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FACTORS AND CRITERIA OF BICYCLE FACILITIES TO ENCOURAGE CYCLING TO WORK

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Abstract: *Cycling to work is a bicycle commuting activity that has many benefits. A strategy is needed to encourage people to cycle to work even after the Covid-19 pandemic ends. Well-designed bicycle facilities in office buildings are needed along with the increasing number of commuting bike users in Indonesia. This study was conducted to identify the factors that influence people's motivation of cycling to work. The encouraging and discouraging factors for cycling need to be known as considerations for determining strategies that can increase the number of cyclists. Criteria for bicycle facilities in the workplace that are considered important by users are also identified. Data were collected through an online questionnaire with a mixed-method approach. The collected text data in the qualitative research were analyzed using content analysis. In the quantitative research, the data were analyzed using factor analysis (FA). The results of factor analysis (FA) show that there are 4 dimensions of the driving factors for cycling to work, including 'environment and self', 'availability of facilities', 'accessibility', and 'social and hobbies'. Meanwhile, the dimensions of the deterrent factors are three, including 'road conditions', 'unavailability of facilities', and 'accessibility and personal reasons'. The criteria for bicycle facilities in the workplace are two dimensions, including 'convenience and security' and 'completeness of facilities'. From the mean value, 'convenience and security' is considered more important than 'completeness of facilities'.*

Keywords: bicycle facility criteria, bike to work motivation, factor analysis, office building

Abstrak: Bersepeda ke tempat kerja adalah salah satu aktivitas sepeda commuting yang memiliki banyak manfaat. Sebuah strategi dibutuhkan untuk mendorong orang bersepeda ke tempat kerja bahkan setelah pandemi Covid-19 berakhir. Fasilitas sepeda yang dirancang dengan baik di bangunan perkantoran juga dibutuhkan seiring dengan peningkatan jumlah pesepeda di Indonesia. Penelitian ini dilakukan dengan mengidentifikasi faktor yang mempengaruhi motivasi bersepeda ke tempat kerja. Faktor pendorong dan penghambat masyarakat untuk bersepeda perlu diketahui sebagai pertimbangan untuk menentukan strategi yang dapat meningkatkan jumlah pesepeda. Kriteria fasilitas sepeda di tempat kerja yang dianggap penting oleh masyarakat juga diidentifikasi. Pengumpulan data dilakukan melalui kuesioner daring dengan pendekatan mixed-method. Data teks yang didapatkan pada tahap kualitatif dianalisis dengan analisis konten. Pada tahap kuantitatif, data dianalisis menggunakan analisis faktor (FA). Dari hasil analisis faktor (FA), ditemukan 4 dimensi faktor pendorong bersepeda ke tempat kerja, yaitu 'lingkungan dan diri', 'ketersediaan fasilitas', 'aksesibilitas', dan 'sosial dan hobi'. Sedangkan, dimensi dari faktor penghambat ada tiga, yaitu 'kondisi di perjalanan', 'ketidaktersediaan fasilitas', serta 'aksesibilitas dan alasan pribadi'. Kriteria fasilitas sepeda di tempat kerja memiliki dua dimensi, yaitu 'kenyamanan dan keamanan' dan 'kelengkapan fasilitas'. Dari nilai rata-rata, dimensi 'kenyamanan dan keamanan' dinilai lebih penting oleh pengguna daripada 'kelengkapan fasilitas'.

Kata Kunci: kriteria fasilitas sepeda, motivasi bersepeda, analisis faktor, bangunan kantor.

1. Introduction

Cycling to work is one kind of bicycle commuting that has many benefits. According to Heinen, et al. (2013) the increasing number of people cycling to work can reduce air pollution, reduce traffic congestion, and increase people's levels of physical activity. Companies can also experience benefits if their employee cycle to work, such as increased productivity because employees are healthier and happier, reduced car parking and related costs, reduced work time lost due to traffic jams, and an image of caring for the environment and health for the company (Queensland Transport, 2006).

Seeing the potential benefits of cycling, especially bicycle commuting, the Indonesian government supports its people to cycle. The government, both central and local, has regulated various policies, such as providing bicycle lanes as road equipment and providing bicycle parking in public facilities. Bicycle facilities in office buildings are also regulated in the Minister of Transportation Regulation (Permenhub) Number PM 59 of 2020 concerning Road Cycling Safety. It regulates the provision of bicycle parking facilities in public facilities with a minimum capacity of 10% for office buildings.

Cycling to work has become popular in Indonesia in recent years. The Covid-19 pandemic has increased the number of people who cycle. For the number of cyclists to keep increasing even after the Covid-19 pandemic ends, a strategy is needed to encourage people to cycle to work. Factors that influence people's interest in cycling need to be identified for consideration.

There have been many studies that discuss the factors that influence people to choose a bicycle as a transportation mode in other countries (Akar & Clifton, 2009; Dill & Carr, 2003; Heinen et al., 2010; Hull & O'Holleran, 2014). Some of them specifically discuss the motivation for cycling to work (Buehler, 2012; Heinen et al., 2013). However, similar studies, especially those that focus on cycling to work activities, have not been widely carried out in Indonesia.

The purpose of this study was to identify the encouraging and discouraging factors that influence a person to cycle to work. This study also aims to determine the criteria for bicycle facilities in office buildings that are considered important by users to be applied as a priority when designing. The results of this study are expected to be a consideration for planners and policymakers in formulating strategies to increase the number of commuter-cyclists in Indonesia.

1.1 Cycling Motivation

A bicycle trip starts from the residential area (origin) which is connected to the destination (Dill & Carr, 2003). A person's decision to cycle or not is determined at the starting point and is influenced by various factors. The factors can be encouraging and discouraging them.

According to Useche et al. (2019), generally, the factors that encourage someone to cycle are health benefits, shorter travel time, and contribution to the environment. Meanwhile, the factors that prevent a person from cycling are generally related to the perception of the risk of traffic accidents and the discomfort of cycling during bad weather, traveling long distances, and facing difficult topographic conditions. Akar and Clifton (2009) also mention that decisions to commuting by bike are influenced by time, cost, and bicycle infrastructure factors.

In planning bicycle infrastructure, it is important to consider bicycle facilities throughout the bicycle trip as a whole. The results of Nelson and Allen's (1997) research which were retested by Dill and Carr (2003) showed that the availability of bicycle infrastructure connecting the origin and destination points had a positive correlation with the level of bicycle commuting users. However, this relationship is not causal. Two possibilities can explain the correlation. The first possibility is that the number of commuting bicycle users will increase because of the facilities. Another possibility is that as an implication of more people traveling by bicycle, a city builds more bicycle facilities.

Research on the factors that influence a person's decision to cycle to work has been studied by Buehler (2012) in Washington, DC. Availability of bicycle facilities at the workplace, such as bicycle parking and cyclist showers, will increase one's chances of cycling to work. Meanwhile, the provision of free car parking at work will reduce the chance of bicycle trips by up to 70%. Heinen et al. (2013) conducted a study that specifically explores work-related factors that can affect bicycle trips to work in the Netherlands. Factors, such as a positive attitude towards bicycles, the work environment in which coworker cycle to work, the availability of bicycle facilities at the workplace, and the need for bicycles for working, will increase the likelihood of someone bike commuting to their workplace. The existence of facilities for other modes of transportation, increased travel distance, and the need to transport goods, will reduce the possibility of

someone cycling to work. These results indicate that individual work situations influence cycling decisions to work.

1.2 Bicycle Facility

There are 2 types of bicycle facilities, namely are bicycle infrastructure that connects the origin and destination points and bicycle facilities at the origin and destination points (end-of-trip facilities) (Queensland Transport, 2006). Good bicycle facility design will encourage cyclists to take bicycle trips because it will affect the user's perception of comfort and safety (Hull & O'Holleran, 2014). According to Tilahun et al. (2007), cyclists are willing to take longer bicycle trips if the quality of bicycle facilities is improved.

For bicycle facilities at the destination point, the type of bicycle parking required and its use depends on six factors, consisting of the required capacity (based on the expected demand) within a certain period, available space, parking duration, distance to destination, type of user (and type of their bicycles), and willingness to pay for parking (van der Spek & Scheltema, 2015). The design criteria for a good bicycle parking facility in general are accessibility, security, and convenience (City Planning of Toronto, 2008).

2. Methodology

This study uses a mixed-method approach (Creswell, 2014). At the initial phase, qualitative research was conducted to explore the factors that encourage and discourage the use of bicycles to work and the criteria of bicycle facilities required by bicycle users in the workplace. Then in the second phase, quantitative research was carried out to ascertain the key factors that resulted through quantitative analysis. Such an approach is taken to reduce bias.

Data collection was carried out through an online questionnaire. Questionnaires were distributed with a non-random sampling method by utilizing the respondent network or also known as snowball sampling (Kumar, 2011). In the first phase, data collection was carried out using a questionnaire containing open-ended questions. Respondents were asked to write down what factors motivated and hindered them from cycling to work. Then, the questionnaire also asked bicycle facilities criteria that respondents needed. Each answer in the form of text data is analyzed using content analysis to identify the code. The codes that have been found are grouped into several categories. The distribution of this questionnaire occurred from September 2, 2020, to September 15, 2020. From the data collection, it was obtained 145 respondents from various cities in Indonesia with 101 respondents having a history of cycling to work and 44 others who had never cycled to work.

The results of the content analysis related to cycling motivation and bicycle facilities criteria were used as the basis for making a closed-question questionnaire. For the encouraging factor, there were 15 variables, namely 'health', 'environmental care', 'energy conservation', 'relation', 'exemplary', 'cost-effective', 'pleasure', 'working spirit', 'availability of bicycle parking', 'availability of bicycle lanes', 'availability of cyclist shower', 'short-distance', 'time-effective', 'avoiding congestion', and 'reducing congestion'. As for the discouraging factors, there were 10 variables, namely 'reluctance to change clothes', 'unhealthy body', 'long-distance', 'poor parking quality', 'no bicycle parking', 'no bicycle lane', 'no cyclist shower', 'uncomfortable road condition', 'unsafe road condition', and 'difficult topography'.

From the question about bicycle facilities criteria needed, 27 variables were obtained as the basis for close-ended questions in the next phase, namely 'easy to use', 'close to the destination', 'controlled access', 'cctv', 'clean', 'bike friendly', 'tidy, 'free', 'thermal comfort', 'roofed', 'close to the guard post', 'clear signage', 'safety lock', 'closed bicycle parking', 'firm', 'bicycle parking', 'for all types of bicycle', 'protected from weather, 'shady', 'parking card', 'availability of bicycle maintenance facilities', 'drinking water refill', 'availability of storage facilities', 'availability of cyclist shower', 'spacious', 'sufficient', and 'wide'.

In the second phase, data collection was carried out using a questionnaire containing closed-ended questions using data obtained from the first phase. The second phase online questionnaire was distributed from October 26, 2020, to November 16, 2020. There were 187 respondents consisting of 57 people who had cycled to work and 130 people who had no history of cycling to work. Respondents came from several cities in Indonesia.

Respondents were asked to choose the reasons that can affect them to cycle to work and the criteria for bicycle facilities in office buildings through close-ended questions. Each question requires an answer with a Likert scale of 1-5 as an interval scale. Examples of questions in the second phase questionnaire can be seen in Table 1.

Table 1 The example of close-ended questions

Category	Example
Encouraging Factor	Do the reasons below encourage you to cycle to work? Improve physical health Strongly Disagree 1 2 3 4 5 Strongly Agree There is bicycle parking at the workplace Strongly Disagree 1 2 3 4 5 Strongly Agree
Discouraging Factor	Do the reasons below prevent you from cycling to work? Feeling unsafe on the trip Strongly Disagree 1 2 3 4 5 Strongly Agree There is no cyclist shower in the office Strongly Disagree 1 2 3 4 5 Strongly Agree
Bicycle Facility Criteria	Bicycle parking can accommodate all kinds of bikes Very Unimportant 1 2 3 4 5 Very Important

After the data was collected, the numerical data of each variable was analyzed quantitatively using factor analysis (FA). FA was carried out using principal component analysis and varimax rotation to obtain latent variables that represent several measured variables. The measured variables of the encouraging factors are 15 variables, the discouraging factors are 10 variables, and the criteria for bicycle facilities are 27 variables. The measured variables are reduced to several latent variables that represent variations of the main principle components. The number of latent variables that represent each measured variable is based on Cumulative Percent. The cumulative percentage taken in this study is around 75%.

3. Results and Discussion

3.1 Cycling to Work Motivation

3.1.1 Encouraging Factor

From the results of the principal component analysis, four latent variables were obtained with the cumulative percent reaching 75.94%. It is considered enough to explain and represent the variables of the encouraging factors. The latent variables obtained from FA (factor analysis) can be seen in Table 2. The four latent variables explain the dimensions of factors that encourage people to cycle to work. These dimensions are *environment and self*, *social and hobbies*, *accessibility*, and *availability of facilities.*

The results of the average (mean) value show that from the four latent variables found, *environment and self* dimension is the most influential dimensions as the reasons that encourage people to cycle to work. This dimension includes concern for the environment, personal health, energy conservation, and saving transportation costs. This shows that people who have more attention to the environment and health will be motivated to cycle. Individual interest in health aspects and the impact of motor vehicle use on the environment is considered to have an influence on increasing commuting bicycle trips (Gatersleben and Appleton, 2007; Stinson and Bhat, 2005; Heinen et al., 2010). This also shows the public perception of bicycles as environmentally friendly transportation that can maintain the fitness of its user.

Table 2 Dimensions of Encouraging Factor of Cycle to Work

Variable	Mean	Factor Loading	Variance	Cum%	α-Cronbach
Dimension 1: Environmen and Self	*3.967*		*3.469*	*23.126*	*0.908*
Environmental Care	4.059	0.821			
Energy Conservation	3.930	0.797			
Cost-effective	3.834	0.779			
Health	4.043	0.769			
Dimension 2: Social and Hobbies	*3.122*		*2.759*	*41.516*	*0.834*
Relation	2.957	0.781			
Working Spirit	3.011	0.769			
Exemplary	3.075	0.721			
Pleasure	3.444	0.691			
Dimension 3: Accessibility	*3.666*		*2.607*	*58.898*	*0.865*
Time-effective	3.342	0.769			
Avoiding Congestion	3.717	0.695			
Reducing Congestion	3.807	0.638			
Short-distance	3.797	0.628			
Dimension 4: Availability of Facilities	*3.781*		*2.557*	*75.944*	*0.909*
Availability of Bicycle Parking	3.818	0.828			
Availability of Cyclist Shower	3.845	0.781			
Availability of Bicycle Lane	3.679	0.750			

The next dimension is the *availability of facilities* with the mean value of 3,781. This dimension includes the availability of bicycle parking, shower facilities (cyclist showers), and bicycle lanes. The availability of cyclist shower is the variable that has the highest mean value, followed by bicycle parking, then bicycle lanes. This shows that the availability of facilities at the destination (end-of-trip facilities) consisting of bicycle parking and cyclist showers has contributed to the community's interest in cycling to work. This result is in line with research by Buehler (2012) which states that the provision of bicycle parking, lockers, and shower facilities for cyclists (cyclist shower) has a statistically stronger effect on bicycle commuting activities to work.

The next dimension is *accessibility* with the mean value of 3,666. This dimension includes short distances, the desire to contribute to congestion reduction, the desire to avoid congestion, and faster travel times when cycling compared to other modes. The large score for reasons related to congestion indicates that it is a problem that is often faced in big cities in Indonesia. Proximity also has a fairly large score on the accessibility dimension. This result is not in line with the research conducted by Akar and Clifton (2009) regarding bicycle commuting trips to campus. Akar and Clifton (2009) found that short distances are not a determining factor for someone to cycle, but the infrastructure in the surroundings.

The last dimension with the mean value of 3.122 is the *social and hobbies* dimension. This dimension includes pleasure, relation, working spirit, and exemplary. This dimension has a moderate average value, which means that social factors are perceived neutrally as the reason for choosing a bicycle as a transportation mode to work. This social and hobbies dimension is related to someone's social environment, such as family, friendship, and workplace. Heinen et al. (2010) found a relationship between bicycle

commuting with one's attitudes and perceptions. If an individual's social environment has a positive perception of cycling, the more likely the person to cycle.

3.1.2 Discouraging Factor

In the group of variables of discouraging factors for a person to cycle to work, 3 latent variables are found with a cumulative percent value reaching 71.784%. These results are considered enough to explain and represent the variables of the discouraging factors. The latent variables obtained from FA (factor analysis) can be seen in Table 3. The three latent variables explain the dimensions of factors that prevent people from cycling to work. These dimensions are *unavailability of facilities*, *accessibility and personal reasons*, and *road condition*.

Table 3 Dimension of Discouraging Factor of Cycle to Work

Variable	Mean	Factor Loading	Variance	Cum Percent	α Cronbach
Dimension 1: Unavailability of Facilities	*3.275*		*2.562*	*25.619*	*0.850*
Poor Parking Quality	3.048	0.893			
No Bicycle Parking	3.278	0.805			
No Cyclist Shower	3.209	0.717			
No Bicycle Lane	3.567	0.551			
Dimension 2: Accessibility and Personal Reasons	*3.447*		*2.353*	*49.151*	*0.774*
Long Distance	3.717	0.796			
Reluctance to Change Clothes	3.684	0.762			
Unhealthy Body	3.080	0.530			
Difficult Topography	3.305	0.512			
Dimension 3: Road Condition	*3.578*		*2.263*	*71.784*	*0.924*
Unsafe Road Condition	3.578	0.874			
Uncomfortable Road Condition	3.578	0.889			

The *road condition* dimension has the largest mean value than the other dimensions (Table 3). This dimension includes the perception of unsafe and uncomfortable conditions on the road. The user's decision to cycle is determined at the origin of the journey, but the decision is influenced by experience and expectations between the origin and destination phases (Akar & Clifton, 2009; Fernández-Heredia, et al., 2014; Parkin, et al., 2008; van der Spek & Scheltema, 2015). The discomfort condition here is an unfavorable road atmosphere, heat, rain, and pollution. Meanwhile, unsafety condition is the feeling of insecurity because bicycle mixes with other vehicles. In contrast to other transportation modes, the comfort felt by cyclists on the trip decreases with the increase of travel time (Noland & Kunreuther, 1995; Heinen et al., 2010). The road condition for a bicycle should become a concern in the development of bicycle infrastructure. To be noted for a designer, the bicycle lane must provide a sense of security and comfort to cyclists.

The next dimension is *accessibility and personal reasons*. This dimension includes long distances, reluctance to change clothes when arriving at the office, difficult topography, and unhealthy body conditions to travel by bicycle. Accessibility problems such as long distances and steep contours are enough to influence someone not to cycle to work. Long distances require a longer travel time so it requires more energy, especially if the road has a steep contour. More effort generally results in a less positive attitude to cycling (Gatersleben and Uzzell, 2007; Heinen et al., 2010). However, some cyclists prefer more effort expended and longer distances. This type of cyclist is usually those who have an interest in sports and health (Heinen et al., 2010).

The last dimension is the *unavailability of facilities*. These dimensions include the absence of bicycle lanes, the absence of bicycle parking in the workplace, poor bicycle parking quality, and the absence of shower facilities for cyclists. The *unavailability of facilities* has the smallest mean value among other dimensions, which is 3,275. These results indicate that the community quite agrees that the unavailability of

facilities can prevent someone from cycling to work. In contrast to the availability of facilities at the destination, such as bicycle parking and bathing facilities, which have a considerable value on the encouraging factor, the unavailability of bicycle lanes has a greater value on the discouraging factor.

3.1.3 The Difference between Encouraging Factors and Discouraging Factors Based on User's History of Cycling to Work

Based on the results of the analysis, there are different values in deciding to cycle to work based on their cycling history to work places. The level of difference is proven through the Anova analysis diagram by looking at the results of compare means. The average difference in perception of the dimensions (latent variable) based on cycling history is indicated by the mean diamond diameter shown in diagrams 1(a), 1(b), 2(a), 2(b), and 2(c). The x-axis shows the cycling history of ever (Yes) or never (No) taking a bicycle trip to work, while the y-axis is a dimension (latent variable) that affects cycling motivation. The two groups of circles on the right of the diagram indicate significant differences between categories.

There are only two of the four dimensions of encouraging factors with a significant difference level based on cycling history, namely the social and hobbies and the availability of facilities. It shows that in the *environment and self* dimension and the *accessibility* dimension, someone with a history of cycling to work and not have almost the same perception or the difference is not significant. Meanwhile, all the three dimensions of discouraging factors, such as *road conditions*, *unavailability of facilities*, and *accessibility and personal reasons*, have a significant level of difference.

Significant Value (p) shows the significance of the analysis results. If a p-value is less than 0.05, it indicates the results of the analysis are significant. The greater the p-value, the analysis results are less significant.

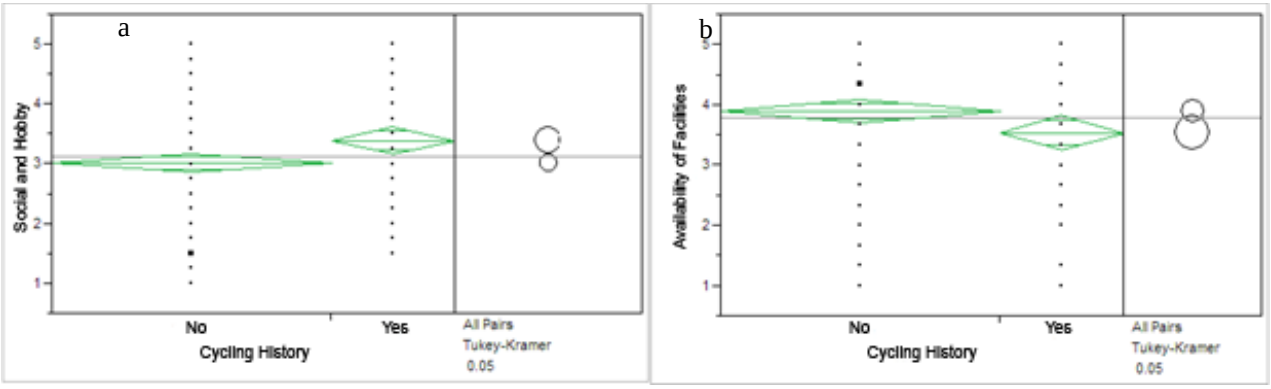

Figure 1 (a) Anova of social and hobby dimension of encouraging factors based on cycling history. p=0.0080* (b) Anova of availability of facilities dimension of the encouraging factors based on cycling history. p=0.0425*

***** Significant Value is used for showing the significance of the analysis results.

Social and hobbies dimension for people who have cycled to work have a higher value than those who have never cycled to work. It shows that the social environment and the joy of cycling which is included in the dimension can motivate those who have a history of cycling to their workplace. Meanwhile, for those who have never cycled to their workplace, the *social and hobbies* dimension is considered neutral to encourage them to take a bicycle trip.

In the driving factors for cycling to work, there is a difference in the results of the analysis between the dimensions of *availability of facilities* and the dimensions of *social and hobbies.* Availability of facilities dimension, such as bicycle lanes, bicycle parking, and cyclist shower, has a higher value for those who had never cycled compared to those who had cycled to work. It shows that those who do not have a history of cycling to work see the availability of facilities as a reason that motivates them to cycle. For those who have a history of cycling, the availability of facilities also influences them to cycle to work, but the effect is not that great.

The results of the analysis of variance (Anova) on the discouraging factors show that the *unavailability of facilities* dimension for people who have never cycled to work have a higher value than those who have cycled to work. It indicates that the absence of bicycle facilities, such as bicycle lanes along the route, bicycle parking, and cyclist shower at the destination, is more influential in discouraging those

who have never cycled to work than those who have cycled to work. Similar results also occur in the dimension of *accessibility and personal reasons* and the dimension of *road conditions*. The results can be seen in Figure 2.

It can be concluded that those who have a history of cycling to work are those who have a social environment with a positive perception of cycling. The presence or absence of facilities, both on the trip and at the destination point, and the other dimensions of discouraging factors affect the motivation of people in cycling whether they have ever cycled to work or not, but the effect is greater for those who have never cycled to work.

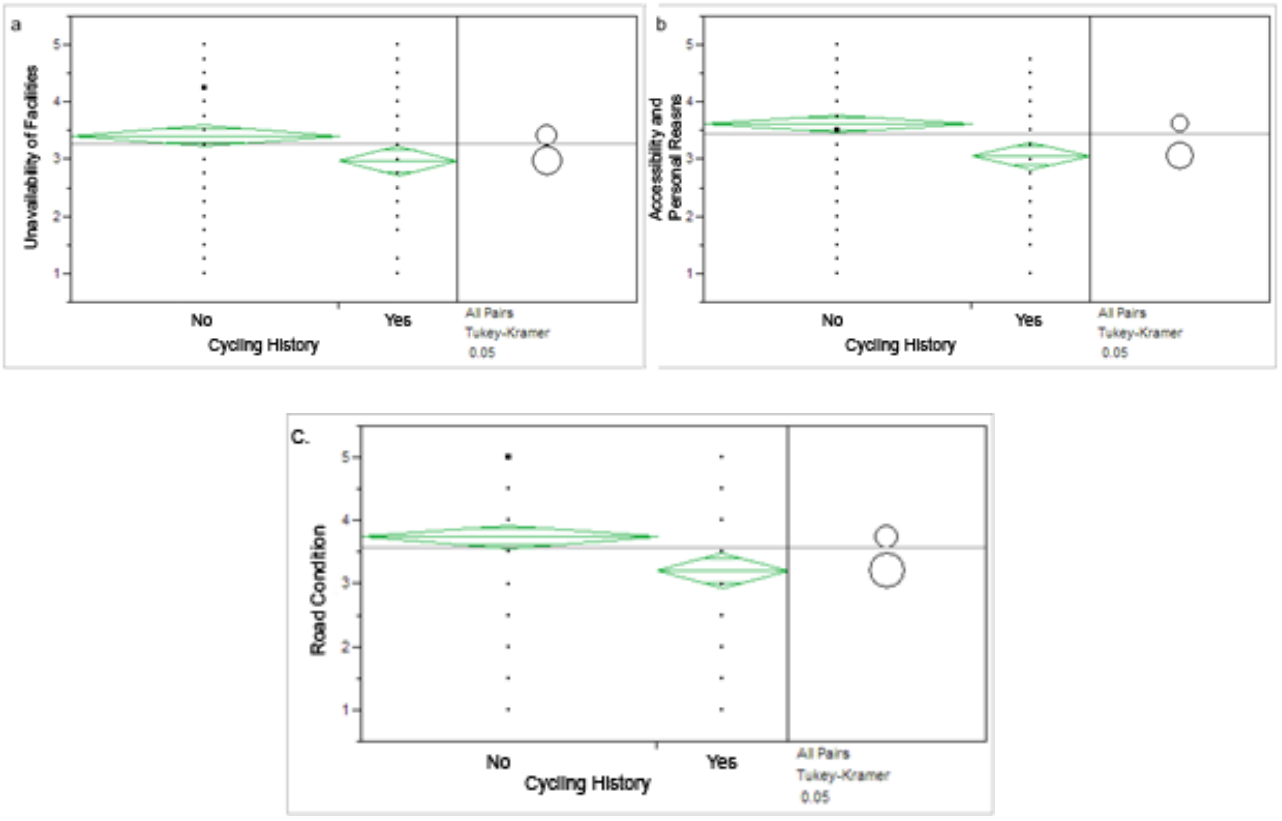

Figure 2 Anova of the dimensions of discouraging factors based on user's cycling history (a) Unavailability of facilities dimension. p=0.0070* (b) Accessibility and personal reasons dimension. p=<0.0001* (c) Road condition dimension. p=0.0018*

***** Significant Value is used for showing the significance of the analysis results.

3.2 Bicycle Facilities Criteria at the Workplace

A well-designed bicycle facility will encourage people to cycle (Hull & O'Holleran, 2014). It takes effort to provide and improve the quality of bicycle facilities in office buildings to encourage workers to choose bicycles as their transportation mode. The criteria needed by cyclists are identified based on their importance according to the respondents.

From the results of the principal component analysis, four latent variables were obtained two latent variables with the cumulative percent reaching 76.951%. These results are considered enough to explain and represent variables of characteristics that are considered important for bicycle facilities in the workplace. The latent variables obtained from FA (factor analysis) can be seen in Table 4. The two latent variables explain the *convenience and safety* dimension and the *completeness of facilities* dimension.

Table 4 Dimension of Bicycle Facilities Criteria at the Workplace

Variable	Mean	Factor Loading	Variance	Cum Percent	α Cronbach
Dimension 1: Convenience and Security	*4.050*		*12.910*	*47.815*	*0.984*
Easy to use	4.123	0.853			
Close to the destination	4.070	0.839			
Controlled access	4.198	0.829			
CCTV	4.203	0.811			
Clean	4.102	0.811			
Bicycle-friendly	4.064	0.802			
Tidy	4.064	0.786			
Free	4.080	0.786			
Comfortable temperature	4.000	0.776			
Roofed	4.133	0.751			
Near the guard post	3.995	0.750			
Clear signage	3.973	0.750			
Security lock	4.021	0.743			
Closed	3.904	0.741			
Firm	3.904	0.728			
Dedicated bicycle parking	4.102	0.691			
For all types of bike	4.070	0.687			
Protected from weather	4.053	0.659			
Shady	3.984	0.651			
Parking card	3.909	0.621			
Dimension 2: Completeness of Facilities	*3.831*		*7.867*	*76.951*	*0.939*
Bicycle maintenance facility	3.866	0.897			
Drinking water refill	3.989	0.727			
Sufficient parking slot	3.941	0.718			
Wide	3.679	0.697			
Storage facility	3.866	0.692			
Spacious	3.658	0.670			
Cyclist shower	4.070	0.658			

Based on the mean value of each factor, the *convenience and security* dimension is considered more important with a mean value of 4.050 compared to the *completeness of facilities* with a mean value of 3.831. The dimension of *convenience and safety* consists of variables showing the required bicycle parking characteristics from the aspects of convenience and safety. Convenience aspects include easy to use, close to the destination, clean, bicycle-friendly, neat, free, comfortable temperature, roofed, clear signage, closed, dedicated bicycle parking, for all types of bicycles, protected from weather, and shady. Security aspects include controlled access, CCTV, near the guard posts, the availability of security locks, firm, and the availability of parking cards. Meanwhile, the dimension of *completeness of facilities* includes the provision of cyclist showers, storage facilities, drinking water refill, bicycle maintenance facilities, and a sufficient number of bicycle parking capacities.

In the dimension of *convenience and security*, the variable with the highest mean value is the availability of CCTV and then controlled access. These variables are included in the security aspect. However, it cannot be concluded whether this security aspect is the most important in designing bicycle parking facilities or not because the mean value of all variables is almost the same. In addition, the importance level of safety aspect is related to socio-economic factors, such as gender, age, and the relative value of bicycles. According to Dickinson, et al. (2003) and Hunt & Abraham (2007) in Heinen et al. (2010), the male gender, young adults, and individuals with more expensive bicycles will be more concerned with the security aspects of bicycle parking facilities.

In the dimension of *completeness of facilities*, the variable with the highest average value is the availability of shower facilities for cyclists, then drinking water refills, sufficient bicycle parking slots, storage facilities, wide and spacious parking, and bicycle maintenance facilities. This result is different from the research of Abraham et al. (2002) which states that bicycle lockers which are storage facilities are the most needed facilities based on respondents' preferences.

The criteria for bicycle facilities in the workplace from the qualitative analysis in the first phase were re-examined in the second stage with quantitative analysis. In the qualitative phase, the number of respondents who have cycled to work is more than those who have not. Meanwhile, in the quantitative stage, the number of respondents never cycling to their workplace is more than the number of respondents with a history of cycling to work. It indicates that all aspects of the criteria for bicycle facilities produced in the first phase are also considered important by respondents in the second phase. However, *convenience and safety* are considered more important than the *completeness of facilities*. The quality of bicycle facilities in the workplace must be concerned, not just the provision. Bicycle facilities must be designed properly to provide a sense of comfort and safety for the users.

3.3 Implementation in Policy, Planning, and Design

Based on the discussion above, several strategies can be applied in terms of policy, planning, and design to increase bicycle trips to the workplace. The implementation is based on the dimensions of the encouraging factors, discouraging factors, and bicycle facilities criteria found in this study.

The availability of bicycle facilities can be a determining factor in a person's decision to cycle to work. One of the strategies is the intervention in the policy. If the government wants to increase the number of bicycle trips, the provision of bicycle facilities in public places, especially office buildings, must be regulated by regulations or laws. The minimum standard of bicycle facilities in the workplace should be determined by the government. Not only available, but the bicycle facilities would also be adequate and well-designed.

At the planning level, the implementation is to provide space for bicycle facilities consisting of bicycle parking and supporting facilities in office buildings. The type of bicycle parking should also be planned as needed. Several factors, such as capacity, duration, type of user, and type of bicycle, should be considered to determine the type of bicycle parking. If the number of cyclists continues to increase, the management of bicycle facilities in office buildings needs to be established.

At the design level, bicycle facilities must be designed by meeting the aspects of security, convenience, and completeness of infrastructure. For example, to meet the security aspect, bicycle parking is closed with controlled access. Bicycle parking can be monitored with CCTV or located close to the security post. Safety aspects can be met with the use of sturdy materials. From the convenience aspect, the bicycle facility needs to be easy to access and comfortable. In terms of accessibility, bicycle parking is easy to reach by bicycles and does not conflict with other vehicles. The location of bicycle parking should be close to the destination, such as on the ground floor or the first basement. Meanwhile, to meet the comfort aspect, bicycle facilities can be designed to be attractive, easy to use, and have a good lighting quality.

Besides bicycle parking, bicycle facilities needed in the workplace are supporting facilities, such as shower facilities, drinking refills, storage facilities, and bicycle maintenance facilities. These supporting facilities, especially the shower facilities, must be located adjacent to the bicycle parking to facilitate mobility. On-site bicycle paths should be provided to connect on-street bicycle paths with bicycle parking and other bicycle facilities. Clear and informative signage is also needed to facilitate the use of bicycles in an office building. The detail implementation can be seen in Table 5.

Table 5 Implementation in policy, planning, and design

Encouraging Factor	Discouraging Factor	Criteria	Implementation		
			Policy	Planning	Design
The availability of facilities	The unavailability of facilities	Completeness of facilities	Regulations related to the provision of bicycle facilities in office buildings	Provision of space for bicycle facilities in the office building programming (bicycle parking and supporting facilities)	1. Cyclist shower is located adjacent to bicycle parking 2. On-site bicycle path must connect the on-street bicycle path and bicycle facilities in it 3. Clear and informative signage
		Convenience and security	Standards and guidelines of bicycle facilities design in office buildings	1. The management of bicycle facilities in office buildings 2. Determination of types of bicycle facilities based on capacity, duration, type of user, and type of bicycle	1. Bicycle parking access is controlled and under the surveillance of security guards 2. Bicycle parking is closed and protected from weather 2. Sturdy bicycle parking material 3. Bicycle parking access does not conflict with other modes 4. Attractive and easy to use bicycle parking design 5. Good lighting performance and thermal comfort 6. Placement of convex mirror to reduce blind spots

4. Conclusion

Based on the results of the principal component analysis and factor analysis, the variables of the encouraging factors to cycle to work are divided into four dimensions, namely the *environmental and self*, *social and hobby*, *accessibility*, and *availability of facilities*. Meanwhile, the variables of discouraging factors to cycle to work are divided into three dimensions, namely the *unavailability of facilities*, *accessibility and personal reasons*, and *road conditions*.

The results of Anova show that there are significant differences in the *social and hobby* dimension and the *availability of facilities* dimension as an encouraging factor for respondents who have a history of cycling to work and those who do not. As for the discouraging factor, the three dimensions have significant differences in perceptions based on the respondent's cycling history. It can be concluded that those who have a history of cycling to work are those who have a positive social environment and perception of cycling. The presence or absence of facilities, both on the way and at the destination point, and the dimensions of other discouraging factors affect the interest of the people whether they have ever or not cycled to work, but the effect is greater for those who have never cycled to work. Differences based on cycling history on the driving and inhibiting factors tend to be overlooked in previous studies.

This study also found two dimensions of bicycle facilities criteria needed in office buildings, namely *convenience and security* and *completeness of facilities*. *The convenience and security* dimension is considered more important than *the completeness of facilities* dimension because it has a higher mean value.

In the *convenience and security* dimension, the presence of CCTV and controlled access is considered the most important criteria. The two variables are the security aspect. The rest of the variables in the dimension have almost the same mean value. It shows that all aspects of the *convenience and security* dimension have almost the same level of significance. In the dimension of the *completeness of facilities*, the variable which is considered the most important is the cyclist shower, then drinking water refill, and sufficient bicycle parking capacity.

People who are never cycling to their workplace are potential cyclists. Strategies that can motivate this potential cyclist to cycle to their workplace are needed to increase the intensity of bicycle commuting in Indonesia. The way to motivate these potential cyclists and increase the intensity of bicycle trips to work is to solve problems that become obstacles for them and pay attention to aspects that can encourage cycling for society. The quality of bicycle facilities, especially the end-of-trip facilities, must be improved by considering the criteria needed by cyclists. This strategy can be implemented at the level of policy, planning, and design. This study still has many limitations in explaining the motivation of cycling to work and the bicycle facilities criteria needed to encourage people to cycle to work in Indonesia. More research related to similar topics is needed in determining the right strategy to increase the number of commuting cyclists in Indonesia.

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