Transportation planning on green campus

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Abstract. Sustainable transportation planning is one indicator of measuring green campus. The transportation system has an influence on CO2 emissions in the campus environment. Transportation policy plays a crucial role in managing the number and type of vehicles that are allowed on campus. This study aims to analyze transportation planning within the campus that supports the application of the green concept on campus based on the perception of students as users. The use of campus buses and bicycles by students may help to realize the green campus. Planning interconnected buildings and corridors is part of transportation planning. The research method is quantitative with descriptive analysis. The study was conducted at the Universitas Sumatera Utara with 100 students as respondents. Universitas Sumatera Utara has campus buses and campus bicycle used by students every day. The results of the study indicate that the campus must have interconnected pedestrian lane between buildings and provide rewards to campus bus and bicycle users. Excellent transportation planning supported by campus management can help realize a green campus.

1. Introduction

The university should be a role model for the application of sustainable concepts and become an ideal place as a source of education regarding sustainable environments [1]. Sustainable development is a guideline in human activities that can provide good things for humans and their environment, both now and in the future [2]. Universities can provide leadership roles to develop knowledge to meet community needs [3]. Sustainable strategies from sustainable universities must include education, research, outreach, and partnership, namely waste management, energy, water, and transportation [4]. The application of green concepts has become a necessity to realize a green campus. Universities which designed as the green campus will provide comfort to students, staff, and lecturers as the users; then they will feel the excellent quality of life [5]. Transportation is one part of a green campus that must plan well. This research focuses on how well transportation planning on a green campus with a case study at Universitas Sumatera Utara.

1.1. Transportation Planning

Transportation Planning

Research by [6] at Universiti Teknologi Malaysia is related to participation towards sustainable campuses. The University provides free-use bicycles and scheduled buses to reduce campus carbon emissions. To reduce the number of vehicles entering and leaving, the university provides buses from the campus to the commercial center around it. An excellent transportation planning can reduce carbon emissions.
There are two main aspects to building a green campus, first about energy consumption and carbon footprint related to land use, green buildings, and green features. Then the second is the socio-cultural aspects involving management, education, and plans to use physical elements on the green campus [7]. Transportation is one of the categories on the green campus. The university must provide public transportation in its environment as a strategy to realize and develop a green campus.

In research from [8], universities that can be accessed by multiple modes of transportation and settlements should have excellent transportation planning. Universities should provide various transportation options and suitable transportation services. Examples of improving alternative transportation include changing large parking lots near the central campus to intermodal transportation centers; Rotate parking spaces along the main line to access bicycles / pedestrians; add pedestrian signals in high traffic areas; add bus services that are more frequent and extended to campus; and start the Car Sharing program [9].

Transportation is one of the main factors in the concept of sustainability, which has many substantial influences on the quality of the economic and social environment and the physical environment [10]. The transportation system must be appropriate by the concept of sustainability, namely environmental, social, and economic quality. Transportation has an impact on the campus environment including air pollution, sound emissions, energy consumption, problems in the work environment and learning, quality evaluation and improvement of the visual and natural environment by providing parking facilities. The social impact of transportation at universities is the effect on the health of students, staff and visitors, accidents, congestion, and increased development costs.

The cause of the increase in the carbon curve in the transportation sector is mainly the increasing number of individually owned cars. According to [11], there were 1.2% of respondents preferring cycling in the city rather than walk to work. Cycling is dangerous because of the high number of passengers and pedestrian accidents in the city, due to the lack of non-motorized vehicle facilities.

Transportation in university campuses have effects on the environment such as disturbance to teaching, loss of natural environment and greener, exfoliation of the visual environment by parking provision, air pollution, noise pollution, energy consumption, traffic congestion, land use and health effects on staff and students [12]. There are a variety of indicators on sustainable transportation such as quality of walking, cycling, public transit, and driving on accessibility category and also land use, energy use, health consequences of transport, crash costs, noise pollution, waste, climate change and CO2, CH4 emissions [13] and [14].

The transportation indicator system has 18% of the total score on green campus assessment by UIGreenmetric. The transportation system has an important role in the carbon emission and pollutant levels in university. Transportation policy to limit the number of motor vehicles on campus, the use of campus buses and bicycles will reduce emissions and encourage a healthier environment. The pedestrian policy will encourage students to walk around campus [15]. Sub-indicators of transportation in universities are: total number of cars owned; the number of cars and motorbikes entering every day; number of buses; passenger of shuttle bus; total bus trips every day; number of bicycles every day; type of parking area; decrease the parking area for the last 3 years; initiative to decrease private vehicles; shuttle service; vehicle travel distance every day; and pedestrian policy.

According to Litman [16], Sustainable transportation in the community has 3 major impact categories, namely social vitality, economic equality, and environmental quality. In the research of [17] the following commonalities or principles of sustainable transportation definitions, first, sustainable transportation derives from the concept of sustainable development, and, therefore, incorporates both intergenerational equity (responsibility to future generations) and intragenerational equity (social justice). Second, sustainable transportation is about a balanced pursuit of multiple objectives (at least, impacts on society, economy, and environment). Third, there should be a definition of how sustainability will be measured or the discussion of setting standards for different transportation systems.

A sustainable transportation system is a system that allows the basic individual and community access needs to meet safely and consistent with human and ecosystems health; and limiting emissions
and waste in the planet's ability to absorb them, limiting consumption of renewable resources to sustainable yields, minimizing the consumption of non-renewable resources, reusing and recycling their components and minimizing land use and noise production; and affordable, operates efficiently, offers a choice of transportation modes and supports a dynamic economy [18].

The sustainable transportation systems divided into two categories, namely motorized and non-motorized, which should provide mobility and accessibility to all users by a secure and environmentally friendly mode [10]. Sustainable motorized transportation systems such as reducing traffic and use of a private car, minimizing land consumption and destroyed green area to build car parking, enhance the quality of the environment and public health by reducing air and noise pollution as well as creating livability. Meanwhile, increasing the support of public transport mode has direct effects on the enhancement of quality of life and health condition in university campus environments because of minimizing travel costs and reducing environmental damage. Sustainable non-motorized transportation systems or green transportation modes includes all form of movements which do not depend on an engine or motor such as walking, cycling, and skating. However, there are many factors which have a direct and indirect effect on the use of non-motorized transport modes such as quality of non-motorized facilities and substructure, socio-cultural, government strategies, physical condition and the accessibility of other transport alternatives.

A reference unit is a measurement unit that is normalized to help compare impacts [19]. The reference unit used can influence how the problem is defined and which solutions to consider, such as vehicle-miles reflect the perspective of traffic that provides high value for car travel; travel time reflects an access perspective that gives higher priority to walking, cycling and transit trips; per trip reflects an access perspective that provides equal value for cars, transit, cycling, walking, and telecommunications; passenger-mile reflects a mobility perspective that assesses car travel and transit but gives less value to non-motorized modes; and, general costs (costs of time and money) reflect an access perspective.

The major widely used strategy in university campus environments, which included a variety of planning and management approaches is Transportation Demand Management (TDM). In the following, currently on university campuses include parking management, U-Pass, promoting bicycle use and creating a pedestrian-friendly campus in university campus environments are explained [20] and [21]. Campuses can have a benefit from modeling sustainable transportation systems. by using alternative transportation modes can help reduce local air pollution and GHG emissions. Cycling and walking provide human health benefits and reduce the need for a large paved surface area, which can help the campus to better manage rainwater. Institutions can realize cost savings and help support the local economy by reducing their dependence on oil-based fuels for transportation [22]. Three broad categories for changing current patterns are transportation infrastructure and programs, technological options, and land-use planning [23].

Based on theory and previous research, this study focuses on transportation planning on campus, which in this case is the green campus. Sustainable transportation planning includes transportation network connectivity, pedestrian lines, inter-building relations, transportation modes used, and rewards for transportation users such as buses and bicycles being the focus of this research.

2. Method

This research uses a quantitative method with a descriptive analysis. The data collection technique conducted by observation and survey with a questionnaire. Research obtain at Universitas Sumatera Utara with 100 students as respondents. Questions arranged with answer choices using a Likert scale 1 to 5 (strongly disagree to agree strongly) to get perceptions from students regarding excellent transportation planning. Questions asked to respondents regarding interconnected pedestrian pathways between buildings, the existence of interconnected pedestrians/walkways, comfortable pedestrian paths, lanes for various modes, the campus has buses and bicycles, special parking for bicycles, 'gifts' for bicycle users and campus buses. The data used descriptive analysis with the SPSS program. The
results of the analysis used as input for the University in planning good transportation on a green campus.

3. Results and Discussions
In the first stages, observations made on transportation planning at the Universitas Sumatera Utara. The modes of transportation that carry the green concept on campus are buses and bicycles. Universitas Sumatera Utara has a campus bus and bicycle which equipped with the stops. The campus buses can be used by the students from morning to evening and pass through all faculties and existing administrative buildings. There are twelve bus stops provided within the campus environment. For the first lane, the campus bus start moving from the campus main gate (Gate 1) to the bus stop at Pancasila building - Faculty of Law - Dr. A. Sofian street - Faculty of Political and Social Science - Faculty of Mathematics and Natural Science - Faculty of Pharmacy and Gate 4. (Figure 1). Then, for the second lane, the campus bus move to Gate 3 – library - Oral and Dental Hospital Building and Student Hall (Figure 2).

Figure 1. Bus Stop In Universitas Sumatera Utara lane 1
Campus bicycles provided from the university by getting assistance from USAID in 2014. In 2015, campus bicycles actively used by students. However, at this time, campus bicycles are no longer used because of their small interest. The University provides several bicycle stops on campus (Figure 3). The bicycle stop is at the office of the Universitas Sumatera Utara Chancellery Bureau, library, main entrance (Gate 1) and Gate 4. The campus should provide supporting facilities for buses and bicycles such as bus stops, bicycle parking and special lanes. This is in accordance with research by [20].

A survey with questionnaires was conducted for students at the Universitas Sumatera Utara from all existing faculties. The descriptive analysis showed through the frequency of each of the questions asked. The results showed in Table 1.
| Question                                                                 | 1 | 2 | 3 | 4 | 5 | Total |
|-------------------------------------------------------------------------|---|---|---|---|---|-------|
| Convenient lane for pedestrians                                         | 1 | 2 | 13| 16| 68| 100   |
| Interconnected pedestrians lane between building                         | 2 | 1 | 17| 14| 66| 100   |
| Separated lane for vehicle, bicycle, and pedestrian                     | 3 | 1 | 15| 21| 60| 100   |
| Campus bicycle                                                          | 6 | 8 | 30| 20| 36| 100   |
| Parking place for bicycle                                               | 3 | 4 | 30| 28| 35| 100   |
| Bus for students, lecturers, and staff                                  | 1 | 5 | 21| 29| 44| 100   |
| Bus at working hours                                                    | 2 | 11| 35| 29| 23| 100   |
| The reward for bicycle users                                            | 7 | 14| 34| 24| 21| 100   |
| The reward for bus users                                                | 8 | 17| 27| 28| 20| 100   |
| Policy for a car-free day once a month                                  | 2 | 17| 23| 32| 26| 100   |

Note: A Likert Scale 1-5 = Strongly disagree to agree strongly

Based on the results of the analysis carried out (Table 1), regarding pedestrian lanes, the majority of respondents strongly agreed that the campus provides a convenient lane for pedestrians, interconnected pedestrian lane between buildings and a separated lane for vehicles, bicycle, and pedestrian. This result is consistent with the research conducted by [9] and [18]. Separation of vehicle lines is needed to provide comfort and safety for its users. Respondents agreed if the campus revived bicycles and supported by the provision of the special parking. Also, the campus must provide buses as mass transportation modes. These two transportations can reduce CO2 emissions on campus and reduce the number of private vehicles on campus. The provision of bicycles and buses on campus is consistent with research by [6], [10] and [15]. Respondents agreed if the university gave rewards to students using bicycles and campus buses. Besides, that campus should have a policy about a car-free day once a month.

4. Conclusions

Universitas Sumatera Utara is one of the green campuses in Indonesia and has campus buses and campus bikes that can be used by students. However, there is still a lot that must be fulfilled by the university in creating good transportation as one indicator in a green campus. The university rector should support transportation planning by implementing a policy regarding the use of vehicles on campus that can reduce CO2 emissions. The university must provide transportation modes such as campus buses and bicycles that can be used by students, lecturers, and staffs and its related to research by [10]. Then, campus should provide bicycle parking. Car-free day activities are possible to do on campus and formulated in the form of regulation. Student involvement is much needed in the management and development of transportation planning because they are the major users. Giving rewards to bus users and campus bicycles need to be held to increase the use of these modes of transportation.

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