. The initial KMO test resulted in a value of 0.77, which is greater than 0.5; thus, the factor analysis can be applied for subsequent analysis [8]. As a result, six factors are identified to be important and named on the basis of the attributes covered (as can be seen in Table 5). Only variables with a factor loading greater than 0.5, are chosen. The six factors are arbitrarily labeled as follows: the policy of promoting bicycle usage, rule and regulation for cyclists, travel behavior, shared-use path, comfort, cost of bike and license for cyclists.

In order to model the willingness to cycle in a given trip we used a logit model with just two options: “Yes, would use bike” or “No, would not consider its use”. The attributes determining choice are potential for all the characteristics of the person gathered during the survey. Several variables are proposed in the logistic regression analysis as (a) FA_1: The policy of promoting bicycle usage, (2)
FA_2: Rule and regulation for cyclists, (2) FA_3: Travel behavior, (4) FA_4: Shared-use path, (5) FA_5: Cost of bike, and (6) FA_6: License for cyclists.

Table 5. Factors structure of the decision to use a bicycle

| Variables                                                                                                                       | Factor loadings | Variance explained (%) |
|-------------------------------------------------------------------------------------------------------------------------------|-----------------|------------------------|
| **Factor 1: The policy of promoting bicycle usage (FA_1)**                                                                    |                 |                        |
| 1. Create a bicycle network that connects continuity throughout Bangkok.                                                         | 0.796           | 15.726                 |
| 2. Privileges for people who ride bicycle to work.                                                                             | 0.737           |                        |
| 3. Bathroom and locker facilities available for bicycle users.                                                                     | 0.721           |                        |
| 4. The agency that oversees the development of bicycle paths.                                                                     | 0.612           |                        |
| 5. Promote the use of cycling instead of using a private car.                                                                     | 0.556           |                        |
| 6. Creating positive attitude about the public image of the bicycle.                                                            | 0.555           |                        |
| **Factor 2: Rule and regulation for cyclists (FA_2)**                                                                          |                 | 12.973                 |
| 7. The plan contains policies regarding the use of bicycles in the development of Bangkok.                                     | 0.828           |                        |
| 8. rule and regulation for cyclists                                                                                             | 0.796           |                        |
| 9. There are facilities for bicycle users such as a bicycle parking.                                                            | 0.691           |                        |
| 10. constructing the exclusive bikeway networks around Bangkok.                                                                   | 0.529           |                        |
| **Factor 3: Travel behavior (FA_3)**                                                                                           |                 | 12.573                 |
| 11. Travel cost                                                                                                               | 0.845           |                        |
| 12. Travel time                                                                                                               | 0.808           |                        |
| 13. Distance                                                                                                                  | 0.763           |                        |
| 14. Monthly income                                                                                                            | 0.675           |                        |
| **Factor 4: Shared-use path (FA_4)**                                                                                           |                 | 8.003                  |
| 15. Space for the bike onto the bus public transport.                                                                           | 0.788           |                        |
| 16. Attitude about shared-use path                                                                                             | 0.665           |                        |
| **Factor 5: Cost of bike (FA_5)**                                                                                              |                 | 6.729                  |
| 17. Current prices of the bicycle.                                                                                            | 0.762           |                        |
| 18. Attitude about rentals bike                                                                                                | 0.501           |                        |
| **Factor 6: License for cyclists (FA_6)**                                                                                       |                 | 6.589                  |
| 19. Provides a bicycle driving license.                                                                                         | 0.758           |                        |
| 20. Traffic signs indicate a bicycle path.                                                                                      | 0.430           |                        |

Several variable transformations and combinations of the factor were tested. Forward Stepwise model selection method, which is added to a variable in the analysis, is the basis of the Score and Significance. The coefficients are statistically significant at 95\% level. Table 6 shows the best model form of willingness to cycle and its terms coefficients. The results show that there are three factors influencing the usage of bicycle: FA_1 the cycling promotion plans which included providing the privilege for cyclists, constructing the exclusive bikeway networks around Bangkok, preparing the related facilities for cyclists, such as bathrooms and storage lockers, promote the use of cycling instead of using a private car.

The Exp (B) can be described as a policy to promote the use of bicycles. If there is a project promoting
the use of bicycles increasing as providing privileges to cyclists or bathroom and storage facilities available to user of bicycle, the cycling will be an opportunity to use bicycles 1.658. Similarly, FA_2 legislation related to the bicycle usage influenced the decision of bicycle usage, when issued regulatory for the use of bicycles will have the opportunity to use the bike 1.994 compare with the current cycling. FA_3 Travel behaviors include travel cost, travel time, travel distance and monthly income. While the generalized cost of travel greater, that affected the decision to use a bicycle less.

Table 6. Binary logit models of willingness to cycle.

| Model terms | Coefficients | Wald  | Exp(B) |
|-------------|--------------|-------|--------|
| Constant    | 1.697        | 63.221| 5.456  |
| FA_1        | 0.505        | 6.234 | 1.658  |
| FA_2        | 0.690        | 10.251| 1.994  |
| FA_3        | -0.608       | 11.510| 0.544  |

|                |               |       |
|----------------|---------------|-------|
| No. of observation | 198            |       |
| LR chi-squared    | 200.266        |       |
| Pseudo R-squared  | 0.369          |       |
| Percent correct prediction | 80.4          |       |

5. Summary and Conclusions

The objective of this research is to study the important factors affecting the decision on bicycle usage in the short-distance trips. The related factors obtained from questionnaire surveys were grouped by using the Factor Analysis Method. The overall 45 factors were categorized into 6 groups to develop the bicycle usage model based on the Logistic Regression Analysis Method.

It was found that there were two main factors affecting the cycle usage in the bicycle user group. First, traveling behavior factors which included travel cost, travel time, travel distance and monthly income. If the cost of travel, travel time, distance traveled and monthly income increase, it will make the use of bicycles decreased. Second, cycling promotion plans and legislation related to the bicycle usage influenced the decision of bicycle usage. The relevant promotion plans were: 1) establishing the specific cycling organization; 2) setting a cycling plan in each district; 3) providing the privilege for cyclists; 4) preparing the related facilities for cyclists such as bathrooms and storage lockers; and 5) constructing the exclusive bikeway networks around Bangkok. If there is a policy to encourage the use of cycling, it will be better for cycling usage.

Determine other variables as the policies related to the use of bicycles in the area because each district may have a policy related to the use of bike different. This may be defined in policy formulation appropriate for each area. Finally, Government agencies should work together to develop and promote the use of bicycles as serious, including the development of a continuous network of bicycle paths. It was the impetus for the project was successful bike in Bangkok. It also increases the use of bicycles in the future.

References

[1] Gatersleben B., Appleton K.M., 2007. Contemplating cycling to work : Attitudes and perceptions in different stages of change. Transportation Research Part A 41, 302-312.
[2] Traffic and Transportation Department (TTD) BMA, 2008. *Bicycling in Bangkok*, Thang Sa-Duak, 7(2), 13-17, Thailand.
[3] The National Statistical Office, 2010. *Population and housing census 2010*, Bangkok.
[4] Rietveld P., Danial V., 2004. *Determinants of bicycle use: do municipal policies matter?* Transportation Research Part A 38, 531-550.
[5] Pucher J., Komanoff C., Schimek P., 1999. Bicycling renaissance in North America? Recent trends and alternative policies to promote bicycling. Transportation Research Part A 33, 625-654.
[6] Outuzar J., Iacobelli A., Valeza C., 2000. *Estimating demand for a cycle-way network*. Transportation Research Part A 34, 353-373.
[7] Hair, J.F., Anderson, R.E., Tatham, R.L., Black, W.C., 2006. *Multivariate Data Analysis*, 6th Edition, Prentice Hall, New Jersey.
[8] Field, A., 2005. *Discovering Statistics Using SPSS*, Second Edition, SAGE Publications Ltd., London.